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ATA

*Driving Trucking's Success*

October 31, 2003



National Highway Traffic Safety Administration
Docket Management
Room PL-401
400 Seventh Street, SW
Washington, DC 20590

**Re: Docket No. NHTSA 03-15651** - 33

The American Trucking Associations (ATA) hereby submits the following comments in response to the National Highway Traffic Safety Administration's request for comments on July 17, 2003 of Notice of Draft Interpretation on Federal Motor Vehicle Safety Standards; Lamps, Reflective Devices, and Associated Equipment.

The ATA is the trade association of the American trucking industry and is vitally interested in matters affecting the nation's trucking fleet, highway safety and productivity including vehicle and component safety performance standards. In addition, we strongly support reliability performance standards for safety related equipment.

The American Trucking Associations supports the voluntary use of technology and devices to enhance highway safety and productivity. We support Federal reliability performance standards of safety related equipment regardless of whether the equipment is required or optional. We are active participants with the Commercial Vehicle Safety Alliance (CVSA) committee which develops the vehicle out of service criteria.

The ATA appreciates the opportunity to comment on optional technology on motor vehicles and on specific petitions from individuals and organizations. The following is our response to the invitation for comments.

The issue is that these draft interpretations are, or should, primarily be addressed toward passenger cars for which there are many aftermarket lighting systems being marketed that are different from the original equipment manufacturer (OEM) certified types. This is a trend that is continuing to grow with the growth of aftermarket suppliers providing lighting accessories.

Commercial vehicles are caught in the middle of this attempt to curb the proliferation of potentially noncompliant exterior passenger car lighting systems. Unlike proprietary aftermarket passenger cars systems, there is a very high degree of commonality and standardization of commercial vehicle systems. Their electrical and lighting systems follow proven industry guidelines, standards and recommended practices established by the Society of Automotive Engineers (SAE) and The Maintenance Council (TMC) for design and maintenance, as well as those of the Commercial Vehicle Safety Alliance (CVSA) for enforcement of Out of Service (OOS) criteria.

These are proven, tested, validated standards and procedures that allow fleets the flexibility of choosing and maintaining their commercial vehicles to remain in compliance with Subpart B, Appendix G of the Federal Motor Carrier Safety Administration (FMCSA) Part 393 – Parts and Accessories Necessary for Safe Operation in the most practical and expeditious manner. The SAE recommended practices and standards and their scope include:

**J163** – Low Tension Wiring and Cable Terminals and Splice Clips

Recommended Practice for application requirements for terminals and splice clips attached to stranded low tension wiring and cable, and maximum voltage drop limits for friction type connections.

**J2202** – Heavy-Duty Wiring Systems for On-Highway Trucks

Recommended Practice for operating performance and durability of primary wiring distribution systems less than 50 Volts for wire sizes of 0.5 to 19 $mm^2$ on heavy-duty on-highway trucks.

**J2174** – Heavy-Duty Wiring Systems for Trailers

Recommended Practice for minimum performance requirements for sealed electrical distribution systems for trailers, including requirements for individual components and the overall system.

**J1128** – Low Tension Primary Cable

Standard for low tension primary cable intended for use at a nominal system voltage of 60 V DC (25 V AC) or less in surface vehicle electrical systems for normal applications with limited exposure to fluids and physical abuse.

**J2030** – Heavy-Duty Electrical Connector Performance Standard

This standard encompasses connectors between two cables or between a cable and an electrical component. This document provides performance requirements based upon the mechanical and electrical environment and covers applications for connectors for direct current electrical systems of 50 V or less in heavy-duty applications.

**J2139** – Tests for Signal and Marking Devices Use on Vehicles 2032 mm or More In Overall Width

This Recommended Practice provides standardized laboratory tests, test methods, and performance requirements applicable to signal and marking devices used on vehicles 2032 mm or more in overall width.

Together these standards and recommended practices describe the design, specification, and testing of durable and reliable electrical and lighting connectors and systems.

While not all commercial vehicles and trailers are equipped by the manufacturer with light emitting diode (LED) technology, the use of replacement LED lamps is a Recommended Practice (RP-143) of TMC, the industry group that recommends engineering and maintenance practices for commercial vehicle operations. These recommendations are reached through consensus by council members.

Following recommended practice, LED use does not increase safety risks for vehicle operators or the public at large. In fact they are now widely used in traffic signal lights as well. LEDs have been proven to be superior to incandescent bulbs. They are:

- More durable
- More reliable
- Brighter
- More energy efficient

Both LED and incandescent lights must meet the minimum and maximum requirements for light output and light pattern as specified by FMVSS 108. However, LEDs and incandescent lights differ with respect to durability.

An incandescent light bulb contains a tungsten filament wire which eventually burns out and fails. Depending on the type of bulb, this generally occurs between 200 to 15,000 hours of service.

"A single LED is a solid-state electronic component. When current flows through the semiconductor compounds, light is emitted. Because there is no evaporation of components, and because it is solid state, LED service life is significantly longer than that of incandescent bulbs. On average, an individual LED remains an effective light source for approximately 100,000 hours. A typical LED lighting device may contain many LEDs." (TMC RP 143-1)

Because LED devices often contain many LEDs, they are more reliable in that should an individual LED in the assembly fail, the device is still operational and in compliance with FMCSA Part 393 Subpart B, Appendix G. With incandescent devices, if the bulb fails the entire component is no longer operational.

LEDs draw less current than traditional incandescent lamps:

"Typically an LED marker lamp requires 0.05 amps at 14 volts, whereas an incandescent lamp requires 0.33 amps at 12.9 volts, and an incandescent stop lamp requires 2.1 amps.... LED lamps can also be designed to provide visible light at up to 40 percent lower voltages than incandescent lamps". (TMC RP 143-2)

Due to their superior performance, lower frequency of failure (e.g. longer service life), and redundancy (multiple LEDs per device), overall vehicle safety is enhanced.

Under braking LED lamps have been found to come on nearly 2/10 of a second quicker than incandescent bulbs, which could alert following vehicles to a panic stop up to about 20 feet sooner.

It is important to have interchangeable lighting system components so that commercial fleets can continue to use established industry practices which provide them with the flexibility to operate with the most cost effective and available lighting systems that meet FMVSS 108.

The Specialty Equipment Manufacturers Association (SEMA) estimates that the automotive aftermarket grew to $6.32 billion in 1996 at the manufacturer level ($17.65 billion at retail), a 45.2% increase from 1990, and has continued to grow since, and that "Specialty Accessories & Appearance" items including LED lighting account for 51.1% of those sales.

As evidenced by the proliferation of aftermarket suppliers and periodicals such as "Sport Compact" magazine and "Import Tuner" magazine, non-OEM replacement lighting for passenger cars is most often done for aesthetic reasons by individuals. In such cases FMVSS Standard 108 may not be met. In many instances this work is performed by untrained hobbyists rather than by certified technicians, without consideration for illumination and safety performance.

The NHTSA has not provided any data that demonstrates negative safety effects from replacement lighting in commercial vehicles. Commercial vehicle lighting equipment is replaced for sound safety reasons (see RP 143), and the work is performed by trained and qualified professionals.

In conclusion, the commercial vehicle industry has a well established and widely implemented set of proven standards and practices that have been reached through consensus, and based on interchangeability of safe, reliable components and systems. These practices enhance the safety, efficiency and quality of our fleets.

In light of the different reasons which have resulted in the increased use of LED replacement lighting assemblies on both commercial and passenger vehicles, the ATA recommends that commercial vehicles be excluded from these interpretations.

The American Trucking Associations appreciates the opportunity to provide comments to the NHTSA. ATA looks forward to continued dialog on this important subject and if requested, we will provide additional appropriate information to support the NHTSA.

Respectfully,

S. William Gouse
Vice President of Engineering
American Trucking Associations

# TMC Recommended Practice

**RP 143** **VMRS 034**

# LIGHT EMITTING DIODE (LED) TECHNOLOGY

## PREFACE

The following Recommended Practice is subject to the Disclaimer at the front of TMC's *Recommended Maintenance Practices Manual.* Users are urged to read the Disclaimer before considering adoption of any portion of this Recommended Practice.

## PURPOSE AND SCOPE

The purpose of this Recommended Practice is to describe for equipment users the benefits and features of lamps containing light emitting diodes (LEDs) when spec'ing heavy-duty signalling and marking devices. The document features:

- light source comparisons,
- installation guidelines,
- connector and wiring recommendations, and;
- a formula with which equipment users can calculate return-on-investment (ROI) associated with spec'ing LED lighting devices.

Significant improvements in both the cost and service life of light-emitting diodes (LEDs) have proven LEDs to be a superior alternative to incandescent bulbs for exterior vehicle lighting. Additionally, the advent of a national mandate for antilock braking systems (ABS) has prompted many fleets to rethink the way they spec tractor and trailer lighting systems. LED lamps will help ensure sufficient voltage is available for ABS operation in longer combination vehicles.

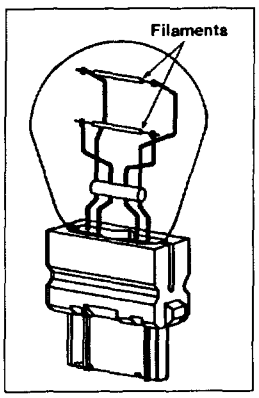


Fig. 1

## INCANDESCENT TECHNOLOGY

An incandescent lamp is essentially a piece of wire in a bottle. Every incandescent lamp contains a tungsten filament wire. **(See Fig. 1.)** When current flows through the filament wire, it encounters resistance and the wire heats up and glows very brightly. Over time, the tungsten evaporates and the filament wire burns out. Generally, this failure occurs between 200 and 15,000 hours—depending on the type of incandescent bulb.

**LED CONSTRUCTION**

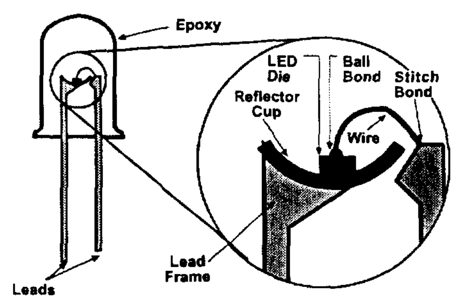


Fig. 2

## LED TECHNOLOGY

A single LED is a solid-state electronic component. When current flows through the semiconductor compounds, light is emitted. **(See Fig. 2.)** Because there is no evaporation of components, and because it is solid state, LED service life is significantly longer than that of incandescent bulbs. On average, an individual LED remains an effective light source for approximately 100,000 hours. A typical LED lighting device may contain many LEDs.

## MAJOR BENEFITS OF LEDs DEFINED

In its research, The Maintenance Council has determined three major benefits associated with the use of LEDs. These benefits are: Improved safety, reduced current demand and greater compatibility with ABS, and improved durability and brightness.

### A. Improved Safety

The fast illumination or "on-time" of LEDs makes this lamp potentially safer for both drivers and motorists following a truck. In fact, the faster response time of LEDs (2/10 of a second quicker than incandescent) may allow for over 20 additional feet of stopping distance at highway speeds. This can reduce accidents, injuries and/or fatalities caused by rear-end collisions. ABS requires a minimum of 7-10 volts for proper operation. The low power consumption of LEDs helps ensure adequate power for proper braking; incandescents may not.

A report from the University of Michigan Transportation Research Institute (UMTRI) see Sivak et. al., September 1993, compared the reaction times of individuals to a standard incandescent brake light (#1157) and an LED light. The results revealed the mean-reaction time of individuals to a standard incandescent brake signal was 662 milliseconds. Whereas, the mean-reaction time to an LED brake signal was 503 milliseconds. The brake signal from an LED light provided an advantage of 159 milliseconds in comparison to the standard incandescent. This may reduce stopping distance in excess of 10 ft.

There are variations in the luminous intensity of both types of lamps and there are variations in reaction times of both older and younger drivers as well as numerous other real world conditions—such as fog and rain—that could affect brake reaction time. The improved reaction time afforded by LED brake lights is a direct result of the faster "light up" time of the LED brake light. It takes approximately one quarter of a second for a standard incandescent light to reach 90 percent of full light output. LEDs are basically "instant on" with light up time in nanoseconds.

**TABLE 1**
**TYPICAL TRACTOR CURRENT DRAW**
**(12 VOLT RATED SYSYEM)**

| LAMP TYPE | TYPICAL NO. OF LAMPS | CURRENT DRAW (A) Incandescent* | CURRENT DRAW (A) LEDs* |
|---|---|---|---|
| Clearance | two | 1.32 | 0.1 |
| ID | three | 1.98 | 0.15 |
| Stop** | two | 4.2 | 1.0 |
| Tail | two | 1.18 | 0.15 |
| Turn** | two | 4.2 | 1.0 |
| Total current | | 12.88 | 2.4 |

* At rated voltage
** Can be combination stop/turn lamps

**B. Reduced Current Demand and Greater Compatibility with ABS**

TMC Recommended Practice (RP) 137 "Antilock Electrical Supply from Tractors Through the SAE J560 Seven-pin Connector" and TMC RP 141 "Trailer ABS Power Supply Requirements" constitute a performance standard for tractor and trailer ABS. RP 141 specifies that a minimum of 9.5 volts should be available to trailer ABS to ensure proper operation. Especially with longer combination vehicles, maintaining this 9.5 volt minimum can be challenging, considering commonly observed voltage drops between tractor and last trailer.

Typically an LED marker lamp requires 0.05 amps at 14 volts, whereas a incandescent lamp requires 0.33 amps. LED stop lamps typically require 0.5 amps at 12.8 volts, and an incandescent stop lamp requires 2.1 amps. **Table 1** shows a comparison for current draw for a typical tractor lighting installation. Note the significantly low current required for LED lights as compared to incandescent lamps. Also note there is no in-rush current associated with LED lamps. LED lamps can also be designed to provide visible light at up to 40 percent lower voltages than incandescent lamps—an important factor lamps at the rear of the trailer.

ABS requires a minimum of 7-10 volts for proper operation. LED lamps feature low current draw that reduces the electrical system power consumption. This results in lower voltage drop or losses, thereby increasing the voltage available for ABS operation.

**C. Improved Durability**

Both LED and incandescent lights must meet the minimum and maximum requirements for light output and light pattern as specified by FMVSS 108. However, LEDs and incandescent lights differ with respect to durability.

Few issues associated with LEDs are as difficult to clearly define as rated life. Manufacturers rate LED lamps for 100,000 hours. Users, indoctrinated on the fundamentals of incandescent bulbs, assume that this means that a typical LED will "go out" after 100,000 hours of use. This is not so.

To determine the rated life of an incandescent bulb, a large number of samples are operated at their design voltage. They are tested in racks, with the bulb in its normal operating position. The voltage is carefully controlled at either the design voltage or the test voltage (accelerated testing) and by definition the average life is 50 percent are out and 50 percent are operating. In practice, multiple small samples are tested to determine manufacturing process control.

**TABLE 2**
**TYPICAL DRY VAN TRAILER CURRENT DRAW AT 12 VOLT SYSTEM**

| LAMP TYPE | TYPICAL NO. OF LAMPS | CURRENT DRAW IN AMPS Incandescent | LED |
|---|---|---|---|
| Clearance | 4 | 2.64 | 0.2 |
| Marker & ID | 9 | 5.94 | 0.45 |
| Stop | 2 | 4.2 | 1.0 |
| Tail | two | 2.36 | 0.30 |
| Turn | two | 4.2 | 1.0 |
| Total Current | | 19.34 | 2.95 |

A similar test cannot be run on LEDs because it would take too long to complete. But the rated service life of 100,000 hours does have basis. LEDs experience output degradation over time. LED suppliers have operated diodes up to 10,000 hours while monitoring intensity. After this amount of time, a 20 percent reduction in output is common. The results, along with knowledge of the design and composition of the LEDs are used to predict that after 100,000 hours, output would drop approximately 50 percent. Thus, a lamp which is still in use after 10-15 years may be about 50 percent dimmer than it was originally, and thus can be considered to have failed.

LEDs are highly reliable devices. If an LED lamp fails within the service life of a trailer, it was likely caused by an outside failure mode, such as physical damage, moisture ingress, or excessive voltage or temperature. Component/vehicle manufacturers and fleets must ensure to the extent possible that the LED devices are protected from these failure modes, so that they may survive to see the end of their rated life.

**Table 2** shows a comparison for current draw for a typical trailer (dry van). Again, note the significant improvement available with LED lighting in comparison to incandescent lighting.

**LED DESIGN CONSIDERATIONS**

**A. Theft Control**

Lamp theft appears to be isolated to Stop/Tail/Turn (S/T/T) lamps. Some deterrents to prevent someone from removing a lamp from a vehicle are:

- Use of a theft-resistant bracket.
- Design a S/T/T lamp with a flange mounting in all versions.
- Use of one-way screws or rivets for attachment.

Future design enhancements may yield other solutions.

**B. Snow and Ice Build-up**

The issue of snow and ice build-up is frequently mentioned as an equipment user concern because LEDs operate at much cooler temperatures. Very little heat is generated to melt snow and ice. Vehicle design may also significantly impact snow and ice build-up on lamps. It remains the responsibility of vehicle operators to ensure that lighting devices are free of snow and ice.

The lighting device manufacturer should take design precautions to eliminate or minimize any thermally induced problem that may affect the long-term performance of the LED device. Care should be taken to prevent any accessory device that adds heat to the lamp assembly. Contact lighting manufacturers for details.

**RECOMMENDED WIRING AND CONNECTOR STANDARDS**

TMC recommends establishing the following performance standards for LED lamp assembly wiring and connector interface to ensure all the electrical interface components of the LED lamp equal the rated life of the lamp.

LED lamp technology offers the trucking industry a lamp rated at 100,000 hours of life. The wiring, PC board, and electrical interface, which are components of the LED lamp assembly, currently have no standard by which their life performance can be measured.

**A. Wiring**

**Cable Selection.** The cable insulation selected shall meet the performance requirements established in SAE J2202 and J2174. Alternate cable designs may be used to meet specific requirements.

**Cable Type.** The cable type selection should include consideration of the following factors:

1. Ambient operating temperature and temperature rise factors.
2. Fuels, lubricants, and other chemicals and fluids to which the cable may be exposed.
3. Expected service life (pinch and abrasion). See SAE J1128, paragraphs 4.9 and 4.10.

**Cable Size Determination**. Cable size should be determined by considering the factors outlined in SAE J2202, Section 4.2.

**Mechanical Strength.** In general, the minimum cable size, for mechanical strength, should be 0.5mm$^2$ in protected areas or where one or two cables are extended from the lamp. Extra care must be used when selecting cables to be used in areas of high vibration and/or constant mechanical flexing.

**B. Terminals.**

1. Terminals shall be used and applied according to manufacturer's specification. A conductive plating on the terminals is recommended to retard corrosion. Terminal materials and/or plating should be chosen to prevent galvanic corrosion when mated.
2. All termination's shall conform to the physical and electrical performance requirements of SAE J163.
3. Terminals should have cable insulation support. If not, the connector body/device should provide support for the cable.

**C. Connectors**

1. Connector bodies should be used at all points where two or more cables terminate and where there is a possibility of misconnection in fabrications, assembly or service.
2. Cable-to-cable or cable-to-lamp connectors must have locking devices.
3. Connector assemblies must be designed such that all uninsulated terminals are on the ground side of each connector. This applies to terminals which may be insulated in their connected state, but which may be uninsulated should a disconnect occur.
4. Multicavity connectors must be polarized in a manner that prevents electrical contact and does not allow the connectors to be mismated partly or fully in any false position when a force of 170N minimum is applied.
5. Connectors designed to use secondary locks are recommended.

**A FORMULA FOR LED RETURN ON INVESTMENT (ROI)**

Based on its investigation, TMC has developed the following formula for equipment users to calculate the return-on-investment time associated with the use of LEDs versus incandescent lamps.

*To calculate potential fleet's savings by the use of LEDs, enter your own fleet's data. In order to perform the necessary calculations use the following formula:*

| | | |
|---|---|---|
| 1. Number of lamps: | ________ | |
| 2. Price of incandescent: | $ ________ | |
| 3. Price of LED: | $ ________ | |
| 4. Investment per lamp: | $ ________ | (Line 3-2) |
| 5. Investment: | $ ________ | (Line: 1x4) |
| 6. Life of Incandescent: | ________ | (Years) |
| 7. Changes/year: | ________ | (Lines: 1/6) |
| 8. Maintenance time: | ________ | (Hours per change) |
| 9. Labor Rate: | $ ________ | (Rate/hour) |
| 10. Savings: | $ ________ | (Lines: 9x8x7) |
| 11. Vehicle downtime rate: | $ ________ | (Rate/hour) |
| 12. Downtime saved: | $ ________ | (Lines: 11x8x7) |
| 13. Investment: | $ ________ | (Line: 5) |
| 14. Yearly Save: | $ ________ | (Line: 10+12) |
| 15. ROI: in years | ________ | (Line:13/14) |

6. Connectors located in unprotected areas shall incorporate a sealed environmental protection appropriate for the application.
7. Connector performance tests shall be:
   - Sealed Connector—SAE J2030, per section 4.2.
   - Unsealed Connector—SAE J2030, per section 4.4

**D. Wiring Installation Requirement**
The routing and clamping of LED lamp wiring shall follow standards outlined in SAE J2174, section 4.9 and SAE J2202, section 4.9.

**E. Internal Moisture Performance for LED Lamps**
LED lamps must meet requirements for internal moisture performance standards as per SAE J2139.

## CONCLUSIONS

Data indicates that the durability of LEDs exceeds that of incandescent light sources in every instance reviewed. LED technology has now improved to where it can replace incandescent lighting in some red and yellow lamps. Understanding the benefits of LED technology provides a means to meet important technical challenges facing the trucking industry today and into the future.

## REFERENCES

[1] Sivak, M., Flannagan, J.J., Sato, T., Traube, E.T., and Aoki, M., "Reaction Times to Neon, LED, and Fast Incandescent Brake Lamps," Report No. UMTRI-93-37, 1993,The University of Michigan Transportation Research Institute, Ann Arbor, MI.

[2] TMC RP 137, *Antilock Electrical Supply from Tractors Through the SAE J560 Seven Pin Connector*, Maintenance Council, American Trucking Assns., 2200 Mill Road, Alexandria, VA 22314.

[3] TMC RP 141, *Trailer ABS Power Supply Requirements,* Maintenance Council, American Trucking Assns., 2200 Mill Road, Alexandria, VA 22314.

[4] SAE J1128, *Low Tension Primary Cable,* The Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

[5] SAE J2202, *Heavy-Duty Wiring Systems for On-highway Trucks*, January 1996.

[6] SAE J2174, *Heavy-Duty Wiring Systems for Trailers,* October 1993.

[7] LED Lighting Study, Markinetics, 1995.