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Recommendations Regarding Future Brake System Air Line Monitoring

Developed by the Technology & Maintenance Council's (TMC)
Future Truck Sensor Enhance Maintenance Task Force

ABSTRACT

Recent advancements in sensor technology are enabling real-time monitoring of system performance and readiness in heavy-duty vehicles. ATA's Technology & Maintenance Council (TMC) recommends that manufacturers leverage this new technology to develop a more accurate means of identifying slow leaks in air brake lines; thus improving driver awareness of developing brake system failures, and reducing the frequency and severity of thermal incidents (i.e., truck fires).

INTRODUCTION

TMC's Future Truck Committee charged its Sensor-Enhanced Maintenance Task Force to study new means of providing drivers with visual alerts to problems within the air brake signal air line (e.g., whenever there is a leak of two pounds per square inch (PSI) or more when the brake pedal is not depressed) and/or the brake service air line (e.g., whenever there is a leak of more than three PSI within 60 seconds of the brake pedal being depressed).

The Task Force had two specific goals: First, providing drivers with a visual reading on the dash of slow air leaks, and second, provide fleets an early warning of developing air leaks to prevent loss of stopping power and potential thermal incidents (i.e., truck fires.)

Accordingly, the Task Force developed a conceptual design for a prototype technology, using commercially available products (re-tasked through software), to provide drivers with increased awareness of developing air line issues. This position paper discusses the benefits and desired features of this prototype gauge technology, and offers recommendations for further actions.

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BACKGROUND

The vast majority of Class 7 and 8 trucks use air brakes supplied by various manufacturers. These vehicles are equipped with a dash-mounted gauge that provides drivers some notice as to the primary and secondary air pressures available for air brake operation. In a typical air brake system, a minimum air pressure of 90 PSI is required for the driver to release the brakes and be able to freely move the vehicle.

Regulatory Requirements

Federal regulations covering *Parts And Accessories Necessary For Safe Operation* (49 CFR Part 393.51(c)), require the following:

> "(c) Air brakes. A commercial motor vehicle (regardless of the date of manufacture) equipped with service brakes activated by compressed air (air brakes) or a commercial motor vehicle towing a vehicle with service brakes activated by compressed air (air brakes) must be equipped with a pressure gauge and a warning signal. Trucks, truck tractors, and buses manufactured on or after March 1, 1975, must, at a minimum, have a pressure gauge and a warning signal which meets the requirements of FMVSS No. 121 (S5.1.4 for the pressure gauge and S5.1.5 for the warning signal) applicable to the vehicle on the date of manufacture of the vehicle. Power units to which FMVSS No. 571.121 was not applicable on the date of manufacture of the vehicle must be equipped with—
>
> (1) A pressure gauge, visible to a person seated in the normal driving position, which indicates the air pressure (in kilopascals (kPa) or pounds per square inch (PSI)) available for braking; and
>
> (2) A warning signal that is audible or visible to a person in the normal driving position and provides a continuous warning to the driver whenever the air pressure in the service reservoir system is at 379 kPa (55 PSI) and below, or one-half of the compressor governor cutout pressure, whichever is less."

Current Procedures for Detecting Air Brake Problems

Drivers are trained to utilize current air brake pressure warning gauges to detect air brake system problems during pre-trip inspections.

An example of a typical air loss test procedure, as described in on-line training materials at *www.truckingtruth.com*, is shown below.

Current gauges are accurate, but are scaled such that drivers are unable to detect slow air leaks (as required by federal regulations) by simply observing the gauge. Instead, as a part of routine inspection (as opposed to the detailed mandatory annual inspection), drivers and maintenance staff are typically trained and instructed to "listen" for air leaks when the truck is stopped and the engine is off, both "with" and "without" the service brake applied.

EXAMPLE — TYPICAL DRIVER TEST PROCEDURE FOR AIR BRAKE LEAKAGE:

With a fully charged air system (typically 125 PSI), turn off the engine, release the service brake, and time the air pressure drop. The loss rate should be less than two PSI within one minute for single vehicles and less than three PSI within one minute for combination vehicles. Next, make a 90 PSI or more brake application. After the initial pressure drop, if the air pressure falls more than three PSI within one minute for single vehicles and more than four PSI for combination vehicles, the air loss rate is too much. Check for air leaks, and repair before driving the vehicle. Otherwise, you could lose your brakes while driving.

During its research, Task Force determined, to the best of its knowledge, that there is no commercially available gauge (other than units intended specifically for use by shop staff) that shows the air pressure present on the signal air line, so the driver may only notice a "loss of pulling power" if a problem with the signal air line pressure is actually causing the brakes to drag. The new technology proposed in this paper will provide early warning of a developing problem.

Regarding the service air line, the gauge assembly which the Task Force is suggesting could be used to improve the test air leakage rate steps shown above. The suggested revised procedure would be as follows:

With a fully-charged air system (typically 125 PSI), turn off the engine, release the service brake, and chock the wheels (If the truck is a manual transmission, shift into first gear to keep it from rolling). Cycle the key to the ON position, and monitor the air pressure drop. The loss rate should be less than two PSI within one minute for single vehicles and less than three PSI within one minute for combination vehicles. Next, make a 90 PSI or more brake application. After the initial pressure drop, if the air pressure falls more than three PSI within one minute for single vehicles and more than four PSI for combination vehicles, the air loss rate is too much. Check for air leaks, and repair before driving the vehicle. Otherwise, you could lose your brakes while driving.

BENEFITS AND FEATURES OF THE PROPOSED GAUGE

At TMC's 2017 Annual Meeting, Task Force considered the desired benefits of this new type of air pressure alert gauge, which include:

- **Reduced Cost** —The Task Force presented an example of the cost of a single road call for an air brake line repair (see **Table 1)**. This illustration does not include any indirect costs associated with delayed freight, a potential for unnecessary maintenance fees, and potential customer disatisfaction.
- **Improved Safety —** Driver attention is very important to the safe operation of vehicles. There are many products being produced to supply information to the driver. The status of the brake system is certainly one of the most significant.

ACTIVITY	QTY	RATE	AMOUNT
Road Service Charge ROAD SERVICE CHARGED	1	125.00	125.00
Red Air Line RED AIR LINE	1	56.99	56.99
Blue Air Line BLUE AIR LINE	1	56.99	56.99
Labor TROUBLESHOOT AIR SYSTEM, LOCATE AND REPLACE BOTH RED AND BLUE AIR LINE ON TRACTOR	1	175.00	175.00
Taxes TAX COLLECTED ONLY ON PARTS USED	1	7.97	7.97
CREDIT CARD TRANS. FEE CRDIT CARD PROCESSING FEE	1	15.82	15.82
TRUCK#D6724 PLATE#P745604 SOUTH CAROLINA VIN#DJ321228	BALANCE DUE		**$437.77**

Table 1: Cost to Diagnose and Repair Air Lines

The Task Force believes that the technology recommended in this position paper would improve driver awareness of a developing problem. If connected to the SAE J1939 databus, this technology would also have the capability to generate a fault code which could be reported to the fleet maintenance department via telematics systems that may be installed on the vehicle.

At that same meeting, a prototype gauge assembly was demonstrated (see **Figure 1**). In addition to air lines and wiring, two commercially available items were re-tasked and presented to those attending the Task Force meeting, combining a gauge and a Smart Dual Pressure Transducer (SPDT). Without offering any commercial endorsement, TMC expresses gratitude to AMETEK for their willingness to provide the SPDT and gauge with re-tasked software, featuring the TMC logo at power up.

The test assembly included a portable air compressor and a power source to simulate a brake pedal position sensor. This combination of hardware, hoses, and wiring was used to demonstrate the feasibility of monitoring both, the signal air line as well as the service air line, providing the air pressure readout in one-pound increments.

Using off-the-shelf technology, the Task Force estimated the cost of the gauge assembly was slightly more than half the cost of the roadside repair described in **Table 1**.

This combination of hardware, hoses, and wiring was used to demonstrate the feasibility of monitoring both the signal air line as well as the service air line, providing the air pressure readout in one-pound increments. The demonstration met the performance criteria expectations described previously:

- whenever there is a leak in the air brake signal line of two pounds per square inch (PSI) or more when the brake pedal is not depressed and/or;
- whenever there is a leak in the service line of more than three PSI within 60 seconds of the brake pedal being depressed.

Visual Alert Considerations

While there are many driver dashboard alert methods, the vast majority have some form of gauge or malfunction indicator lighting for various accessories. While TMC is not recommending one type over another, the Task Force observed that with more details available, the driver has improved knowledge regarding the criticality of a problem with the brake system, and what action must be taken. Therefore, the Task Force recommends any gauge should:

- conform to all SAE J1455 and J1113 requirements for vehicular instrumentation;
- be environmentally sealed against dust and moisture penetration;
- use SAE J1939 databus communication.

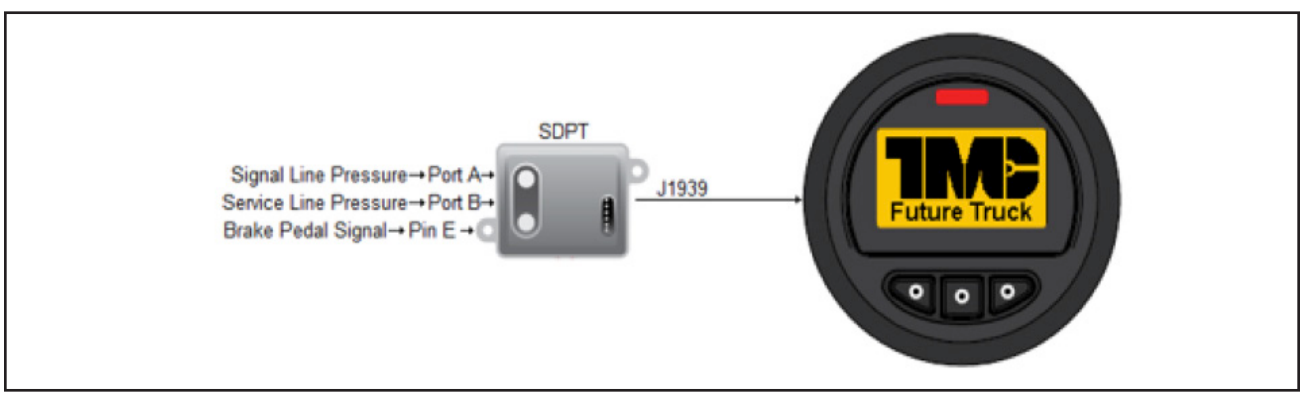

Figure 1: Protoype of the Proposed Alert Gauge

RECOMMENDATIONS FOR FUTURE RESEARCH AND DEVELOPMENT

TMC recommends the following research and development and standardization actions:

- Field testing (or, at a minimum, lab testing) to verify the feasibility of this proposal;
- Determining which data elements should presented to the driver, and under what conditions;
- Defining the manner of presentation of the data elements, including:
  - Decimal accuracy requirements, the display font and other characteristics (such as blink or coloration) if presented through a gauge;
  - Type and color of a dash indicator light, if that method is preferred;
- Determining the Service Peripheral Name (SPN) and Functional Mock-up Interface (FMI) that are most appropriate, and/or the need for SAE to provide additional SPNs.
- Defining the appropriate duration of a valid and reliably accurate pressure reading. For example, should the driver ignore a transient reading during the test air leakage rate procedure?

REFERENCES

- United States Code of Federal Regulations, Title 49, Part 393.51(c), *Parts And Accessories Necessary For Safe Operation, Brakes, Warning signals, air pressure and vacuum gauges, air brakes.*
- TruckingTruth, *CDL Training Program, Section 5.3, Inspection Air Brake Systems* (*http://www.truckingtruth.com/cdl-training-program/page45*).
- SAE J1455, *Recommended Environmental Practices for Electronic Equipment Design in Heavy-Duty Vehicle Applications*.
- SAE J1113, *Electromagnetic Compatibility Measurements Procedure for Vehicle Components.*
- SAE J1939, *Serial Control and Communications Heavy Duty Vehicle Network*.