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Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

Sub-Committee of Experts on the Transport of Dangerous Goods
Geneva, 21-30 June 2010
Item 5 of the provisional agenda
Miscellaneous proposals of amendments to the Model Regulations on the Transport of Dangerous Goods

Dynamic longitudinal impact testing of UN MEGCs, section 41.2.2 of the Manual of Tests and Criteria

Transmitted by the Compressed Gas Association (CGA), European Industrial Gases Association (EIGA), and International Tank Container Organisation (ITCO)

Introduction

1. The Sub-Committee adopted the current method for dynamic longitudinal impact testing of UN portable tanks and multiple-element gas containers (MEGCs) in 2004, based on a proposal from the expert from Canada, at the twenty-sixth session (see ST/SG/AC.10/C.3/52, para. 104). The impact test protocol has since been successfully used by testing establishments in various parts of the world and has been adopted into various regulatory instruments, including the IMDG Code, European RID/ADR/ADN, and U.S. 49 CFR.

2. During consideration of the Canadian impact testing proposal by this Sub-Committee in 2004, it was noted that ISO/TC 104/SC 2 had been working on standardising the impact test protocol since 1996 and that the work at ISO was continuing. An amendment to ISO 1496-3 adopting the impact test requirements was finally published in February 2006. The test requirements included in ISO 1496-3 were identical to those adopted in the Manual of Tests and Criteria under the UN Recommendations on the Transport of Dangerous Goods (TDG) in 2004, except for the "permitted design variations". These variations describe the permissible range of designs qualified (for impact test only) by a successful prototype impact test.

3. At the thirty-fourth session in December 2008 (see ST/SG/AC.10/C.3/68, para. 76 and ST/SG/AC.10/36/Add.2), the Sub-Committee recognised the improvements made within the ISO standard regarding these "permitted design variations" and adopted this text

into the Manual of Tests and Criteria, such that the test protocol and the permitted design variations, as they apply to portable tanks, were completely harmonised with ISO 1496-3 Annex D. It was noted that ISO 1496-3 applies only to portable tanks meeting the definition of container in the International Convention for Safe Containers (CSC) (tank containers), intended for the transport of liquids, liquefied gases, and solids (pressurised dry bulk); MEGCs are outside the scope of ISO 1496-3.

4. In December 2008, the Sub-Committee decided to have the previous text regarding permitted design variations remain applicable for MEGCs, although it was recognised that further work would be needed to improve that text and its applicability to MEGCs. CGA, EIGA, and ITCO have hence collaborated to establish the following proposal regarding "permitted design variations" for MEGCs, in consultation with technical experts from Transport Canada and the U.S. Department of Transportation.

5. The Sub-Committee is reminded that these "permitted design variations" merely relate to the requirement, or not, to conduct a further qualifying dynamic longitudinal impact test, following a design change (for example, a change in diameter, material of construction, maximum permissible gross mass, etc.). Moreover, any such design variation must always also be set against the requirements to conform separately to a design approval certificate issued by the competent authority. It is therefore understood that a "permitted design variation", specified in 41.2 of the Manual of Tests and Criteria, may qualify further production models without the need to conduct a further impact test, but may require a new design type approval. (Reference is made to 6.7.2.18, 6.7.3.14, 6.7.4.13, and 6.7.5.11 of the Model Regulations.)

Background

6. The following proposal regarding "permitted design variations" for prototype impact testing of MEGCs was developed collaboratively by representatives from MEGC manufacturers, MEGC users, and impact test experts, in consultation with competent authorities. These permitted design variations will not compromise the ability of a MEGC to contain safely both the elements and the lading under conditions specified in the impact test and are consistent with current impact test results and practices.

7. In contrast with most portable tank designs, wherein the outer shell is an integral part of and welded to the framework structure, the elements of a MEGC are not secured in this manner. The elements are secured by mechanical fasteners to a bulkhead within the framework and are not as directly loaded as a portable tank shell. (It should be noted that 6.7.5.10.2 of the Model Regulations states that "[i]n no case shall mountings or attachments be welded onto the elements.") The bulkhead transfers loads/stresses from the elements to the longitudinal and diagonal members of the framework, but the bulkhead is actually located away from the corner castings connecting the longitudinal and diagonal members. (Photographs and drawings are provided in the Annex to illustrate examples of MEGCs and how the elements of a MEGC are secured to the bulkhead and framework, in comparison to examples of portable tanks and how most portable tanks are secured to the framework.)

8. It should be noted that, for permitted MEGC design variations not requiring additional impact testing, the mounting apparatus and/or method of attachment of the elements to the framework must remain the same as that for the already-tested prototype MEGC design.

9. A reduction in mass results in a reduction in stress. Hence, a decrease in the mass of the elements and their lading, individually and in total, would result in a decrease in the damaging stresses that are transferred to the attachments and overall framework of the MEGC.

10. It is feasible for the length of an element to decrease and the diameter of the element to increase, with the mass of that element (with its lading) decreasing. Conversely, it is also feasible for the length of an element to increase and the diameter of the element to decrease, with the mass of that element (with its lading) decreasing. In proposed paragraphs 41.2.2(e) and (f), permitted increases in the diameter or length of the elements are limited to restrict the possibility of damaging stresses that would result from excessive increases in the diameter or length of the individual elements; permitted decreases in the diameter or length of the elements are limited to prohibit an excessive reduction in the role that the elements play in a successful prototype impact test.

11. The length of a MEGC framework may be decreased to a certain extent without it negatively affecting its performance in or the applicability of the results of a dynamic longitudinal impact test. In proposed paragraph 41.2.2(g), the permitted decrease in the length of a MEGC framework is limited to not more than 3.1 metres (10 feet) to restrict the possibility of damaging stresses that would result from excessive reductions in length. The 10-foot length is based on the standard increments of ISO containers, and current practices and impact test results justify a reduction of a 40-foot-long MEGC design to 30 feet, or a 20-foot-long MEGC design to 10 feet, without additional impact testing. Based on the provision in 6.7.5.11.1 of the Model Regulations for "approval of smaller MEGCs", these reductions in length have been supported by authorised third-party inspection bodies for many years.

12. The height of a MEGC may be decreased significantly without it negatively affecting its performance in or the applicability of the results of an impact test. In proposed paragraph 41.2.2(h), the permitted decrease in the height of a MEGC is limited to not more than 50% to restrict the possibility of damaging stresses that would result from excessive reductions in height. The 50% value is based on standard-height ISO containers, and current practices and impact test results justify, for example, a reduction of an 8-foot-6-inch-high MEGC design to 4 feet 3 inches in height, without additional impact testing. The height of MEGC designs has regularly been decreased to various heights within this 50% range with a strong safety record. Also based on the provision in 6.7.5.11.1 of the Model Regulations for "approval of smaller MEGCs", these reductions in height have been supported by authorised third-party inspection bodies for many years.

13. Within a given MEGC framework, the number of elements may be decreased, thereby decreasing the total mass of the elements. Within a given MEGC framework, it is also feasible for the diameter of the elements to decrease, allowing the number of elements to increase; increases in the number of elements would be limited by other criteria for permitted design variations, such as prohibitions from increasing the maximum permissible gross mass (in accordance with proposed paragraph 41.2.2(c)), the total mass of the elements and their lading (in accordance with proposed paragraph 41.2.2(d)), and the height of the MEGC (in accordance with proposed paragraph 41.2.2(h)). In proposed paragraph 41.2.2(i), the permitted change in the number of elements is limited to not more than 50% to restrict the possibility of damaging stresses that would result from excessive increases or decreases in the quantity of the individual elements.

14. MEGCs do not have nozzles and manholes, baffles and surge plates, and insulation systems; these components feature only on certain types of portable tanks.

15. Welding only applies to the MEGC framework and not the elements. Whereas portable tanks shells are welded, 6.7.5.2.3 of the Model Regulations requires that elements of a MEGC be made of seamless steel.

16. Pressure does not have a bearing on the impact test. It should be noted that 41.3.4.1(b) of the Manual of Tests and Criteria states that MEGCs shall not be pressurised during the impact test. Any change in working pressure or test pressure that affects the wall

thickness of the elements or mass is addressed by other criteria for permitted design variations.

17. Service equipment and manifolds have a limited mass and thus an insignificant effect on the structural integrity of a MEGC. (Note that “service equipment” and “manifold” are defined in 6.7.5.1 of the Model Regulations.) In accordance with 41.3.4.1(b) of the Manual of Tests and Criteria, the impact test is performed with the elements containing water or other non-pressurised substances, and the tested MEGC is not fitted with all of the exact service equipment necessary for specific gas services. Components such as valves, gauges, manifold piping, and pressure-relief devices do not contribute to the structural integrity of the MEGC. However, in proposed paragraph 41.2.2(k), the permitted change in the service equipment and manifold is specified such that their total mass may not change more than 10% of the maximum permissible gross mass (MPGM) of the MEGC, to address any concerns regarding “unlimited” changes to the service equipment and manifold. (It should be noted that it is actually unnecessary to include the qualification that a change to the service equipment and manifold must not result in an increase in the MPGM as compared to that of the already-tested prototype, since that is already limited by proposed paragraph 41.2.2(c), but it was thought that it would be more clear to repeat that requirement in proposed paragraph 41.2.2(k).)

Proposal

18. Amend 41.2.2 of the Manual of Tests and Criteria to read as follows:

"41.2 Permitted design variations

The following variations in container design from an already tested prototype are permitted without additional testing:

41.2.1 *Portable tanks*

(a) A reduction of no more than 10% or an increase of no more than 20% in capacity, resulting from variations in diameter and length;

(b) A decrease in maximum permissible gross mass;

(c) An increase in thickness, independent of design pressure and temperature;

(d) A change to the grade of material of construction provided that the permitted yield strength meets or exceeds that of the tested portable tank;

(e) A change in location of, or a modification to, nozzles and manholes.

41.2.2 *MEGCs*

(a) A decrease in the ~~initial~~ maximum design temperature, not affecting thickness;

(b) An increase in the ~~initial~~ minimum design temperature, not affecting thickness;

(c) A decrease in the maximum permissible gross mass;

(d) A decrease in the mass of each individual element and its lading or a decrease in the total mass of the elements and their lading;

(~~d~~e) ~~A reduction in capacity not exceeding 10% resulting only from variations in diameter or length;~~ An increase of no more than 10% or a decrease of no more than 40% in the diameter of the elements;

(f) A change of no more than 10% in the length of the elements;

(g) A decrease of no more than 3.1 metres (10 feet) in the length of the MEGC framework;

(h) A decrease of no more than 50% in the height of the MEGC;

(i) A change of no more than 50% in the number of elements;

~~(e) A change of location or a modification to nozzles and manholes provided that:~~

~~(i) An equivalent level of protection is maintained; and~~

~~(ii) The most unfavourable configuration is used for the purpose of the tank strength calculations;~~

~~(f) An increase in the number of baffles and surge plates;~~

(~~g~~j) An increase in the ~~wall~~ thickness of the materials of the framework provided the thickness stays within the range permitted by the welding procedures specifications;

~~(h) A decrease of the maximum allowable working pressure, or maximum working pressure, not affecting thickness;~~

~~(i) An increase in the insulation system effectiveness from using:~~

~~(i) A greater thickness of the same insulating material; or~~

~~(ii) The same thickness of a different insulating material having better insulation properties;~~

(~~j~~k) A change to the service equipment and manifold ~~provided that the untested service equipment:~~

~~(i) Is located at the same place and meets or exceeds the same performance specification as the existing equipment; and~~

~~(ii) Is approximately of the same size and mass as the existing equipment; and~~

such that the total mass of the service equipment and manifold changes no more than 10% of the maximum permissible gross mass (but not resulting in an increase in the maximum permissible gross mass as compared to that of the already-tested prototype);

(~~k~~l) The use of a different grade of the same type of material for the construction of the ~~shell or~~ framework, provided that:

(i) The results of the design calculations for the different grade, using the most unfavourable specified values of mechanical properties for that grade, meet or exceed the results of the design calculation for the existing grade; and

(ii) The alternate grade is permitted by the welding procedures specifications.

Annex

English only

Figure 1: 40-foot-long MEGC (full-length and full-height – 12 tubes)

Figure 2: MEGC undergoing an impact test

Figure 3: 40-foot-long MEGC (full-length and half-height – 8 tubes)

Figure 4: 20-foot-long MEGC (half-length and full-height – 10 tubes)

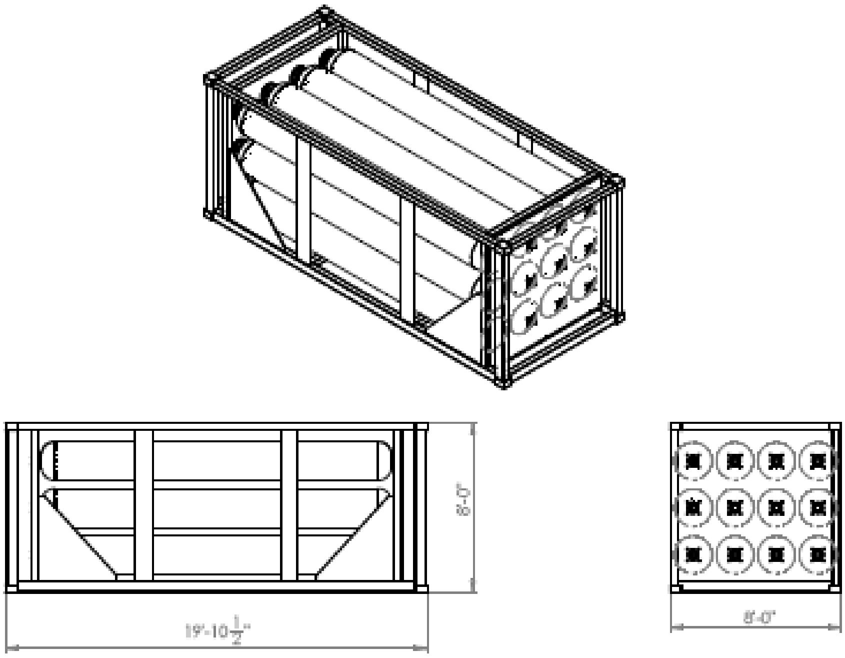

Figure 5: Drawing of 20-foot MEGC (half-length and full-height – 12 tubes)

Figure 6: 20-foot-long MEGC (half-length and half-height – 8 tubes)

Figure 7: Front view of bulkhead on 8-tube MEGC

Figure 8: Tube end with flange threaded to tube neck and bolted to MEGC bulkhead

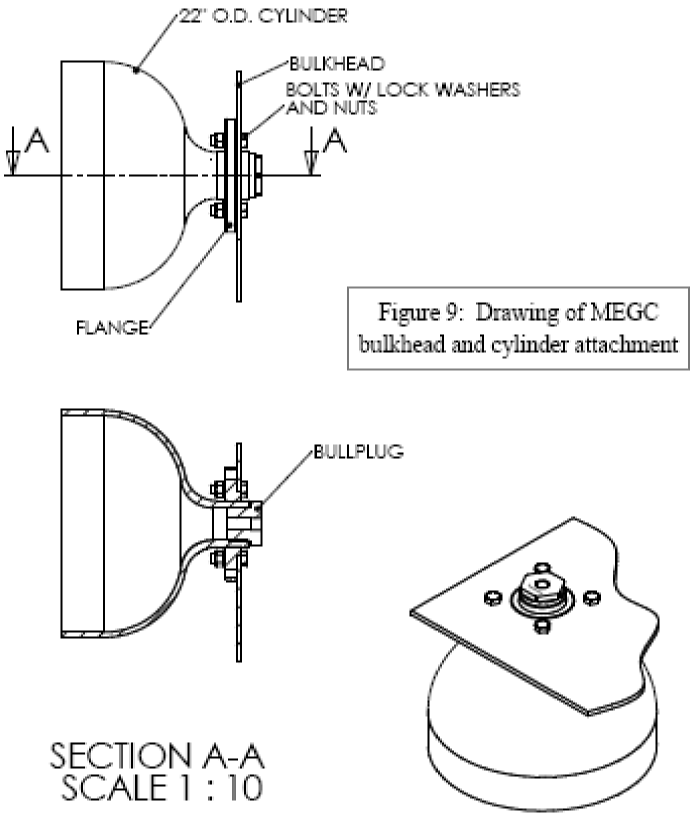

Figure 9: Drawing of MEGC bulkhead and cylinder attachment

Figure 10: Vacuum-jacketed cryogenic portable tank

Figure 11: Vacuum-jacketed cryogenic portable tank
