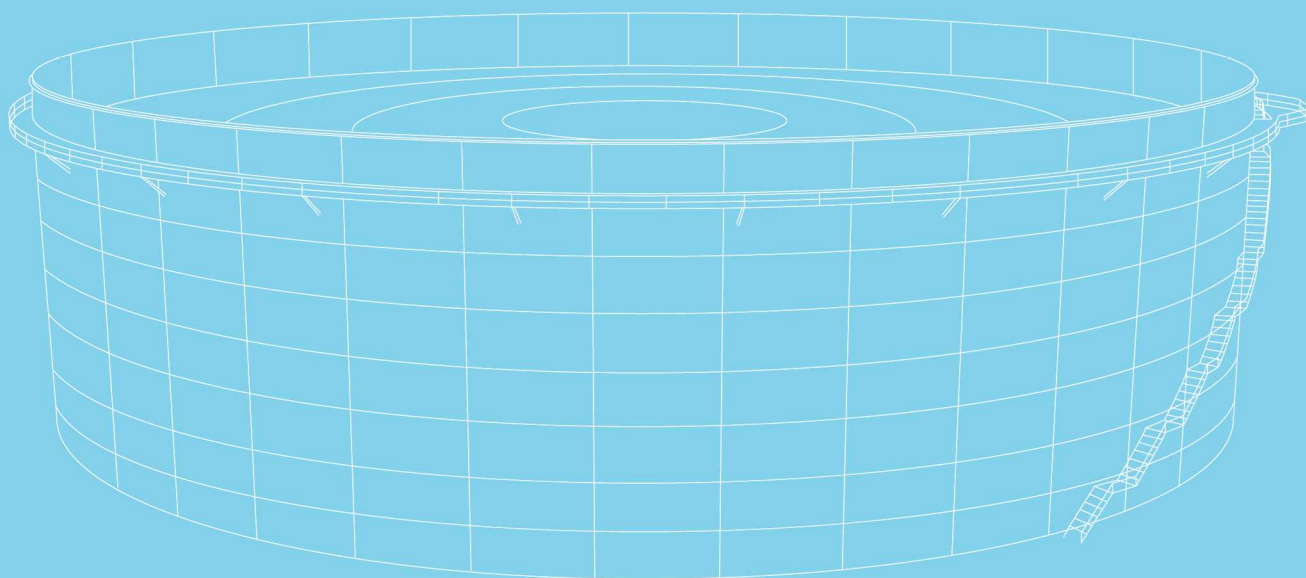




Study according to BPRR Site Technical Practice

based upon EEMUA 159 3rd edition



Tank:	TK059
Client:	BP Raffinaderij Rotterdam
Print date:	28-07-2021
File name:	rbi-report_57.4.pdf
Version:	4
Study status:	Company reviewed

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1 Summary

The conclusions and recommendations mentioned in this case study are based on a qualitative assessment of the several investigations and inspections conducted on the storage tanks. The interpretation of the individual measurements are valued against the rejection limits stated within the EEMUA 159 3rd edition. Engineering judgement is used to combine the individual results into an overall judgement and to compose mitigating actions.

Onstream	TTAR
[mm-yyyy]	[mm-yyyy]
06-2025	04-2027

1.1 Results of analysis

Study according to BPRR Site Technical Practice

Component	Part	DM	RL		K	Inspection interval	Manual interval	Last inspection	Next inspection
			[yr]		[-]	[yr]	[yr]	[mm - yyyy]	[mm - yyyy]
Roof	Roof plates	general-thinning	50.00		1.00	20.00	8	06-2017	06-2025
Shell	Course 7	general-thinning	46.58	<div></div>	1.00	20.00	8	09-2017	09-2025
	Course 6	general-thinning	46.58	<div></div>	1.00	20.00	8	09-2017	09-2025
	Course 5	general-thinning	46.58	<div></div>	1.00	20.00	8	09-2017	09-2025
	Course 4	general-thinning	46.58	<div></div>	1.00	20.00	8	09-2017	09-2025
	Course 3	general-thinning	46.58	<div></div>	1.00	20.00	8	09-2017	09-2025
	Course 2	general-thinning	46.58	<div></div>	1.00	20.00	8	09-2017	09-2025
	Course 1	general-thinning	46.58	<div></div>	1.00	20.00	8	09-2017	09-2025
Floor-to-shell	Fillet weld	fillet-weld-thickness	Status: undefined					undefined	undefined
Floor	Membrane	general-thinning	50.00		0.90	20.00	-	04-2007	04-2027
	Membrane	pitting	50.00		0.90	20.00	-	04-2007	04-2027
	Annular	general-thinning	50.00		0.90	20.00	-	04-2007	04-2027
	Annular	pitting	50.00		0.90	20.00	-	04-2007	04-2027
	Annular proj.	annular-projection	Status: ok					10-2014	10-2034
	Sump 1	general-thinning	50.00		0.90	20.00	-	04-2007	04-2027
	Sump 1	pitting	50.00		0.90	20.00	-	04-2007	04-2027
	Sump 2	general-thinning	50.00		0.90	20.00	-	04-2007	04-2027
	Sump 2	pitting	50.00		0.90	20.00	-	04-2007	04-2027
	Sump 3	general-thinning	50.00		0.90	20.00	-	04-2007	04-2027
	Sump 3	pitting	50.00		0.90	20.00	-	04-2007	04-2027
Foundation	Tank pad	planar-tilt	Status: ok					03-2017	03-2037
	Tank pad	sagging	Status: ok					08-2006	08-2026
	Tank pad	bottom-ripples	Status: undefined					undefined	undefined
	Tank pad	voids	Status: undefined					undefined	undefined
	Tank pad shoulder	edge-settlement	Status: ok					08-2006	08-2026
	Tank pad shoulder	differential-settlement	Status: ok					10-2014	10-2034
Nozzles	No data to display								


Wind load



1.2 Conclusion

Conclusie

 2E 10-06-2016

10-06-2016 ()

Dak:

Het dak is in orde bevonden. Tijdens de laatste TAR is er een aluminium inwendig drijvend dak geïnstalleerd.

Wand:

De wand is in orde bevonden. Echter hadden hier in 2013, wanddiktemetingen op uitgevoerd moeten worden. Ook voor de nieuwe ISI termijn zijn deze metingen overdue!

Bodem:

De bodem is tijdens de laatste TAR in 2008 vervangen (annular, membraam en sumps) daarbij is deze ook van een coating voorzien en is er een SLOD geïnstalleerd.

De oude bodem had vooral veel last van corrosie van de onderzijde.

Er is enkel op differentiele zetting en scheefstand gemeten, het is aan te bevelen tijdens de volgende TAR ook te meten op zakking, bodemrimpels en randzetting.


De bodem voldoet, i.c.m. de huidige terp aan de Nederlandse Richtlijn Bodembescherming ten tijde van de geprojecteerde datum.

Door de maximale termijn van 20 jaar na de laatste inspectie op de bodem, komt de berekende datum van eerst volgende inwendige inspectie op 2027.

De volgende in service inspectie dient uitgevoerd te worden in 2017.

Het opgeslagen product (G10) valt onder groep 4 en hiermee komt de interval voor in service inspectie neer op 8 jaar volgens tabel B3.1 van EEMUA 159.

volgens Zie GP 32-44-1 hoofdstuk 8.2.2 A hoeft de on stream inspectie pas 0.9 x 8 jaar vanaf de RBI datum uitgevoerd te worden echter omdat de metingen uit 2010 niet naar behoren zijn en de enige waarden uit 2006 zijn, wordt geadviseerd om de on-stream inspectie gepland in 2017 te laten plaats vinden.

11-01-2018 ()

Metingen volgens plan uitgevoerd. De gemeten waardes hebben geen invloed op de vastgestelde tank TAR datum.

2 Remaining life

2.1 Roof

Part	DM	ABT	t_{last}	$t_{min,acc.}$	TA	CR	RL
		[mm]	[mm]	[mm]	[mm]	[mm/yr]	[yr]
Roof plates	general-thinning	4.76	4.4	3.808	0.59	0.010	50.00

2.2 Shell

Part	DM	ABT	t_{last}	$t_{min,acc.}$	TA	CR	RL
		[mm]	[mm]	[mm]	[mm]	[mm/yr]	[yr]
Course 7	general-thinning	6.35	6.5	5.64	0.86	0.018	46.58
Course 6	general-thinning	6.35	6.5	6.03	0.47	0.010	46.58
Course 5	general-thinning	6.35	5.9	5.19	0.71	0.015	46.58
Course 4	general-thinning	8	7.9	7.21	0.69	0.015	46.58
Course 3	general-thinning	9.4	9.4	8.56	0.84	0.018	46.58
Course 2	general-thinning	10.1	10.4	9.87	0.53	0.011	46.58
Course 1	general-thinning	12.2	12.1	11.62	0.48	0.010	46.58

Wind load

2.3 Floor-to-shell

Part	DM	t_{nom}	t_{last}	$t_{min,acc.}$	TA	CR	RL
		[mm]	[mm]	[mm]	[mm]	[mm/yr]	[yr]
Fillet weld	fillet-weld-thickness	Status: undefined					

2.4 Floor

Part	DM	ABT	t_{last}	$t_{min,acc.}$	TA	CR	RL
		[mm]	[mm]	[mm]	[mm]	[mm/yr]	[yr]
Membrane	general-thinning	8	8.04	2.5	5.54	0.070	50.00
Membrane	pitting	8	8.04	1.25	6.79	0.112	50.00
Annular	general-thinning	10	9.84	4	5.84	0.050	50.00
Annular	pitting	10	9.84	2	7.84	0.074	50.00
Annular proj.	annular-projection	Status: ok					
Sump 1	general-thinning	undefined	11.5	4	7.50	0.070	50.00
Sump 1	pitting	undefined	11.5	2	9.50	0.112	50.00
Sump 2	general-thinning	undefined	11.5	4	7.50	0.070	50.00
Sump 2	pitting	undefined	11.5	2	9.50	0.112	50.00
Sump 3	general-thinning	undefined	11.5	4	7.50	0.070	50.00
Sump 3	pitting	undefined	11.5	2	9.50	0.112	50.00

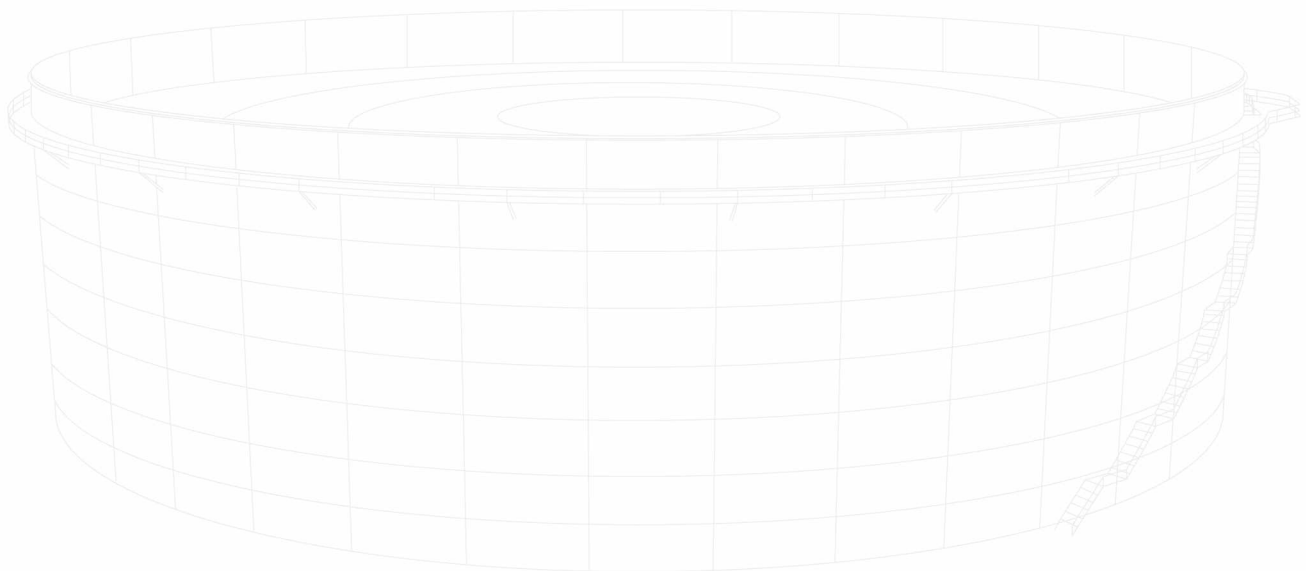
2.5 Foundation

2.5.1 Non-trendable parts

Part	DM	Status
Tank pad	planar-tilt	ok



Part	DM	Status
Tank pad	sagging	ok
Tank pad	bottom-ripples	undefined
Tank pad	voids	undefined
Tank pad shoulder	edge-settlement	ok
Tank pad shoulder	differential-settlement	ok



3 Notes and assumptions

3.1 Data analysis

CR's

 10-06-2016

10-06-2016 ()

Dak:

Hier is gekozen voor de CR op basis van LS-fit omdat er meerdere metingen zijn uitgevoerd.

Wand:

Omdat er meerdere metingen zijn uitgevoerd is hier gekozen voor CR LS-fit.

Bodem:

Voor het membraam en de annular is de CR bepaald op basis van de afname tussen ontwerp in 1966 tot de eerste daaropvolgende meting in 1983. De grootste CR welke voorkomt op het membraam is als representatief beschouwd voor de sumps.

11-01-2018 ()

Omdat er meerdere metingen zijn uitgevoerd is hier gekozen voor CR LS-fit.

3.2 Fitness for purpose

Dak afkeur

 10-06-2016

De afkeurgrens voor het dak is vastgesteld op 3,808 mm. De omtrekafstand tussen 2 opeenvolgende onders-teuningspunten in het dak is namelijk groter dan 1,7 meter.

4 Tank details

This chapter displays all tank specifications and component properties. Note that when a foundation or a floor-to-shell connection has been installed this will not appear in this chapter as these components have no configurable properties.

4.1 Tank specifications

Property	Value
Tank name	TK059
Tank nr.	0041-0059
Location	OME
Date of construction	01-01-1966
Design code	API 650
Type	-
Diameter [m]	29.26
Height [m]	16.557
Maximum filling height [m]	16
Capacity [m ³]	11000
Design pressure [mbar]	0
Design vacuum pressure [mbar]	5
Design wind speed [m/s]	45
Operational max. temperature [°C]	50
Operational min. temperature [°C]	-20
Has heating coil	Yes
Group	-
Class	K3
PV vents	-
Comments	-
Circumference [m]	92
Surface [m ²]	672

4.2 Roof specifications

Property	Value
Roof type	Cone roof + innerfloat
Seal range	-X/+X
Superimposed load [N/mm ²]	1200
Roof plates load [N/mm ²]	0
Roof framing load [N/mm ²]	648
Top angle load [N/mm]	0.1
Roof columns	No
Roof insulation	No

4.3 Shell specifications

Property	Value
Shell insulation	No
Youngs modulus [N/mm ²]	210000



4.4 Floor specifications

Property	Value
Floor type	
Youngs modulus [N/mm^2]	210000
Coated	Yes
Double bottom with leak detection	No
External coating applied at	-

4.5 Product details

Property	Value
Product name	G10
Product group	Gas Oil
Specific gravity [-]	0.86
Flash point [$^{\circ}C$]	60
Toxicity	Toxic substance

4.6 Product group details

Product group '**Gas Oil**' with service condition group '**Group 4**' has the following theoretical corrosion rates:

Tank part	Theoretical corrosion rate
Bottom plates [mm/yr]	0.1
Shell liquid exposed area [mm/yr]	0.05
Shell vapour exposed area [mm/yr]	0.1
Fixed roof plates [mm/yr]	0.1
Fixed roof supporting structure [mm/yr]	0.1
Floating roof plates [mm/yr]	0
Floating pontoon area [mm/yr]	0

5 Risk analysis tank roof

5.1 Analysis results

Probability rating	Risk assessment matrix						Risk rating	Factor K	Established factor K
$\xi = 1.43$	Probability	H	L	H	E	E	*N*	*0.90*	0.90
Consequence rating		M	L	M	H	E	L	0.80	Sum of credit and debit points
$\chi_{ecc.} = 1.00$		L	N	L	M	H	M	0.70	0.20
$\chi_{h. \& s.} = 2.00$		*N*	N	*N*	L	M	H	0.60	Adjusted factor K
$\chi_{env.} = 2.00$			N	*L*	M	H	E	0.50	1.00
						Consequence			

5.2 Probability of failure analysis

Question	Answer
Internal coating is applied on tank roof plates	Internal coating not existing
External coating is applied on tank roof plates	External coating applied and quality is sound (or material is SS)
Storage conditions	Between 40 and 85 °C
Vapour corrosivity	Group 4, Risk L
The tank is operated with an inert blanket system above product	No, but storage temperature is below 85 °C
Is roof supporting structure located below roof plates?	Yes, but crevice corrosion is likely to occur
Is roof supporting structure located on top of roof plates?	No, roof supporting structure is not located on top of roof plates and proper water draw-off is secured at all times
Is tank roof insulated and rain water may cause corrosion under insulation (CUI)?	No, tank roof is not insulated

5.3 Consequence of failure analysis

5.3.1 Economical

Question	Answer
Time to repair	No internal entry required, limited repair, no limitation on repair time
Cost of repair	Negligible, or less than 5% of capital cost
Probable magnitude of product loss	No release of product

5.3.2 Health & safety

Question	Answer
Likelihood of injury to personnel	Minor injury
Product flammability	Class III(1) and unclassified product
Product toxicity	Toxic substance
Location of tank farm	Flat tank farm
Is tank near public fence	No

5.3.3 Environment

Question	Answer
Environmental hazard to soil and water has the potential to cause	Environmental nuisance affecting neighbourhood
Vapour emission	No or negligible harmful (toxic) release



5.4 Confidence analysis

Question	Answer
NDT method used and extent of coverage (number of readings) to establish actual roof plate thickness	US on gridline system
Frequency of inspections performed during service life of tank	Multiple inspections carried out
Differential settlements between the tank structure and the supports of the piping to/from the tank will affect the allowable minimum thickness of roof plates	No moments in roof nozzles or supporting structures



6 Risk analysis tank shell

6.1 Analysis results

Probability rating	Risk assessment matrix						Risk rating	Factor K	Established factor K
$\xi = 1.36$	Probability	H	L	H	E	E	*N*	*0.90*	0.90
Consequence rating		M	L	M	H	E	L	0.80	Sum of credit and debit points
$\chi_{ecc.} = 2.00$		L	N	L	M	H	M	0.70	0.10
$\chi_{h.\&s.} = 2.00$		*N*	N	*N*	L	M	H	0.60	Adjusted factor K
$\chi_{env.} = 2.00$			N	*L*	M	H	E	0.50	1.00
				Consequence					

6.2 Probability of failure analysis

Question	Answer
Internal coating is applied to tank shell plates	Internal coating not existing
External coating is applied to tank shell plates	External coating applied and quality is sound (or material is SS)
Storage conditions	Between 40 and 85 °C
Heating coils in tank	No, or not in direct contact with shell plates
Product corrosivity	Group 4, Risk L
Vapour corrosivity	Group 4, Risk L
Tank shell has been insulated, and rain water may cause corrosion under insulation (CUI)	Tank shell is not insulated

6.3 Consequence of failure analysis

6.3.1 Economical

Question	Answer
Time to repair	Internal entry required, limited repair (< 3 months)
Cost of repair	5-10% of capital cost
Probable magnitude of product loss	< 5% of tank contents

6.3.2 Health & safety

Question	Answer
Likelihood of injury to personnel	Minor injury
Product flammability	Class III(1) and unclassified product
Product toxicity	Toxic substance
Location of tank farm	Flat tank farm
Is tank near public fence	No

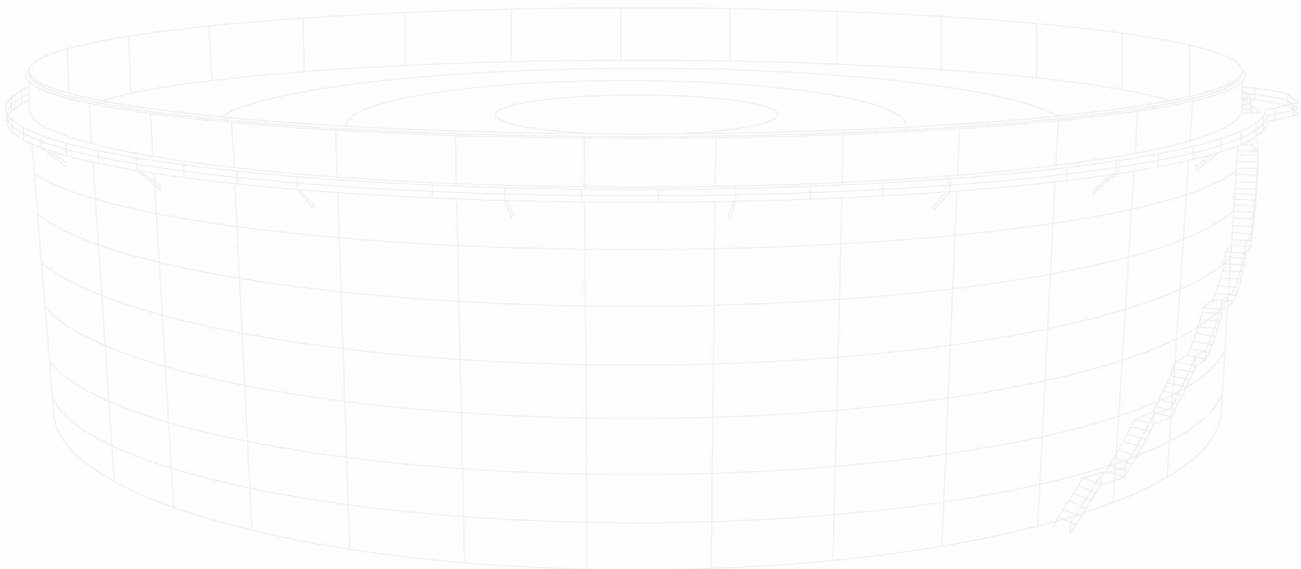
6.3.3 Environment

Question	Answer
Environmental hazard to soil and water has the potential to cause	Environmental nuisance affecting neighbourhood
Vapour emission	No or negligible harmful (toxic) release



6.4 Confidence analysis

Question	Answer
NDT method used and extent of coverage (no. of readings) to establish actual shell plate thickness	Crawler / beetle + US
Frequency of inspections performed during service life of tank	Multiple inspections carried out
Corrosion on wind girders will effect the tank's stability and thus the allowable minimum thickness of shell plates under external loads (wind and vacuum)	No corrosion on windgirder
Buckles in shell plates will effect the tank's stability and thus the allowable minimum thickness of shell plates under external loads (wind and vacuum)	No buckles on tank shell plates
Bending moments in shell nozzles, induced by differential settlements between the tank structure and the supports of the piping to/from the tank, will effect the allowable minimum thickness of shell plates	Moments present and they induce effects on integrity of tank shell plates



7 Risk analysis tank floor

7.1 Analysis results

Probability rating	Risk assessment matrix						Risk rating	Factor K	Established factor K
$\xi = 1.94$	Probability	H	L	H	E	E	N	0.90	0.70
Consequence rating		M	L	M	H	E	L	0.80	Sum of credit and debit points
$\chi_{ecc.} = 3.00$		L	N	L	M	H	*M*	*0.70*	0.20
$\chi_{h.\&s.} = 2.00$		*N*	N	N	L	*M*	H	0.60	Adjusted factor K
$\chi_{env.} = 2.00$			N	L	M	*H*	E	0.50	0.90
			Consequence						

7.2 Probability of failure analysis

Question	Answer
Impressed cathodic protection	Readings are below 0.60 V thus no effective CP existing or CP does not exist
Sacrificial cathodic protection	Sacrificial CP not available nor operating
Internal coating or lining is applied to bottom plates	Internal coating applied and quality is sound (or material is SS)
External coating is applied to bottom plates (other than shop primer)	Not existing
Storage conditions temperature of product	Between 40 and 85 °C
Type of bottom	Cone up
Heating coils in tank	No, or not in direct contact with bottom plates
Product corrosivity	Group 4, Risk L
Foundation type	2E pad with annular ring of coarse granular material
Tank bottom free from contact with water	Yes
Effectiveness of drainage	Slope of tank pad shoulder allows for adequate drainage away from tank bottom

7.3 Consequence of failure analysis

7.3.1 Economical

Question	Answer
Time to repair	Internal entry required, major repair (3-8 months)
Cost of repair	10-50% of capital cost
Probable magnitude of product loss	> 5% of tank contents

7.3.2 Health & safety

Question	Answer
Likelihood of injury to personnel	No injury or near miss
Product flammability	Class III(1) and unclassified product
Product toxicity	Toxic substance
Location of tank farm	Flat tank farm
Is tank near public fence	No



7.3.3 Environment

Question	Answer
Environmental hazard to soil and water has the potential to cause	Environmental nuisance affecting neighbourhood
Vapour emission	No or negligible harmful (toxic) release

7.4 Confidence analysis

Question	Answer
NDT method used and extent of coverage (number of readings) to establish actual bottom plate thickness	Floorscan + US
Frequency of internal inspections performed during service life of tank	Multiple inspections carried out
Type of interconnecting bottom plate welds outside of annular section	Double pass lap welds



A Tank history

This chapter describes the tank history of the storage tank for the tank components which are evaluated within RBIT360°, it is therefore not necessarily the complete tank history. The Tank Integrity Assessor notes on the individual measurements are also presented here. The actual values of these individual measurements are left out of this overview and can be found in RBIT360°.

Date	Type	Subtype	Note
01-01-1966	Measurement	Membrane, annular, sump	Ontwerpdikte als '0' meting ingevoerd.
01-01-1966	Measurement	Course	Ontwerpdiktes al '0' meting ingevoerd.
01-01-1966	Measurement	Roof plates	Ontwerpdikte als '0' meting ingevoerd.
01-02-1978	Measurement	Roof plates	Kruismeting op het dak uitgevoerd. Er is minus 0.7 mm coatingcorrectie toegepast op de ingevoerde waarde. Bron: TK059 OUDE WIN FILES.PDF
01-02-1978	Measurement	Course	Er is een meting langs de trap uitgevoerd. Er is minus 0.7 mm coatingcorrectie toegepast op de ingevoerde waarde. Bron: TK059 OUDE WIN FILES.PDF
01-04-1982	Measurement	Course	Meting is langs de trap uitgevoerd. Er is een coatingcorrectie toegepast minus 0.7 mm voor de ingevoerde waarde. Bron: TK059 OUDE WIN FILES.PDF
01-04-1982	Measurement	Roof plates	Kruismeting op het dak uitgevoerd. Er is minus 0.7 mm coatingcorrectie toegepast op de ingevoerde waarde. Bron: TK059 OUDE WIN FILES.PDF
01-11-1983	Measurement	Membrane, annular, sump	Kruismeting uitgevoerd op de bodem. Er is minus 0.7 mm coatingcorrectie toegepast op de ingevoerde waarde.
01-01-1988	Measurement	Roof plates	Kruismeting op het dak uitgevoerd. Er is minus 0.7 mm coatingcorrectie toegepast op de ingevoerde waarde. Bron: TK059 OUDE WIN FILES.PDF
01-01-1988	Measurement	Course	Meting is langs de trap uitgevoerd. Er is minus 0.7 mm coatingcorrectie toegepast. Bron: TK059 OUDE WIN FILES.PDF
01-08-1999	Measurement	Course	Wandmeting uitgevoerd langs de trap. Er is een coatingcorrectie minus 0.7 mm uitgevoerd. Bron: TK059 1999-08-11 SGS US RAPP. 51007.PDF
01-08-1999	Measurement	Roof plates	Kruismeting uitgevoerd op het dak. Er is minus 0.7 mm toegepast op de ingevoerde waarde. Bron: TK059 1999-08-11 SGS US RAPP. 51007.PDF
09-08-2006	Measurement	Membrane, annular, sump	5-puntsmeting op de bodemplaten uitgevoerd. De kleinste van de gemiddelde waarde is ingevoerd voor de annular (plaat 76) en het membraam (plaat 32). Voor de sumps zijn de kleinste gevonden waarden ingevoerd. Er is geen coatingcorrectie toegepast. Bron: TK059 2006-08-09 RTD VIS.-UT-ZETTING RAPP.0131.PDF
09-08-2006	Measurement	Edge settlement	RTD heeft een randzettingsmeting uitgevoerd, op elke annularplaat op 3 locaties. De grootste afwijking per annularplaat is ingevoerd. Bron: TK059 2006-08-09 RTD VIS.-UT-ZETTING RAPP.0131.PDF
09-08-2006	Measurement	Sagging	Bodemzettingsmeting uitgevoerd door RTD. Bron: TK059 2006-08-09 RTD VIS.-UT-ZETTING RAPP.0131.PDF
11-08-2006	Measurement	Membrane, annular, sump	RTD heeft m.b.v. Slofec een scan van de bodem gemaakt. Hierbij is voor het membraam een minimale restplaatdikte kleiner dan 2,0 mm gemeten en voor de annular een minimale restplaatdikte van 5,0 mm. Bron: TK059 2006-08-09 RTD SLOFEC RAPP. 0653.PDF
18-08-2006	Measurement	Course	RTD heeft een beetle meting op de tankwand uitgevoerd. Bron: TK059 2006-08-18 RTD BEETLE RAPP.0666.PDF
19-04-2007	Measurement	Membrane, annular, sump	Na installatie van de nieuwe bodem is er een '0' meting uitgevoerd. De kleinst gevonden gemiddelde plaatdikte is ingevoerd en voor de sumps de kleinste gevonden waarde. Bron: TK059 2007-04-07 IP6 UT12162007.PDF
15-10-2014	Measurement	Planar tilt	Scheefstand is op 12 locaties rondom de tank gemeten. De grootste afwijkingen per 3 meetpunten is ingevoerd. Bron: TK059 2014-10-15 ZETTINGMETING D19 34327 39064.PDF
15-10-2014	Measurement	Differential settlement	De differentiele zetting is gemeten bij een vulhoogte van 13.092 meter. Bron: TK059 2014-10-15 ZETTINGMETING D19 34327 39064.PDF
28-10-2014	Measurement	Roof plates	5-puntsmeting op de dakplaten uitgevoerd. De kleinste van de gemiddelde plaatdikte is hierbij ingevoerd. Er is geen coatingcorrectie toegepast. Bron: TK059 2014-10-28 UT-RT RAPP.102-44-2014.PDF



Date	Type	Subtype	Note
28-10-2014	Measurement	Annular projection	De uitwendige annularrand is gemeten op 46 locaties. De kleinst gevonden waarde is ingevoerd. Bron: TK059 2014-10-28 UT-RT RAPP.102-44-2014.PDF
29-03-2017	Measurement	Planar tilt	Scheefstand is op 12 locaties rondom de tank gemeten. De grootste afwijkingen per 3 meetpunten is ingevoerd. Bron: TK059 2017-03-29 van Steenis Rapp.D19 17S040
28-06-2017	Measurement	Roof plates	5-puntsmeting op de dakplaten uitgevoerd. De kleinste van de gemiddelde plaatdikte is hierbij ingevoerd. Er is geen coatingcorrectie toegepast. Bron: TK059 2017-06-28 A+RTD UT Dakplaten.PDF
21-09-2017	Measurement	Course	Applus RTD rapport 100-38-2017

