EEMUA 159 Edition 4

Corrigendum

The following pages list the changes and amendments to EEMUA 159 Edition 4 published in June 2014. It covers the published version labelled as Imprint Reference 06-2014.

It also covers the published version labelled as Imprint Reference 07-2014 although some of the listed changes have already been included in that Imprint.

April 2015

Page no. First Imprint	Section Number	Change
21	3.5	First bullet item now reads • understanding by operating personnel is critical for the steel components of storage tanks;
40	Table 4	Table title changed to **Table 4 Record sheet for fitness for purpose analysis** 'Dimensions top angle iron' now reads 'Dimensions top curb angle'
50	5.3.4.2	Opening sentence now reads 'As indicated in Appendix B.3'
51	5.3.4.2	Final sentence of first paragraph now refers to Appendix B.3 First sentence of final paragraph of Section 5.4.3.2 changed from: 'Using the procedures described above and in Appendix B.4' to 'Using the procedures described above and in Appendix B.3'
57	5.4	Final sentence above Figure 22 changed to read: The value of $t_{min\ average}$ should not to be less than $t_{min\ acc.\ shell\ liq.}$ (see section 8.3.1 and flow chart figure 49).
67	6.3.7	Last paragraph now reads 'A graphical representation of differential shell settlement is shown in Figure **35**. Figure 37 in first imprint now placed at end of Section 6.3.7 as Figure 35.
69	6.5.1	First paragraph now refers Figure 36. Figure 35 now Figure 36. Reference in brackets now reads (from Figure 36).
71	6.5.1	Formula to read "$S^t = \frac{4*M_{total}}{\pi*D^2*t}$"
72	6.5.1	1st para, 3rd line. "snow load" changed to "superimposed load acting on the roof"
72	6.5.1	1st para, 4th line: "snow moment" changed to "moment induced by the superimposed roof load".
72	6.5.1	Equation now reads Q= $(W_{total}+W_{contents})*\sin(\theta)$ And the note now reads 'Note: the value of sin(ɵ) can be closely…'
74	6.5.1	Last paragraph now reads '….and the sin of the angle….'
75	6.5.1	On 2 occurrences 'Factor of safety' replaced by 'Unity check'
75	6.5.1	First formula should now read $$S^t = \frac{4 * M_{total}}{\pi * D^2 * t} = 2.62\ N/mm^2$$ and $s_a = S^n + S^t = 1{\cdot}84 + 2.62 = 4.46$ and "Factor of Safety = 21.22 / 8.4 = 2.5" to read "Unity Check = 21.22 / 4.46 = 4.8"

<table>
<tr><td>76</td><td>6.5.2</td><td>Figure 36 now Figure 37.

Title ‘6.5.3 Differential settlement’ now moved to below the equation which now reads:-
$$H = \frac{550}{750} \times 125 = 91.7$$</td></tr>
<tr><td>78</td><td>6.5.3</td><td>Under item b) the following new sentence inserted.
‘Reference is made to API 653 Annex B where the formulas below as well as Figure 35 is extensively explained.’</td></tr>
<tr><td>78</td><td>6.5.3</td><td>Definition of Y now reads
Y Minimum specified yield strength of the lowest shell course (N/mm^2)</td></tr>
<tr><td>90</td><td>7.4.3</td><td>New section heading under Figure 44.
7.4.3.1 Fillet weld

Also ‘as shown in Figure 45’ added to end of first paragraph.</td></tr>
<tr><td>92</td><td>7.4.3.1</td><td>Section headings 7.4.3.1, 7.4.3.2 and 7.4.3.3 updated to 7.4.3.2, 7.4.3.3 and 7.4.3.4 respectively.</td></tr>
<tr><td>98</td><td>Figure 49</td><td>Title changed to ‘Flowchart for assessing fitness for purpose of tank shells for load combination 1 (hydrostatic pressure and vapour pressure)’</td></tr>
<tr><td>101</td><td>Table 6</td><td>Additional note 6 added to and Table updated accordingly.
Line for EN 14015 now reads
<table><tr><td>EN 14015</td><td>0</td><td>5</td><td>10</td><td>2.5^6</td><td>25</td><td>6^6</td><td>60</td><td>6^6</td></tr></table>
6 use 5 mbar for non-pressure tanks and 8.5 mbar for low and high pressure tanks in accordance with Rev 1 of EN 14015 in formula for factor K calculations (stability calculations)</td></tr>
<tr><td>102</td><td>8.3.2</td><td>Definition of V_w now reads
V_w wind speed as per original design (see also Section 5.1.2) (m/s)</td></tr>
<tr><td>105</td><td>8.4</td><td>First bullet item now reads:
• For the maximum tensile stress in the net section of the plate, use the lesser value of 0.8 times minimum specified yield strength of the shell plate (or $0.8 \times 215\ N/mm^2 = 172\ N/mm^2$ if not known);</td></tr>
<tr><td>111</td><td>8.6.2</td><td>Reference to Figure 51 at the end of the first paragraph now reads (see Figure 59).</td></tr>
<tr><td>112</td><td>8.7.1</td><td>Reference to Figure 52 at the end of the first paragraph now reads (see Figure 60).</td></tr>
<tr><td>113</td><td>8.7.2</td><td>Third paragraph now reads
‘To prevent excessive stresses in the shell and roof nozzles, i.e. under excessive settlements and outward bulging of the tank shell (see Figure 60), expansion joints or bellows may be introduced to minimise the transfer of forces from tank connections to the shell (see Figure 61).‘</td></tr>
<tr><td>119</td><td>9.3</td><td>Wording changes to Section 9.3 to 9.3.2. See Addendum.</td></tr>
<tr><td>128</td><td>10.3.3.1</td><td>Section title changed to ‘10.3.3.1 Operational Pressure/Vacuum Relief Vents’

‘OFL examination’ at the end of first paragraph removed and replaced by ‘inspection’.

Last sentence of 3rd paragraph to read
‘A maximum incremental on-line inspection interval should be</td></tr>
</table>

		identified, and the inspection interval amended if anomalies are found during the inspection'.
129	10.3.3.3	Section title changed to '10.3.3.3 Emergency vents' First paragraph now reads 'These are normally pivoted or guided lids, which use a dead weight to provide a seal against a soft joint, and are designed to provide a safe release of a large volume of vapour. A maximum incremental in-service inspection interval should be identified, and the inspection interval amended if anomalies are found during the in-service inspection.'
129	10.3.3.4	Section title of 10.3.3.4 to read '10.3.3.4 Explosion doors and frangible joints'
139	11	New introduction section immediately after the title. See addendum. 11.1.2 First paragraph of 11.1.2 now reads 'For these roofs, buoyancy is provided by an annular pontoon of approximately 20 to 30% of the total roof area. Roofs are designed to enable the centre deck to carry approximately 250 mm depth of rainfall over the total roof area that accumulates on the centre deck, and with sufficient buoyancy for the roof to remain afloat when two adjacent pontoon compartments and the centre deck are punctured (See Figures 74 and 75).'
140	11.1.3	New second paragraph with Note. See addendum.
141	Figure 77	New Figure 77. See addendum.
142	11.2	Note under Section heading deleted and replaced with 'Note: The following sections have been written as a guideline to assess degradation allowances on single deck floating roofs that are exposed to the normative loads as described in Section 11.1. Roofs should not be operated beyond the stated degradation limits subject to these loads without further integrity assessment.'
142	11.2.1	Section now re-written with an additional Table 8. See addendum
165	11.10.3	Second paragraph located under bullet items now reads 'Dimensional tolerances are specified in the design and construction codes, for example EN 14015. During maintenance and repair, tanks should be brought back to as close as possible to the tolerances stated in the As Built norm, see Section 5.1.2. However, these tolerances include nominal radius, verticality, weld peaking and rim space. These are often difficult to achieve, particularly after major repair or modification work on the shell and in these cases an integrity assessment should be carried out.'
171	12.1	Table number and all subsequent Table numbers increased by 1. Paragraph above Table 10 not refers to Table 11 and Table 12.
237	Table 21 B.1	Table updated to include vegetable oils but no change in inspection intervals. See Addendum
259	B.3	Replacement check sheet for Planar tilt measurement with use of laser level tool. See Addendum.
261	B.3	Additional check sheet for Circumferential settlement. See Addendum.
272	B.3	Additional check sheet for UT inspection columns check sheet. Additional check sheet for UT inspection roof columns check sheet. See Addendum.
273	B.3	Visual inspection tank bottom (ripples and bulges)

		New notes replacing existing notes
332	E4.3	Removed. *Note: The maximum interval between Internal inspections may not exceed 20 years, even when results of calculation models give a longer period.*
335	E4.3	Box 10a Time to repair. “>3 months” changed to “< 3 months”
338	E4.3	Box 19. “See 6.3” changed to “See 17.3”
340	E4.3	Box 3a Heating coils in tank? “temperature of product > 85 ºC” changed to “temperature of product > 85 ºC =2”
341	E4.3	Box 7a Time to repair. “>3 months” changed to “< 3 months”
341	E4.3	Box 9d Location of tank farm “*” after all queries
343	E4.3	Box 13 Establish probability factor. Formula changed to: (3 x[1] + 3x[2] + 2x[3] + 2x[4+5] + 1x[6])/5
343	E4.3	Box 16. “See 16.3” changed to “See 17.3”
344	E4.3	Under Box 19 “*See 9.3” changed to “*See 8.3.1” “†See 9.5” changed to “†See 8.3.2” “‡See API 620” changed to “‡See 8.3.3”
347	E4.3	Title changed to “STEP 2 Determine consequence factors and ratings for the various aspects – bottom roof plates (E3.3)”
347	E4.3	Box 8a Time to repair “>3 months” changed to “< 3 months”
348	E4.3	Box 10e. Formula changed to “10a or [(10b+10c+10d)/3]”
348	E4.3	Box 12c. “14a or 14b” changed to “12a or 12b”
349	E4.3	Box 17. “See 16.3” changed to “See 17.3”
349	E4.3	Box 19b. Add “See Section 9.3”
349	E4.3	Box 20. Formula changed to “(18a-19b)/18b”
350	E4.3	Box 30. Formula changed to “(25 + 29)”
350	E4.3	Remove *Note: may never exceed 20 years* under Box 31
360	E8	5th paragraph, 2nd line: “in-service period” changed to “out-of-service period”

April 2015

Addendum

April 2015

9.3 Degradation limits fixed roofs

The minimal acceptable thicknesses of the different roofs and roof components are described in the following paragraphs.

9.3.1 Supported fixed roof

a) Structural integrity

For tanks satisfying the following requirement: distance between support structure at periphery close to the tank shell < 1.7 m for cone roof tanks or < 3.25 m for dome roof tanks.

The degradation limit with respect to general corrosion of the roof plates of a fixed roof is 75% of the nominal plate thickness. In formula:

$$t_{\text{min acc fxt. roof gen.}} = 0.75 t_{\text{nom}}$$

Where:

$t_{\text{min acc. fxt roof gen.}}$	Minimum acceptable plate thickness of the fixed roof (mm)
t_{nom}	Nominal as built plate thickness excluding an initial applied corrosion allowance (mm)

For tanks <u>NOT</u> fulfilling the following requirement: distance between support structure at periphery close to the tank shell < 1·7 m for cone roof tanks or < 3·25 m for dome roof tanks.

The degradation limit with respect to general corrosion of the roof plates of a fixed roof is 80% of the nominal plate thickness. In formula:

$$t_{\text{min acc. fxt. roof gen.}} = 0.8 t_{\text{nom}}$$

Where:

$t_{\text{min acc. fxt roof gen.}}$	Minimum acceptable plate thickness of the fixed roof (mm)
t_{nom}	Nominal as built plate thickness excluding any initial applied corrosion allowance (mm)

or

The degradation limit with respect to general corrosion of the roof plates can be calculated considering the following normalised loads:

- dead-weight of the roof plates; and
- Superimposed load.

The superimposed load is the larger of:

- The combined load by Snow load (see for instance EN 1991-1-3) and design vacuum;
- The combined load by Live load (see for instance EN 1993-4-2) and design vacuum; or
- 1·2 kN/mm^2.

or

The degradation limit with respect to general corrosion of the roof plates can be established by means of a structural analysis.

A degradation limit of 2.25 mm under general corrosion may be used only when the following additional requirements are satisfied:

- An effective snow accumulation prevention program should be in place;
- Access of personnel over 3 persons is denied and providing that they do not gather together in a small area of the roof.

or

- A vacuum should be prevented during the time access of personnel on to the roof is required (no liquid movements out of a tanks during the actual work time of personnel on the roof).

$$t_{mn.acc.\ \ fxt\ roof\ gen.} = 2.25\ \text{mm}$$

Where:

$t_{min\ acc.\ \ fxt\ roof\ gen.}$ Minimum acceptable plate thickness of the fixed roof (mm)

b) Operational integrity

The degradation limit with respect to operational integrity is such that no perforations are allowed.

c) Safety integrity

The degradation limit with respect to safety is 2 mm in a 500 x 500 mm area.

$$t_{min\ acc.\ \ Fxt.\ \ roof\ sfty.} = 2\ \text{mm}$$

Where:
$t_{min\ acc.\ \ fxt.\ \ roof\ sfty.}$ Minimal acceptable plate thickness of a fixed roof (mm)

d) Internal pressure

The degradation limit shall be calculated using the following formula:

For spherical (dome) roofs:

$$e_p = \frac{pR_1}{20SJ}$$

For conical roofs:

$$e_p = \frac{pR_1}{10SJ}$$

Where:
e_p Minimal roof plate thickness (mm)

p Internal pressure less dead weight of roof plates (mbar)
S Maximum allowable stress (N/mm^2) ($S = 0{\cdot}8 \times$ minimum specified yield strength or 172 N/mm^2 when no material data is available)
J Joint efficiency factor [-]
R_1 Radius of the curvature of the roof (m) (for conical roofs; $R_1 = R/\sin\theta$)
where:
R Radius of tank (m)
θ Slope of roof (°)

9.3.2 Roof supporting structure

In case the roof plates are corroded from the inside > 12·5% of the nominal as-built thickness; the structural integrity of the roof support structure is assumed to be 25% corroded and will, in such occasion, need to be evaluated by a structural analysis.

9.3.3 Self-supporting fixed roof

a) Structural integrity

For self-supporting fixed roofs (roofs without a roof support structure) the degradation limit for structural integrity can be calculated using the following formula:

$$t_{\text{min acc. fxt roof gen}} = 0.8t_{\text{nom}}$$

Where:

$t_{\text{min acc. fxt roof gen.}}$	Minimum acceptable plate thickness of the fixed roof (mm)
t_{nom}	Nominal as built plate thickness excluding an initial applied corrosion allowance (mm)

Alternatively, the degradation limit can determined with help of a structural analysis.

b) External pressure (buckling)

For self-supporting fixed roofs (roofs without roof support structure), the degradation limit for external pressure/buckling can be calculated using the following formula:

$$e_p = 40R_1\sqrt{\frac{10P_e}{E}}$$

Where:
e_p Minimal roof plate thickness (mm)
P_e External loads plus self-weight of the plates plus design internal negative pressure where applicable (kN/m^2)
E Young's modulus (N/mm^2) for the material in use and under the actual operating temperature of subject tank. For carbon/carbon-manganese steel the temperature where the factor E is to be adjusted is above 100 ºC. For stainless steel this temperature is 50 ºC
R_1 Radius of the curvature of the roof (m) (for conical roofs; $R_1 = R/\sin\theta$, where
R Radius of tank (m)
θ Slope of roof (°).

Note: For dome roofs the radius (curvature) of the roof should not be beyond following boundaries:

$$0.8D_{\text{tank shell}} < R_{\text{roof}} < 1.5D_{\text{tank shell}}$$

11 Floating roofs

To limit the risks of roof failures special attention should be given to operational procedures. The following actions may be considered:

1. A three monthly visual inspection of the pontoons for leakages. In case leakage in one pontoon is detected the tanks should be taken out of service and the leakage will need to be repaired.

and

2. A effective drainage program including a program for monitoring the rainwater level. When the rainwater level on the centre deck is larger than 100 mm, the collected rainwater should be drained.

or

3. The installation/presence of (aluminium) dome roof covering the external floating roof (preventing the accumulation of rainwater and snow).

11.1.3 Double-deck floating roofs

For this roof type, the entire roof area is designed/constructed with a double deck, making the roof more rigid than the pontoon roof. The double deck consists generally of an annular pontoon with concentric rings in the centre part of the roof; see Figure 76.

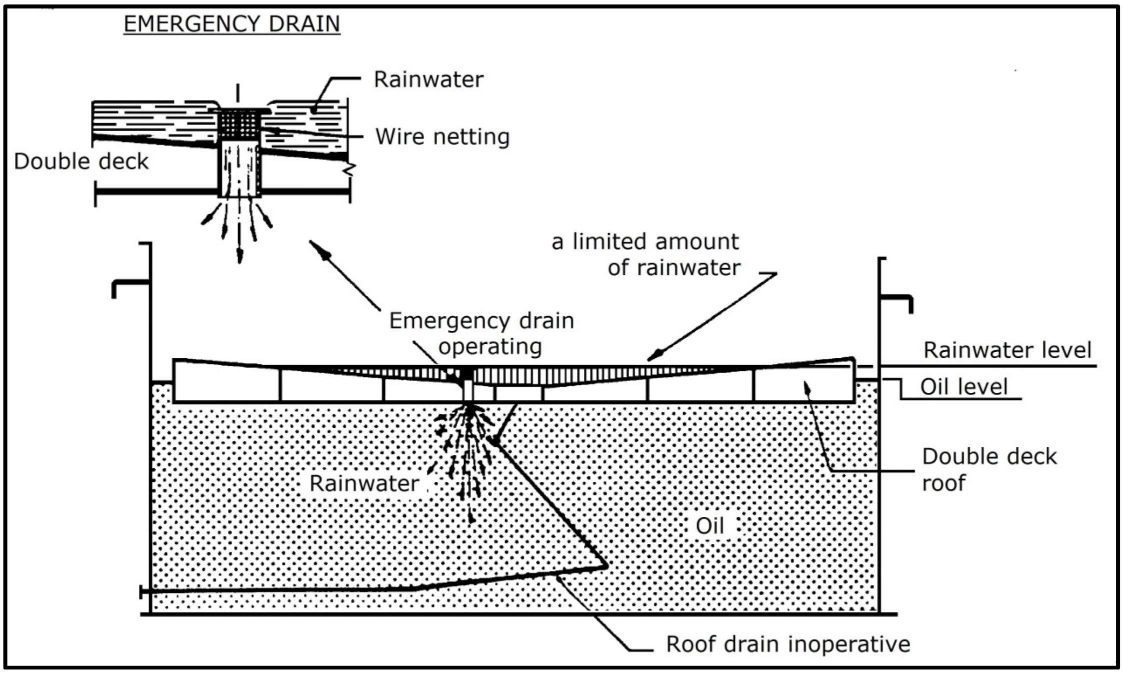


Figure 76 Rainwater load on the upper deck of a double-deck with drain inoperative

The design specification of double deck floating roofs requires that the roof remains afloat with any two adjacent pontoon compartments punctured and flooded: see Figure 77.

Note: Two adjacent compartments could well be two peripheral compartments but depending on the type of roof design this could be two adjacent compartments somewhere else existing in the total surface of the roof. Figure 77 provides two examples of what the compartment design might be: the most critical situation should be determined to assess the buoyancy capabilities of the roof. The structural integrity of the roof under the loads induced by punctured and flooded compartments in adjacent structures of the roof should also be investigated.

Double-deck roofs are generally installed in large diameter tanks (over 50 m diameter). They avoid the wind problems of pontoon roof centre decks. They are also used in small diameter tanks (e.g. up to 15 m diameter), since for such diameters the centre deck of a pontoon roof would be too small.

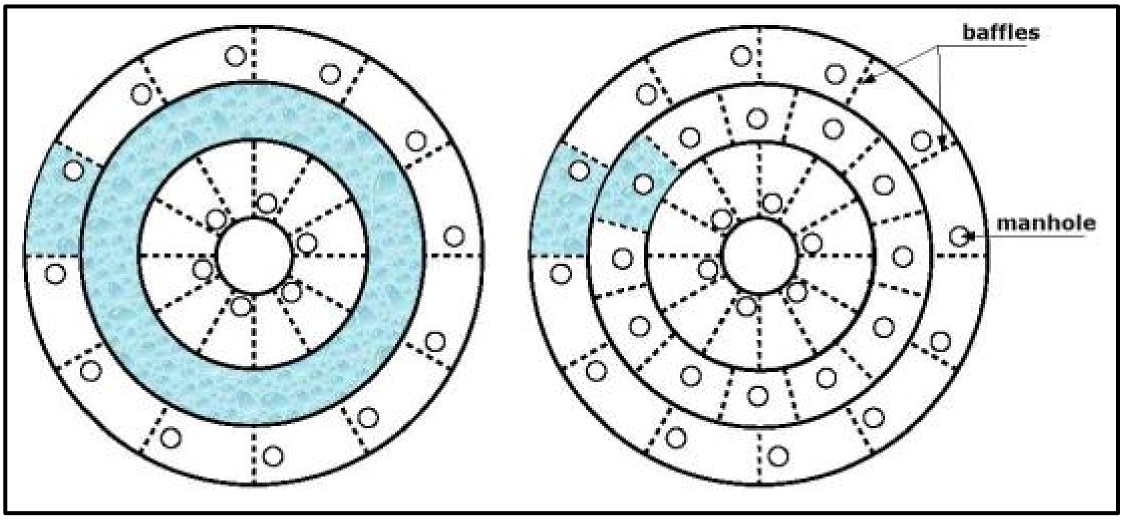


Figure 77 Design of a double deck roof
(*capable of floating with two peripheral pontoons punctured and flooded)*

Excess rainwater on the roof due to a non-functioning roof drain will be automatically discharged via the emergency drain into the tank product. The setting of the emergency drain overflow level should be checked against the draught of the deck in the product. The top level of the centre deck should always be above the level of the product in the tank.

11.2 Degradation limits

Note: The following sections have been written as a guideline to assess degradation allowances on single deck floating roofs that are exposed to the normative loads as described in Section 11.1. ***Roofs should not be operated beyond the stated degradation limits subject to these loads without further integrity assessment.***

11.2.1 General corrosion

As an example, the degradation limits as described in sub-sections a) and b) below are valid for single deck roofs satisfying the so called "30% rule" subject to the normative loads. In this case the surface of the pontoons shall be equal to or higher than 30% of the total surface of the floating roof. In formula:

$$\frac{D^2 - d^2}{D^2} \geq 30\%$$

Where:
d Inner rim diameter of the pontoons/centre deck diameter (m)
D Outer rim diameter of the pontoons (m)

For roofs that do not satisfy this requirement (the 30% rule) degradation limits of the floating roof components should be evaluated.

The degradation limits shown in these examples are valid for the material located near welds where joint efficiency factors (see Table 8) have been taken into account. These joint efficiency factors are applicable in areas of 16×nominal thickness on both sides of the weld.

Table 8 Weld efficiency factors

Weld type	Efficiency factor	Remark
butt welded	0.85 1.00	tanks built $\leq$ 1968 tanks built > 1968
single lap welded	0.35	
double lap welded	0.50	

a) *Centre deck*
The degradation limit with respect to general corrosion of the centre deck of a floating roof is the larger of 50% of the nominal thickness or 2.5 mm. In the formula:

$$t_{min\ acc.\ fl.\ roof\ gen} = 0.5t_{nom},\ 2{\cdot}5\ \text{mm (whichever is larger)}$$

Where:

$t_{min\ acc.\ fl\ roof\ gen.}$ Minimum acceptable plate thickness of the centre deck of a floating roof (mm)
t_{nom} Nominal as built plate thickness excluding an initial applied corrosion allowance (mm)

b) *Floating roof pontoons*

b.1 Bottom plates

The degradation limit of the bottom plates of the pontoons is the larger of 80% of the nominal thickness or 2.5 mm.
In formula:

$$t_{min\ acc.\ pont.\ bottom} = 0.8t_{nom}, \text{ or } 2.5 \text{ mm (whichever is larger)}$$

Where:

$t_{min\ acc.\ pont.\ bottom}$ Minimal acceptable thickness for the bottom plates of the pontoons (mm)

b.2 Top plates

The minimal acceptable thickness of the top plates of the pontoons is the larger of 50% of the nominal thickness or 2.5 mm. In formula:

$$t_{min\ acc.\ pont.\ top} = 0.5t_{nom}, 2{\cdot}5 \text{ mm (whichever is larger)}$$

Where:

$t_{min\ acc.\ pont.\ top}$ Minimal acceptable thickness of the top plates of the pontoons (mm)

Note: For a, b.1 and b.2 above 2·5 mm is the absolute minimum that can be allowed including any compensation for joint efficiency factors.

b.3 Rim plates

Inner and outer rim plate thicknesses are governed largely by considerations of buckling stability or the combination of membrane and bending stresses. Some calculations show that even a 9% decrease in design thickness may lead to stresses above the allowable ones, under normative loads. However, this percentage is greatly depending on the type of roof, the design thicknesses used etc. For this reason this document cannot state a single degradation limit for the rim plates.

Note: History shows that corrosion of the rim plates is usually not the governing failure mode of floating roofs.

B.1 Inspection frequencies

Table 21 Inspection frequencies

Group	Service conditions	INSPECTION FREQUENCY						
		Maximum operational external routine visual (Months)	EXTERNAL Detailed visual including ultrasonic thickness measurements of the shell, roof and external annular (Years)			INTERNAL Detailed visual including ultrasonic thickness measurements of bottom, shell & annular (Years)		
			Climate code (see below)					
			A	B	C	A	B	C
1	Slops; corrosive or aggressive chemicals, raw water, brine.	3	1	1	1	3	3	3
1A	Same as Group 1 except where internally protected as in Appendix C.5.3	3	5	5	7	10	10	10
2	Bio-fuels, fatty acids	3	1	1	5	5	5	5
2A	Same as Group 2 except where internally protected as in Appendix C.5.3	3	5	5	7	10	10	10
3	Crude oil (unprotected)	3	5	5	5	10	15	15
3A	Crude oil (where internally protected as in Appendix C.5.3)	3	5	5	7	15	20	20
4	Gas oil, lube oil, diesel oil, caustic soda, inert or non-aggressive chemicals, ethanol, methanol, air foam liquid, non-heated fuel oil.	3	5	5	5	15	20	20
5	Jet A1 (fully internally protected)	3	5	5	5	15	20	20
6	Light products, kerosene, gasoline, cracked distillates, treated water, vegetable oils (not internally protected)	3	5	5	5	10	15	15
7	Heated & insulated tanks	3	5	5	5	6	10	10
7A	Sulphur	3	3	3	3	6	10	10
8	De-min water	3	5	5	5	10	15	15
8A	Same as Group 8 except where internally protected as in Appendix C.5.3	3	5	5	5	15	20	20
9	Products with unknown	3	3	3	3	5	5	5

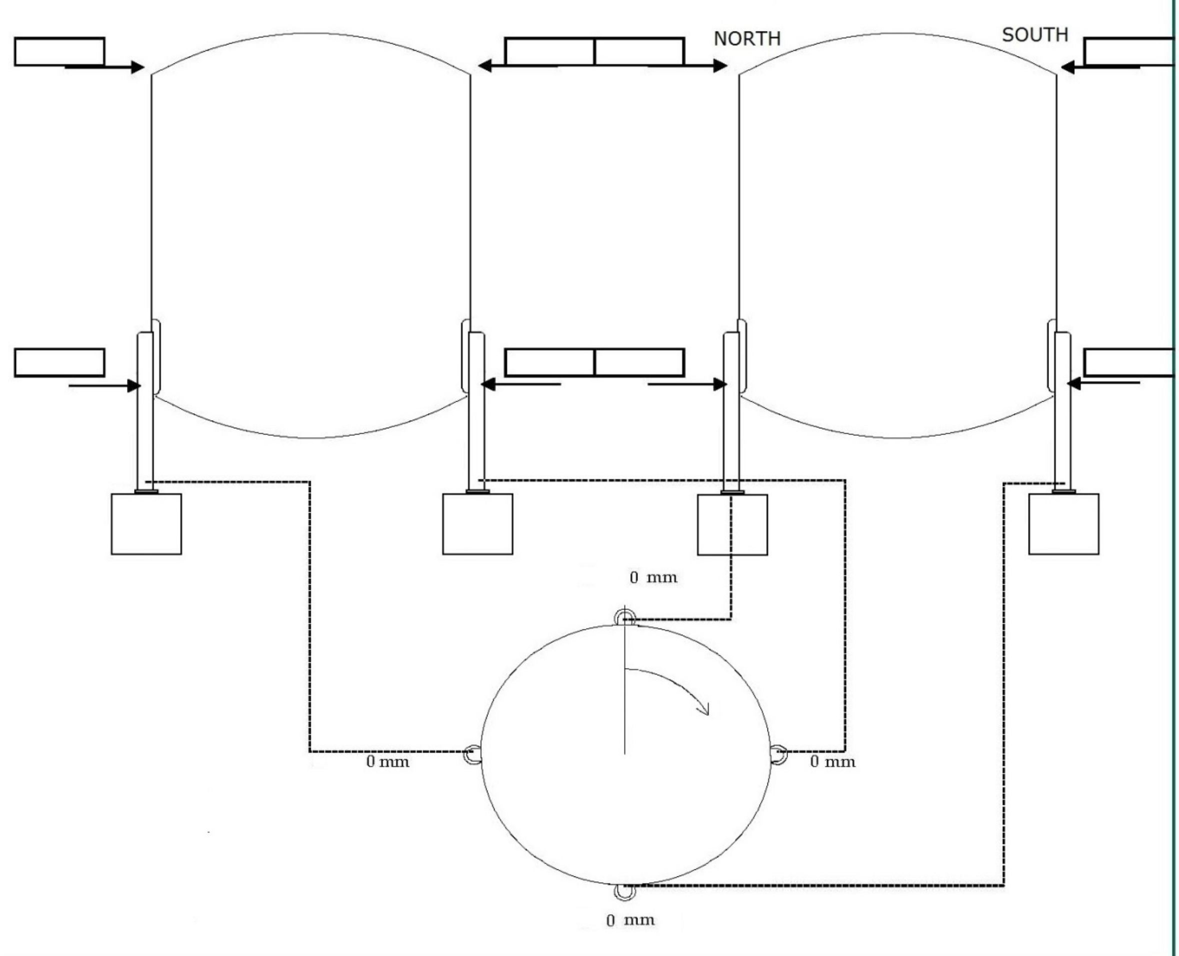
	corrosion rates							

B.3 Example NDT inspection sheets

Planar tilt measurement with use of Laser level tool	

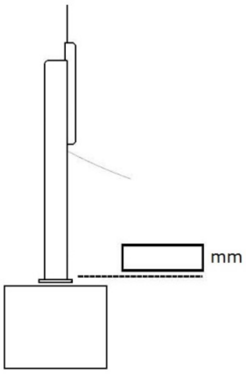
Location:
Tank No.: Type: Class: Date of inspection:
Diameter: metre Report number:
Height: metre Name of inspector:

Planer tilt measurement:
Measure on number of measurement points (to be established by the formula:
N = D/3·05 with a minimum of 8 points and maximum distance of 10 m between measuring points).
Locate measuring points starting from spiral stair or liquid level measuring device:
1 position as low as possible at tank shell
1 position as high as possible near top of shell
Mark the difference between the 2 perpendicular points

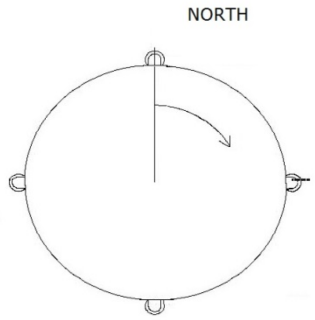


Circumferential Settlement

Location:
Tank no. Type: Class: Date of inspection:
Diameter: metre Report number:
Height: metre Name of inspector:



Level measurement
Measure level on base plate of each column.
Start numbering on North side and count clockwise.



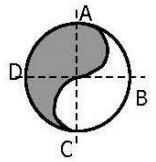
Point	Value	Correction	dH [mm] interval 10m	Result.	Remarks
1					
2					
3					
4					
5					
6					
7					
8					

UT Inspection
Columns

Location:
Tank No.: Type: Class:
Diameter: metre
Height: metre

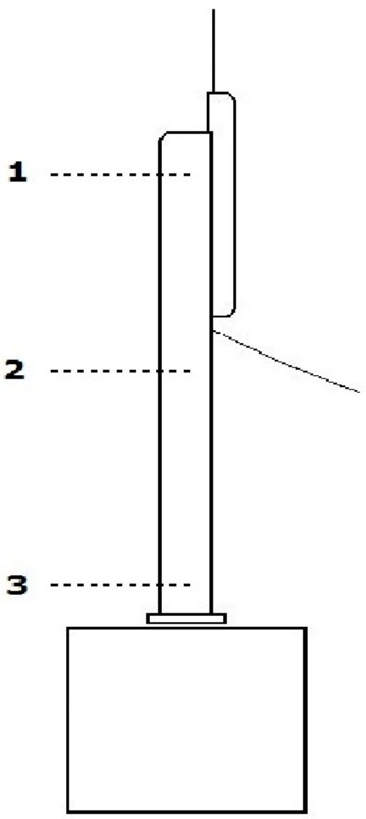
Date of inspection:
Report number:
Name of inspector:

Thickness measurement columns
Measurement locations at connections to tank, 1/2h and 30 mm above the base of the collumn.
4 measurements shall be taken at 90 degrees at each location



CROSS SECTION OF COLUMN

Point	Location				
	A	B	C	D	
1				X	[mm]
2					[mm]
3					[mm]

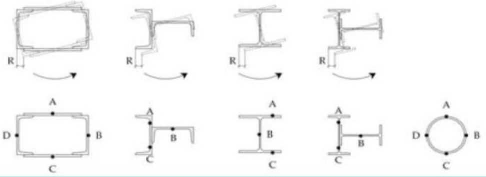


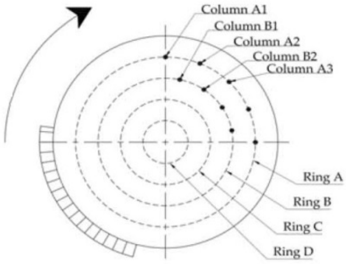
UT Inspection
Roof columns

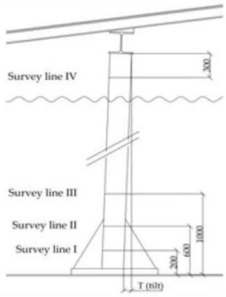
Location:
Tank No.: Type: Class:
Diameter: metre
Height: metre

Date of inspection:
Report number:
Name of inspector:

Measurement
Each column has to be measured at 4 survey lines
Each survey line has 4 measurement locations
Maximum allowable tilt (T) H/100 with a maximum of 125 mm
R is the rotation of the profile







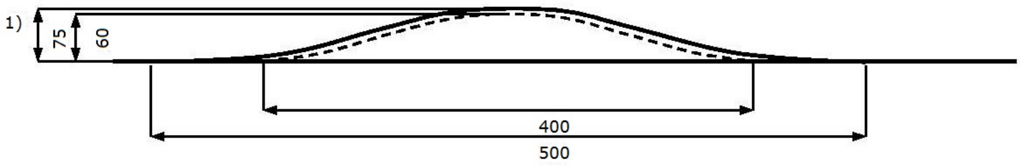
Ring	Column	Survey line	Thickness Measurement location				Avg.	Min.	Tilt A-C	Tilt D-B	twist R	Remarks
			A	B	C	B						
A	1	I										
		II										
		III										
		IV										
	2	I										
		II										
		III										
		IV										
	3	I										
		II										
		III										
		IV										
	4	I										
		II										
		III										
		IV										
	5	I										
		II										
		III										
		IV										
	6	I										
		II										
		III										
		IV										
	7	I										
		II										
		III										
		IV										
	8	I										
		II										
		III										
		IV										

Visual Inspection
Tank bottom (Ripples and Bulges)

Location:
Tank No.: Type: Class: Date of inspection:
Diameter: metre Report number:
Height: metre Name of inspector:

When, during visual inspections, ripples or bulges are found, the dimensions of these deformations should be measured in accordance with EEMUA 159

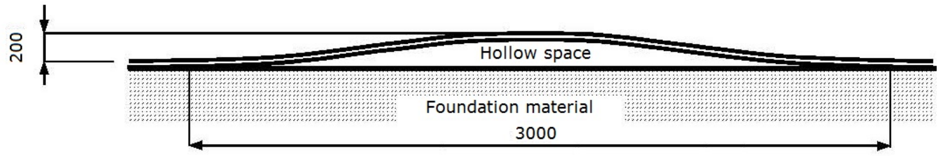
1) For ripples (fully supported by foundation materials) see Section 7.5.5
H/W ratio should be > 0.15
2) For hollow section see Section 8.5
H/W ratio should not exceed 1:15



Example: the maximum allowable height of a ripple with a width of 400 mm should be 0.15 x 400 = 60 mm

Figure 40 Maximum ripple diemnsions

No.	Measured height (mm)	Measured width (mm)	Ratio
1	75	500	0.15
2	75	490	0.153
3	60	480	0.125
4			
5			
6			



No.	Measured height (mm)	Measured width (mm)	Ratio
1	200	3000	0.067
2	190	3000	0.063
3	210	2950	0.071
4			
5			
6			