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8484 WESTPARK DRIVE, SUITE 220,
MCLEAN, VA 22102
(703) 788-2700 | www.cganet.com

POSITION STATEMENT

USE OF RAILROAD TANK CARS FOR STATIONARY LIQUID CARBON DIOXIDE STORAGE

Background

In the 1950s and 1960s, many railroad pressure tank cars designed for ambient temperature shipment of liquefied petroleum gas (LPG) and ammonia were manufactured using ASTM A212 Grade B and A285 Grade C carbon steels. The ASTM A212 specification was withdrawn in 1967 and replaced by ASTM A515. ASTM A285 Grade C and A515 Grade 70 carbon steels continued to be used through the 1970s, but none of these materials are presently authorized for construction of new railroad tank cars because of inadequate low temperature fracture resistance.

Typically these railroad tank cars have the designation ICC 112A340W, DOT 112A340W, DOT 112J340W, DOT 112S340W, or DOT 112T340W. These railroad tank cars were constructed to meet Interstate Commerce Commission (ICC), U.S. Department of Transportation (DOT), or Association of American Railroads (AAR) standards and were not designed or stamped to meet the requirements in Section VIII, Division 1 of the *ASME Boiler & Pressure Vessel Code* (ASME Code) [1].

The minimum design metal temperature (MDMT) for A212 Grade B and A515 is 20 °F (−6.7 °C) in accordance with ASME Code [1]. Several accidents have been reported where railroad tank cars manufactured with A212 Grade B carbon steel ruptured due to derailments or other impacts that occurred at ambient temperatures below the MDMT.

A variation on the DOT 112A340W design is the “dual diameter” railroad tank car. These cars had standard diameter ends over the trucks, but a larger diameter center section between the trucks. A number of these cars have failed in service leading the National Transportation Safety Board to issue a safety recommendation that the Federal Railroad Administration requires operators of dual diameter railroad tank cars to inspect them for evidence of cracks [2].

Some of the dual diameter railroad tank cars have been converted for use as stationary liquid carbon dioxide storage containers. There are two classes of liquid carbon dioxide containers: customer tanks that typically operate at 300 psi to 350 psi (with corresponding saturation temperatures of approximately 2 °F to 11 °F [−16.8 °C to −11.7 °C]); and plant or depot tanks that typically operate at 200 psi to 250 psi (with corresponding saturation temperatures of approximately −20 °F to −8 °F [−28.9 °C to −22.2 °C]). All of these temperatures are well below the MDMT for A212 Grade B, A285 Grade C, and A515 Grade 70 carbon steels.

There has been at least one documented accident where a DOT 112A340W railroad tank car converted to stationary liquid carbon dioxide storage service ruptured due to metal embrittlement resulting in one death, multiple injuries, and significant property damage.

Currently the typical railroad tank cars certified to transport refrigerated liquid carbon dioxide are designated DOT 105A500W or DOT 105J500W as defined in Title 49 of the U.S. *Code of Federal Regulations* (49 CFR), Part 174 [3]. These railroad tank cars are designed with an MDMT of −50 °F (−45.6 °C) and are manufactured to meet DOT/TC and AAR specifications.

Railroad tank cars have a limited frame life, but the tanks can have an unlimited life in accordance with the AAR *Manual of Standards and Recommended Practices*, Section C, Part III, Paragraph 1.3.10 “Age Limits”:

“There is no life limit on a tank car tank if the tank conforms to both the federal regulations and the AAR requirements. Underframes built prior to July 1, 1974, have an AAR life limit of 40 years, unless the underframe is rebuilt or has received extended service status. Underframes built since July 1, 1974, have an AAR life limit of 50 years.

When applying a tank to a new or existing underframe, the Tank Car Committee must approve the application. After applying a tank to a new or existing underframe, the tank must be qualified to verify tank integrity” [4].

Some DOT 105A500W or DOT 105J500W railroad tank cars that have been retired from service have been purchased and converted to stationary carbon dioxide service. These cars have been manufactured to meet DOT and AAR standards metal alloy designations that are similar to, but not recognized by, ASME for stationary pressure vessels.

Questions

1. Should ICC 112A340W, DOT 112A340W, DOT 112J340W, DOT 112S340W, or DOT 112T340W railroad tank cars manufactured with ASTM A212 Grade B, A285 Grade C, and A515 Grade 70 be used for stationary liquid carbon dioxide storage?

2. Should DOT 105A500W or DOT 105J500W railroad tank cars be used for stationary liquid carbon dioxide storage?

Answers

1. The Compressed Gas Association, Inc., (CGA) strongly recommends that railroad tank cars manufactured with ASTM A212 Grade B, A285 Grade C, and A515 Grade 70 not be used for stationary liquid carbon dioxide storage, based on the following:

- The railroad tank cars were built to ICC or DOT/TC regulations, not ASME Code. Most states and local jurisdictions require that stationary pressure vessels be manufactured and stamped to meet ASME Code requirements. Because railroad tank cars do not meet ASME Code requirements, they cannot be installed in most jurisdictions as stationary containers;
- The material(s) from which the railroad tank cars were manufactured does not have sufficient low temperature fracture resistance and is therefore not suitable for the temperatures encountered in liquid carbon dioxide storage; and
- This type of railroad tank car has experienced container failures even in the services for which it was originally designed.

For more information see CGA G-6.12, *Standard for the Suitability of Carbon Steel Containers for Stationary Carbon Dioxide Storage* [5].

2. CGA recommends that DOT105A500W and DOT105J500W tank cars not be converted to stationary liquid carbon dioxide storage for the following reasons:

- ASME Code certification is required for stationary pressure vessels by all but a few states and most local jurisdictions;
- The materials of construction and certification are to DOT/TC specifications, which only apply to the transportation of hazardous goods;
- Railroad tank car pressure vessels have been subjected to mechanical abuse in service that far exceeds those of normal ASME stationary pressure vessels;
- DOT/TC requires that railroad tank cars be internally inspected every 10 years, which is not required for stationary ASME pressure vessels;
- Railroad tank car safety relief devices are not designed in accordance with ASME Code;
- DOT/TC requires that safety relief devices be tested every 5 years, which is not required for stationary ASME pressure vessels;
- Railroad tank cars have no bottom connections and are not well suited for stationary liquid service; and
- Railroad tank cars are not designed for overfill protection as are stationary tanks.