Engineering Summary Report

Test Request # TR05024TPM

To:	Chris Steph	**From:**	Daylen D. Borders
CC:	Ken Veit	**Date:**	9/19/2005
Re:	AirBAT Tire Sealant Compatibility Test: Ride-On Brand Tire Sealant		

Background:

Various customer inquiries have been made regarding the use of the AirBAT tire pressure monitoring product on tires using liquid sealant products. Currently we believe that this should not impact the AirBAT product as long as the sealant is not applied or passed through the AirBAT filler nipples and/or hoses. To date we have not conducted any testing to verify this hypothesis, thereby making this test necessary.

Summary:

The purpose of this testing was to determine if tire sealant within a tire can adversely affect the operation of an AirBAT unit over time. To do so, an AirBAT was repeatedly exposed to the testing duty cycle defined in this TR for a period of 30 days with the goal of proving it able to still meet the following performance goals at the conclusion of the exposure:

1) The unit must yield accurate (+/- 2 PSIG) tire pressure when read using the AirBAT unit.
2) The unit must accurately (+/- 2 PSIG) indicate low pressure and high pressure conditions visually through the LED and LCD interfaces.
3) The unit must still allow tire pressure adjustments to be made via the filler nipples on the unit.

Testing was conducted on a randomly chosen, STEMCO AirBAT, part number 01-812-1024. The test was conducted on a wheelend test stand configured with a representative heavy duty tire and wheel (see photos below). The test rig was programmed to run a simulated vehicle speed/time duty cycle as prescribed within this test regimen. Since the primary users of tire sealant products are customers in the waste services sector, the Federal Government EPA Urban Dynamometer Driving Schedule (UDDS) for Heavy-Duty Vehicles (CFR 40, 86, App.I) was used for the test stand "recipe".

The EPA UDDS schedule has been developed for chassis dynamometer testing of heavy-duty vehicles (CFR 40, 86, App.I) and is sometimes referred to as "cycle D". The following are basic parameters of the cycle:

- Duration: 1060 seconds
- Distance: 5.55 miles = 8.9 km
- Average speed: 18.86 mi/h = 30.4 km/h
- Maximum speed: 58 mi/h = 93.3 km/h



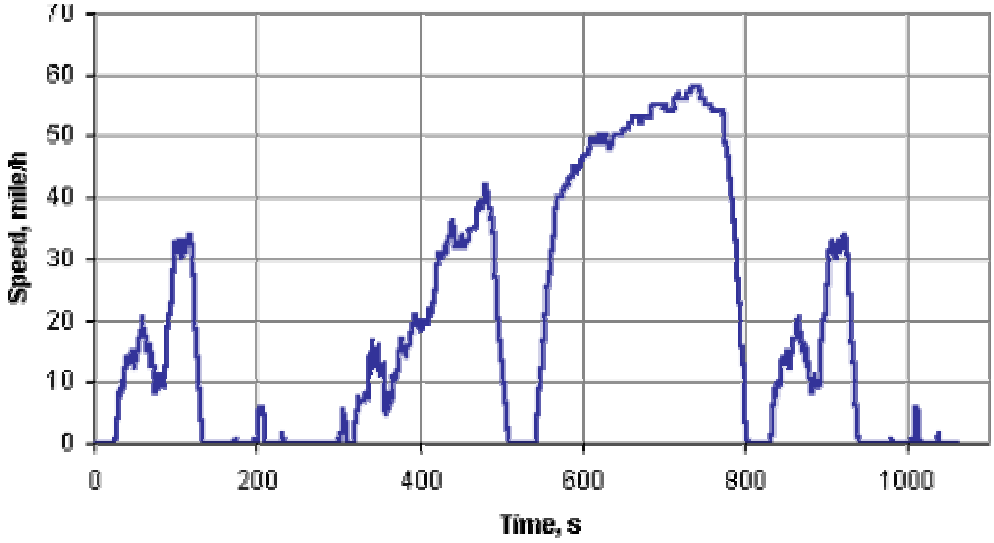

***Figure 1**. HD UDDS Cycle*

This 5.5 mile cycle was automatically repeated by the test rig over a period of 30 days. The test was periodically interrupted as required to allow evaluation by the test technician of the test article per the above success criteria using a HandBAT handheld reader (provided by the requesting engineer).

The tire was filled with Ride-On brand tire sealant (provided by a representative from the product's company) to the manufacturer's instructions for the tire size used in this test (50 fluid ounces). The sealant (Ride-On batch 1143) was installed through the tire valve stem (see photo) using a pressure pot before installation of the AirBAT. Once the sealant was installed, the AirBAT was mounted to the tire/wheel assembly per Stemco's installation instructions. Note: only one hose was tested since this was a single tire setup. The tire was then pressurized to 107 PSIG using shop air via the AirBAT filler nipple. Pressure inside the tire was verified against lab instrumentation and the HandBAT handheld reader.

Installation of Ride-On Brand Sealant via a Pressure Pot

Once per day and at the same approximate time of day, the test rig was momentarily stopped with the exception of non-workdays in which case checks were performed on the first workday thereafter. The test was paused over extended holiday weekends for safety. However, this did not affect the outcome nor

introduce bias. Pressure measurement with the HandBAT was performed at each check to verify performance of the AirBAT per the success criteria. The LCD/LED indicators were verified visually.

Results / Conclusions / Recommendations:

At the conclusion of the 30 day exposure, the test rig was shutdown and the AirBAT pressure reading was checked with the HandBAT reader used throughout the test cycle. Pressure was measured at 107psig (the same value as read at the start of the test). No leakage or other failure modes were observed, and both indicators were functioning properly. The AirBAT hose was then disconnected from the tire valve stem while still under pressure. The valve stem valve button was momentarily depressed to check for signs of sealant in the stem. The blast of air indicated no obstructions, or signs of the sealant in the air flow stream.

The AirBAT unit was then removed from the wheel mounting and taken to the seal inspection area for closer review and examination for traces of sealant that had potentially entered the system from the volume of the tire. The hose ends were inspected and found free of sealant. The hose was blown through with air and found clear of sealant residue. The focus was then shifted to the manifold. The fittings were removed and closely inspected, again showing no signs of sealant ingress. The manifold ports were clean and dry as well with no evidence of sealant present (see photos).

In conclusion, there was no evidence to indicate that the 50ozs of sealant contained in the tire had migrated backwards through the stem into the AirBAT. The question of compatibility between the sealant and the AirBAT was therefore deemed unnecessary since this test had indicated no actual contact of the two products while in use. Furthermore, the likelihood of this occurring was deemed remote especially given this test's accelerated nature of the repeated duty cycle of a waste hauler truck as simulated by the EPA test regimen that was used.

Since no migration of the sealant material occurred, the Ride-On brand sealant material was determined to be "compatible" with the Stemco AirBAT product. Furthermore, given the similar nature and mode of operation for most sealant brands, it is reasonable to propose that other sealant materials of this type would behave similarly. However, no direct conclusions can be made at this time. If required, additional testing will be needed to positively determine compatibility of other sealant brands / types, chemical make-up. It is therefore suggested that further testing be conducted as time and resources allow investigating the following:

- AirBAT hose leakage (risk of sealant ingress under steady state air loss via a simulated partial hose failure)
- Sealant brand comparison (correlation with sealant chemical make-up / viscosity)
- Migration potential of sealants under varied environmental conditions (cold, hot, road dynamics, sealant volume injected in tire)
- Risk of AirBAT function loss with tire sealant injection via the AirBat filler nipple and hose

End.

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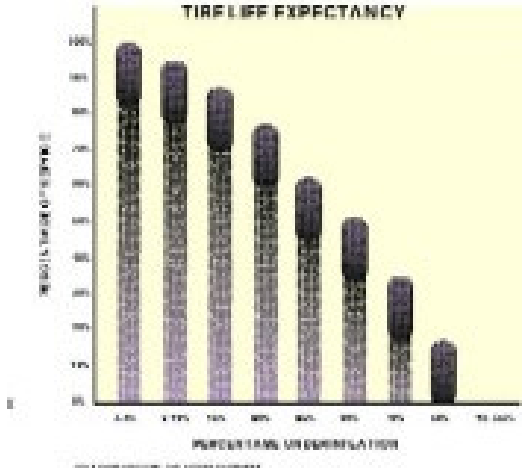
APPENDIX

Station #	Test Unit #	Date & Time	Iteration	Step	Pressure	Tech.	Specific Observation
54	1	5/20/2005 5:09	53	854	107	MLM	Test stopped 5:09 AM for unrelated error
54	1	5/23/2005 7:00	239	854	107	TLH	OK
54	1	5/24/2005 7:00	313	317	107	TML	OK
54	1	5/25/2005 7:00	344	398	107	TML	OK
54	1	5/26/2005 7:00	394	209	107	TML	OK
54	1	5/27/2005 7:00	538	1026	107	TML	OK
54	1	5/31/2005 6:30	394	209	107	TML	reset
54	1	6/1/2005 6:30	453	50	107	TML	ok
54	1	6/2/2005 6:30	394	768	107	TLH	OK
54	1	6/3/2005 6:30	394	768	107	MM	Stupid Machine
54	1	6/6/2005 6:30	700	25	107	TML	reset
54	1	6/7/2005 6:30	781	692	107	TML	OK
54	1	6/8/2005 6:30	863	329	107	TML	OK
54	1	6/9/2005 6:30	944	778	107	TML	OK
54	1	6/10/2005 6:30	1024	1030	107	TML	OK
54	1	6/14/2005 6:30	1132	980	107	TML	OK
54	1	6/15/2005 6:30	1214	784	107	TML	OK
54	1	6/16/2005 6:30	1295	907	107	TML	OK
54	1	6/17/2005 6:30	1377	200	107	TML	OK
54	1	6/20/2005 6:30	1409	210	107	TML	reset

Solutions That Keep the World Rolling!™

Ride-On Tire Protection System (TPS) Tire Sealants

Ride-On Tire Protection System (TPS) tire sealants are revolutionary new products that prevent flats caused by punctures and help increase tire performance and tire life.



While you drive, a protective layer of Ride-On (TPS) - tire sealant containing fibers six times stronger than steel - evenly coats the inner surface of your tire. If your tire is punctured, the centrifugal force of the rotating tire and the internal air pressure force Ride-On into the hole, sealing it instantly for the legal life of the tire.

With **Ride-On (TPS)** tire sealant, your tire literally fixes itself! And since it stops slow leaks the moment they start, Your tires always stay properly inflated. Your tires last longer, your vehicle handles better, your fuel economy improves, and you ride more safely.

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Ride-On TPS is available in five formulations: a Commercial High Speed (CHS) formula for commercial vehicles that travel at speeds in excess of 30 mph, a Heavy Duty Off-Road (OTR) formula for off-road construction and industrial vehicles, a Passenger & Light Truck (PLT) formula for all high speed passenger and light truck applications, a Motorcycle formula, and the Bike-On formula designed for bicycles.

Ride-On TPS tire sealants are easy to install. A fleet can either use the manual HP-300T Hand Pump or the cart mounted Ride-On Tire Injection System (ROTIS) Automatic Pump. The ROTIS pump is a patented, cart mounted, battery powered tire sealant pumping system. For ease of use in remote field locations, it has been designed to operate without an extension cord or air hose.

Ride-On Tire Protection System Benefits

	YES	NO
1. Prevents flats by sealing multiple punctures for the legal life of the tire	x	
2. Extends tire life by up to 25% or more	x	
3. Helps hydrodynamically balance truck tires	x	
4. Seals punctures made by objects up to 1/4" (3/8" for Off-Road Formula) in diameter	x	
5. Works in tube & tubeless tires	x	
6. Easily washes out of the tire with water	x	
7. Lowers operating and maintenance costs	x	
8. Improves fuel economy	x	
9. Maintains proper tire inflation	x	
10. Helps tires run cooler	x	
11. Eliminates slow leaks and porosity leaks	x	
12. Conditions tire casings, making retreads more effective	x	
13. Contains corrosion inhibitors and guards wheels and tire belts against corrosion	x	

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14. Is environmentally friendly	x	
15. One application lasts for the legal life of the tire	x	
16. Works effectively at all speeds	x	
17. Does not dry or flake inside of a tire	x	
18. Is non-toxic & non-flammable	x	
19. Works effectively in all seasons	x	
20. Carries a lifetime guarantee *	x	
21. Comes with road-side assistance *	x	

** Please refer to actual programs for details*

Smithers Scientific Services, Inc.
425 WEST MARKET STREET • AKRON, OHIO U.S.A. 44303
TELEPHONE: 330/762-7441 FAX: 330/762-7447

January 19, 1998

CUSTOMER: INOVEX AUTOMOTIVE INC.
7799 Leesburg Pike
Suite 900, North Tower
Falls Church, VA 22043

ATTENTION: Mark Farkhan
Smithers Job #9710-02480A

SUBJECT: TEST REPORT:
The above mentioned firm submitted one (1) sample for testing identified as "Ride-On Tire Sealant".

TESTING:

CHEMICAL ANALYSIS: Tested to US Postal Service FMB V-21-93	REQUIREMENTS
pH Value	8.8 ± 0.8, max.
Stability	Homogeneous and not separate in container
Heat Stability	Shall not separate
Cold Stability	Shall not freeze
Flammability	Shall not exhibit flash
Corrosion	Corrosion must exhibit weight loss of .025% or more to justify failure
Evaporative Curing	1/4" wide dried strip shall wrap around 1/8" diameter mandrel without cracking or separation. Also it shall resist tearing when elongated to 20% of its original length.

PHYSICAL ANALYSIS	
Tire Sealant Test	No Out-of-Balance Condition
Tire Sealant Puncture Test	No Loss of PSI

RESULTS: CHEMICAL ANALYSIS:

pH Value — The pH limits of the material shall be between 8.8 ± 0.8 when testing fresh tire sealant. The pH of the material was checked at 25°C (77°F) using Beckman Type "E" high pH glass electrode.

Results	Pass/Fail
8.16	Pass

Stability — The tire sealant must be homogeneous and cannot separate in the container. The sealant must not require stirring or mixing to use.

Results	Pass/Fail
Homogeneous	Pass

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Mark Farkham
INOVEX AUTOMOTIVE INC.
January 19, 1998
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RESULTS: CHEMICAL ANALYSIS:

Heat Stability	The tire sealant shall not separate after being exposed to temperatures up to 82 ± 2°C (180 ± 4°F), although a slight amount of clear liquid (less than 3% by volume) on top is allowed.	Results No Separation	Pass/Fail Pass
Cold Stability	The tire sealant shall not freeze at -40 ± 5°C (-40 ± 9°F).	Results No freezing	Pass/Fail Pass
Flammability	The tire sealant, including chemical carriers or propellants, shall have no flash when tested up to and including the initial boiling point.	Results No flash	Pass/Fail Pass
Corrosion	The tire sealant shall not cause corrosion on material from common steel wheels or aluminum wheels. The corrosion must exhibit a weight loss of .025% or more to justify failure.	Results Steel and aluminum corrosion was less than .025%	Pass/Fail Pass
Evaporative	Wrap material around 1/8" diameter mandrel having greater than a 20% elongation.	Results No cracking or tearing shall be observed.	Pass/Fail Pass

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INOVEX AUTOMOTIVE INC.
January 19, 1998
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RESULTS: TIRE SEALANT BALANCE TEST

The radial tire used for this portion of the analysis was a P205/65R15 all season steel belted radial tire. This tire was match mounted prior to being mounted. Once mounted, the tire and rim were balanced with the use of a dynamic (spin) balancer. Once balanced, the "Ride-On Tire Sealant", (5 oz.), was added to the tire and rim assembly through the valve stem. The tire was then mounted to the test vehicle, (a 1993 Ford Taurus), and driven approximately 200 miles on both city streets and interstate. Upon completion of the 200 miles, the tire was removed from the test vehicle, rebalanced on the dynamic balancer and accelerated to a speed of 10 - 25 MPH. Once the tire had reached that speed, the balancer was immediately shut off. Upon completion of the re-balance, no indication of any out-of-balance condition was observed.

Pass/Fail Pass

TIRE SEALANT PUNCTURE TEST

Test Objective: To simulate if the "RIDE-ON" tire sealant could plug a series of punctures which were deliberately initiated into the tread area of the tire, maintaining constant air pressure.

Test Procedure: The tire used for this simulation was a Dunlop Radial Truck Tire - 285/75 R24.5. This truck tire was mounted on a 24.5 X 8.25 steel rim, and injected with 32.5 oz. of "Ride On" tire sealant through the tire valve. After the sealant had been injected into the tire, the completed tire assembly was rotated 3 to 4 revolutions to uniformly disperse the tire sealant throughout the inside of the tire. Upon completion, the tire was inflated to 110.0 psi., and mounted on a road wheel machine, applying a static load of 6175 lbs. for 8 hours. (This static load was done in order to simulate a vehicle being parked overnight). After the 8 hour static load period was complete, the tire assembly was taken to a speed of 35 mph for 24 hours. After this 24 hour cycle, the tire inflation pressure was re-checked registering 124.0 psi. (The 14.0 psi. increase was due to the heat the tire had conducted while being rotated @ 35.0 mph for the 24 hr. period). Once the tire was examined for any visual defects, and the inflation pressure was checked, the tread area was deliberately punctured by using a devise resembling a 16 penny nail, (an instrument with a 1/4" shaft diameter). This device was pounded completely through the tread and carcass area and removed causing a hole. Once the puncture was performed, the tire was taken back to a speed of 35 mph with the 6175 load being applied for another 24 hour cycle. The tire inflation pressure was taken at the end of the 24 hour cycle indicating 124.0 psi. This 24 hour cycle was followed by the 8 hour static cycle, again having the 6175 lb. load applied, and having the inflation pressure taken. This test cycle was continued for a total of 4 puncture tests and 4,200 total test miles. Upon the completion of each 24 hour road wheel test, followed by the 8 hour static load period, there was no indication of air loss or any visual defects found from the tire or assembly.

Pass/Fail Pass

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