TÜRK LOYDU

Construction, Fitting and Testing of Closed Fuel Overflow Systems

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This latest edition incorporates all rule changes. The latest revisions are shown with a vertical line. The section title is framed if the section is revised completely. Changes after the publication of the rule are written in red colour.

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SECTION 1

CONSTRUCTION, FITTING AND TESTING OF CLOSED FUEL OVERFLOW SYSTEMS

Page

A. General

The construction, equipment and testing of closed fuel oil overflow systems shall be in accordance with these Additional Rules.

1. Other rules

Beside of these Additional Rules the following **TL** Rules apply also:

– Chapter 1 – Hull, Section 12

– Chapter 4 – Machinery, Sections 13 and 16

– Chapter 5 – Electrical Installation

2. Definition of designations

2.1 Closed overflow system

A closed overflow system is a system which is so constructed and equipped that during fuel oil bunkering the permitted design pressure of the storage tanks cannot be exceeded.

A closed overflow system consists of all pipe lines (bunker lines, overflow pipeline, transfer lines of the tanks), storage tanks and overflow tanks together with their associated valves and fittings as well as all control and measuring devices.

2.2 Overflow pipeline

The overflow pipeline (overflow main and branches) is the part of the closed overflow system through which the fuel oil is led to the overflow tank. The overflow pipeline may be arranged before or after the storage tanks.

2.3 Design pressure

The design pressure for the storage tanks is the test pressure height according to **TL** Rules, Chapter 1 – Hull, Section 12.

For overflow systems according to 3.1 the dynamic pressure losses are to be considered in addition.

2.4 Bunker station

The bunker station is the location from where the bunkering operation is centrally monitored and controlled.

3. Grouping of closed fuel oil overflow systems

Within the scope of these Additional Rules closed fuel oil systems are subdivided into three groups.

3.1 Systems of group I

Systems of group I (Fig. 1.1) are systems having monitoring devices whereby excess pressure in the storage tanks is prevented by reduction of the bunker rate.

Overflow is effected by means of an overflow line between storage tank and overflow tank.

3.1.1 The storage tanks may be filled only to a maximum level defined by the shipyard with the maximum designed bunker rate.

3.1.2 On reaching of the maximum level, the tanks are finally filled by the calculated topping-up rate. The maximum permitted topping-up rate is to be monitored by the flow meter.

If the flow meter shall be dispensed with (with owners confirmation), the maximum permitted topping-up rate shall be reduced down to 2/3 of calculated topping-up rate.

3.1.3 If the overflow line is constructed for the designed bunker rate, the requirements according to 3.1.1 and 3.1.2 may be dispensed with.

3.2 Systems of group II

Systems of group II (Fig. 1.2) are systems having pressure limiting devices **(1)** whereby pressures in excess of the tank design pressure are prevented by means of an intermediate overflow valve.

Overflow is effected by means of an overflow line and overflow valve between bunker line and overflow tank.

3.2.1 The overflow valve may be direct acting or be controlled by auxiliary energy.

3.2.2 Each storage tank is to be fitted with two independently actuating limit switches.

3.2.3 The storage tank may be filled by the maximum designed bunker rate up to the first level (limit switch slowdown). Topping-up of the tanks is to be carried out at a reduced bunker rate.

3.2.4 The maximum permitted filling level of each storage tank is monitored by a second limit switch (max. alarm). With this alarm/signal the tank filling valve shall be closed.

3.2.5 If overflow valves are controlled by auxiliary energy they will be opened by the limit switch “max. alarm” when the maximum permitted filling level is exceeded.

3.3 Systems of group III

Systems of group III (Fig. 1.3) are systems equipped with pressure limiting devices and automatic control of the tank valves, whereby pressures in excess of the design pressures of the storage tanks are prevented by automatic limitation of the filling levels.

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(1) *Overflow valves or other suitable devices can be applied as pressure limiting devices. In the following the designation “overflow valves” is used.*

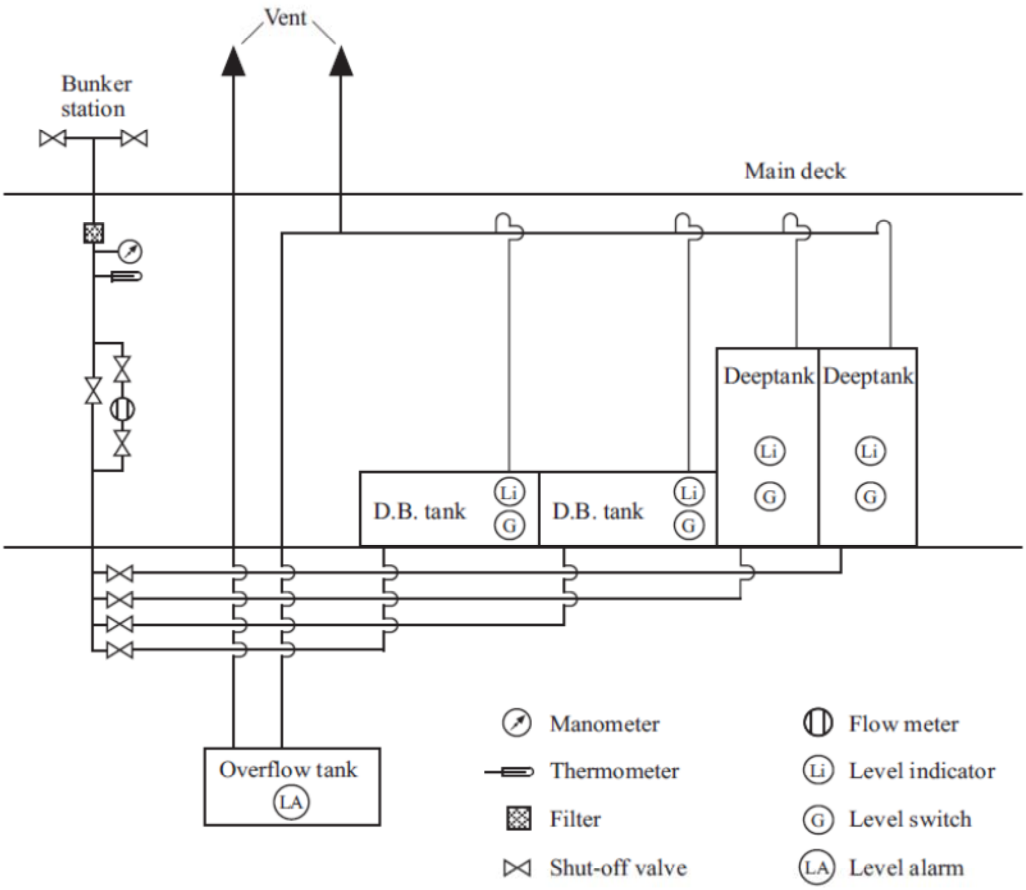

Fig. 1.1 Fuel oil overflow system of group I

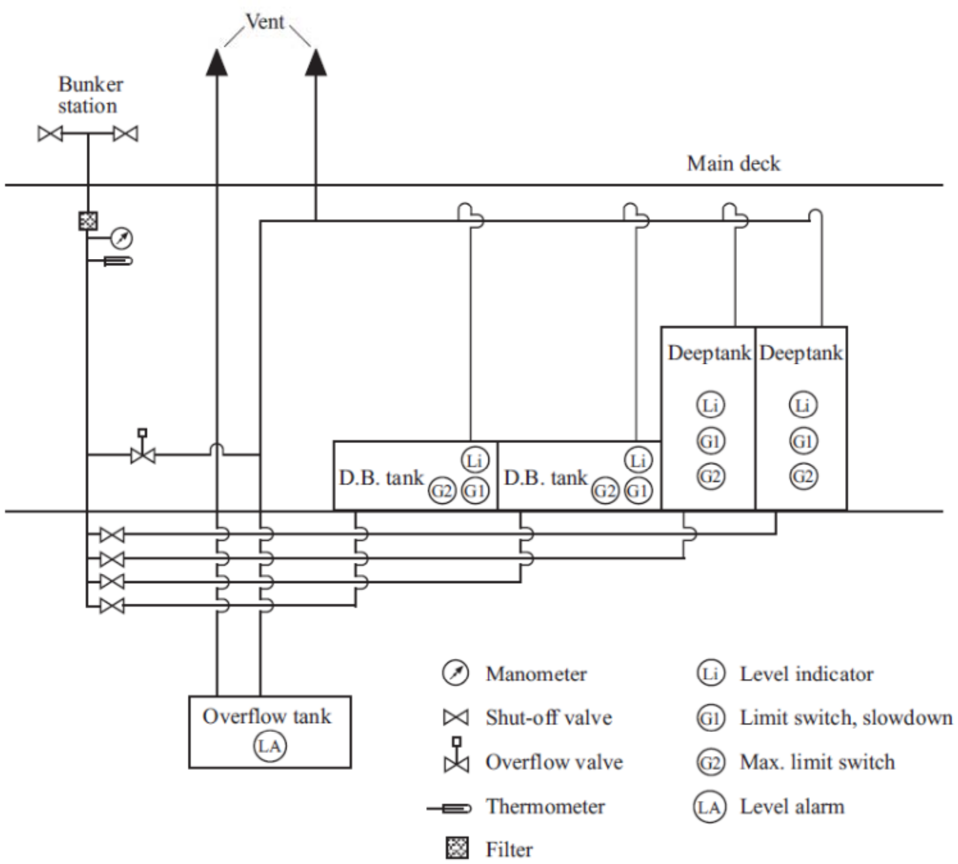

Fig. 1.2 Fuel oil overflow system of group II

Overflow is effected by an overflow line and overflow valve between bunker line and overflow tank.

3.3.1 Each storage tank is to be equipped with two independently actuating limit switches by which control of the tank inlet valves and the overflow valve is effected.

3.3.2 The storage tanks may be filled with the maximum designed bunker rate up to the first limit level (limit switch slowdown alarm).

By actuation of the limit switch slowdown alarm, the filling valve of the tank concerned is closed and locked. When the last tank to be filled has reached that limit level, the overflow valve is opened simultaneously. Fuel oil bunkering shall be stopped.

3.3.3 The system shall be switched to topping-up operation. This effects closing of the overflow valve and opening of the inlet valves of the tanks to be filled-up. The storage tanks can then be further filled by the topping-up rate.

By means of the second limit switch (max. alarm) the filling valves of the individual tanks are closed and locked. When the last tank has reached that level, the overflow valve is opened simultaneously.

Bunker / topping-up operation has to be stopped.

3.3.4 On completion of fuel oil bunkering the overflow system may be switched to normal operation. Now the tank valves are unlocked, the overflow valve is closed and the limit switches are inactive.

3.3.5 Filling valves of storage tanks which are not to be filled, are to be closed and locked prior to fuel oil bunkering and the corresponding limit switches are to be switched to the position “inactive”.

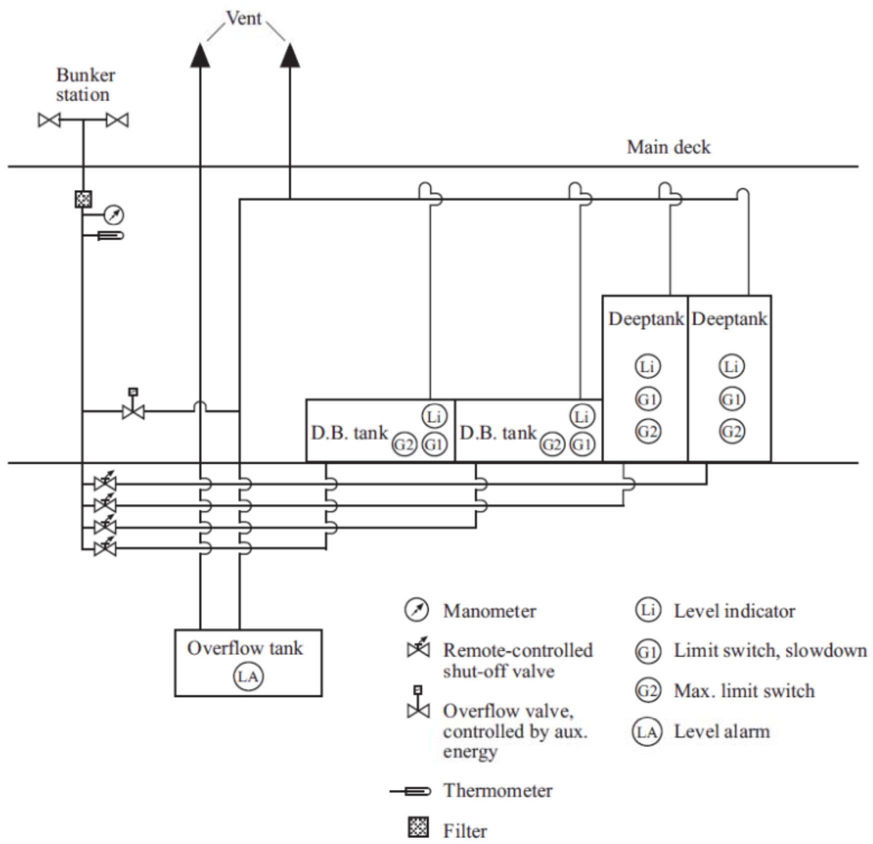

Fig. 1.3 Fuel oil overflow system of group III

4. Documents for approval

The following documents are to be submitted to **TL** in triplicate for approval.

4.1 For systems of groups I. II and III

– tank plan of the storage tanks including tank design pressures

– schematic drawing of the overflow system

– pressure loss calculation for the overflow pipeline

– technical data on level indicating arrangement and limit switches

– list of pipes and valves

– electrical wiring diagrams

– bunkering instructions

4.2 Additionally for systems of group I

– dimensioned isometric drawing of the overflow pipeline

– technical data of the flow meter

4.3 Additionally for systems of group II

– technical data of the overflow valves

– in the case of using direct acting overflow valves: Dimensioned isometric drawing of bunker line, overflow pipeline and transfer lines as well as a pressure loss calculation for the filling lines of the tanks up to the overflow valve.

4.4 Additionally for systems of group III

– technical data of the overflow valves and the remote controlled tank valves and their wiring diagrams

B. Construction and Equipment of the Systems

1. Systems of group I

1.1 Construction

1.1.1 It is to be proved by calculation that the total resistance through the overflow line does not exceed the design pressure of the tanks connected to the system during overflow, taking the topping-up rate into consideration.

The calculation of the overflow line is to be carried out for the proposed topping-up rate according to Annex A.

1.1.2 The level limits in the tanks are to be so arranged that the remaining volume between the level switch and tank top is sufficient to take up the volume until the bunker rate is reduced **(2)**.

1.2 Equipment

1.2.1 Bunker line

The bunker line is to be fitted with filter, pressure gauge, thermometer and flow meter **(3)**.

1.2.2 Storage tanks

The storage tanks are to be fitted with level indicating arrangements. Each tank is to be provided with an independent limit switch.

1.2.3 Overflow line

The overflow line is to be provided with heat tracing and insulation, if necessary.

1.2.4 Bunker station

The following equipment shall be arranged in the bunker station:

- remote level indicators and level alarms of the storage tanks
- end position indicators for remote controlled tank valves, if provided
- indicator of the flow meter, if provided
- level alarm of the overflow tank
- bunkering instructions

2. Systems of group II

2.1 Construction

2.1.1 The overflow line is to be so designed as to allow overflow of the maximum permitted bunker rate to the overflow tank with opened overflow valve without excess pressure increase in the tanks.

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(2) *For guidance, a period of approximately 5 minutes can be assumed for the time needed until the bunker rate is reduced down to topping rate.*

(3) *Without flow meter, the maximum permitted topping-up rate shall be reduced down 2/3 of maximum calculated topping-up rate. See also A.3.1.2*

2.1.2 The set pressure of direct acting overflow valves is to be determined as follows:

$$p_o = (H_1 - H_2) \cdot g \cdot \rho_w \quad [N/m^2]$$

p_o = set pressure of the overflow valve [N/m²]

H_1 = height of test pressure of the tanks above base [m]

H_2 = fitting position of the overflow valve above base [m]

g = acceleration due to gravity [m/s²]

ρ_w = density of water [kg/m³]

If the tanks have been designed for different test pressure values, the lowest pressure value is to be set for H1.

2.1.3 Overflow valves with auxiliary energy shall open automatically at failure of energy supply and be equipped with means for manual operation.

2.1.4 When using overflow valves with auxiliary energy, the limit switch (max. alarm) is to be so adjusted that the overflow valve will open before the design pressure of the particular tank is reached.

2.2 Equipment

2.2.1 Bunker line

The bunker line is to be fitted with filter, pressure gauge and thermometer.

2.2.2 Storage tanks

The storage tanks are to be fitted with level indicating arrangements. Two independent actuating limit switches are to be installed in each tank.

2.2.3 Overflow line

The overflow line is to be provided with an overflow valve.

2.2.4 Bunker station

The following equipment is to be arranged in the bunker station:

– remote level indicators and level alarms of the storage tanks

– end position indicators for remote controlled tank valves, if provided

– level alarm of the overflow tank

– pressure gauge for the bunker line if a direct acting overflow valve is arranged

– end position indicator for the overflow valve

– bunkering instructions

3. Systems of group III

3.1 Construction

3.1.1 The filling limit levels are to be determined by consideration of bunker rate and topping-up rate respectively, volume and shape of tanks, closing time of the tank inlet valves of the tanks as well as opening time of the overflow valve **(4)**.

3.1.2 Overflow valves with auxiliary energy shall open automatically at power failure and be fitted with means for manual operation.

3.1.3 The overflow line is to be so designed as to allow the maximum permitted bunker rate to be discharged to the overflow tank with open overflow valve without excess pressure increase in the tanks.

3.1.4 The air pipes of the storage tanks are to be dimensioned and arranged as to avoid any pressure increasing which may affect the measuring.

3.2 Equipment

3.2.1 Bunker line

The bunker line is to be fitted with filter, pressure gauge and thermometer.

3.2.2 Storage tanks

The storage tanks are to be fitted with level indicating arrangements. Two independently actuating limit switches are to be installed in each tank.

3.2.3 Overflow line

The overflow line is to be provided with an overflow valve.

3.2.4 Bunker station

The following equipment is to be arranged in the bunker station:

– remote level indicators and level alarms for the storage tanks

– end position indicators for remote controlled tank valves and overflow valves

– level alarm for the overflow tank

– bunkering instructions

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(4) *Guidance for the limit levels in the tanks: Limit level 1: approximate 80 ~ 90 % filling level; Limit level 2: approximate 95 ~ 98 % filling level*

4. Overflow tanks

Overflow tanks are to be so dimensioned that they can take up the volume flow entered until bunkering is stopped. Overflow tanks are to be equipped with level alarms at approximate 1/3 full.

C. Testing

1. Initial operation of the system

1.1 After completion and prior to the first operation every fuel oil overflow system is to be tested.

The following equipment and instruments are to be tested and adjusted:

– safety devices

– pressure indicators and their drives

– alarm and locking devices

– indicating and measuring instruments

1.2 A **TL** Surveyor is to be present during the first operation of the system.

ANNEX A

CALCULATION OF THE OVERFLOW LINE

1. Formula characters

Δ_p = loss of pressure [Pa]

λ = coefficient of pipe friction **(1)** [-]

L = length of the straight pipe [m]

d_i = inside pipe diameter [m]

d_a = outside pipe diameter [m]

d_{gl} = equivalent pipe diameter [m]

w = velocity of flow [m/s]

ρ = density [kg/m³]

ς = resistance coefficient **(2)** [-]

h_{geod} = geodetic height [m]

V = volume flow [m³/s]

A = cross section of pipe [m²]

A_d = cross section of pipe running full

U = wetted circumference [m]

g = acceleration due to gravity [m/s²]

R_e = Reynolds number [-]

R_{ekr} = critical Reynolds number (2320)

ν = kinematic viscosity [m²/s]

c = correction factor [-]

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(1) *In the systems handled in these Additional Rules laminar flow (Re < Rekr) can be assumed*

(2) *The Zeta values needed for the calculation are to be taken from recognized standards or publications* s = thickness of pipe [mm]

Δs = tolerances of wall thickness [mm]

2. Calculation of the overflow line

The overflow line is to be so designed that the dynamic and static pressure losses due to flow through the line with the topping-up rate will not exceed the design pressure of the storage tanks.

This means that

$\Delta p_{ges} = \Delta p_{dyn} + \Delta p_{stat}$ < design pressure

3. Calculation of the pressure losses in the overflow line

The calculation of the pressure losses in the overflow line is made in consideration of the following parameters:

- maximum allowable viscosity of the fuel oil at bunkering
- density **(3)** of the fuel oil related to the temperature

3.1 Calculation of the dynamical pressure losses

The loss of pressure in a pipeline results from the resistance behaviour of the straight pipe lengths and their fittings for changes in direction, cross section and flow as well as from their components (valves, sight glasses) and can be determined as follows:

$\Delta p = \lambda \cdot \frac{L}{d_i} \cdot \frac{\rho}{2} \cdot w^2$ for straight pipe length (1)

$\Delta p = \varsigma \cdot \frac{\rho}{2} \cdot w^2$ for the fittings (2)

From formulae (1) and (2) results the dynamical pressure loss of a pipe section, since:

$\Delta p_{dyn} = \sum\left[\left(\lambda \cdot \frac{L}{d_n} + \sum \varsigma_n\right) \cdot \frac{\rho}{2} \cdot w_n^2\right]$ (3)

$\lambda \cdot \frac{L}{d_n}$ = resistance coefficient for the straight pipe length of inside diameters d_1 ….. d_n

$\sum \varsigma_n$ = sum of the individual resistance coefficients for fittings and components in pipe sections of flow rate w_1 ….. w_n

3.2 Correction factor and equivalent diameter

The allowable tolerances for pipes given in the standards are to be taken into consideration by means of a correction factor.

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(3) *In the calculation the density is given with minimum 1000 [kg/m³]*

This can be approximately calculated as follows:

$$c = \left[\frac{1}{1-\frac{\Delta s}{s}\left(\frac{d_a}{d_i}-1\right)}\right]^5 \qquad (4)$$

Equation (4) put in equation (3), results in:

$$\Delta p_{dyn} = \sum\left[\left(\lambda \cdot \frac{L}{d_n} + \sum\varsigma_n\right)\cdot c_n \cdot \frac{\rho}{2}\cdot w_n^2\right] \qquad (5)$$

Where c_n are the correction values for $d_1 \ldots d_n$ pipe diameters.

Equation (1) also applies to non-circular cross sections if instead of the inside diameter d_i the equivalent diameter d_{gl} is put in:

$$d_{gl} = \frac{4 \cdot A_d}{U} \qquad (6)$$

3.2.1 Pressure losses for pipes connected in parallel

If two or more overflow pipe lines are lead from a storage tank to the collecting manifold, the following applies:

- same pressure loss:

Δp_{dyn} = const.

- single volume flows add up to the total volume flow

$V = V_1 + V_2 + \ldots V_n$

The solution of the individual equations (3) can only be found by iteration, since $\lambda = f(Re)$ and $Re = f(w)$.

3.2.2 Pressure losses for pipes connected in series

Analogous to 2.2.1 the pressure losses for the individual pipes are to be determined according to equation (3).

The pressure loss of all pipes results from the sum of all individual pressure losses:

$\Delta p_{dyn} = \Delta p_{dyn1} + \Delta p_{dyn2} + \ldots \Delta p_{dynn}$

4. Calculation of statical pressure losses

The statical pressure loss results from the geodetic heights of the overflow pipelines, measured between tank top and overflow summit (peak) of the pipes.

This is to be determined as follows:

$$\Delta p_{stat} = h_{geod} \cdot g \cdot \rho \qquad (7)$$