# TANK 305
# API 653 TANK INSPECTION
# Final Report

## Ploiesti, Romania

## January 2012

**Report Number:** T14-001-01/305-F

## Inspection Summary

An out-of-service American Petroleum Institute (API) 653 tank inspection on Tank 305 at Ploiesti, Romania in February 2012 has been carried out. This inspection complied with the API 653 standard. This tank inspection included visual inspection of the tank, tank appurtenances, tank foundation, and tank containment. NDT data gathered will be part of the final report.

This report is generated on data gathered from three locations: applicable codes, regulations, and laws; the observed field conditions existent during the API inspection; and material provided in written form by the facility, end-user, or client (*e.g.*, as-builts, previous inspection reports, written transcriptions of conversations with the facility.)

This inspection report is based solely on empirically observable conditions observed during the inspection process and correspondence with the facility or end-user. Information not empirically observable or presented to us in the course of this inspection, but which may be relevant to the inspection's findings, have not been evaluated or included in this inspection. The API inspector bears no responsibility for findings which could only be ascertained by information not made available to the API inspector.

## References Used

The following standards and procedures were used during the inspection:

1. API Std 650 (Welded Tanks for Oil Storage) 11th Edition, Addendum 3, August 2011
2. API 653 (Tank Inspection, Repair, Alteration and Reconstruction) 4th Edition, Addendum 1, August 2010
3. EEMUA 159 (Users' Guide to the Inspection, Maintenance and Repair of Aboveground Vertical Cylindrical Steel Storage Tanks) 3rd Edition, 2003
4. API RP 652 (Linings of Aboveground Petroleum Storage Tank Bottoms) 5th Edition, October 2005
5. API RP 575 (Guideline and Methods for Inspection of Existing Atmospheric and Low-Pressure Storage Tanks) 2nd Edition, May 2005
6. API Std 2015 (Safe Entry and Cleaning Of Petroleum Storage Tanks) 6th Edition, August 2001, Reaffirmed May 2006
7. API Std 2000 (Venting Of Atmospheric and Low-Pressure Storage Tanks) 6th Edition, November 2009
8. NFPA 30 (Flammable and Combustible Liquids Code) 2008 Edition

# Tank Suitability for Service Statement

This report contains all the details and evaluation results used to arrive at this tank suitability for service determination. The following text briefly explains the suitability for key criteria. Complete details are presented in the report.

### *General Condition*

Tank 305 is an aboveground storage tank that contains currently gasoline. The tank is 11.73 meter tall with a 22.78 meter diameter. Further details about the tank's history are unknown; this includes the date of construction or the construction standard.

### *Hydraulic Integrity*

We define hydraulic integrity as a tank's ability to retain product without compromising tank bottom, shell, and other joint condition. In addition, a tank with proper hydraulic integrity displays characteristics of a solid, intact, cohesive containment with no signs of product leakage around or beneath the tank.

A tank bottom inspection using a magnetic flux leakage (MFL) scanner has been performed. The MFL survey detected no perforations or holes (Refer to FR-40-PLO-305-20120130-0). *(Note: (Note: The detection threshold for the MFL floor scanner is 20 % t metal loss. (t=actual thickness))*.

Based on our inspection and engineering evaluation, Tank 305 is considered to have unsuitable hydraulic integrity.

### *Structural Integrity*

We define tank structural integrity as the capability of the tank to remain freestanding, with or without product, under the conditions of its design basis. Structural attributes include the tank bottom, shell, roof and their attachments. Ultrasonic inspections of the shell were performed utilizing scaffolding built around the tank. The design code of this tank is unknown.

Based on our inspection of the accessible components and engineering evaluation, Tank 305 is considered to have suitable structural integrity.

### *Coating Integrity*

We define coating integrity as the interior wetted coating's ability to provide an impervious, completely continuous film barrier that prevents harmful environmental and service conditions corrosive agents to penetrate to the base metal, which could over time compromise hydraulic integrity.

Although corrosion and coating failures may not indicate structural failures; they present conditions which, in time, can lead to structural integrity failures. The coating inside this tank is not present, outside the integrity is not given.

Based on our inspection of the accessible components and engineering evaluation, Tank 305 is considered to have unsuitable coating integrity.

### *Suitability for Service Determination*

Based on the above findings and the detailed report below, we have determined that:

- Mandatory repairs are required before this tank is returned to service.
- Tank 305 is not considered suitable for immediate return to service.

### *Next Inspection Schedules*

API 653 recommends the interval to the next internal inspection be determined based on known corrosion rates, but in no case shall the interval exceed 20 years from the date of inspection. When corrosion rates are not known or well established, API 653 recommends that the tank be inspected within 10 years. Based on the current calculated corrosion rates, the useful life of this tank does not exceed 20 years. We recommend the following scheduled inspections:

- **API internal inspection (out-of-service)** inspection should be scheduled no later than 10 years from this inspection date, no later than January 2022 or sooner if a change in tank condition has occurred. In the interim, a limited out-of-service inspection of the coating should be performed during maintenance cleanings (if applicable).
- **API external inspection (in-service)** inspection be conducted in accordance with API 653 requirements no later than January 2013 (1 year from 2011 inspection) for a visual inspection and no later than January 2014 (2 years from 2011) for a UT inspection of the shell, or sooner if a change in condition has occurred.

## Inspector's Certification

I acknowledge that I am familiar with API Standard 653's provisions; the inspection and evaluation performed on Tank 305 at Ploiesti, Romania, and certify that the inspection was performed per the API Standard 653 provisions, good engineering practices, and with usual and customary care.

# Table of Contents

## List of Appendices

# 1. Tank Summary

## *1.1. Project Scope*

An out-of-service API 653 tank inspection has been performed on the subject tank. This tank inspection included visual inspection of the tank, tank appurtenances, tank foundation, and tank containment. Following the API 653 inspection's completion, a preliminary findings report is provided detailing all tank conditions and repair recommendations.

## *1.2. Tank repairs*

### 1.2.1 Tank Repair Definitions

- **Mandatory Repairs** – repairs that need to be completed before the tank can be returned to service. Mandatory Repairs consists of any failure / deficiency that has breached the hydraulic and/or structural integrity of the tank, and/or presents an imminent danger to personnel and/or adjacent structures.
- **Non-Mandatory Recommended Repairs Preceding Return-To-Service** – repairs that do not meet the requirements of being a Mandatory Repair, but will help maintain or improve tank operability / serviceability, or else are required to meet current codes. Repairs noted under this category are recommended for performance prior to the tank being returned to service.
- **Future Non-Mandatory Recommended Repairs** – repairs that do not meet the requirements of being a Mandatory Repair, but will help maintain or improve tank operability / serviceability, or else are required to meet current codes. Unlike the Non-Mandatory Recommended Repairs Preceding Return-To-Service, Future Non-Mandatory Recommended Repairs are not being recommended for performance prior to the tank being returned to service.
- **Recurring Maintenance Recommendations** - actions that should be taken on a recurring basis

### 1.2.2 Tank Repair Recommendations

The API 653 inspection has resulted in the following repair conditions:

| | |
| --- | --- |
| **Mandatory Tank Repairs Preceding Return To Service** | |
| I.1 | Perform MPI on the welds where necessary. |
| **Non-Mandatory Recommended Repairs Preceding Return-To-Service** | |
| II.1 | Install telltale holes in the reinforcement plates |
| II.2 | Install a suitable moisture barrier all around the tank bottom perimeter. |
| II.3 | Disconnect the roof column ring from the clips welded to the tank bottom. |
| II.4 | Renew / repair painting outside where necessary. |
| II.5 | Remove the abandoned support remain in the critical zone; perform MPI afterwards. |
| II.6 | Let the foundation and diked area be reviewed by a civil engineer. |
| II.7 | Inspect the roof and the roof appurtenances. |
| II.8 | Install an independent level alarm system. |
| II.9 | Install a diffuser nozzle for the inlet line. |
| II.10 | Attach a name plate. |
| II.11 | Replace the damaged / deformed floaters for the outlet swivel |
| II.12 | Clean and modify the stilling well |
| II.13 | Re-fasten the loose gusset plate at the wind girder. |
| II.14 | Install bearing pads underneath the swivel support legs |
| II.15 | Repair the tank bottom |
| II.16 | Apply an internal coating on the tank bottom and 1 meter high on the shell |
| **Future Non-Mandatory Recommended Repairs** | |
| III.1 | Modify the pipe supports according to common standards (ASME B 31.3). |
| **Recurring Maintenance Recommendations** | |
| IV.1 | Let the fire and safety systems be checked on an annular base by a safety engineer. |
| IV.2 | Perform proper housekeeping on a regular base. |
| IV.3 | Perform visual and UT inspections as per Inspection Interval Recommendation. |

### *1.3. Tank Details Table*

| | | | |
|---|---|---|---|
| **General** | | | |
| Tank Number: | | 305 | |
| Tank Type: | | AST | Vertical, Cone roof |
| Design Standard: | | Unknown | Assumed Russian |
| As Built Drawings Available: | [y/n] | Yes | Partially |
| Construction date: | [year] | Unknown | |
| Manufacturer: | | Unknown | |
| Nameplate Present: | [y/n] | No | |
| Last In-Service Inspection Date: | | 09/2008 | |
| Last Out-of-Service Inspection Date: | | Unknown | |
| **Dimensions** | | | |
| Diameter: | | 22.78 m | |
| Height: | | 11.73 m | |
| Maximum Filling Height: | | Unknown | |
| Nominal Capacity: | [m³] | 5000 | |
| **Roof** | | | |
| Roof Type: | | Cone | Assumed |
| Construction of plates: | | Lap | Assumed |
| Roof Slope: | [°] | ~3 | According client |
| Roof Vents: | | Unknown | |
| Internal Floating Roof? | [y/n] | No | |
| Internal Coated? | [y/n] | No | |
| **Shell** | | | |
| Main Material: | | OL 37.4k | |
| Construction: | | Welded | Butt / Lap |
| Height/Thickness Course 1 | | 1.49 m | 9.7 mm |
| Height/Thickness Course 2 | | 1.50 m | 8.2 mm |
| Height/Thickness Course 3 | | 1.48 m | 7.4 mm |
| Height/Thickness Course 4 | | 1.51 m | 6.7 mm |
| Height/Thickness Course 5 | | 1.43 m | 5.7 mm |
| Height/Thickness Course 6 | | 1.51 m | 5.6 mm |
| Height/Thickness Course 7 | | 1.43 m | 4.9 mm |
| Height/Thickness Course 8 | | 1.38 m | 4.8 mm |
| Wind Stiffener Installed? | [y/n] | Yes | Inside the tank |
| Top Curb Angle Dimensions: | | N/A | |
| Internal Coated? | [y/n] | No | |
| **Bottom** | | | |
| Main Material: | | OL 37.4k | |
| Installed Date: | [year] | Unknown | |
| Nominal Thickness: | | 6 mm | |
| Construction: | | Lap | |
| Cone: | | None | |
| Sump Location: | | N/A | No sump present |
| Annular Plates Installed: | [y/n] | Yes | |
| Annular Plates Nominal Thickness: | | 8 mm | |
| Internal Coated? | [y/n] | No | |
| **Foundation** | | | |
| Type: | | Concrete | |
| Foundation Height: | | N/A | |
| Construction: | | Gravel pad | Assumed |

| | | | |
|---|---|---|---|
| Anchored? | [y/n] | No | Concrete blocks |
| Leak Detection Present? | [y/n] | No | |
| **Operational** | | | |
| Product Stored: | | Gasoline | |
| Product Gravity: | | 0.74 | |
| Storage Temperature: | | Ambient | |
| Pressure / Vacuum range: | [mbar] | Atmospheric | |
| Product Inflow Rate: | [m³/hr.] | 350 | |
| Product Outflow Rate: | [m³/hr.] | 200 | |
| **Cathodic Protection** | | | |
| Cathodic Protection Installed? | [y/n] | No | |
| Type: | | N/A | |
| Last Inspection Date : | | N/A | |
| **Coated** | | | |
| Last External Coating Application Date: | | Unknown | |
| Last External Coating Inspection Date: | | Unknown | |
| Last Internal Coating Application Date: | | NA | |
| Last Internal Coating Inspection Date: | | NA | |

# 2. Inspection Checklists and Summary.

The following inspection summaries list all noted deficiencies and the governing criteria with which they fail to comply fully.

## *2.1. Tank Online Inspection*

### *2.1.1 Diked Area and Containment - Checklist*

| | | |
|---|---|---|
| 1. | Dike access | 2 |
| 2. | Diked area condition (vegetation, debris, erosion, cracks): | 3 |
| 3. | Dike wall condition: | 3 |
| 4. | Flammable materials within the diked area (trash, product) | UA |
| 5. | Site drainage: | UA |
| 6. | Standing water: | UA |
| 7. | Pipe work (corrosion, paint) | 3 |
| 8. | Pipe supports | 3 |
| 9. | Leak detection | NA |
| 10. | Fire Prevention and Fire Risk Control (NFPA 30) | 3 |
| 11. | Electrical Systems (NFPA 30, Chapter 7) | 3 |

Legend:

| | | | | | |
|---|---|---|---|---|---|
| 1 | Good Condition | 3 | Repair or alteration recommended | U/A | Un-assessable |
| 2 | Satisfactory Condition | 4 | Repair or alteration required | NE | None Evident |
| xx | Not to Code | | | N/A | Not applicable |

#### 2.1.1.1 Diked Area and Containment - Comments*:*

- Heavy vegetation has been detected all around the tanks circumference (bottom projection) and surroundings. It is recommended to remove the existing and prevent further vegetation build up by proper housekeeping.
- The whole diked area could not have been inspected due to weather conditions (ice and snow). It is recommended to perform a thorough visual inspection as soon as the area is completely free from ice and snow.
- Heavy coating and painting failure have been detected on the outside piping system. These areas should be cleaned and re-coated conform applicable standards. Where it seems necessary, pipe sleeves should be considered for corrosion prevention at the areas of concern.
- The pipe supports in the diked area of Tank 305 are of bad design. Piping is lying directly on the concrete support or metal beams which causes coating failure and crevice type / contact corrosion. No U-Bolts are in place to prevent lateral movement. Consideration should be given to modify the pipe supports so that they meet the requirements of ASME B 31.3, e.g. welded on steel shoes at the pipe-support contact area or applied plastic

blocks to prevent direct contact and coated metal U-Bolts around the pipe to prevent lateral movement.

- The fire lines are leading directly into the ground and show paint failure. The pipes should be cleaned and the coating be repaired where applicable. Sprinkler systems, or fire safety systems in general, shall be check annually by the responsible department conform companies policies for functionality.
- The diked area seems to be sufficient to contain the product in case of a tank leakage. However, the dike wall shows cracks and some areas of the wall are completely missing. It is recommended to repair these spots and seal the cracks to prevent further damage due to freeze / thaw cycles. A full inspection and review of the dike system is highly recommended at a convenient time (e.g. summer) by a civil engineer.

### 2.1.2 Tank Foundation - Checklist

| | | |
|---|---|---|
| 1. | Level survey required (base on visual planar tilt) C.1.1 & C.1.1.1: | 1 |
| 2. | Foundation (cracks, breaks, spalling): | 3 |
| 3. | Foundation 300 mm above dike basin | 3 |
| 4. | Bitumen cover (cracks, washouts, erosion): | NA |
| 5. | Foundation seal (deterioration, peeling): | NE |
| 6. | Foundation (erosion, leaks, cond. API 650 5.3.1, API 653 10.5.6): | 3 |
| 7. | Water ingress/egress/vegetation against bottom C.1.1.1 | 3 |
| 8. | Indications of bottom leaks: | 1 |
| 9. | Bottom plate extension cond. (API 650 5.4.2, API 653 4.4.7.7): | UA |
| 10. | Bottom plate extension welds (pitting, corrosion, undercut): | UA |
| 11. | Earth grounding cables and connectors cond. (API 575. 7.2.5): | 2 |
| 12. | Cathodic protection | NA |
| 13. | Tank settlement into pad C.1.1.2: | 3 |
| 14. | Does washout of pad reveal crushed rock under bottom C.1.1.4: | 3 |

Legend:

| | | | | | |
|---|---|---|---|---|---|
| 1 | Good Condition | 3 | Repair or alteration recommended | U/A | Un-assessable |
| 2 | Satisfactory Condition | 4 | Repair or alteration required | NE | None Evident |
| xx | Not to Code | | | N/A | Not applicable |

#### 2.1.2.1 Tank Foundation - Comments:

- The tank is standing on a concrete ring / gravel foundation, in level with the ground.
- The ring is in a poor to doubtful condition; heavy spalling and cracking has been detected all over the circumference. There is a gap of about 100 mm between the concrete ring and the bottom projection. The foundation sand underneath the tank is partially washed out so that water can ingress easily underneath the tank. In addition to that, several voids have been observed between the tank bottom and the foundation. It is recommended to install a suitable moisture barrier (Bottom to foundation seal) to prevent water migrating under the bottom. In addition to that, consideration can be taken to let the foundation be reviewed by a civil engineer.
- The shell to bottom weld could not have been fully assessed due to the presence of ice and snow but shall be done at convenient time (i.e. ice and snow free).

### 2.1.3 Shell External - Checklist

| | | |
|---|---|---|
| 1. | Coating or painting on shell plates (blisters, peeling, stains): | 3 |
| 2. | Insulation (cracks, leaks, moisture retention): | NA |
| 3. | Shell pitted or corroded (API 653. 4.3): | 2 |
| 4. | Deformation of shell (banding, peaking) (API 653. 10.5.4, 10.5.5): | 2 |
| 5. | Bottom course deformation: | 2 |
| 6. | Shell lap patches (API 653. 9.3): | NA |
| 7. | Indication of shell leaks: | 1 |
| 8. | Shell misalignment (API 650. 5.6.1.4): | 2 |
| 9. | Weld reinforcement (API 650. 5.7.2): | 2 |
| 10. | Riveted joint condition (worn, corroded): | NA |
| 11. | Riveted vertical joints full fillet lap welded: | NA |
| 12. | Tank roundness (API 653. 10.5.3): | 2 |
| 13. | Seam weld undercut (API 653. 10.4.2.5): | 2 |
| 14. | Remnant welds (API650 3.8.1.2C)(API 652 4.3) (API 653 9.6.5): | 2 |
| 15. | Shell vertical seam weld spacing (API 650. 5.1.5.2): | 1 |
| 16. | Name plate attachment (API 650. 10.1, API 653. 13.1): | NE |
| 17. | Check overflow slots for corrosion and screening: | NA |
| 18. | Check overflow does not drain over valves or equipment: | NA |
| 19. | Check autogauge system (C.1.1.3) | NA |

Legend:

| | | | | | |
|---|---|---|---|---|---|
| 1 | Good Condition | 3 | Repair or alteration recommended | U/A | Un-assessable |
| 2 | Satisfactory Condition | 4 | Repair or alteration required | NE | None Evident |
| xx | Not to Code | | | N/A | Not applicable |

### 2.1.3.1 Shell External - Comments

- No nameplate is present on tank 305. According API 650, section 10 a tank shall be identifiable by a name plate attached to the shell.
- The coating on the shell is in general fair condition, however all over the shells surface spots are present where the coating is deteriorating in conjunction with corrosion; it is recommended to remove the corrosion and repair those coating failures with a compatible coating (patch painting) as preventive measure.
- The shell thickness calculations and remaining life calculation indicate that the shell passes the minimum thickness requirements, however some courses (especially the critical two bottom courses) are close to be rejected. As per table 2.1.3.3 it is recommended to perform annually a detailed visual inspection of the shell and every two years a UT thickness survey. For this it is strongly recommended to measure the

thickness always at the same spot to be sure that wall thinning due to internal corrosion will be revealed.

- The maximum filling height for a hydrotest is 10.4 meter.
- The shell is slightly deformed all over the surface, however not that much as further engineering evaluation would be required. It can be assumed that the majority of the deformation is initiated during construction.

### 2.1.3.2 Shell Thickness Calculations

The minimum acceptable shell plate thickness for tanks with a diameter equal to or less than two-hundred (200) feet is calculated as follows (Ref. API 653, Para. 4.3.3.1):

$$t_{\min} = \frac{4.9(H - 0.3)DG}{SE}$$

***Where:***

| | | | |
|---|---|---|---|
| ***S*** = | See Table | = | Allowable Stress (N/mm²) |
| ***D*** = | 22.78 | = | Nominal Diameter of Tank (meter) |
| ***G*** = | 0.74 | = | Highest Specific Gravity of Contents |
| ***H*** = | See Table | = | Product Height (meter) |
| ***E*** = | See Table | = | Joint Efficiency |

| Course | Course Height (m) | Product Height (m) | Joint Efficiency | Allowable Stress (N/mm²) | Minimum Thickness (mm) | Required Thickness (mm) | Pass / Fail |
|---|---|---|---|---|---|---|---|
| 1 | 1.49 | 11.73 | 0.7 | 163 | 9.0 | 8.3 | Pass |
| 2 | 1.50 | 10.24 | 0.7 | 163 | 8.0 | 7.2 | Pass |
| 3 | 1.48 | 8.74 | 0.7 | 179 | 7.0 | 5.6 | Pass |
| 4 | 1.51 | 7.26 | 0.7 | 179 | 6.4 | 4.6 | Pass |
| 5 | 1.43 | 5.75 | 0.7 | 179 | 5.3 | 3.6 | Pass |
| 6 | 1.51 | 4.32 | 0.7 | 179 | 5.2 | 2.7 | Pass |
| 7 | 1.43 | 2.81 | 0.7 | 179 | 5.9 | 2.5 | Pass |
| 8 | 1.38 | 1.38 | 0.7 | 179 | 5.9 | 2.5 | Pass |

*Note: Course Number 1 is the bottom course*

### 2.1.3.3 Shell Corrosion Rate Calculations

API Standard 653 requires that inspection intervals are based upon corrosion rate calculations. However, visual inspection intervals should never exceed 5 years from the date of the most recent inspection (API 653, Para 6.3.2.1) and UT inspection intervals should never exceed 15 years from the date of the most recent inspection (API 653, Para 6.3.3.2). A tank's specific inspection interval is based upon known corrosion rates and corrosion forecasting. TWISEA has based the corrosion rate calculations on the following equations:

$$I_V = \frac{t_{act} - t_{\min}}{4C_R} \qquad I_{UT} = \frac{t_{act} - t_{\min}}{2C_R} \qquad C_R = \frac{t_{prev} - t_{act}}{\Delta Y}$$

*Where:*

$C_R$ = *Corrosion rate*

$t_{prev}$ = *Previous thickness*

$t_{act}$ = *Actual measured thickness*

$t_{\min}$ = *Minimum required thickness*

$I_{UT}$ = *UT inspection interval*

$I_V$ = *Visual inspection interval*

$\Delta Y$ = *Years between current and previous measured thickness*

| Course | As Built Thickness | Previous Thickness (tprev) | This Inspection Thickness (tact) | Required Thickness (tmin) | Corrosion Rate Per Year (CR) | Visual Inspection Interval (IV) | UT Inspection Interval (IUT) |
|---|---|---|---|---|---|---|---|
| 1 | 10.0 | Unknown | 9.0 | 8.3 | 0.15 | 1 | 2 |
| 2 | 9.0 | Unknown | 8.0 | 7.2 | 0.15 | 1 | 2 |
| 3 | 8.0 | Unknown | 7.0 | 5.6 | 0.15 | 1 | 2 |
| 4 | 7.0 | Unknown | 6.4 | 4.6 | 0.15 | 1 | 2 |
| 5 | 6.0 | Unknown | 5.3 | 3.6 | 0.15 | 1 | 2 |
| 6 | 6.0 | Unknown | 5.2 | 2.7 | 0.15 | 1 | 2 |
| 7 | 6.0 | Unknown | 5.9 | 2.5 | 0.15 | 1 | 2 |
| 8 | 6.0 | Unknown | 5.9 | 2.5 | 0.15 | 1 | 2 |

*Note: As the corrosion rate is unknown due to lack of previous inspection data, a conservative corrosion rate is derived from tanks in similar service. Inspection interval calculations made for the "worst" course.*

### 2.1.4 Shell Appurtenances - Checklist

| | | |
|---|---|---|
| 1. | Leakage around reinforcement plate welds: | 1 |
| 2. | Reinforcement telltale holes (API 650 5.7.5): | 3 |
| 3. | Reinforcement plate spacing (API 650 5.7.3): | 3 |
| 4. | Reinforcement plate size/thickness (API 650 5.7.2): | 1 |
| 5. | Two (2") inch nozzle reinforcement (API 650 5.7.2): | 1 |
| 6. | Nozzle weld corrosion/undercut (API 650 8.5.1): | 2 |
| 7. | Excessive dimpling of shell plate or bowing of piping: | 2 |
| 8. | Indications of leakage around manifolds, flanges, or valves C.1.3.2: | 1 |
| 9. | Indications of leakage around manways and nozzles: | 1 |
| 10. | Indications of leakage around flange bolts and welds: | 1 |
| 11. | Tank mixer mounting base (weld failure, damage): | NA |
| 12. | Leakage around mixer shaft seal: | NA |
| 13. | Condition of welds on davit clips (valve, mixers, cleanouts): | NA |
| 14. | Wind girder, supports, handrails (corrosion, weld failure): | UA |
| 15. | Wind girder, (debris buildup, paint failure): | UA |
| 16. | Leaks at sample connection C.1.3.2: | 1 |
| 17. | Visual check of fire equipment C.1.3.2: | 3 |
| 18. | Emergency overflow screens clean and free of debris: | NA |
| 19. | Anchor bolt condition: | XX |
| 20. | Independent level alarm system | NE |

Legend:

| | | | | | |
|---|---|---|---|---|---|
| 1 | Good Condition | 3 | Repair or alteration recommended | U/A | Un-assessable |
| 2 | Satisfactory Condition | 4 | Repair or alteration required | NE | None Evident |
| xx | Not to Code | | | N/A | Not applicable |

#### *2.1.4.1* Shell Appurtenances - Comments*:*

- None of the reinforcement plates have telltale holes (See table 2.1.4.2). API 650, Para 5.7.2.10 indicates reinforcing plates should be installed with telltale holes left open to the atmosphere. It is recommended that the holes be drilled, but before the tank is returned to service, the reinforcing plates shall be tested by applying up to 100 kPa gauge pneumatic pressure between the tank shell and the reinforcement plate on each opening using the telltale. While each space is subjected to such pressure, a soap film, linseed oil, or another material suitable for the detection of leaks shall be applied to all attachment welding around the reinforcement, both inside and outside the tank (API 650, Para 7.3.4). The telltale holes should then be left open to the atmosphere.

- Some reinforcement plates suffer from lack of weld spacing to adjacent shell plate welds (See table 2.1.4.2). API requires at least 3 inch (75mm) space to horizontal welds and 6 inch (150mm) to vertical welds. Such practice results in areas of increased stress

concentration and possible accelerated corrosion. It is recommended that future repairs (e.g. installation of new nozzles) are being checked/approved by at least an API 653 inspector or preferably by an experienced qualified tank engineer.

- One wind girder is attached to the inside of the shell. The dimension is unknown, it is placed about 6.7 m above the bottom. Due to the construction of the shell with one vertical lap weld from the bottom to the top the wind girder is distorted in the vicinity of this weld and a gusset plate next to the weld is loose. It is recommended to re-attach the gusset plate.

- Several concrete blocks (dimension 900 x 500 x 150 mm) are attached to the bottom shell course, equally spaced around the circumference. The blocks itself are not anchored to the foundation by any means (thus a self-anchored tank) and therefore either seen as ballast against uplift by the combination of wind forces and internal pressure (see API650, Sections 5.11 for more details) or for resistances against earthquake. It would be worthwhile to seek consultancy with a tank engineer with national earthquake calculation experiences to check current suitability (and compliance with the national structural design standards since the national standard will be govern above the API650 requirements). The report and any modification shall be part of the tank record system for future references. The blocks are not endangering the technical integrity of the tank and therefore no further inspection or maintenance actions to be defined at this stage.

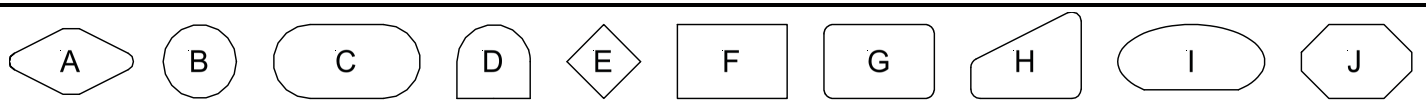
  Reference is made to (Seismicity Map Romania):
  http://earthquake.usgs.gov/earthquakes/world/romania/seismicity.php

- No independent level alarm system is installed on this tank. It is recommended to install an independent alarm system:
  - Provide a level alarm system including High and High-High alarms
  - While the high alarm system may be connected to the gauging system, the high-high alarm system should be fully independent.
  - The use of a Low alarm is not immediately required since there is no internal floating roof present; however installing one is common practice for protection of the pumps as they might run dry.

### *2.1.4.2 Nozzle and Appurtenance Table (Shell)*

| Item | Description | Size (in.) | | CL Elev. (mm) | Reinforcing Plate Length (mm) | Width (mm) | Thick (mm) | Shape | Neck Thick (mm) | Flng Thick (mm) | Cover Thick (mm) | Tell-tale | Weld Space | Comments | Pass / Fail |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Manhole | 20 | | 500 | 900 | 900 | 9.4 | B | 10.5 | 28 | 26 | NO | OK | | FAIL |
| 2 | Fire line | 4 | | 11400 | | | | | | | | | | | FAIL |
| 3 | Outlet 1 | 8 | | 470 | 400 | 400 | 6.5 | B | 5.4 | 28 | | NO | NOT | | FAIL |
| 4 | Outlet 2 | 8 | | 470 | 400 | 400 | 6.6 | B | 7.2 | 28 | | NO | NOT | | FAIL |
| 5 | Drain | 4 | | 450 | 200 | 200 | 6.5 | B | 6.1 | 22 | | NO | OK | | FAIL |
| 6 | Inlet 1 | 8 | | 500 | 400 | 400 | 6.6 | B | 6.9 | 28 | | NO | OK | | FAIL |
| 7 | Inlet 2 | 16 | | 500 | 600 | 600 | 6.8 | B | 9.5 | 38 | | NO | OK | | FAIL |
| 8 | Manhole | 20 | | 500 | 900 | 900 | 9.0 | B | 10.0 | 28 | 26 | NO | NOT | | FAIL |
| 9 | Unknown | 6 | | Roof | | | | | | | | | | | |
| 10 | Fire line | 4 | | 11400 | | | | | | | | | | | |
| 11 | Fire line | 4 | | 11400 | | | | | | | | | | | |
| 12 | Fire line | 4 | | 11400 | | | | | | | | | | | |
| 13 | Fire line | 4 | | 11400 | | | | | | | | | | | |
| 14 | Fire line | 4 | | 11400 | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

**Shape**



### 2.1.5 Access Structure – Checklist

| | | |
|---|---|---|
| 1. | Ladder attachments to concrete base (corrosion, broken): | 2 |
| 2. | Bolts and fasteners on stairways and ladder stringers: | 2 |
| 3. | Welds on stairways and ladder stringers (corrosion, broken): | 2 |
| 4. | Stairways and ladders (corrosion, paint failure): | 3 |
| 5. | Tread attachments to stringers (corrosion, broken): | NA |
| 6. | Safety drop bar or safety chain provides adequate protection: | NE |
| 7. | Gauger platform frame and supports (corrosion, broken): | 2 |
| 8. | Gauger platform deck (corrosion, thinning, weld failure): | 3 |
| 9. | Gauger walkway for thinning and slots: | 2 |

Legend:

| | | | | | |
|---|---|---|---|---|---|
| 1 | Good Condition | 3 | Repair or alteration recommended | U/A | Un-assessable |
| 2 | Satisfactory Condition | 4 | Repair or alteration required | NE | None Evident |
| xx | Not to Code | | | N/A | Not applicable |

#### *2.1.5.1* Access Structure - Comments*:*

- The roof access structure of tank 305 is in satisfactory condition. A spiral stairway and a vertical ladder are present to access the roof. Minor paint failure and corrosion has been observed, it is recommended to repair these spots as a preventive measure.

### 2.1.6 Fixed Roof (Cone / Dome) - Checklist

| | | |
|---|---|---|
| 1. | Roof plate distortions: | UA |
| 2. | Roof plates (corrosion, pitting, holes API 653 4.2.1.2): | UA |
| 3. | Roof plates (coating or paint failure): | UA |
| 4. | Remnant welds (API 652 7.3)(API 653 9.6.5): | UA |
| 5. | Roof plate lap joints (API 650 5.1.3.4, 5.1.3.5) | UA |
| 6. | Indications of product staining: | UA |
| 7. | External rafter spacing (API 650 5.10.4.4): | UA |
| 8. | Emergency venting (NFPA 30) | UA |
| 9. | U/T thickness survey for internal corrosion before accessing roof C.1.4.1: | UA |
| 10. | Rain water standing, sag of roof C.1.4.3: | UA |

Legend:

| | | | | | |
|---|---|---|---|---|---|
| 1 | Good Condition | 3 | Repair or alteration recommended | U/A | Un-assessable |
| 2 | Satisfactory Condition | 4 | Repair or alteration required | NE | None Evident |
| xx | Not to Code | | | N/A | Not applicable |

### 2.1.6.1 Fixed Roof (Cone / Dome) - Comments:

- The roof is not accessible due to the presence of ice and snow on the roof plates.
- Inspection of the roof and roof fittings / accessories by means of a detailed visual inspection and NDT shall be performed at a convenient time this year (accessibility should be guaranteed), but shall be carried out before October 2012 (including the integrity assessment, which is the review of the NDT data and the visual observations).
- Some spot UT checks could have been performed from the underside. The lowest value recorded was 3.5 mm; it can be assumed that local thinning of the roof plates is present. Extra precaution shall be given when entering the roof for further inspection.

### 2.1.7 Roof Appurtenances - Checklist

| | | |
|---|---|---|
| 1. | Free vent (General condition, corrosion) | UA |
| 2. | P/V (Breather) vents (General condition, corrosion, discs move freely) | UA |
| 3. | Vent screens (API 650, 5.8.5.5): | UA |
| 4. | Nozzles ≥ 150 mm [6 in.] reinforcement (API 650 table 5-14 note: optional): | UA |
| 5. | General coating condition of the roof appurtenances | UA |
| 6. | Fixed roof scaffold supports (API 650, 5.5.8) | UA |
| 7. | Autogauge (General condition, corrosion) (C.1.5.4) | UA |
| 8. | Roof manhole (General condition, corrosion, damages) | UA |
| 9. | Liquid level gauge / Tape gauge (General condition, corrosion): | UA |
| 10. | ATG system (General condition, corrosion): | UA |

Legend:

| | | | | | |
|---|---|---|---|---|---|
| 1 | Good Condition | 3 | Repair or alteration recommended | U/A | Un-assessable |
| 2 | Satisfactory Condition | 4 | Repair or alteration required | NE | None Evident |
| xx | Not to Code | | | N/A | Not applicable |

### 2.1.7.1 Roof Appurtenances - Comments:

- A thorough inspection of the roof appurtenances was not possible due to the presence of ice and snow.

- Inspection of the roof and roof fittings / accessories by means of a detailed visual inspection and NDT shall be performed at a convenient time this year (accessibility should be guaranteed), but shall be carried out before October 2012 (including the integrity assessment, which is the review of the NDT data and the visual observations).

### *2.1.7.2 Nozzle and Appurtenance Table (Roof)*

| Item | Description | Size (in.) | Reinforcing Plate | | | | Neck | Flng | Cover | Comments | Pass / Fail |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Length (mm) | Width (mm) | Thick (mm) | Shape | Thick (mm) | Thick (mm) | Thick (mm) | | |
| 1 | | | | | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |
| 8 | | | | | | | | | | | |
| 9 | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

**Shape** A B C D E F G H I J

## *2.2 Tank Offline Inspection*

### 2.2.1 External floating roof - Checklist

| | | |
| --- | --- | --- |
| 1. | Floating roof cleanliness (clean and free of debris): | NA |
| 2. | Roof plates (corrosion, pitting, holes, API 653 4.2.1.2): | NA |
| 3. | Remnant welds (API 652 7.3)(API 653 9.6.5): | NA |
| 4. | Levelness of floating roof: | NA |
| 5. | Standing water or product on floating roof deck: | NA |
| 6. | Water or product in the pontoon compartments: | NA |
| 7. | Site mechanical contractor to remove all pontoon manhole covers: | NA |
| 8. | Flexibility and resilience of wedge type wiper seals: | NA |
| 9. | Cracks or tears in wedge type wiper seals: | NA |
| 10. | Wiper seal static cables: | NA |
| 11. | Mechanical shoes damaging shell or coating: | NA |
| 12. | Condition of the floating roof ground connections: | NA |
| 13. | Tightness of rim and column seals (C.2.11.1(o)): | NA |
| 14. | Primary shoe seal fabric pulling away from shell: | NA |
| 15. | Deterioration, holes, tears and cracks in primary seal fabric: | NA |
| 16. | Binding with shell or columns: | NA |
| 17. | Roof Rolling ladder (corrosion, weld failure): | NA |
| 18. | Roof Rolling ladder handrail (corrosion, weld failure): | NA |
| 19. | Roof Rolling ladder and handrail (coating or paint failure): | NA |
| 20. | Roof Rolling ladder attachment to shell (corrosion, wear): | NA |
| 21. | Roof Rolling ladder rails (welds, corrosion, wear): | NA |
| 22. | Roof Rolling ladder wheels and securing pins to axles: | NA |
| 23. | Roof Rolling ladder to roof static cable (frayed, connections): | NA |
| 24. | Roof Rolling ladder to shell static cable (frayed, connections): | NA |
| 25. | Floating roof support legs (corrosion, pitting bending): | NA |
| 26. | Roof leg sleeves (bending, corrosion): | NA |
| 27. | Roof leg pins (corrosion, sticking): | NA |
| 28. | Roof leg reinforcement pads (bending cracking): | NA |
| 29. | All roof legs at same level: | NA |
| 30. | Emergency overflow screens clean and free of debris: | NA |
| 31. | Roof drain sumps clean and free of debris, corrosion: | NA |
| 32. | Pontoon manhole seals condition: | NA |

| | | |
|---|---|---|
| 33. | Anti-rotation/guide poles rollers for grooving: | NA |
| 34. | Number of vacuum breakers C.1.5.11: | NA |
| 35. | Rim vent functional C.1.5.12: | NA |
| 36. | Check gooseneck vent on pontoon cover not plugged C.1.5.13: | NA |
| 37. | Pull back weather shield and measure gap 10 m intervals C.1.4.7 : | NA |
| 38. | Check for vapor rim around underside of roof | NA |
| 39. | Check pontoon cover lock down devices: | NA |
| 40. | Check rim seal mechanisms and seal shoes: | NA |
| 41. | Adequate opening of vacuum breakers: | NA |
| 42. | Hammer test pipes of roof drain: | NA |
| 43. | Inlet/Outlet nozzles. Record if elbow up or down: | NA |
| 44. | Note elbow-up lines direct to roof and not rim seal gap: | NA |
| 45. | Check the condition of flexible roof drain hose | NA |

Legend:

| | | | | | |
|---|---|---|---|---|---|
| 1 | Good Condition | 3 | Repair or alteration recommended | U/A | Un-assessable |
| 2 | Satisfactory Condition | 4 | Repair or alteration required | NE | None Evident |
| xx | Not to Code | | | N/A | Not applicable |

### *2.2.1.2* External floating roof - Comments*:*

- No external floating roof present.

### 2.2.2 Fixed Roof (Internal) - Checklist

| | | |
|---|---|---|
| 1. | Underside of roof (Visual check): | 2 |
| 2. | Roof coating condition | NA |
| 3. | Roof plate lap joints (API 650 5.1.3.4, 5.1.3.5): | UA |
| 4. | Roof support rafters condition (Visual check): | 2 |
| 5. | Rafter spacing (API 650 5.10.4.4): | 1 |
| 6. | Rafter attachment to shell (API 650 5.10.4.6): | UA |
| 7. | Shell clips/brackets condition: | UA |
| 8. | Roof columns (Verticality, condition) | 2 |
| 9. | Column supports: | 2 |
| 10. | Roof venting nozzles trimmed flush (API 650 fig. 5-19) | 1 |

Legend:

| | | | | | |
|---|---|---|---|---|---|
| 1 | Good Condition | 3 | Repair or alteration recommended | U/A | Un-assessable |
| 2 | Satisfactory Condition | 4 | Repair or alteration required | NE | None Evident |
| xx | Not to Code | | | N/A | Not applicable |

#### *2.2.2.1* Fixed Roof (Internal) - Comments*:*

- The underside of the roof has been visually inspected from the tank bottom with aid of a torch; no light was present in the tank during the inspection.
- The roof support structure seems to be in good condition, no evidence of distortions or loose supports.
- A center column in satisfactory condition is present to support the roof structure. A ring is connected to the column with gusset plates. Lateral movement of this ring is prevented by L-Beams, which are welded to the tank bottom; however the beams are also welded to the ring. It is recommended to remove the connection (welds) from the ring to the beams as at the moment the roof has a rigid connection with the tank bottom. The area in between the gusset plates is covered by dust and debris, it is recommended to clean this area and perform a thorough visual inspection.

### 2.2.3 Internal Floating Roof - Checklist

| | | |
|---|---|---|
| 1. | Full contact aluminum honeycomb floating pan present: | NA |
| 2. | Shell secondary manhole: | NA |
| 3. | Floater panels vapor tight (API 650 H.4.1.3): | NA |
| 4. | Evidence of leaking panels (water spots on internal floater): | NA |
| 5. | Rim or skirt fitted around all opening (API 650 H.4.1.4): | NA |
| 6. | Roof/shell static cables (API 650 H.4.1.6): | NA |
| 7. | Tightness of rim and column seals (API 650 H.4.1.4): | NA |
| 8. | Foam logs fill roof rim space: | NA |
| 9. | Foam logs or fabric deteriorating: | NA |
| 10. | Damage or slack in anti-rotational cable: | NA |
| 11. | Damage to ladder or column wells and covers: | NA |
| 12. | Floating cover legs: | NA |
| 13. | Overflow slots present | NA |
| 14. | Roof-mounted vents (clean, free of debris): | NA |

Legend:

| | | | | | |
|---|---|---|---|---|---|
| 1 | Good Condition | 3 | Repair or alteration recommended | U/A | Un-assessable |
| 2 | Satisfactory Condition | 4 | Repair or alteration required | NE | None Evident |
| xx | Not to Code | | | N/A | Not applicable |

#### *2.2.3.1* Internal Floating Roof - Comments*:*

- No internal floating roof present.

### 2.2.4 Shell (Internal) - Checklist

| | | |
|---|---|---|
| 1. | Shell internal coating condition: | NA |
| 2. | Damages / dents / scratches on the shell plates present: | 2 |
| 3. | Shell corrosion (API 653 4.3.1.3): | 2 |
| 4. | Seam weld undercut (API 653 10.4.2.5): | 2 |
| 5. | Remnant welds (API 650 3.8.1.2C)(API 620 4.3)(API 653 9.6): | 2 |
| 6. | Gauge wells (corrosion, pitting): | 3 |
| 7. | Gauge wells attach to shell (weld corrosion, crack): | 2 |
| 8. | Gauge wells slotted properly: | 2 |
| 9. | Grooving due to rise/tall of floating roof rubbing on shell C.1.2.2: | NA |

Legend:

| | | | | | |
|---|---|---|---|---|---|
| 1 | Good Condition | 3 | Repair or alteration recommended | U/A | Un-assessable |
| 2 | Satisfactory Condition | 4 | Repair or alteration required | NE | None Evident |
| xx | Not to Code | | | N/A | Not applicable |

#### *2.2.4.1* Shell (Internal) - Comments*:*

- The stilling well is attached to the shell and properly supported. However, it is clogged up with debris up to the third hole from the bottom. It is recommended to remove all the debris and clean the stilling well. In addition to that, it can be considered to extend the holes to slots to prevent further clogging up.
- The shell is buckled inwards in the vicinity of the vertical lap weld. Due to this, one gusset plate from the wind girder is loose. It is recommended to re-fasten this gusset plate.

### 2.2.5 Tank bottom and internal appurtenances - Checklist

| | | |
|---|---|---|
| 1. | Tank bottom plate condition (corrosion, pitting): | 3 |
| 2. | Remnant welds (API 620 4.3, 4.4)(API 653 9.6): | 3 |
| 3. | Bulges/depressions (API 653 B3.3): | 3 |
| 4. | Tank bottom coating condition: | NA |
| 5. | Standing water: | 3 |
| 6. | Striker plate condition: | NA |
| 7. | Bottom weld joints (API 650 5.1.3.4, 5.1.3.5): | 3 |
| 8. | Edge settlement (API 653 B3.4): | 2 |
| 9. | Three way joint spacing (API 650 5.1.5.4): | 1 |
| 10. | Bottom/shell joggle joints (API 650 5.1.5.4): | NA |
| 11. | Annular plate width (API 650 5.5.2): | 1 |
| 12. | Bottom plate patches (Type, location) (API 653 9.10.1.1, 9.10.1.2): | NA |
| 13. | Bottom plate joints from shell vertical joints (API653 Fig.9-1): | 1 |
| 14. | Shell-to-bottom fillet weld (API 650 5.1.5.7): | 3 |
| 15. | Internal piping general (Coating, corrosion): | 2 |
| 16. | Inlet piping (Diffusor present, supports, corrosion): | 3 |
| 17. | Outlet piping (Main and low suction present, supports, corrosion): | 3 |
| 18. | Drainage piping (Corrosion, supports): | 2 |
| 19. | Shell-to-bottom HAZ (UT survey): | NE |
| 20. | Sump condition (Visual, UT survey): | NA |

Legend:

| | | | | | |
|---|---|---|---|---|---|
| 1 | Good Condition | 3 | Repair or alteration recommended | U/A | Un-assessable |
| 2 | Satisfactory Condition | 4 | Repair or alteration required | NE | None Evident |
| xx | Not to Code | | | N/A | Not applicable |

#### *2.2.5.1* Tank bottom (Internal) - Comments*:*

- The tank bottom weld work of tank 305 is of poor quality. It is recommended to check 100% of the whole weld length by MPI to make sure no cracking is present. Particular attention should be given to the corner weld. Visibly poor areas (undercut, lack of fusion, poor start-stop etc.) should be repaired prior to inspection.
- UT thickness measurements of the bottom plates indicate that two different plate thicknesses were used during the bottom construction; or several bottom plates have been replaced entirely.
- An abandoned remain of a support beam is present in the critical zone. It is recommended to remove this remain, grind the surface flush and perform MPI to ensure no cracking is present in this area.

- A visual inspection indicated that edge settlement is present, however still within the limits of API 653, B 2.3
- The tank bottom has been scanned by a floor scanner using MFL (Report Number FR-40-PLO-305-20110130-0). One indication deeper that 40% t is present.
- Remaining life calculations show that the tank in its current state will not reach the estimated remaining life time of ten years. It is recommended to repair all corrosion above and including 41%t on the bottom plates, above and including 28%t in the critical zone and above and including 26%t on the annular plates according to MFL report FR-40-PLO-305-20110130-0 and apply an internal bottom coating according to API RP 652 to avoid any internal corrosion. The repair work shall be carried out in accordance with API 653, 9.10.
- Both floaters from the swivel outlet are heavily damaged and deformed; reason is unknown. It is recommended to exchange both floaters.
- The legs from the swivel supports are standing directly on the tank bottom. It is recommended to lift the legs and inspect the area underneath. After that, full seal welded bearing pads shall be applied.
- No inlet diffuser is present in tank 305; the fill pipe is cut approximately 30 mm behind the shell. The inlet fill pipe should have a diffuser to minimize flow speed and electrostatic charge. When it seems necessary from operational point of view, consideration should be given to install a diffuser according to current recommended practices.

### *2.2.5.2 Tank bottom internal (Service Interval)*

The next internal inspection should be conducted within 10 years subject to intermediate confirmation of continuing coating integrity.

| | Bottom Plate API653 (Table 4-4) | Critical Zone API653 (Para. 4.4.5.4) | Annular Plate API653 (Table 4-5) |
|---|---|---|---|
| Average Bottom Plate Thickness | 6.4 | 7.4 | 7.6 |
| Maximum Underside Corrosion Depth (MAX UC) | 2.7 | 2.9 | 3.0 |
| Maximum Internal Corrosion Depth (MAX IC) | 1.3 | 1.5 | 1.5 |
| Year of Inspection (Yi) | 2012 | 2012 | 2012 |
| Year of previous inspection (Yo) | NA | NA | NA |
| Minimum Remaining Thickness from Underside Corrosion after Repairs (RTbc) | 3.8 | 5.3 | 5.6 |
| Minimum Remaining Thickness from Internal Corrosion after Repairs (RTip) | 5.1 | 5.9 | 6.1 |
| Minimum Remaining Thickness at Next Inspection (MRT) | 2.5 | 4.0 | 4.3 |
| Underside Corrosion Rate (UPr) | 0.13 | 0.13 | 0.13 |
| Internal Corrosion Rate (StPr) | 0 | 0 | 0 |

$$UP_r = \frac{MAX_{UC}}{\Delta Y}$$

$$StP_R = \frac{MAX_{IC}}{\Delta Y}$$

$$O_r = \frac{(\min RT_{bc} or RT_{ip}) - MRT}{S_t P_r + UP_r}$$

| | | | |
|---|---|---|---|
| ***Interval to next inspection after repairs*** | 10 | 10 | 10 |

*Note: As the internal corrosion rate is unknown due to lack of previous inspection data, a conservative corrosion rate is derived from tanks in similar service. The external corrosion rate has been derived according to API 581, 2B12 "Soil Side Corrosion".*

# 3 Warranty

The API inspector has evaluated the condition of this tank based on the observations and measurements as made by us. While our evaluation accurately describes the condition of the tank at the time of inspection, the tank owner/operator must independently assess the inspection information/report provided by us and any conclusions reached by the tank owner/operator and any action taken or omitted to be taken are the sole responsibility of the owner/operator. With respect to inspection and testing, we warrant only that the services have been performed in accordance with accepted industry practice. If any such services fail to meet the foregoing warranty, we shall re-perform the service to the same extent and on the same conditions as the original service.

The preceding paragraph sets forth the exclusive remedy for claims based on failure or of defect in materials or services, whether such claim is made in contract or tort (including negligence) and however instituted, and, upon expiration of the warranty period, all such liability shall terminate. The foregoing warranty is exclusive and in lieu of all other warranties, whether written, oral, implied or statutory. NO IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE SHALL APPLY, nor shall we be liable for any loss or damage whatsoever by reason of its failure to discover, report, repair or modify latent defects or defects inherent in the design of any tank inspected. In no event, whether a result of breach of contract, warranty or tort (including negligence) shall we are liable for any consequential or incidental damages including, but not limited to, loss of profit or revenues, loss of use of equipment tested or services by us or any associated claims of other damages.

Pic 1: Tank 305 overview.

Pic 2: Broken dike wall.

Pic 3: Access Structure, crack in dike wall.

Pic 4: Crack in dike wall over whole height.

Pic 5: Previously repaired (?) crack in the dike wall.

Pic 6: Diked area.

Pic 7: Pipe work in the diked area. Pipes are running through metal sleeves and are surrounded by heavy vegetation.

Pic 8: Pipe sleeve close up.

Pic 9: Pipe work, concrete bridge. Heavy vegetation is present all over.

Pic 10: Misaligned concrete bridge. No handrail.

Pic 11: Misaligned, corroded and distorted bridge over pipe work. Handrail facing the tank missing.

Pic 12: Concrete base of the bridge.

Pic 13: Pipe work lying on a concrete brick.

Pic 14: Pipe work lying on a metal beam.

Pic 15: Pipe work connected to the tank.

Pic 16: Pipe work, purpose of the pit is unknown.

Pic 17: Manhole. No telltale hole present in the reinforcement plate.

Pic 18: Satisfactory weld work on the manhole.

Pic 19: Lack of weld space between the reinforcement plates.

Pic 20: Reinforcement plate made of two halves.

Pic 21: Reinforcement plate close up.


Pic 22: Concrete blocks hanging all over the tank circumference.

Pic 23: Vegetation behind concrete block.

Pic 24: Concrete block connection. Paint failure and beginning corrosion on the shell plate.

Pic 25: Damaged concrete ring, big gap between concrete ring and tank bottom projection.

Pic 26: Damaged concrete ring, heavy vegetation. Soil under the tank bottom washed out.

Pic 27: Foundation close up. Bottom projection in fair condition, however soil washed out and gravel visible.

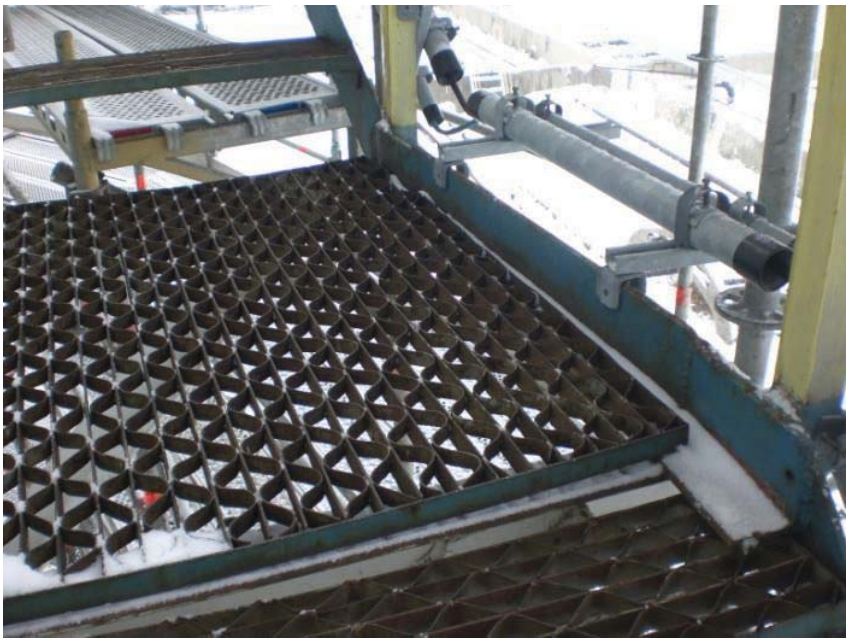
Pic 28: Tank settled about 70 mm into the foundation.

Pic 29: Bottom projection.

Pic 30: Excavation for soil examination.

Pic 31: Grounding strap, about 80 mm settlement.

Pic 32: Spiral stairway in fair condition; minor paint failure and corrosion visible.



Pic 33: Platform on spiral stairway.

Pic 34: Support for spiral stairway, lack of weld space.

Pic 35: Vertical ladder, slightly misaligned.

Pic 36: Corroded rung connection.

Pic 37: Paint failure, corrosion and product stains on the shell. Origin of staining is the roof, however exact location unknown.

Pic 38: Product stains, paint failure, corrosion.

Pic 39: Product stains coming from the roof.

Pic 40: Roof appurtenances.

Pic 41: Roof to shell connection. No Top Curb Angle (TCA) present.

Pic 42: Paint failure and corrosion at the top of the shell.


Pic 43: Roof appurtenances.

Pic 44: ATG (Radar) connection damaged.

Pic 45: Roof overview, fire lines.

Pic 46: Fire line connection

Pic 47: Center column.

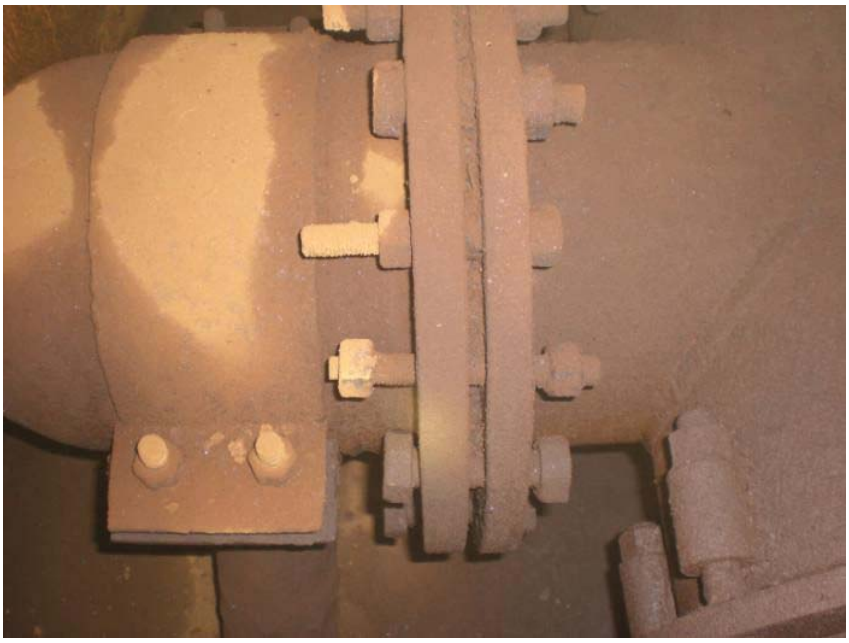
Pic 48: Lateral fixation for center column.

Pic 49: Column ladder.

Pic 50: Outlet swivel. Support not fully welded to the bottom.

Pic 51: Swivel support pads not seal welded to the bottom plate.

Pic 52: Massive deformation of the swivel floaters.



Pic 53: Bolts not properly tightened on the outlet connection.

Pic 54: Drain connection.

Pic 55: Patch plate or abandoned striker plate.

Pic 56: Vertical shell lap weld.

Pic 57: Vertical shell lap weld.

Pic 58: Shell and wind girder deformation in the vicinity of the vertical shell weld.

Pic 59: Loose gusset plate due to deformation.

Pic 60: Heavy undercut and lack of fusion at the bottom welds.

Pic 61: Undercut and underfill present on the bottom welds.

Pic 62: Poor weld work of the corner weld.

Pic 63: Abandoned beam remains in the critical zone.

Pic 64: Undercut on the corner weld.

## B1 Equipment Used

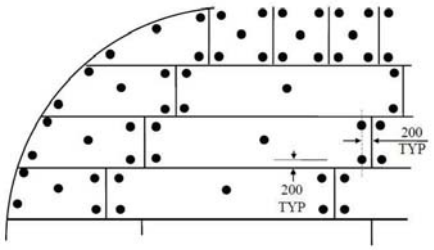
| Equipment | Manufacturer | Type | Serial Number | Calibration |
|---|---|---|---|---|
| Equipment, procedure and personnel according to ArcTechnic inspection report **7/06.02.2012** | | | | |

## B2 Bottom Plate UT Measurements

Ultrasonic thickness measurements were carried on the floor plates with a minimum of five (5) readings per plate.

*Note: The diagram is generic. It is intended to convey only the general pattern of UT's on four sided plates vs. three sided sketch plate, and is not intended to represent the geometry of the tank bottom.*

- The plates inspected **PASSED** the thickness criteria of API653




**UT Inspection Plan**

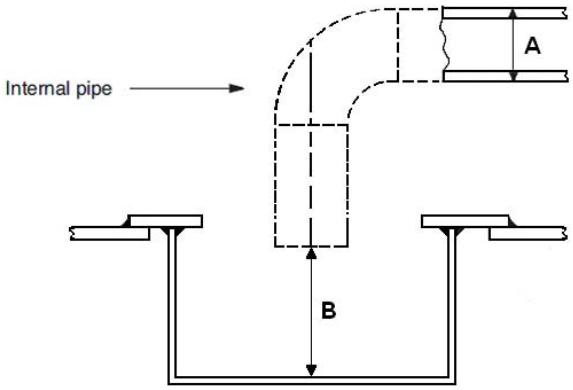
| Plate Nr | MP1 mm | MP2 mm | MP3 mm | MP4 mm | MP5 mm |
|---|---|---|---|---|---|
| 1 | 7.1 | 7.4 | 7.3 | 7.5 | 7.5 |
| 2 | 7.5 | 7.4 | 7.2 | 7.0 | 7.6 |
| 3 | 7.5 | 7.4 | 7.2 | 7.5 | 7.4 |
| 4 | 8.5 | 8.0 | 8.3 | 7.9 | 7.7 |
| 5 | 7.9 | 7.8 | 7.7 | 7.7 | 7.6 |
| 6 | 7.7 | 7.8 | 7.6 | 7.4 | 7.9 |
| 7 | 7.9 | 7.8 | 7.4 | 7.7 | 7.6 |
| 8 | 7.8 | 7.9 | 7.5 | 7.8 | 7.9 |
| 9 | 7.5 | 7.4 | 7.6 | 7.3 | 7.5 |
| 10 | 7.5 | 7.4 | 7.3 | 8.0 | 7.9 |
| 11 | 7.8 | 7.5 | 7.1 | 7.6 | 7.0 |
| 12 | 7.1 | 7.0 | 7.3 | 7.4 | 7.6 |
| 13 | 6.5 | 7.7 | 7.8 | 7.6 | 7.2 |
| 14 | 6.2 | 6.0 | 6.0 | 6.3 | 6.4 |
| 15 | 6.5 | 6.5 | 6.2 | 6.3 | 6.0 |
| 16 | 6.8 | 6.7 | 7.0 | 6.9 | 6.5 |
| 17 | 6.7 | 6.8 | 6.5 | 6.7 | 6.3 |
| 18 | 6.0 | 6.5 | 6.7 | 6.5 | 6.7 |
| 19 | 6.3 | 6.7 | 6.5 | 6.6 | 6.0 |
| 20 | 5.2 | 6.5 | 5.9 | 6.3 | 6.5 |
| 21 | 5.4 | 6.0 | 5.3 | 5.9 | 5.8 |
| 22 | 5.4 | 5.6 | 5.4 | 5.0 | 5.7 |
| 23 | 4.8 | 5.7 | 5.5 | 5.4 | 5.0 |

| | | | | | |
|---|---|---|---|---|---|
| 24 | 5.6 | 6.0 | 5.6 | 5.9 | 5.4 |
| 25 | 6.0 | 5.6 | 5.4 | 5.1 | 5.3 |
| 26 | 5.4 | 5.9 | 5.8 | 5.4 | 5.6 |
| 27 | 5.4 | 5.5 | 5.7 | 5.6 | 5.9 |
| 28 | 4.8 | 6.7 | 4.9 | 6.6 | 5.4 |
| 29 | 4.9 | 5.2 | 5.3 | 5.7 | 6.1 |
| 30 | 5.9 | 5.0 | 5.4 | 5.3 | 5.7 |
| 31 | 5.4 | 5.3 | 5.5 | 5.0 | 4.9 |
| 32 | 5.7 | 5.5 | 5.6 | 5.8 | 5.7 |
| 33 | 5.2 | 4.8 | 5.0 | 5.3 | 5.7 |
| 34 | 5.3 | 5.4 | 5.7 | 5.8 | 5.1 |
| 35 | 5.5 | 5.4 | 5.7 | 5.6 | 5.1 |
| 36 | 5.8 | 4.9 | 5.3 | 5.2 | 5.6 |
| 37 | 5.3 | 5.4 | 5.5 | 4.9 | 5.3 |
| 38 | 5.2 | 5.3 | 5.6 | 5.7 | 5.0 |
| 39 | 6.4 | 6.5 | 7.5 | 7.4 | 7.1 |
| 40 | 6.1 | 6.0 | 5.9 | 6.2 | 6.4 |
| 41 | 6.4 | 7.6 | 7.5 | 7.6 | 7.1 |
| 42 | 6.5 | 6.2 | 6.6 | 6.4 | 6.5 |
| 43 | 6.0 | 6.1 | 6.1 | 5.9 | 6.4 |
| 44 | 6.4 | 6.4 | 6.1 | 6.2 | 6.2 |
| 45 | 6.7 | 6.6 | 6.8 | 6.8 | 6.4 |
| 46 | 6.6 | 6.7 | 6.4 | 6.6 | 6.2 |
| 47 | 5.9 | 6.4 | 6.6 | 6.4 | 6.6 |
| 48 | 5.2 | 5.9 | 5.5 | 6.2 | 6.4 |
| 49 | 6.2 | 6.6 | 6.5 | 6.1 | 6.2 |
| 50 | 6.4 | 6.4 | 6.1 | 6.3 | 5.9 |
| 51 | 6.7 | 6.6 | 6.9 | 7.1 | 6.4 |
| 52 | 6.1 | 6.0 | 5.9 | 6.2 | 6.3 |
| 53 | 7.1 | 6.4 | 7.6 | 7.5 | 7.1 |
| 54 | 7.5 | 7.1 | 7.4 | 7.3 | 7.1 |
| 55 | 7.7 | 7.4 | 7.0 | 7.5 | 7.1 |
| 56 | 6.9 | 7.4 | 7.3 | 7.9 | 7.8 |
| 57 | 7.4 | 7.3 | 7.5 | 7.2 | 7.6 |
| 58 | 7.7 | 7.8 | 7.5 | 7.7 | 7.8 |

| | | | | | |
|---|---|---|---|---|---|
| 59 | 7.8 | 7.7 | 7.4 | 7.6 | 7.5 |
| 60 | 7.6 | 7.7 | 7.5 | 7.3 | 7.8 |
| 61 | 7.8 | 7.7 | 7.6 | 7.5 | 7.4 |
| 62 | 8.3 | 8.1 | 7.9 | 7.8 | 7.6 |
| 63 | 7.3 | 7.2 | 7.1 | 7.4 | 7.3 |
| 64 | 7.4 | 7.3 | 7.1 | 6.9 | 7.1 |
| 65 | 7.0 | 7.3 | 7.4 | 7.4 | 7.2 |

***Note: All measurements excluding coating. Plates 1 to 12 are annular plates.***

## B3 Sump & internal piping measurements




| Sump point | Edge / mm | Bottom / mm |
|---|---|---|
| 1 | N/A | N/A |
| 2 | N/A | N/A |
| 3 | N/A | N/A |
| 4 | N/A | N/A |
| Diameter A | N/A | |
| Distance B | N/A | |

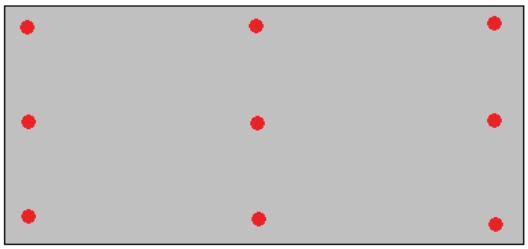
*Note: Sump measurements at 4 locations on the shell and the bottom at 3, 6, 9 and 12 o'clock*

| Internal piping | Inlet / mm | Outlet / mm | Drain / mm | Roof column |
|---|---|---|---|---|
| 1 | N/A | N/A | N/A | 10.9 |
| 2 | N/A | N/A | N/A | 10.8 |
| 3 | N/A | N/A | N/A | 10.9 |
| 4 | N/A | N/A | N/A | 10.8 |
| 5 | N/A | N/A | N/A | 11.0 |
| 6 | N/A | N/A | N/A | 11.2 |
| 7 | N/A | N/A | N/A | 11.3 |

*Note: Internal piping measurements at 2 meter intervals from the shell to the center at 3, 6, 9 and 12 o'clock. The lowest value is noted.*

## B4 Shell measurements

Up to 65 measurements were taken on each plate of the bottom course; from on the second to the top course 5 measurements were taken on each plate according to the sketch.



**UT Inspection Plan**

- The plates inspected **PASSED** the thickness criteria of API653 (See calculations in 2.1.3.2: Shell Thickness Calculations.)

| Course number | Height | | mm |
|---|---|---|---|
| 1 | 1.49 | Avg | 9.7 |
| | | Min | 9.0 |
| | | Max | 9.9 |
| 2 | 1.50 | Avg | 8.2 |
| | | Min | 8.0 |
| | | Max | 8.6 |
| 3 | 1.48 | Avg | 7.4 |
| | | Min | 7.0 |
| | | Max | 7.8 |
| 4 | 1.51 | Avg | 6.7 |
| | | Min | 6.4 |
| | | Max | 7.8 |

| Course number | Height | | mm |
|---|---|---|---|
| 5 | 1.43 | Avg | 5.7 |
| | | Min | 5.3 |
| | | Max | 6.1 |
| 6 | 1.51 | Avg | 5.6 |
| | | Min | 5.2 |
| | | Max | 6.2 |
| 7 | 1.43 | Avg | 4.9 |
| | | Min | 5.9 |
| | | Max | 4.1 |
| 8 | 1.38 | Avg | 4.8 |
| | | Min | 5.9 |
| | | Max | 4.0 |

*Notes:*

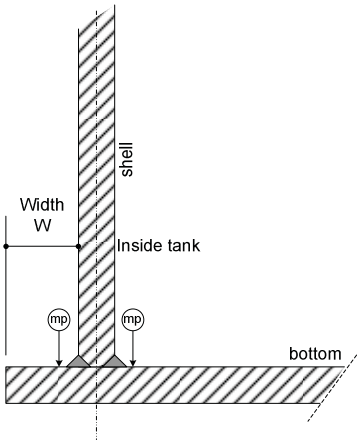
*Course number 1 is the bottom course. Average, minimum and maximum values noted here. All original values can be found in the original NDT report.*

## B5 Bottom projection, corner weld and inside HAZ

Ultrasonic thickness measurements were carried on the bottom projection and inside as close to the corner weld as possible. In addition to that, the throat thickness and projection width were checked. All measurements were taken at 2 meter intervals circumferentially.

*Note: The diagram is generic and is intended to convey only the general concept of taking UT's and width measurements along the circumference and is not intended to represent these intervals.*

- The inspection **PASSED** the criteria of API653




| | Outside bottom projection | | Inside HAZ and corner weld | |
|---|---|---|---|---|
| Measuring point | Thickness / mm | Width / mm | Thickness / mm | Throat / mm |
| 1 | UA | 35 | 6.4 | 6 |
| 2 | UA | UA | 6.5 | 6 |
| 3 | UA | UA | 6.8 | 5 |
| 4 | UA | 40 | 6.6 | 6 |
| 5 | UA | UA | 6.2 | 6 |
| 6 | UA | UA | 7.3 | 6 |
| 7 | UA | 35 | 7.7 | 7 |
| 8 | UA | UA | 7.9 | 6 |
| 9 | UA | UA | 6.9 | 6 |
| 10 | 7.4 | 35 | 6.8 | 6 |
| 11 | UA | UA | 6.3 | 6 |
| 12 | UA | UA | 6.5 | 5 |
| 13 | UA | 30 | 6.6 | 6 |
| 14 | UA | UA | 7.4 | 5 |
| 15 | UA | UA | 7.5 | 5 |
| 16 | 7.5 | 35 | 7.8 | 6 |

| | | | | |
|---|---|---|---|---|
| 17 | UA | UA | 7.6 | 6 |
| 18 | UA | UA | 7.5 | 6 |
| 19 | UA | 35 | 8.0 | 5 |
| 20 | UA | UA | 8.1 | 5 |
| 21 | UA | UA | 8.2 | 6 |
| 22 | UA | 35 | 7.9 | 6 |
| 23 | UA | UA | 7.0 | 6 |
| 24 | UA | UA | 7.3 | 6 |
| 25 | 8.3 | 35 | 7.5 | 6 |
| 26 | UA | UA | 7.6 | 6 |
| 27 | UA | UA | 7.8 | 6 |
| 28 | UA | 35 | 7.7 | 5 |
| 29 | UA | UA | 7.4 | 6 |
| 30 | UA | UA | 7.8 | 5 |
| 31 | UA | 30 | 7.6 | 5 |
| 32 | UA | UA | 7.9 | 6 |
| 33 | UA | UA | 8.0 | 6 |
| 34 | 8.2 | 35 | 8.2 | 6 |