EIGA

INTERNAL INSPECTION OF DECOMMISSIONED FLAT BOTTOM TANKS

Doc 234/20

EUROPEAN INDUSTRIAL GASES ASSOCIATION AISBL

AVENUE DES ARTS 3-5 • B – 1210 BRUSSELS
Tel: +32 2 217 70 98 • Fax: +32 2 219 85 14
E-mail: info@eiga.eu • Internet: www.eiga.eu

Doc 234/20

INTERNAL INSPECTION OF DECOMMISSIONED FLAT BOTTOM TANKS

Prepared by AHG-3.27 of Working Group 3 – Atmospheric Gases Process & Equipment

Disclaimer

All technical publications of EIGA or under EIGA's name, including Codes of practice, Safety procedures and any other technical information contained in such publications were obtained from sources believed to be reliable and are based on technical information and experience currently available from members of EIGA and others at the date of their issuance.

While EIGA recommends reference to or use of its publications by its members, such reference to or use of EIGA's publications by its members or third parties are purely voluntary and not binding.

Therefore, EIGA or its members make no guarantee of the results and assume no liability or responsibility in connection with the reference to or use of information or suggestions contained in EIGA's publications.

EIGA has no control whatsoever as regards, performance or non performance, misinterpretation, proper or improper use of any information or suggestions contained in EIGA's publications by any person or entity (including EIGA members) and EIGA expressly disclaims any liability in connection thereto.

EIGA's publications are subject to periodic review and users are cautioned to obtain the latest edition.

© EIGA grants permission to reproduce this publication provided the Association is acknowledged as the source

EUROPEAN INDUSTRIAL GASES ASSOCIATION AISBL
Avenue des Arts 3-5 B 1210 Brussels Tel +32 2 217 70 98 Fax +32 2 219 85 14
E-mail: info@eiga.eu Internet: www.eiga.eu

Table of Contents

Figures

1 Introduction

Flat bottom storage tanks form an integral part of the production process of industrial gases. They are typically field erected, large volume tanks that contain mainly either liquid nitrogen or liquid oxygen, although there are some flat bottom tanks in argon service.

Flat bottom cryogenic storage tanks have been in service for over fifty years in the industrial gases industry and have demonstrated excellent in-service performance. The global industrial gases industry, including EIGA members, have produced guidance on the design, manufacture and in-service inspection of flat bottom storage tanks, see EIGA Doc 127, *Bulk Liquid Oxygen, Nitrogen and Argon Storage Systems at Production Sites* [1].[1]

The industrial gases industry does not carry out periodic internal inspection of bulk cryogenic storage tanks. This policy has been established over many years, based on operating experience, the inherently stable and benign conditions within an operating cryogenic storage tank and an absence of the traditional failure mechanisms for such equipment including corrosion, erosion and fatigue.

Occasionally cryogenic flat bottom storage tanks are decommissioned due to reasons such as stopping production, plant relocation etc. On the rare occasions when tanks are decommissioned, an opportunity inspection should be performed to gather information on aging equipment.

This publication aims to give recommendations for inspections of decommissioned cryogenic flat bottom tanks. It also aims to build a library of inspections available to EIGA members that will demonstrate the absence of aging mechanisms in this type of equipment and allow continued operation of the equipment without periodic internal inspection.

2 Scope and purpose

2.1 Scope

This publication provides guidance for inspections when a cryogenic flat bottom tank is decommissioned. However, in some exceptional cases, an internal inspection can be required, for example after an overfill or overpressure incident, tank contamination, or after repairs / refurbishment.

Only flat bottom tanks (FBT) used for storage of nitrogen, oxygen and argon service are included in this publication.

Safety considerations such as confined space entry and atmospheric monitoring are not in the scope of this publication.

2.2 Purpose

The main purpose of this publication is to:

- promote the internal inspection and testing when decommissioning FBT;
- provide guidance on what inspections and tests should be performed;
- collect and share inspection data regarding FBT performance and susceptibility to aging mechanisms in this type of equipment; and
- provide information to support the exemption for internal inspection of FBT in cryogenic liquid service.

1

3 Definitions

For the purpose of this publication, the following definitions apply.

3.1 Publication terminology

3.1.1 Shall

Indicates that the procedure is mandatory. It is used wherever the criterion for conformance to specific recommendations allows no deviation.

3.1.2 Should

Indicates that a procedure is recommended.

3.1.3 May

Indicates that the procedure is optional.

3.1.4 Will

Is used only to indicate the future, not a degree of requirement.

3.1.5 Can

Indicates a possibility or ability.

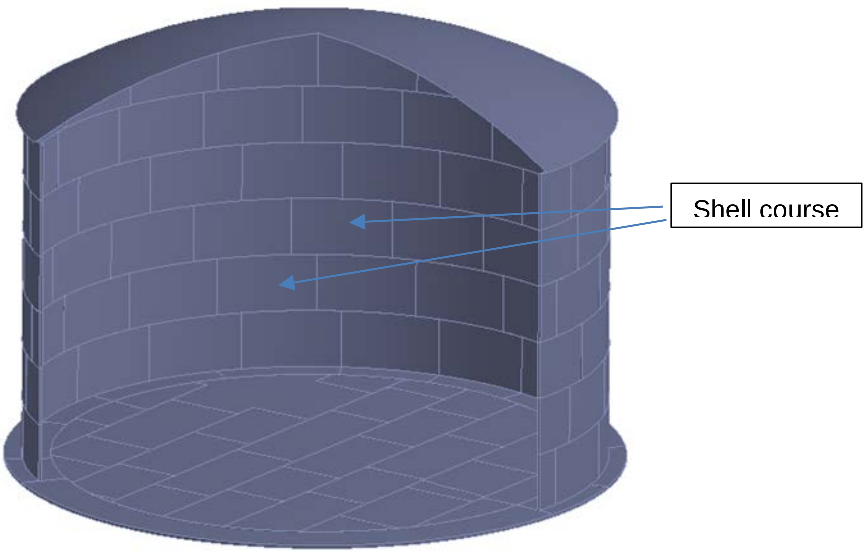
3.2 Technical definitions

3.2.1 Penetrant test

Dye penetrant testing or also known as penetrant testing (PT), is an inspection method used to check surface-breaking defects in metals. For FBTs the method is used to detect surface defects such as hairline cracks, surface porosity and fatigue cracks on welds.

3.2.2 Shell course

A course of the planking or plating of a flat bottom tank running longitudinally along the tank's bottom and sides.



4 Precautions and safety

A tank may be inspected while still commissioned for further service or after decommissioning i.e. completion of its service life.

In both cases when the tank is taken out of service, a slow warm-up is recommended to prevent deformation to the shell and bottom. Company or manufacturer operating procedures shall be followed for tank warm-up from cryogenic temperatures.

The annular space is typically filled with the insulating material perlite. The perlite material shall be completely removed before gaining entry into the annular space.

EIGA Doc 146, *Perlite Management*, provides guidance on safe practices for removing and installing perlite [2]. Additional information can also be found in EIGA TPXX, *Perlite Management* [3].

The information in these publications covers areas including:

- risk assessment for perlite removal including the hazards of removing perlite when cryogenic liquid has collected within the perlite;
- Personal Protective Equipment (PPE), see also EIGA Doc 136, *Selection of Personal Protective Equipment* [4];
- perlite removal method;
- training of personnel;
- equipment required; and
- confined space hazards.

Before attempting perlite removal, the top manhole cover of the outer jacket should be opened to ensure that a vacuum is not created during the removal process. For tanks that are still required for further service, the locations for perlite removal may be limited to existing nozzles and manways. In all cases, the perlite filled annular space should be first checked for oxygen content before starting the activity.

For decommissioned tanks, more holes may be cut in the outer jacket to aid complete removal of perlite. To reduce the risk of uncontrolled perlite releases, the holes cut should start at the top of the outer jacket with subsequent perlite removal before proceeding downward on the jacket. Perlite should not first be withdrawn from the bottom of the tank to reduce the risk of perlite eruption and engulfment.

A doorway may be created in the outer jacket and should only be attempted after perlite removal is completed. The doorway will aid in entry into the annular space at floor level, provide additional ventilation and reduce risks associated with confined spaces. For tanks still required for service, the entry will be by the manhole at the top of the roof.

Entry into the annular space shall only be done under a safe work permit process and under company requirements for confined space entry. Whenever possible, all perlite should be removed and swept up from the floor, around piping and mechanical joints in the annular space.

When making entry into the annular space, care and consideration shall be made for perlite that may have lodged around overhead piping and insulation boxes. The appropriate PPE shall be worn to reduce the risk of airborne perlite entering the eyes or being inhaled into the lungs.

5 Preparation for inspection and entry

For decommissioned tanks, it is recommended that doorway(s) be created at the floor level of the inner tank. Creating the opening should be done using an appropriate cutting tool that avoids deformation of the shell.

Where entry is from the top manhole, it should only be done after safety review using the proper access equipment such as harness, man-baskets or ladders.

It should be noted that cutting tools with excessive heat input will distort as-found inspection results. Consideration of the choice of cutting tools should be taken for tanks in oxygen service, for example no flame cutting tools (such as oxy-acetylene torches) should be used. The atmosphere should be checked for oxygen content before starting the activity.

If applicable, tank contamination shall be considered and avoided by collecting debris from cutting and maintaining cleanliness.

On entry into the inner tank, a note should be taken of any residue found in the bottom of the tank and this should be marked for sample collection. Ensure that any residue is not debris from gaining entry to the inner tank.

The inner tank floor and structure should first be checked before work platforms (for example scaffold, ladders) are assembled or inspections commence.

6 Inspections

6.1 General

The scope of inspections and tests described are general recommendations. They may be adapted or completed according to different situations and shall be in compliance with the country regulation, if applicable.

The critical areas to focus on (with highest stress in the inner tank) are normally the:

- welds of the first two shell courses, and mainly longitudinal welds;
- weld of the shell to base; and
- nozzles near the bottom of the tank, particularly the discharge nozzle.

If an internal inspection is needed before putting back the tank into service, only a visual examination of the inner shell and dye penetrant tests on welds can be performed.

It is recommended that the inspection be led by a third party with a combined report issued that includes all the tests performed. Non-destructive tests shall be made by certified personnel according to recognised standards.

6.2 Inner shell visual examination

A visual inspection of 100% of the internal surface of the inner shell should be done from the ground level to determine any evidence of significant in-service degradation or structural damage. Particular attention should be given to critical areas as defined in 6.1. The examination of other parts less critical, like the roof, can be done from the floor.

It is recommended to take photos of the different parts (bottom, shell, roof etc.) and of specific details (welds, nozzles, manholes etc.).

If any significant deformation is detected on the floor or the shell from visual inspection (clearly visible without additional aids) it should be quantified with tools such as laser measurement and profile gauges.

For a decommissioned tank, any deformation greater than the manufacturing tolerance, should be noted in the inspection report. For a tank that will be put back into service, a technical review of any observed distortion or deformation shall be completed before returning to service. Common causes of deformation are inappropriate procedures for tanks warm-up or cool-down.

In cases where visible residue is seen on the floor of the tank, a sample should be taken for chemical analysis, and in particular if the tank is being put back in service.

6.3 Annular space visual examination

A visual inspection of the accessible parts in the annular space should be done, to check the condition of the external surface of the inner vessel to search for obvious damage.

If any suspicious defects on welds of inner shell are visually detected, it should be confirmed by dye penetrant test.

Particular attention should be given to anchor bolts to check for general condition, engagement, and the possibility of movement.

It is recommended to take photos of the different parts (shell, roof, etc.) and of specific details (anchor bolts, nozzles etc.).

6.4 Non-destructive tests

Dye penetrant tests should be performed on the following critical welds:

1. 100% of the shell to base weld (circumferential) on internal surface (annular plate to 1st shell course), see Figures 1 and 2;
2. 100% of the shell to base weld (circumferential) on external surface in the annular space (annular plate to 1st shell course), if accessible, see Figure 2;
3. 100% of the longitudinal welds on the first shell course, see Figure 1 and 2;
4. 100% of the tee joints between the circumferential welds and the longitudinal welds between the first and second shell courses of the inner vessel (from the base), see Figure 1;
5. 10% of the circumferential weld between the first and second shell courses, see Figure 1;
6. 100% of nozzle and the manhole internal welds (if on the first shell course or the tank bottom), the most important weld is the discharge nozzle, see Figure 6;
7. 100% of nozzle and the manhole external welds in the annular space (if accessible and on the first shell course or the tank bottom), the most important weld is the discharge nozzle, see Figure 7;
8. 10% of the tee joints on the bottom plates. This can be replaced by a leak test (by vacuum method or other) see Figure 8; and
9. at least 4 of the anchor bolt support welds in the annular space, if accessible, see Figure 3.

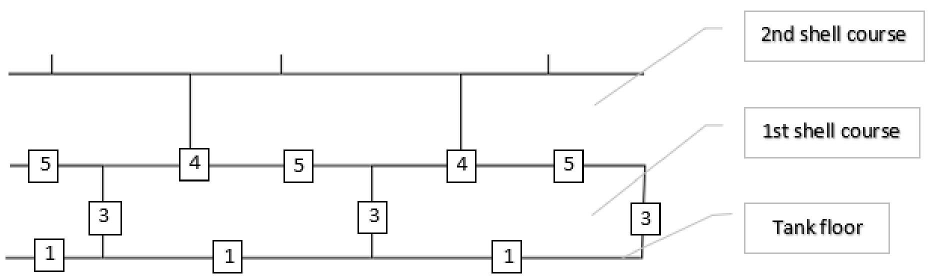


Figure 1: Inspections on 1st and 2nd shell courses

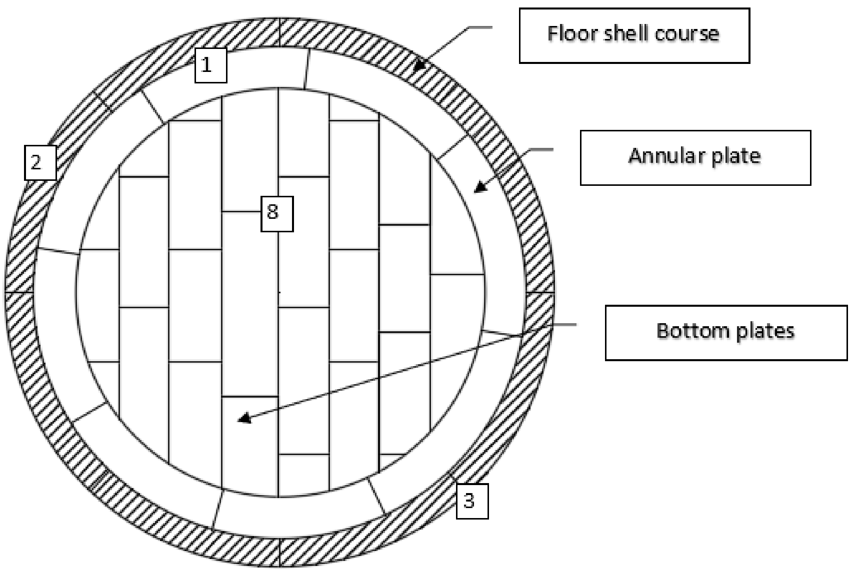


Figure 2: Inspections on the tank bottom

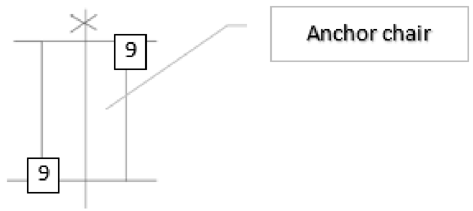


Figure 3: Anchor bolt and strap inspection

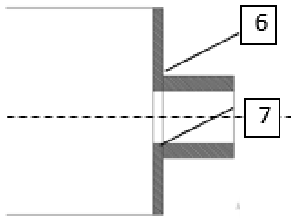


Figure 4: Nozzle Penetration inspection

If defects are seen during visual inspection that require further investigation, dye penetrant tests should be performed (in addition to the scope above).

Dye penetrant test can reveal two types of defect, manufacturing defect or in-service defect. Manufacturing defects on welds such undercut, overlap, lack of fusion or penetration, porosity should be noted but do not require further investigation. For in-service defects, linear indications and any unidentified defect, it is recommended to perform a macrographic examination (destructive and metallurgical tests, see 6.5) or replica for confirmation.

6.5 Destructive and metallurgical tests

Two samples of plate on the shell should be removed to be able to complete the destructive tests on a longitudinal weld and on a circumferential weld including for one or both a tee joint. It is recommended to remove 500 x 500 mm samples, this should be confirmed with the metallurgical laboratory.

The destructive and metallurgical tests below should be performed for both longitudinal and circumferential welds, including:

- 2 cross weld tensile tests;
- 1 low temperature impact test (3 specimens for parent metal, heat affected zone and weld metal);
- 1 macrographic examination; and
- 1 micrographic examination.

Macrographic tests or replicas should also be performed on any other sample removed, for example where defects were identified during dye penetrant testing (see 6.4). Any crack defects should be sized (depth and length). Depending on defect type, chemical analysis of base metal and weld metal should be considered.

7 Recording

The inspection report should include:

- date of inspection;
- inspector name(s) and certification(s);
- tank details such as location, tank identification, dimension, service, age, materials, reason for inspection;
- scope of examination;
- photos;
- visual inspection;
- dye penetrant tests;
- destructive and metallurgical tests;
- other tests performed (for example analysis of contaminants); and
- conclusions.

A final report should be issued after all test and report have been received.

It is preferred that a summary of inspection and conclusion is provided in English if the report is in a language other than English.

8 EIGA inspection database

Inspection reports should be submitted to EIGA for retention. A summary of the inspection will be added to a table of previous inspections which will be available to all EIGA members on request to the EIGA office. EIGA members can request access to the complete inspection reports through the EIGA Office who will seek permission of the member owning the tank prior to issuing the report.

9 References

Unless otherwise specified, the latest edition shall apply.

[1] EIGA Doc 127, *Bulk Liquid Oxygen, Nitrogen and Argon Storage Systems at Production Sites*, www.eiga.eu.

[2] EIGA Doc 146, *Perlite Management*, www.eiga.eu.

[3] EIGA TP 60, *Perlite Management (Perlite and Deperliting Operations)*, www.eiga.eu.

[4] EIGA Doc 136, *Selection of Personal Protective Equipment*, www.eiga.eu.