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# Future Truck Program Position Paper: 2014-1

## *Future Trailer Productivity—*
### *Increasing the Efficiency of Pre and Post Trip Inspections*

Developed by the Technology & Maintenance Council's (TMC)
Future Trailer Productivity Task Force


## ABSTRACT
Traditional methods for both pre- and post-trip inspections have existed for decades with few changes or improvements. Traditional tools and technology limit inspection effectiveness, add time to both the inspection and reporting, and contribute to the potential for errors and miscommunication of the resulting data. This paper explores technologies that may increase the efficiency of pre- and post-trip trailer inspections and provides a vision for future development of technologies and systems for that purpose.


## INTRODUCTION
It is the responsibility of every commercial carrier to facilitate and conduct pre- and post-trip inspections of the tractor and trailer at least once per day while in service. The Code of Federal Regulations Part 396.11 specifically states "prior to operating or permitting a driver to operate a vehicle, every motor carrier or its agent shall repair any defect or deficiency listed on the driver vehicle inspection report which would be likely to affect the safety of operation of the vehicle." Further it goes on to state that "every motor carrier shall require its driver to report in writing at the completion of each days work on each vehicle operated." Thus, the pre- and post-trip inspection are required by law, but more importantly these inspections serve as a foundation for the safe operation of the vehicle and as an important component of an effective maintenance program.

Under CFR 396.11, specific areas of the vehicle are cited for scrutiny. This paper explores technologies that may increase the efficiency of pre- and post-trip trailer inspections and provides a vision for future development of technologies and systems for that purpose.

## TRADITIONAL METHODS
Traditional methods for both pre- and post-trip inspections have existed for decades with few changes or improvements. The driver "visually"

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| TABLE 1: PRESCRIBED INSPECTION ITEMS AS PER CFR 396.11 |
|---|
| Service Brakes (Including Connections) |
| Parking Brake |
| Steering Mechanism (Tractor) |
| Lighting Devices and Reflectors |
| Tires |
| Horn (Tractor) |
| Windshield Wipers (Tractor) |
| Rear Vision Mirrors (Tractor) |
| Coupling Devices |
| Wheels and Rims |
| Emergency Equipment |

inspects the vehicle for condition focusing on the list of items as listed in **Table 1**.

Traditionally the driver uses a pre-printed form and simple hand tools such as a tire pressure gauge or unfortunately even just a tire "billy" as he or she walks around and inspects the vehicle. Traditional tools and technology limit inspection effectiveness, add time to both the inspection and reporting, and contribute to the potential for errors and miscommunication of the resulting data.

## INCREASING EFFICIENCY THRU USE OF EXISTING TECHNOLOGIES

Several companies have developed and are selling stand-alone wired or wireless systems that automate or simplify the trailer inspection process (e.g., tire pressure monitoring and brake stroke monitoring/inspection products). These systems use incompatible technologies, however, and neither offer the realistic possibility of expansion to monitor additional systems. Finally, these systems do not employ an industry standard communications (hardware and protocol) to operate, and thus two standalone systems are necessary for these two inspection parameters.

Other companies offer power line carrier (PLC)-based or telematic solutions to monitor additional trailer components or systems. Typically, these systems use the trailer antilock braking system (ABS) to power and/or communicate with sensors on the various components being monitored. The data may then be analyzed, stored for later retrieval or communicated to the tractor or other devices such as a gate reader, a telematics transponder or some other type of "reader."

These "onboard" monitoring systems offer sensors for tire pressure, brake friction material wear, proper tractor/trailer coupling, trailer door opening/closing, trailer reefer unit operation and potentially others as sensors are available. The monitored functions are sensed and available (as appropriate) while the vehicle is stationary or in motion, and could potentially be used as a part of a pre or post trip inspection.

Again, hardware and software technologies of these systems are somewhat proprietary, although most do use industry standard communication protocols to some extent. And, as stated previously, such systems do offer the possibility of expansion to accommodate additional sensors and satellite systems as they come available.

## LEVERAGING EXISTING TECHNOLOGIES

Clearly technologies exist to sample or monitor data central to the pre- and post-trip inspection process. Additionally, other systems and components could be added to the mandated items listed in **Table 1** and made available for pre- and post-trip inspections. A partial listing of suggested additional data or inspection points follows in **Table 2** (a more complete listing of data or systems to be inspected or monitored is contained in **Appendix A**).

| TABLE 2: SUGGESTED ADDITIONAL DATA OR INSPECTION ITEMS |
| --- |
| Wheel End (proper lubrication, proper bearing adjustment, and proper temperature) |
| ABS Functionality |
| Doors/Hatches (properly closed) |
| Reefer Fuel Tank (fuel level) Liftgate (position) |
| Slider Pin Engagement |
| Support Gear and Bracing (lift position) |
| Suspension System (airbag pressure, leaks, air imbalances) |

## NEW METHODOLOGIES

Many potential solutions could be formulated, so for purposes of discussion only two will be described here.

The first involves the creation of an inspection panel to be mounted on the trailer. At the push of a button, the panel would provide information concerning the condition of the inspection points through the use of indicator lights, and an LCD display or some similar device. The readings could also provide some instructions related to the output (e.g., red warning indications to require that the vehicle go to the shop for inspection, etc.) The panel could, of course, take on other functions as needed; however, one thing the panel could not do is visually inspect the trailer and its components.

Another potential approach would allow a "walk around" review and recording of various parameters to amend or enhance visual

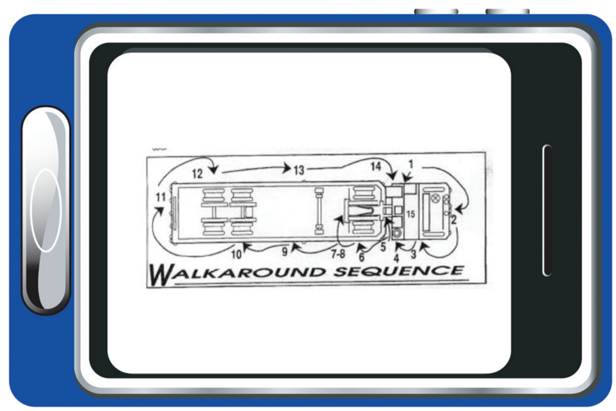


**Figure 1**

inspection. A hand-held device would allow the person inspecting to "zero in on" and interrogate various systems or components and measure, qualify and record vital information. (See **Figure 1**.) The device would be capable of discriminating between components — for example, tires in a set in terms of pressures while the inspector checked the tire visually for damage. Pressure could be displayed on the device or a "go/no go" indication could be given. The device could record and save information for later download and report generation by wired or wireless means.

Both types of systems would communicate with other system devices (e.g., transducers, other recording or reporting devices, maintenance or condition-based maintenance systems, etc.) through standardized communications protocols. Visual and tactile interaction with the user is possible via the hand-held device through software applications to be developed for generic devices (e.g., iPhone, iPad, Android, etc.). Along with wireless transmission to network operations or maintenance centers, specific protocols would allow both approaches to read transducers from different vendors and of different styles. Going back to the tire pressure example, the devices should read tires with embedded chips, valve stems with sensory capability or sensors mounted on the wheel inside the tire regardless of brand.

Both approaches to the problem face essentially the same hurdles:

- *Sensing and measuring*; meaning translating the visual and physical inspection into automatic, continuous measurements through electronic or electro-mechanical means. This is where individual organizations can innovate and compete to provide the best solutions.
- *Communications and data transmission*; which could involve either receipt of raw sensor data, or pre-processed data in the form of alerts. The panel could serve as an onboard hub for such data and provide subsequent processing of the data as appropriate. (See **Figure 2.**) Delivery as needed could then take place from the panel to a centralized location such as the shop office, or perhaps the "cloud" (or another service or facility). Many technologies exist and thus, data transfer should be "flexible" and allow for multiple technologies to coexist in the system or on the device.

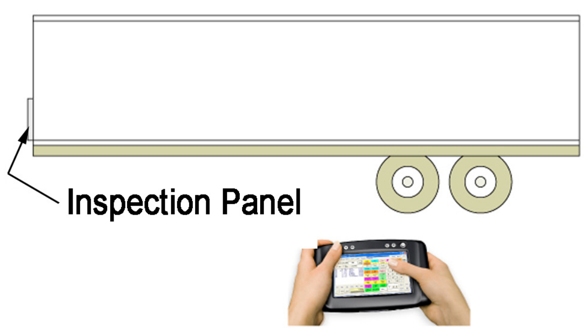


**Figure 2**

In the case of the hand-held device; it would function to take receipt of raw sensor data, processing as appropriate and potentially delivering data from the device to the centralized location such as the shop office or other location such as the "cloud." Again, many technologies exist and thus, communication should be flexible allowing multiple technologies on the same devices and system, which could, of course, utilize both panel and hand-held devices.

Both the panel and the hand held device would need to be rugged and waterproof (or highly water-resistant in the case of the hand-held device), capable of operating over a long period of time without changing batteries or recharging, and have a logic screen visible in full sunlight. The units would self-test, be field software upgradable, and employ modular construction for ease of repair.

Sensors should be available from a variety of components or systems as needed, be rugged and weatherproof, resistant to road chemicals, inexpensive and capable of functioning for the life of the vehicle. In the event of sensor failure or damage, the sensor should be easily replaceable, widely available and compatible with all standardized panels and hand-held devices on the market.

The system as a whole should be accurate, precise and low cost. Standardization of communications protocols, system modularity and expandability should be exploited to drive down cost and increase the number of units in operation. Only through such an approach is it realistic to expect that users can be offered an affordable solution that enhances productivity and accuracy while at the same time saving money overall by doing a better job than traditional methods allow.

For a more complete listing of desirable system characteristics and features see Appendix B.

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## APPENDIX A
## LISTING OF DATA OR SYSTEMS TO BE INSPECTED OR MONITORED

The following is a listing of data or systems that should be inspected or monitored on trailers in a pre- and post-trip inspection device or platform:

- Service Brakes, including connections (stroke length, imbalance, airflow per chamber, available air pressure or flow, timing, friction material thickness)
- Parking Brake
- Lighting Devices and Reflectors (through open or closed circuit)
- Tires (tread depth, pressure, mechanical damage)
- Coupling Devices (pintle hook and kingpin properly engaged and locked)
- Wheels and Rims
- Emergency Equipment
- Wheel End (proper lubrication, proper bearing adjustment, and proper temperature)
- ABS functionality
- Doors/Hatches (properly closed)
- Reefer Fuel Tank (fuel level)
- LiftGate (position)
- Slider Pin Engagement
- Other items as required by all applicable regulations.

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## APPENDIX B
## LISTING OF DESIRABLE SYSTEM CHARACTERISTICS AND FEATURES

The following is a user-driven listing of desirable system characteristics and features for a pre- and post-trip inspection device used to inspect trailers:

***Fixed Panel Display or Hub Device***

Standardized locations
Lightweight
Inexpensive modular construction
Designed for component replacement instead of repair
Transducer vendor independent
Able to repeatably measure, qualify/quantify and record vital information
Rugged and weatherproof
Touchscreen
Standardized communications protocols (wired and wireless)
Software updatable (and self testing)
Long battery life
Logic screen that is viewable in direct, bright sunlight
Capable of quantifiable measurements or go no/go operation
Room to expand to other inspection items that may be application related

## APPENDIX B (CONTINUTED)

### *Handheld Device*

Lightweight
Able to discriminate between components in a group
Transducer vendor independent
Able to measure, qualify/quantify and record vital information
Rugged and weatherproof
Touchscreen
Standardized communications protocols (wired and wireless)
Software updatable (and self testing)
Long battery life
Logic screen that is viewable in direct, bright sunlight
Capable of quantifiable measurements or go no/go operation

### *Sensors*

Standardized communications protocol (wired or wireless)
Widely available
Resistant to Road Chemicals
Inexpensive
Capable of lasting the life of the vehicle

### *System*

Robust
Low likelihood if a false reading or error (accurate, precise and repeatable)
Low cost
Modular
Expandable
Standardized communications protocols (wired and wireless)