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COMPRESSED GAS ASSOCIATION, INC.

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4221 WALNEY ROAD, 5TH FLOOR
CHANTILLY, VA 20151
703-788-2700
cga@cganet.com

DESIGN CONSIDERATIONS FOR TUBE TRAILERS

This technical bulletin defines basic design considerations for new tube trailers (including tube modules) to maintain structural integrity during normal conditions of handling and transport. In addition these design considerations should reduce the likelihood of separation of the tubes from the trailer or bundle and minimize the unintentional release of product when subjected to the multidirectional forces that can occur in a highway collision including a rollover accident. Tube modules shall meet the loading and accident protection standards that are applied to tube trailers.

Definitions

For the purpose of this publication, the following definitions apply:

Endplug—fitting installed in the end of a tube that acts as an adapter between the tube and the pressure relief device (PRD), valve, or other fitting installed in the end of the tube.

NOTE—Also known as a bullplug.

Internal PRD—pressure- and/or temperature-activated device used to prevent the pressure in a tube from rising above a predetermined maximum, which is installed within the tube and/or endplug to protect it from accidental damage that may cause the device to activate prematurely.

Motor vehicle—vehicle, machine, tractor, trailer, or semi-trailer, or any combination thereof, propelled or drawn by mechanical power and used on the highways in the transportation of passengers or property.

Tube—seamless compressed gas cylinder.

NOTE—A tube is authorized for transportation only when horizontally mounted on a motor vehicle or in an ISO framework or other framework of equivalent structural integrity.

Tube bundle—group of tubes and their related attachments such as bulkheads or saddles.

NOTE—This grouping of tubes and related attachments and framework cannot be used independently of the tube trailer or tube module.

Tube trailer—trailer or semi-trailer motor vehicle designed specifically for the transportation of horizontally mounted tube bundles.

Tube module—assembly, comprised of a tube bundle mounted within a structural frame, which is designed to be temporarily mounted on a motor vehicle for transportation.

NOTE—This group of tubes and related attachments and framework forms a stand-alone unit attached to the trailer chassis as a whole, separate and distinct unit. Tube modules are also commonly referred to as skid containers, ISO skids, ISO containers, or multiple-element gas containers.

Basic design considerations

In addition to current U.S. Department of Transportation (DOT) regulations, tube trailers shall be designed to withstand the static, dynamic, and thermal loads found during normal conditions of handling and transport without loss of contents. The design shall demonstrate consideration of the effects of fatigue caused by repeated application of these loads through the expected life of the tube trailer. The design shall address the following key areas:

- mounting of individual tubes in the tube bundle;

- attachment of the tube bundle to the motor vehicle chassis or attachment of a tube bundle to a tube module structural frame; and
- accident damage protection for pressure-retaining equipment.

Accurate and verifiable performance testing, analytical methods, or a combination thereof, shall be used to prove the adequacy of the design.

For each of the loading conditions described in this bulletin, the safety factor for the materials used in the construction of the framework and fastenings shall be as follows:

- for steels having a clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed yield strength;
- for steels with no clearly defined yield point, a safety factor of 1.5 in relation to the guaranteed 0.2% proof strength, and for austenitic steels, the 1% proof strength; or
- for materials other than steel, design practices shall ensure a level of safety equivalent to those established for steel.

Mounting of tubes in the tube bundle

The tubes shall be mounted in a manner that minimizes frictional wear under normal operating conditions.

The mounting apparatus for the individual tubes should be capable of withstanding the following separately applied static forces:

- in the direction of travel (fore and aft), a force equivalent to two times the weight of the individual tube plus the maximum weight of the contents;
- horizontally at right angles to the direction of travel, two times the weight of the individual tube plus the maximum weight of the contents;
- vertically upwards, the weight of the individual tube plus the maximum weight of the contents; and
- vertically downwards, two times the weight of the individual tube plus the maximum weight of the contents.

Attachment of the tube bundle to either the motor vehicle chassis or to the tube module structural frame

The tube bundle and method of attachment should be capable of withstanding the following separately applied static forces:

- in the direction of travel (fore and aft), a force equivalent to two times the total weight of the tube bundle including the maximum weight of the contents;
- horizontally at right angles to the direction of travel, two times the total weight of the tubes including the maximum weight of the contents plus the weight of the associated framework that forms the tube bundle;
- vertically upwards, the total weight of the tubes including the maximum weight of the contents plus the weight of the associated framework that forms the tube bundle; and
- vertically downwards, twice the total weight of the tubes including the maximum weight of the contents plus the weight of the associated framework which forms the tube bundle.

If the tube bundle is left unrestrained in the direction along the axis of the tubes to accommodate thermal expansion, any of the previously listed forces that are applied along the axis of the tube shall be evaluated at the fixed end of the bundle only.

Accident damage protection

Each tube trailer should be designed to minimize the potential for loss of lading due to an accident including rollover. At a minimum, the design shall address all valves, PRDs, and other piping components in direct communication with the lading (up to and including the first closed shutoff valve) that shall be installed:

- within the envelope of the tube or endplug (internal PRD);
- within the motor vehicle framework; or
- within a suitable collision-resistant guard, protective device, or housing.

Each protective device or housing and its manner of attachment to the vehicle structure shall be designed to minimize the loss of product lading when subjected to static loading as a result of front, rear, side, or sideswipe collision, or the overturn of the vehicle. The static loading shall equal two times the loaded gross weight of the motor vehicle combination. The stresses shall not exceed the ultimate tensile strength of the material used. The housing shall be suitable for use in normal operations without adding additional personnel hazards. Accurate and verifiable performance testing, analytical methods, or a combination thereof, can be used to prove the adequacy of the design.

Any valve or PRD not protected with a collision-resistant guard or housing shall be designed so damage resulting in breakage of the device minimizes the loss of lading.

Each discharge device such as vent tube shall be protected to reduce the likelihood of damage to the attached PRD if the vehicle is upset onto a hard surface (including rollover).

Each tube trailer shall be provided with at least one rear bumper designed to protect the tubes and piping in a rear end collision. The bumper design shall transmit the force of the collision directly to the chassis of the vehicle. The rear bumper and its attachments to the chassis shall meet the requirements of Title 49 of the U.S. *Code of Federal Regulations* (49 CFR) Part 393.86, "Rear impact guards and rear end protection," and it shall be designed, constructed, labeled, and maintained in accordance with 49 CFR Part 571, Standard No. 223, "Rear impact guards" and Standard No. 224, "Rear impact protection" [1].

Reference

Unless otherwise specified, the latest edition shall apply.

[1] *Code of Federal Regulations*, Title 49 (Transportation) Parts 393 and 571, Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. www.gpoaccess.gov

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