Rec 109 (Oct 2009) Acceptance criteria for cargo tank filling limits higher than 98%

The International Code for the Construction and Equipment of Ships Carrying Liquified Gases in
Bulk (IGC Code), 15.1.3 reads:

"The Administration may allow a higher filling limit (FL) than the limit of 98% specified in 15.1.1 at the reference temperature, taking into account the shape of the tank, arrangements of pressure relief valves, accuracy of level and temperature gauging and the difference between the loading temperature and the temperature corresponding to the vapour pressure of the cargo at the set pressure of the pressure relief valves, provided the conditions specified in 8.2.17 are maintained."

In order to assist societies in advising Administrations on how to apply paragraph 15.1.3 IACS developed the following acceptance criteria:

1. General

1.1 Functional requirements

The maximum filling limit of cargo tanks shall be so determined that the vapour space has a minimum volume at reference conditions (temperature of liquid corresponding to the opening pressure of pressure relief valves) to account for:

- tolerance of level gauges and temperature gauges;
- volume expansion due to pressure rise in cargo tanks above set opening pressure of pressure relief valves under maximum relieving conditions;
- an operational margin to account for liquid drained back to cargo tanks after stop of loading, closing time of valves and operator reaction time.

1.2 Definitions

Filling limit (FL) means the maximum liquid volume in a cargo tank relative to the accepted total tank volume when the liquid cargo has reached the reference temperature.

Loading limit (LL) means the maximum allowable liquid volume relative to the tank volume to which the tank may be loaded.

2. Acceptance criteria for a higher filling limit than 98%

2.1 According to para. 15.1.3 a higher filling limit than 98% may be allowed at the reference temperature taking into account the following parameters:

.1 accuracy of level gauges;

.2 accuracy of temperature gauges;

.3 pressure rise above opening pressure when pressure relief valves are relieving at maximum flow rate under fire condition;

Rec 109 (cont)

.4 an operational margin to account for liquid in loading lines drained back to cargo tanks, closing time of loading valves and operators reaction time; and

.5 shape of the tank and arrangement of pressure relief valves,

provided the conditions specified in 8.2.17 are maintained.

2.2 The parameters specified under 2.1.1 – 2.1.5 may be expressed by the expansion factors α_1 through α_4 as follows:

α_1 = relative increase in liquid volume due to tolerance of level gauges

α_2 = relative increase in liquid volume due to the tolerance of temperature gauges

α_3 = expansion of cargo volume due to pressure rise when pressure relief valves are relieving at maximum flow rate

α_4 = operational margin of 0.1%

The factors α_1 through α_4 are to be determined as follows:

$$\alpha_1 = \frac{dV}{dh} \cdot \frac{\Delta h}{V} \cdot 100(\%)$$

where:

$\frac{dV}{dh}$ = variation of tank volume per metre filling height at the filling height h (m^3/m)

h = filling height (m) at the filling limit FL to be investigated (FL > 98%)

V = accepted total tank volume (m^3)

Δh = max. total tolerance of level gauges (m)

$$\alpha_2 = \beta \cdot \Delta T(\%)$$

where:

β = volumetric thermal expansion coefficient at reference temperature (%/ºK)

ΔT = max. tolerance of temperature gauge (ºK)

$$\alpha_3 = \left(\frac{\rho_{PRV}}{\rho_{PRV \cdot 1.2}} - 1 \right) \cdot 100(\%)$$ expansion due to pressure rise when relieving at full capacity

ρ_{PRV} = ρ_R cargo density at reference conditions, i.e. corresponding to the temperature of the cargo at set opening pressure of the pressure relief valve (PRV)

$\rho_{PRV \cdot 1.2}$ = cargo density corresponding to the temperature of the cargo at 1.2 times the set opening pressure of the pressure relief valve (PRV)

Rec 109 (cont)

$\alpha_4 = 0.1\%$ operational margin

2.3 Based on the factors α_1 through α_4 the following total expansion factor α_t is to be determined

$$\alpha_t = \sqrt{\alpha_1^2 + \alpha_2^2} + \alpha_3 + \alpha_4 (\%)$$

2.4 The filling limit at reference temperature may now be taken

$$FL_{(\max)} = (100 - \alpha_t)\%$$

In no case is $FL_{(max)}$ to exceed 99.5%.

2.5 Subsequently the sloped liquid level under conditions of 15° list and 0.015L trim is to be determined.

It is to be verified that under these conditions the suction funnels of the pressure relief valves remain above the sloped liquid level at a minimum distance of 40% of the diameter of the suction funnel measured at the centre of the funnel, and that no vapour pockets are formed not communicating with the vapour dome.

2.6 The maximum allowable loading limit results from the following formula:

$$LL = (100 - \alpha_t)\frac{\rho_R}{\rho_L}(\%)$$

ρ_L, ρ_R = cargo densities as defined in 15.1.2 of the Code.

Note:
IACS has decided that these Recommendations shall be re-issued as IACS Unified Interpretations once the ongoing revision of the IGC Code has been completed unless such revisions require any modification of these Recommendations.

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