INTERNATIONAL STANDARD

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Liquefied natural gas (LNG) — Tanks for on-board storage as a fuel for automotive vehicles

Gaz naturel liquéfié (GNL) — Réservoirs pour le stockage à bord comme carburant pour véhicules automobiles

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 12991 was prepared by Technical Committee ISO/TC 220, *Cryogenic vessels*.

Introduction

The fuel tanks described in this International Standard are intended to be used in conjunction with the fuelling system interface described in ISO 12617, which is under preparation.

Liquefied natural gas (LNG) — Tanks for on-board storage as a fuel for automotive vehicles

1 Scope

This International Standard specifies the construction requirements for refillable fuel tanks for liquefied natural gas (LNG) used in vehicles as well as the testing methods required to ensure that a reasonable level of protection from loss of life and property resulting from fire and explosion is provided.

This International Standard is applicable to fuel tanks intended to be permanently attached to land vehicles but can be used as a guide for other mode of transport.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1176, *Road vehicles — Masses — vocabulary and codes*

ISO 1431-1, *Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 1: Static and dynamic strain testing*

ISO 2768-1, *General tolerances — Part 1: Tolerances for linear and angular dimensions without individual tolerance indications*

ISO 6957, *Copper alloys — Ammonia test for stress corrosion resistance*

ISO 9227, *Corrosion tests in artificial atmospheres — Salt spray tests*

ISO 21013-3, *Cryogenic vessels — Pressure-relief accessories for cryogenic service — Part 3: Sizing and capacity determination*

ISO 21014, *Cryogenic vessels — Cryogenic insulation performance*

ISO 21028-1, *Cryogenic vessels — Toughness requirements for materials at cryogenic temperature — Part 1: Temperatures below -80 degrees C*

ISO 21029-1:2004, *Cryogenic vessels — Transportable vacuum insulated vessels of not more than 1 000 litres volume — Part 1: Design, fabrication, inspection and tests*

ISO 23208, *Cryogenic vessels — Cleanliness for cryogenic service*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
accessory
device fixed directly to the inner tank or outer jacket of a fuel tank such as a pressure relief valve, shut-off valve, non-return valve or level gauge

3.2
boil-off management system
system that controls the boil-off of gas under normal conditions

3.3
burst pressure
pressure that causes the rupture of a pressure vessel subjected to a constant increase of pressure during a destructive test

3.4
design temperature
temperature of the inner tank, the outer jacket and all other accessories to which fabrication drawings, inspections and physical measurements such as volume are referred

3.5
fuel tank
vessel used for the storage of cryogenic liquefied natural gas (LNG) fuel

3.7
impermissible fault range
pressure range within which an unwanted event is to be expected

3.8
inner tank
part of the fuel tank that contains liquefied natural gas (LNG)

3.9
level gauge
device that measures the level of liquefied natural gas (LNG) in the fuel tank

3.10
maximum allowable working pressure
MAWP
maximum pressure to which a component is designed to be subjected to and which is the basis for determining the strength of the component under consideration

3.11
normal operating range
range planned for the process values

NOTE In the case of inner tanks, the normal operating range of the inner tank pressure is from 0 bar to the set pressure of the primary pressure relief valve, which is lower than or equal to the maximum allowable working pressure (MAWP) of the inner tank.

3.12
outer jacket
part of the fuel tank that encases the inner tank(s) and its insulation system

3.13
outer pressure
pressure acting on the outside of the inner tank or outer jacket

3.14
permissible fault range
range between the normal operating range and the impermissible fault range

3.15
pressure
pressure for which the value is equal to the algebraic difference between the absolute pressure and the atmospheric pressure

NOTE This is also known as gauge pressure.

3.16
holding time
time of the pressure increase in the inner tank measured from a starting pressure of 0 bar at the corresponding boiling point of liquefied natural gas (LNG) (–164° C) up to the maximum allowable working pressure (MAWP) of the inner tank

NOTE The holding time is a measure of the insulation performance of the fuel tank.

3.17
batch inner tank heads
number (no more than 100) of tank heads produced by the same manufacturer, from the same material, and having the same dimensions

3.18
maximum mass
a maximum authorized total mass, as defined in ISO 1176

4 Requirements

4.1 General requirements

The fuel tank and its accessories shall function in a correct and safe way. It shall withstand and remain gas tight when subjected to the mechanical, thermal and chemical stresses specified in this International Standard.

4.2 Mechanical stresses

4.2.1 Inner/outer pressure

4.2.1.1 Inner tank

The inner tank shall be designed to resist the following inner test pressure:

$$p_{\text{test}} = 1{,}3(\text{MAWP} + 1)$$

$$\left[p_{\text{test}} = 1{,}3(\text{MAWP} + 0{,}1)(MPa)\right]$$

where

p_{test} is the test pressure, expressed in bar

MAWP is the maximum allowable working pressure of the inner tank, expressed in bar. The inner tank and its accessories shall be designed to resist an outer pressure of 1 bar.

4.2.1.2 Outer jacket

The outer jacket shall be designed to resist an outer pressure of 1 bar (see 4.5.2).

4.2.2 Accelerations

4.2.2.1 General

The fuel tank and its accessories shall be mounted and protected so that the accelerations shown in Table 1 can be absorbed without structural damage to the fuel tank and its accessories. No uncontrolled release of LNG is permitted.

Table 1 — Accelerations

Vehicle categories	Accelerations
Vehicles of categories M1 and N1	20 g in the direction of travel
	8 g horizontally perpendicular to the direction of travel
Vehicles of categories M2 and N2	10 g in the direction of travel
	5 g horizontally perpendicular to the direction of travel
Vehicles of categories M3 and N3	6,6g in the direction of travel
	5 g horizontally perpendicular to the direction of travel
The vehicle categories include the following:	
— Category M1: Vehicles used for the transportation of passengers and comprising not more than eight seats in addition to the driver's seat.	
— Category M2: Vehicles used for the transportation of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass that does not exceed 5 000 kg.	
— Category M3: Vehicles used for the transportation of passengers, comprising more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5 000 kg.	
— Category N1: Vehicles used for the transportation of goods and having a maximum mass that does not exceed 3 500 kg	
— Category N2: Vehicles used for the transportation of goods and having a maximum mass exceeding 3 500 kg, but not exceeding 12 000 kg.	
— Category N3: Vehicles used for the transportation of goods and having a maximum mass exceeding 12 000 kg.	

4.2.2.2 Inner and outer support

When exposed to the accelerations described in Table 1, the stress in the support elements shall not exceed the minimum ultimate tensile strength of the material (R_m, calculated according with the linear stress model).

The allowable stress in the support elements may not have to be calculated if it can be demonstrated that the fuel tank supports the accelerations given in Table 1 without any structural damage to the inner tank or its supports.

Acceptable calculation methods include

— finite element,

— finite difference,

— boundary element, and

— established calculation method.

In these calculations static loads shall be substituted for static plus dynamic loads.

4.3 Thermal stresses

4.3.1 Design temperature

The design temperature of the inner tank, the outer jacket and the accessories shall be 20°C. In addition, the inner tank, the outer jacket and the accessories shall be designed to withstand a temperature range from the lowest to the highest possible operating temperatures that will be encountered in service.