ISSN 1041-9489

SAFETY BRIEF

December, 2002 — Volume 22, No. 2

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Consulting Engineers & Scientists – Safety Philosophy & Technology

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Gladhands - An Achilles Heel in Truck Air Brakes

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Figure 1 - Semi-Trailer with Coiled Brake Air Hoses

Introduction

The *semi-trailer brakes* on a tractor-trailer combination receive their air supply from the *tractor's system* via two hoses which are hanging between the tractor and the trailer. (See Figure 1) One of the hoses feeds the service brakes on the trailer and the other feeds the emergency/parking system. The hoses hang down from the back of the tractor where they are permanently connected. The ends of the hoses are coupled to the front of the trailer using quick-connect couplings called "gladhands." Without the use of tools, a truck driver can quickly connect and disconnect the gladhands whenever s/he needs to couple or uncouple a semi-trailer. The reliability of the gladhand connections is critical to the operation of the trailer's brake system. If the service brake gladhand connection separates while driving, the driver will not sense there is a problem until attempting to stop. The air for the trailer's service brakes will then freely exhaust from the disconnected service brake gladhand and the trailer brakes will not apply. Without trailer brakes, a substantial amount of the rig's total braking power will be lost and there will be an elevated risk of jackknifing.

The Role of Gladhands

Compressed air generated by the tractor's compressor is supplied to the trailer by means of color-coded flexible tubing and gladhands (see Fig. 2). A red-colored hose, referred to as the "emergency line," provides air to the trailer's spring

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brakes and air tank reservoirs. While driving, this hose is normally pressurized at up to 120 psi. The pressure compresses the springs and releases the brakes. If the pressure is lost for any reason, the springs will be released and the brakes will automatically apply. Thus, a gladhand failure in the emergency circuit is rendered failsafe.

A blue-colored hose, referred to as the "service line," provides air to the trailer's service brakes. While driving, this hose is normally *not* pressurized. When the brake pedal is depressed, this hose becomes pressurized and the trailer brakes apply in synchronization with the tractor's brakes. A separation of the gladhand in the service brake circuit will cause the air to be exhausted rather than be used to apply the trailer's brakes, with potentially serious consequences. Figure 3 depicts the two brake hoses and the cable for the trailer electrical system.

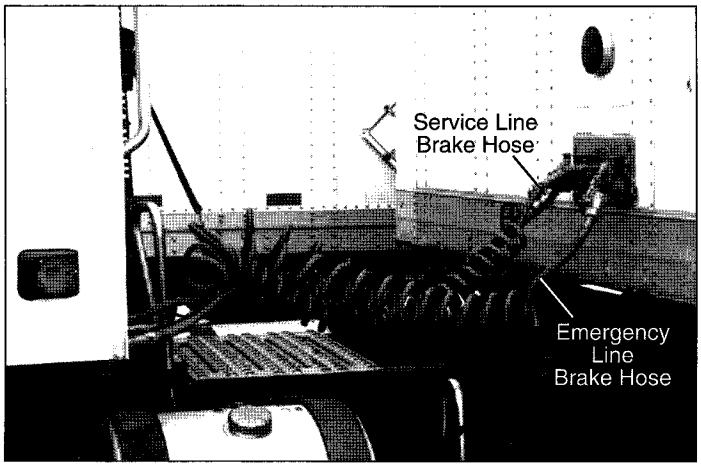

Figure 2 - Coiled Brake Hoses

The tractor's gladhands are connected by placing them into the mating gladhands attached to the front of the trailer and rotating them downwards about 80°. (See Figure 4) A holding detent and a stop provide a tactile signal to the driver's hands that the coupler is fully connected. Rubber seals between the matching gladhands prevent air from escaping through the connection. The emergency line gladhand incorporates an interference lug to prevent an inadvertent mismatch between the service and emergency gladhands while making the connection.

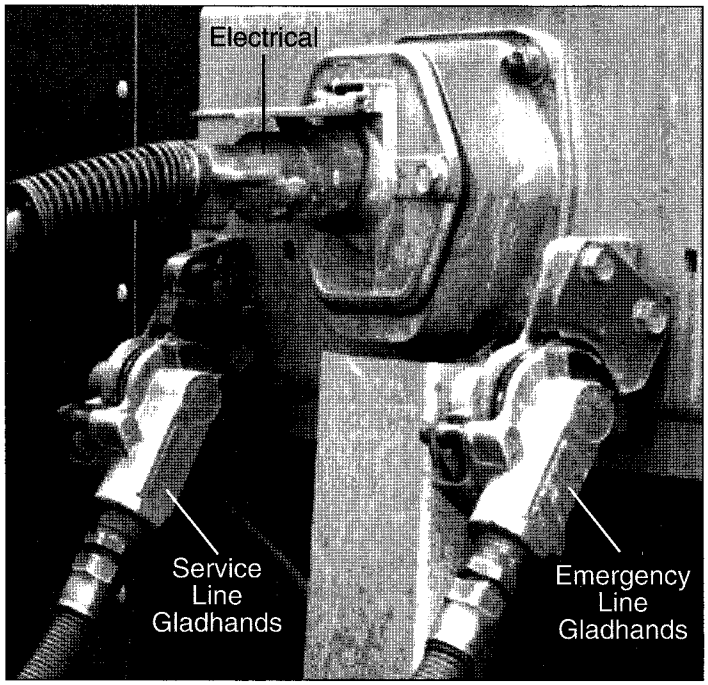

Figure 3 - Gladhands

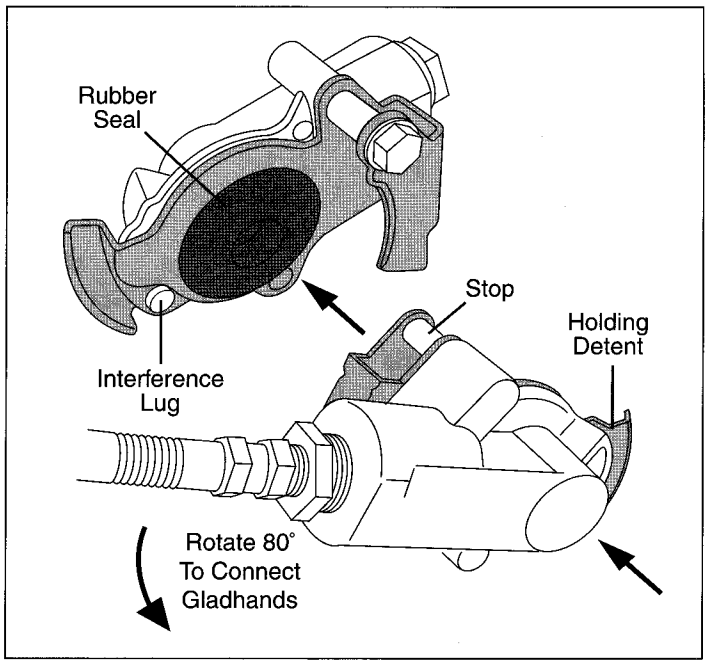

Figure 4 - Connecting Gladhands

Failure Mode Analysis

The ability of the gladhand connection to stay connected while in use depends on how completely the driver makes the connection and how tightly the rubber seal and detent hold the gladhands and keep them from rotating apart. In addition, the air pressure in the emergency line generates a force which acts to keep the connection tight. Since the service line is normally not pressurized, this additional holding force is not available in the service brake gladhand.

Every time a trailer is coupled to or uncoupled from a tractor the gladhands are connected or disconnected. Over the course of the service life of the tractor and trailer, the gladhands see thousands of cycles of use. In time, the rubber seal and detent will wear and the forces holding the gladhands together will deteriorate.

SAE Recommended Practice J318 includes a "Coupling and Uncoupling Torque Performance Test" which requires 100 ± 50 inch-pounds of torque to disconnect a pair of gladhands in a normal manner at ambient temperature after being subject to an endurance test of 2,500 cycles. At least 50 inch-pounds of torque must remain after the endurance testing to ensure that the gladhands stay connected in their expected application. During typical use, vibrations, bouncing and jouncing of the hoses will pull on the connection. The flexible brake hoses may behave like large Slinkies™ bouncing up and down as the vehicle travels, constantly tugging at the connection. Tensile forces can be generated from hoses that are too short. Oftentimes, hoses are pulled upward by hose suspension springs designed to compensate for slack in the hoses and prevent them from contacting the tractor's frame. If the wear on the rubber seal and detent becomes too severe, the gladhand connection may spontaneously separate while the truck is in use.

If the service brake gladhands separate during driving, the driver will not be aware of the failure until attempting to reduce speed. With the service gladhand disconnected, the trailer brakes will not apply. The total braking capacity of the truck is reduced to that which the tractor alone can provide, resulting in a substantial decrease in braking power and an increase in stopping distance. Also, when the driver senses that braking is abnormally weak, s/he may push harder on the brake pedal to demand more braking. This may cause the tractor's drive wheels to skid. Skidding the tractor wheels while the trailer wheels continue to roll may cause the tractor to jackknife. Following an accident, the disconnected gladhands may go unnoticed at the accident site. If the tractor and trailer are uncoupled during recovery from the accident scene, the evidence related to the failed gladhand is lost. While the driver may contend that the brakes failed, the cause of the failure will not be readily evident during inspection of the brake parts at some offsite facility.

Countermeasures:

The frequency of this type of brake failure in accidents is unknown because the failure is so easy to overlook after an accident. In addition, the significance of a worn out gladhand (except for air leakage) and the potentially serious consequences of a spontaneous separation is not readily apparent to drivers and mechanics. Most truck driver manuals, service manuals, pre-trip and post-trip inspection checklists do not address this potential problem. Typically, only leakage from the gladhand seals is addressed.

As a safety countermeasure, the potential for gladhand separation should be addressed in the relevant literature. For example, truck drivers and mechanics should be made aware of the potential consequences of badly worn gladhands and the need to periodically check their condition. The connection should feel tight and the holding force of the detent should be noticeable. The tractor air hoses should drape downward with sufficient slack to prevent pulling the gladhand forward and/or upwards during travel, and during sharp turns.

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December, 2002 – Volume 22, No. 2

Editor: Paula L. Barnett
Illustrated and Produced by
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