

# R110 LNG ISO Progress

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Chart, Inc.

# Codes, Standards & Guidelines

- TPED (EN 1251)
  - DOT 4L (49 CFR 178.57)
  - 49 CFR 393 Subpart E
  - NFPA 52 / 57
  - CGA S-1.1 / S-1.2
  - SAE J2343
  - Product Manual(s)
- 
- ECE R110 \*
  - ISO 12991 \*\*

\* Not applicable below -40 °C

\*\* Not yet finalized

# Inconsistencies

- Applied Loads & Evaluation Criteria
  - NFPA 52 / 57
    - 8G vs. 'No loss of contents'
  - ECE R110 / ISO 12991
    - 6.6G & 5G → 20G & 8G
    - 'No damage' (R110) FEA required
    - Tensile strength / 2 (ISO)
  - TPED (EN 1251)
    - 2G vs. 0.67 → 0.9 Yield Strength
    - Test method alternative
  - SAE J2343 / 49 CFR 393 Subpart E
    - Drop tests vs. 1 oz / min leak rate

# Inconsistencies

- Bonfire Tests
  - ECE R110 / R67
    - At 590 °C until full release / burst
    - PRD (temp) vs. PRV (press)
  - CGA C-14
    - At 649 °C; partial release within 10 min & complete release within 20 min
  - SAE J2343
    - At 538 °C below RVP for 20 min
  - ISO 12991
    - At 590 °C hold-time > 5 min

# TC220 – ISO 12991 (DIS)

Table 1 — Accelerations

Vehicle categories	Accelerations
Vehicles of categories M <sub>1</sub> and N <sub>1</sub>	20 g in the direction of travel 8 g horizontally perpendicular to the direction of travel
Vehicles of categories M <sub>2</sub> and N <sub>2</sub>	10 g in the direction of travel 5 g horizontally perpendicular to the direction of travel
Vehicles of categories M <sub>3</sub> and N <sub>3</sub>	6,6 g in the direction of travel 5 g horizontally perpendicular to the direction of travel
<p>The vehicle categories include the following :</p> <ul style="list-style-type: none"><li>— Category M<sub>1</sub> : Vehicles used for the transportation of passengers and comprising not more than eight seats in addition to the driver's seat.</li><li>— Category M<sub>2</sub> : 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.</li><li>— Category M<sub>3</sub> : 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.</li><li>— Category N<sub>1</sub> : Vehicles used for the transportation of goods and having a maximum mass that does not exceed 3 500 kg</li><li>— Category N<sub>2</sub> : Vehicles used for the transportation of goods and having a maximum mass exceeding 3 500 kg, but not exceeding 12 000 kg.</li><li>— Category N<sub>3</sub> : Vehicles used for the transportation of goods and having a maximum mass exceeding 12 000 kg.</li></ul>	

# TC220 – ISO 12991 (DIS)

## 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 ;
- established calculation method.

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

# TC220 – ISO 12991 (DIS)

## 4.5.1 Design validation

Each type of vessel shall be validated in accordance with the design options specified in 10.1 of ISO 21029-1 and in accordance with one of options given in 4.5.1.1 and 4.5.1.2.

### 4.5.1.1 Validation by calculation

This option requires calculation in accordance with 10.3 of ISO 21029-1. Additional calculations are required to validate the design for accelerations in 4.2.2.

### 4.5.1.2 Validation by experiment method

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This option requires validation in accordance with 10.4 of ISO 21029-1 with the following modification, drop tests shall include a 9 m drop test of the fuel tank on the most critical area of the tank (other than the piping end) and a 3 m drop test on the piping end.

# TC220 – ISO 12991 (DIS)

## A.2 Holding time test

### A.2.1 Procedure

The inner tank shall be at the same temperature as the temperature of the LNG. This requirement shall be deemed met if, during the previous 24 hours, the fuel tank has contained a volume of liquid LNG at least equal to half of the volume of the inner tank.

The fuel tank shall be filled with LNG so that the quantity of LNG measured by the mass measurement system shall be within 10 % of the maximum allowed quantity that may be contained in the inner tank.

The length and the width of the fire shall exceed the plan dimensions of the fuel tank by 0,1 m. ISO 11439 contains directions to produce a suitable fire test. The average temperature of space 10 mm below the fuel tank as measured by two or more thermocouples shall be at least 590 °C. The average temperature shall remain above 590 °C for the duration of the test.

The pressure of the fuel tank at the beginning of the test shall be from 0 MPa to 0,01 MPa at the boiling point of LNG in the inner tank.

The lapse of time, from the moment that the average temperature first reaches 590 °C until the opening of the primary pressure relief valve, shall be measured.

Once the pressure relief valve opens, the test shall continue until the blow off of the pressure relief valve is complete.

### A.2.2 Acceptance criteria

The Holding time of the fuel tank, which is the lapse of time before the opening of the pressure relief valve, shall not be less than 5 min under an external fire.

The fuel tank shall not burst and the pressure inside the inner tank shall not exceed the permissible fault range of the inner tank. The secondary pressure valve shall limit the pressure inside the inner tank to the values specified in 4.7.2.



# ISO 12991 (DIS)

- Encourage p-members to vote (& comment)
  - Australia (SAI)
  - Austria (ON)
  - Canada (SCC)
  - China (SAC)
  - France (AFNOR)
  - Germany (DIN)
  - Italy (UNI)
  - Korea (KATS)
  - Russia (GOST R)
  - Switzerland (SNV)
  - UK (BSI)
  - USA (ANSI)

# Inconsistencies

- Component Testing
  - ECE R110
    - Prescribed test plan
  - ISO 12991
    - Prescribed test plan
  - NFPA 52 / 57
    - Performance requirements
  - TPED (EN 1251)
    - Directional considerations
  - Product Manual(s)
    - Intended Service

# TC22/SC25 – ISO 12614-XX (NP/WD)

ISO 12614	Description	ISO 15500	R110
-1	General requirements and definitions	-1	
-2	Performance and general test methods	-2	
-3	Check valve	-3	X
-4	Manual valve (Manual cylinder valve)	-4 -5	
-5	Automatic valve	-6	
-6	(Gas injector)	-7	X
-7	Tank pressure gauge	-8	X
-8	Over-pressure regulator	-9	X
-9	(Gas flow adjustor)	-10	X
-10	(Gas/air mixer)	-11	X
-11	Pressure relief valve – primary	-12/13	X
-12	Pressure relief valve – secondary		
-13	Excess flow valve	-14	X
-14	Gas-tight housing and ventilation hose	-15	
-15	Rigid fuel line in stainless steel	-16	X
-16	(Flexible fuel line)	-17	X
-17	(Filter)	-18	X
-18	Fittings	-19	X
-19	Rigid fuel line in material other than stainless steel	-20	X
-20	Pressure control regulator		
-21	Differential pressure gauge		
-22	Capacitance fuel content gauge		
-23	Heat exchanger – vaporizer		
-24	Natural gas detector		
-25	Gas temperature sensor		

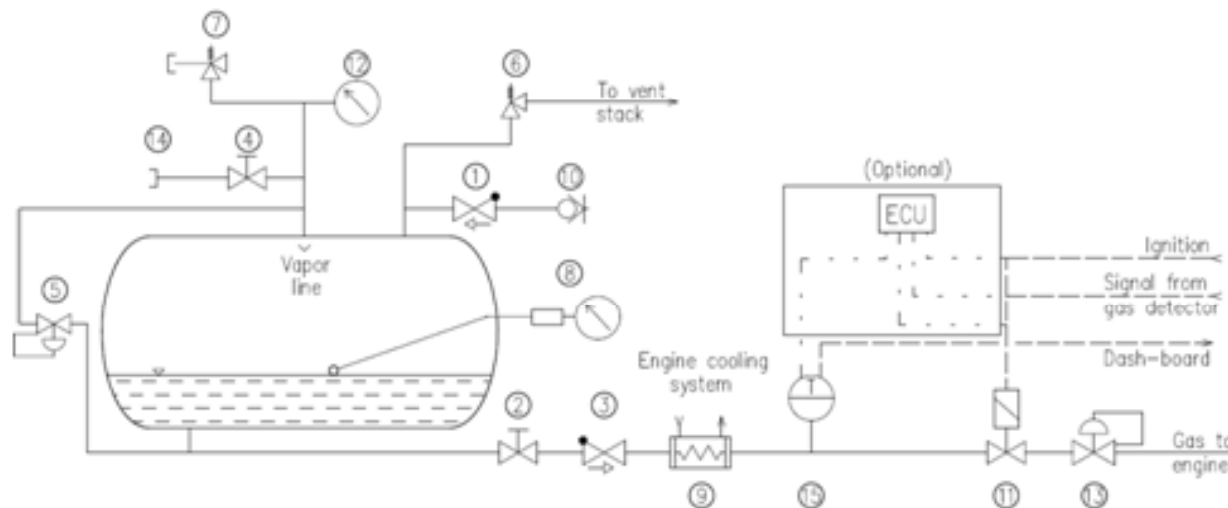
Chart – Sept 7, 2011

# TC22/SC25 – ISO 12614-XX (NP/WD)

## Annex A (informative)

### Construction and assembly

Figure A.1 — LNG fuelling system



- |   |                              |     |                                   |
|---|------------------------------|-----|-----------------------------------|
| 1 | Fill check valve             | 9   | Heat exchanger – vaporizer        |
| 2 | Fuel shutoff valve           | 10  | Fill fitting                      |
| 3 | Excess flow valve            | 11  | Automatic fuel shutoff valve      |
| 4 | Vapor shutoff valve          | 12  | Tank pressure gauge               |
| 5 | Pressure control regulator   | 13  | Overpressure regulator            |
| 6 | Primary relief valve (PRV)   | 14  | Vent connector                    |
| 7 | Secondary relief valve (PRV) | 15  | Gas temperature sensor            |
| 8 | Fuel contents gauge          | ECU | Electronic control unit of engine |

# ISO 12614-XX (NP/WD)

- Encourage committee members to...
  - Participate
  - Identify gaps
  - Comment
  - Draft revisions
  - **Expedite solutions!**