Explosive Risks in Transporting Ammonium Nitrate

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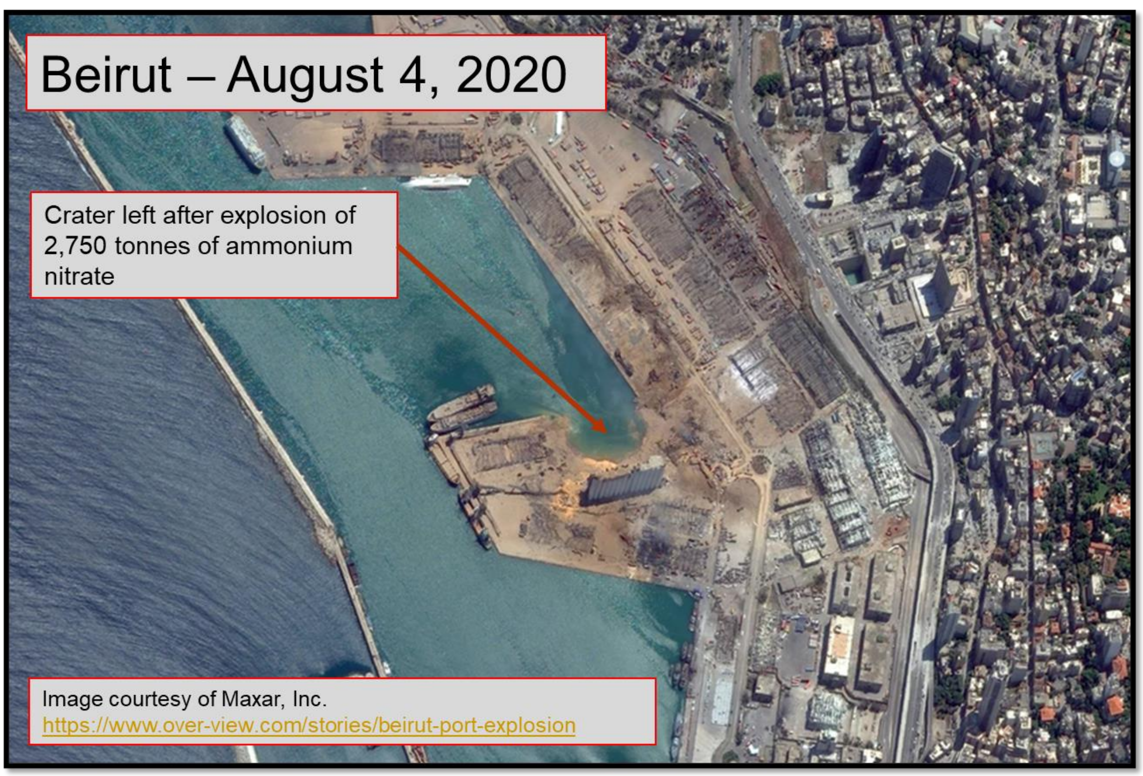
Summary

The explosion in Beirut was a dramatic example of the risks associated with storing large quantities of ammonium nitrate. Transporting this material also exposes the public to explosive risks daily as will be illustrated in this paper. ***Road-Aware*** *technology can mitigate the transportation risk, but improving safety requires immediate action.*

The explosion in Beirut (August 4, 2020) served to underscore the risks associated with handling or storing large quantities of ammonium nitrate. Producers and large buyers such as mining companies understand and manage those risks on their properties. Thus, safety standards are strictly enforced at production sites and at the mine sites where it is used.



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However, the results of our ***Road-Aware*** field trial conducted with a trucking contractor last year illustrated that **there are gaps in the safety oversight during the transportation** of the ammonium nitrate. In normal operations the risk of an explosion is relatively low because ammonium nitrate is stable during loading, unloading and transit to the destination. The load only becomes a risk if the temperature is raised to the ignition point of 572 degrees F. This happens if there is an external event that causes the temperature of the ammonium nitrate to increase to the ignition point such as the initial fire that broke out next to the stored ammonium nitrate in Beirut.

Last year there was an explosion of ammonium nitrate in transit. The load was being carried by a semi-truck through rolling hills in Arkansas. The driver noticed smoke coming from the rear of his trailer and then flames appeared. (The brakes may not have been properly adjusted or the driver may have over-used the brakes on the down slopes.) He called 911 and moved his rig a safe distance from the nearby village and waited for the fire truck. The fire truck only had 500 gallons of water on board and no access to a hydrant which made it impossible to extinguish the fire consuming the rear tires. The protocol in that situation required the fire truck to back off, close the road to traffic and warn nearby residents - which were done. A few minutes later the heat from the burning tires heated the load to the ignition point and the entire load exploded. (see image below) Unfortunately the truck driver had returned to his rig and was killed in the explosion.

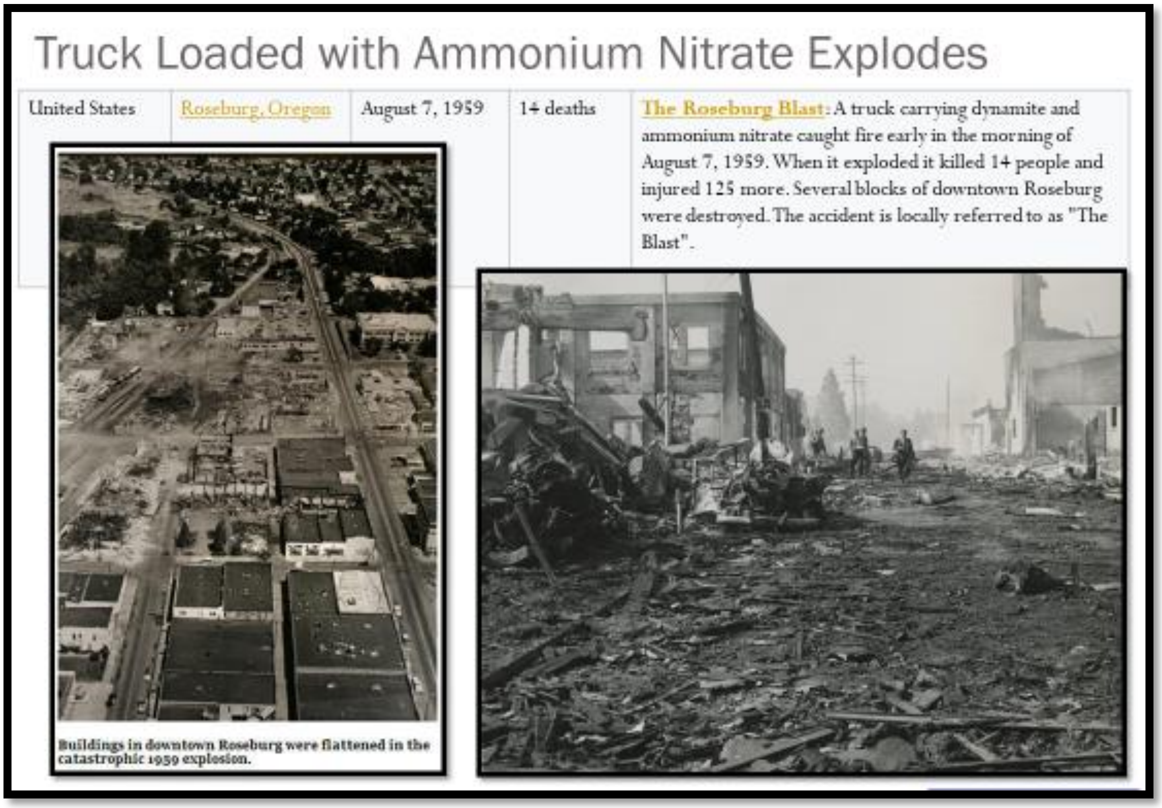
A field trial of ***Road-Aware*** (see www.road-aware.com for a product description) was carried out to measure and record driver behavior while carrying ammonium nitrate and acid loads for a mining company. The field trial measured driver behavior on curves and descents. The analysis of the speed data illustrated that drivers were not aware of the stability and performance limits of their vehicles. Thus, speeds around curves and down descents left an inadequate margin for safety. In the second phase of the field trial the driver received alerts and recommended safe speeds specific to the geometry of the road ahead, the load, and vehicle dynamics. A description of one such descent is provided in the attachment showing improved driver performance. The results illustrate that the speeds being used by drivers will lead to overheated brakes if the engine brake is not engaged. The brakes will also overheat if the driver selects a gear ratio that is too high allowing the engine speed to drop below 1900 rpm.

So, what are the consequences if the driver heats up the brakes on his rig?

If the brakes are well balanced and if the driver does not need to come to a full stop, there are no significant consequences. However, if the brakes are not well balanced, the rig will overheat the brake with the closest tolerance which can then cause a wheel fire as likely happened in Arkansas last year.

Alternatively, if the driver needs to come to a full stop, the truck will have reduced braking authority. The driver will find the stopping distance for the truck is multiplied several fold or the driver may not be able to stop the truck at all. This sequence of events caused a 28 vehicle crash with 4 deaths and multiple injuries on I70 in Denver last year.

In conclusion if the rig catches fire, whether from an overheated wheel fire or a collision, it could lead to a catastrophic explosion in a populated area. Illustrated below is an example of a truck loaded with ammonium nitrate that did explode in a town in Oregon. The blast killed 14 people, injured 125, and caused widespread property damage. If an event like this occurred today, it would likely trigger financial claims exceeding $200 million or more.



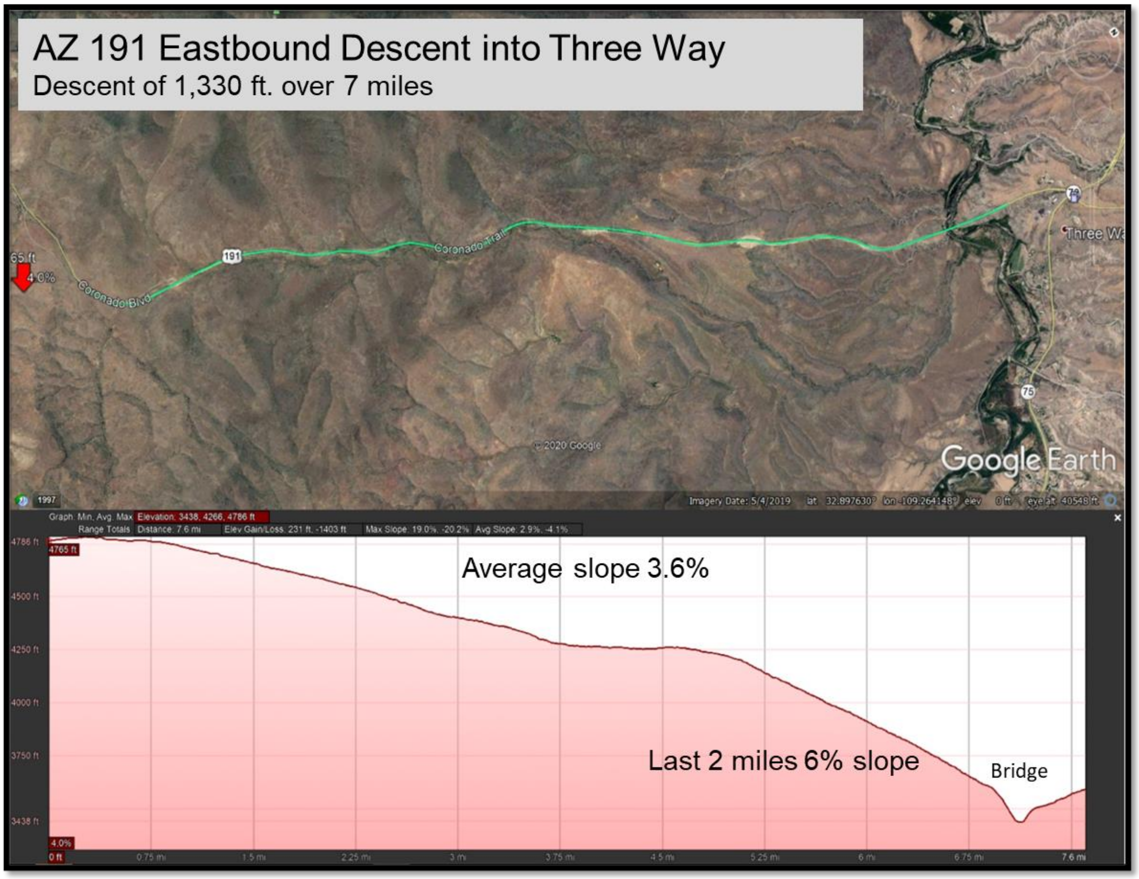
The ***Road-Aware*** product has been upgraded to be server based so that it can mitigate risk for the driver, the carrier, the shipper and most importantly the public.

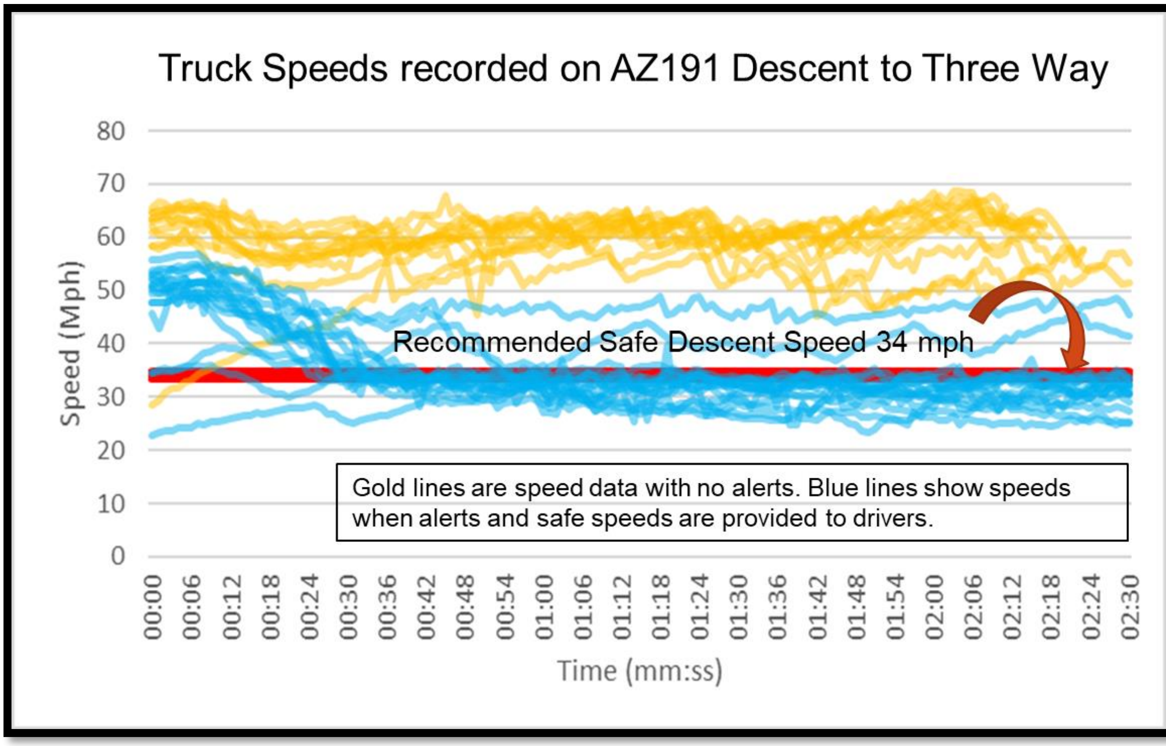
- It provides alerts & safe speeds (specific to the road geometry, truck dynamics and load carried) for each curve and descent to the driver.
- It also records the driver’s speed and position at 1 second intervals for the entire trip.
- It automatically scores each driver for every trip and will automatically send notices of any speeds that exceed safety standards set by the carrier.

This product converts drivers from being an unsupervised labor force saddled with the responsibility for making safety decisions beyond their training, into a supervised labor force with safety alerts and safe speeds for each road geometry on each trip.

Attachment:

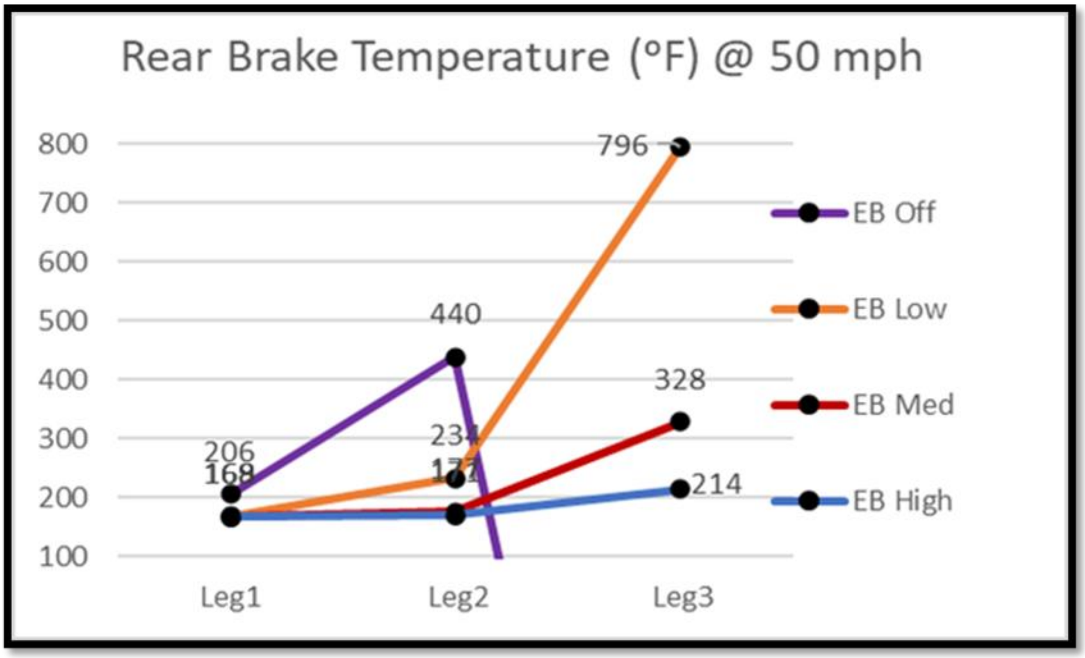
Example Analysis of Truck Speeds on a Steep Descent in Arizona:





Since completing the field trial, the descent speed data have been examined in more depth by applying a multi-mode model that accounts for engine retardation, aerodynamic forces and calculates the expected temperatures in the service brakes for various descent speeds and engine braking options. The results show that if the driver forgets to engage the engine brake or selects a gear that is too high to keep the engine RPM to 1900 or above, the truck will have overheated brakes at the bottom of the descents at the speeds the drivers are currently using for these descents.

The graphs below illustrate predicted brake temperatures after a 50 mph descent on AZ 191 east bound into Three Way. The model assumes full engine brake HP is 390, medium is 285 and low is 180. To achieve this amount of braking HP, the driver must ensure that the engine brake is activated, and he has selected a gear ratio that keeps engine RPM above 1900. The model also assumed that all the brakes are balanced left and right and between the tractor and trailer. It further assumes that the rig has 10 brakes in total so 10% of the total energy is dissipated by each brake. The graphs show that if the driver does not engage the engine brake (EB) the brakes will experience total failure during the descent on leg three. If the driver selects the low setting for the engine brake the trailer brakes will reach 796 degrees at the end of the descent. (Brakes smoke at 500 degrees and at 800 degrees there is a significant risk of a wheel fire).


Rear Brake Temperature (°F) @ 50 mph
800
700
600
500
400
300
200
100
Leg1
Leg2
Leg3
206
168
440
234
796
328
214
EB Off
EB Low
EB Med
EB High