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**Gas cylinders — Classification of imperfections arising during the manufacture of seamless steel and aluminium alloy gas cylinders**

*Bouteilles à gaz — Classification des imperfections de fabrication des bouteilles à gaz en acier et en alliage d'aluminium sans soudures*



Reference number  
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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 58, *Gas cylinders*, Subcommittee SC 3, *Cylinder design*.

## Introduction

Based on a resolution taken by ISO/TC 58/SC 3 at its 54th meeting in Sydney, a particular working group, WG 34, was created with the following tasks:

- a) consider the issue of the manufacturing defects and imperfections at the time of manufacture in International Standards for seamless steel and aluminium alloy cylinders;
- b) develop requirements that are verifiable, measurable, and practicable;
- c) put forward proposals for how to include such requirements in SC 3 International Standards, no later than the next revision of the International Standards, e.g. as an annex in the design standards or within the main body of the text.

SC 3 asked that WG 34 take the current defect annexes of ISO 9809-1, ISO 9809-2, and ISO 9809-3 for seamless steel and ISO 7866 for seamless aluminium alloy cylinders as a starting point.

In order to address the SC 3 resolution, it was further decided to create this Technical Report.



# Gas cylinders — Classification of imperfections arising during the manufacture of seamless steel and aluminium alloy gas cylinders

## 1 Scope

This Technical Report specifies the procedure on how to evaluate and treat the most commonly found manufacturing imperfections on seamless steel and aluminium alloy gas cylinders at visual inspection at the stage of product acceptance.

[Annex A](#) contains a template for the relevant cylinder design International Standards (i.e. ISO 9809-1, ISO 9809-2, and ISO 9809-3 for seamless steel and ISO 7866 for seamless aluminium alloy cylinders). It further contains information on how to implement the provisions into other cylinder design standards.

## 2 Explanatory introduction and provisions for the implementation into the cylinder design standards

It is intended that the provisions laid out in this Technical Report should be followed by ISO/TC 58/SC 3 working groups dealing with the design standards for seamless steel (ISO 9809-1, ISO 9809-2, and ISO 9809-3) and aluminium alloy gas cylinders (ISO 7866) at the next revision of these International Standards.

The tables in [Annex A](#) are based on the current “Defect Annexes” of ISO 9809-1, ISO 9809-2, and ISO 9809-3 for seamless steel cylinders and ISO 7866 for seamless aluminium alloy cylinders. Those imperfections applicable for the ISO 9809 series are contained in [Tables A.1](#) and [A.2](#), and those applicable for ISO 7866 are contained in [Tables A.3](#) and [A.4](#).

They are written in such a way that they can also be incorporated in other design standards as a normative annex.

The provisions of this Technical Report should also serve as a basis for a future annex to each of the other relevant design standards (other than ISO 9809-1, ISO 9809-2, ISO 9809-3, and ISO 7866) for seamless cylinders and tubes.

If incorporated in other design standards the content of the columns “Type of imperfection”, “Description”, and “Note” in [Tables A.1](#), [A.2](#), [A.3](#), and [A.4](#) (which were established by WG 34) should remain unchanged.

The tables should be reviewed by the other relevant ISO/TC 58/SC 3 working groups, in particular, the column “Decision at the time of inspections and follow-up actions” and the three imperfection levels. Where necessary, these conditions can be adapted to reflect the conditions appropriate to their product.

If the individual working groups intend to adopt other typical manufacturing imperfections specific to their product, they can do so, provided the structure of the tables and the remaining provisions are followed.

## Annex A (normative)

# Description and evaluation of manufacturing imperfections of seamless gas cylinders

### A.1 Introduction

Several types of imperfections can occur during the manufacture of seamless gas cylinders.

Such imperfections can be due to material defects, the manufacturing process, handling, and other circumstances during the manufacturing process.

The aim of this Annex is to identify the manufacturing imperfections most commonly found on finished cylinders and to provide requirements for the visual inspection at the stage of product acceptance.

NOTE 1 This Annex does not address customer specifications, e.g. cylinder aesthetics, special surface preparations, etc.

NOTE 2 Cylinder sampling method(s) and the quantity sampled for inspection, after cylinders with imperfections have been found, are not covered by this Annex and are prescribed in the main body of the design standard.

NOTE 3 Manufacturing imperfections can be identified and evaluated at any stage of the manufacturing process.

### A.2 General

**A.2.1** The visual inspection shall be conducted in good lighting on a product that is clean, dry, and suitable enough for proper inspection of all surfaces. The visual inspection shall be conducted by eye, and internal inspections can be augmented by a scope, dental mirror, or other suitable device. Where magnification is used, the final assessment of the imperfection shall be evaluated as if no magnification had been used.

In thicker parts of the cylinder, the acceptable absolute value of the size of the imperfection can be proportionately increased to the thickness, provided that it does not adversely affect the safe performance or integrity of the cylinder.

Where needed, the severity of a detected imperfection can be further evaluated by the use of other devices or methods.

NOTE If unclean, the cylinder surfaces should be re-cleaned before submitting the cylinder for inspection.

**A.2.2** If appropriate, small imperfections, as permitted by [Tables A.1](#) and [A.3](#), can be removed by local dressing, grinding, machining, or other suitable methods. Great care shall be taken to avoid introducing new defects or imperfections.

After such a repair, the cylinders shall be re-examined, and if the wall thickness is reduced, it shall be rechecked and be at least at minimum guaranteed wall thickness.

### A.3 Manufacturing imperfections and the procedure for their evaluation

The most commonly found safety- and performance-related manufacturing imperfections and their descriptions are listed in [Table A.1](#) for seamless steel cylinders and [Table A.3](#) for seamless aluminium

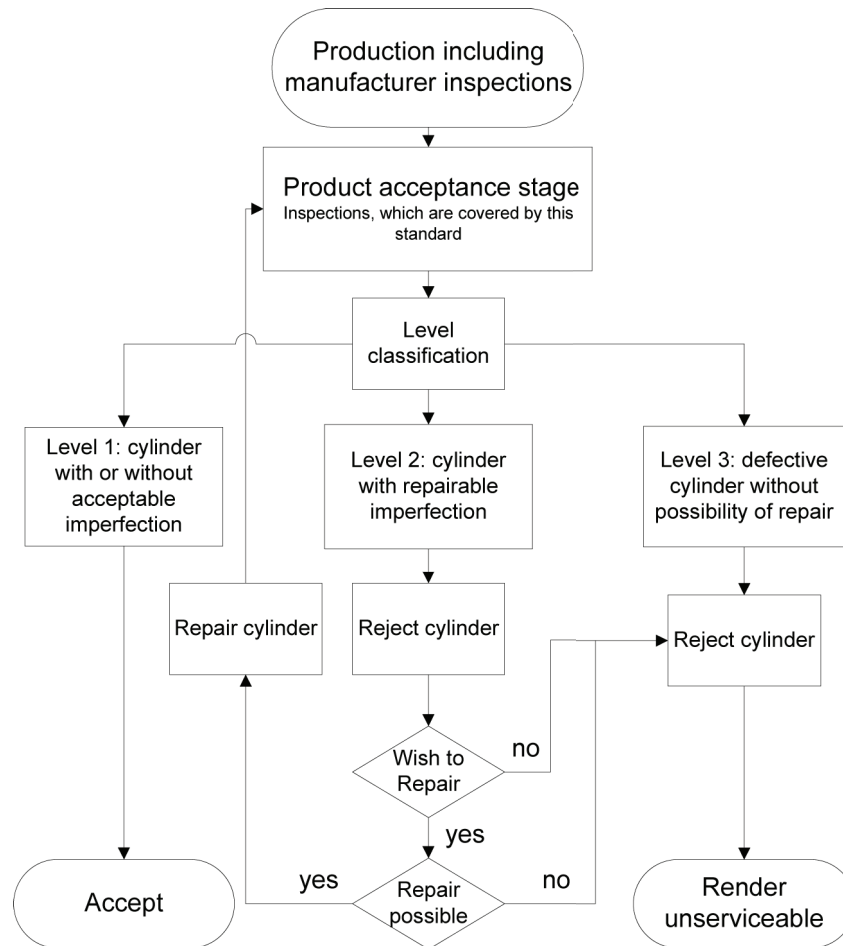


alloy cylinders. In addition, the manufacturing imperfections and their descriptions for features which are not safety- or performance-related (cosmetic) are listed in [Tables A.2](#) and [A.4](#).

Limits for the repair or rejection of cylinders manufactured to this Technical Report are included in [Tables A.1](#) and [A.3](#).

The acceptance or rejection conditions for gas cylinders are categorized into three levels, in accordance with [A.4](#).

The process that shall be followed at the final visual inspection is given in [Figure A.1](#).



**Figure A.1 — Flow-diagram for the final visual inspection of gas cylinders at the time of product acceptance**

#### A.4 Acceptance and rejection conditions

The following categorize the levels of imperfections and provide instructions depending on the severity of the imperfection and regarding the disposition of the cylinders.

##### Level 1 imperfection

Conforming condition of a cylinder that has no adverse effects on the safe performance or integrity of the cylinder. Cylinders with Level 1 imperfections are acceptable and do not require repair.

##### Level 2 imperfection

Non-conforming condition of a cylinder with features more severe than Level 1 imperfections. Cylinders with Level 2 imperfections shall be rejected. If it is decided that a rejected cylinder with Level 2

imperfections is to be repaired, it shall be repaired in accordance with [A.2.2](#) and be re-inspected. Otherwise, the cylinders are to be treated as cylinders with Level 3 imperfections.

### **Level 3 imperfection**

Non-conforming condition of a cylinder with features more severe than Level 2 imperfections. Cylinders with Level 3 imperfections shall be rejected. Rejected cylinders with Level 3 imperfections shall not be repaired and shall be rendered unserviceable.

The cylinders presented to the inspector for inspection at the time of product acceptance should have been found acceptable and should be free of imperfections to Levels 2 and 3 by the manufacturer.

## **A.5 Definitions**

### **A.5.1 repair**

action to return a rejected cylinder to a Level 1 condition

### **A.5.2 reject**

cylinder that has been set aside (Level 2 or Level 3) and not allowed to go into service

### **A.5.3 rendered unserviceable**

cylinder that has been treated in such a way as to render it impossible for use

NOTE Examples for acceptable methods to render cylinders unserviceable can be found in ISO 6406. Any actions on cylinders rendered unserviceable are outside the scope of this Technical Report.



Table A.1 — Safety- and performance-related manufacturing imperfections and their evaluation for seamless steel cylinders

Pos	Type of imperfection	Description	Decision at the time of inspections and follow-up actions			Note
			Level 1 imperfection Acceptable	Level 2 imperfection Reject and repair if possible (for repairs, see A.2.2)	Level 3 imperfection Reject and render unserviceable	
1 S	Bulge	A visible swelling of the wall (see Figure A.2).			All cylinders with such imperfection.	The cause of such failure shall be identified.
2 S	Dent (Flat)	A visible depression in the wall that has neither penetrated nor removed metal and is greater in depth than 0,5 % of the external-cylinder diameter (see Figure A.3). (See also excessive grinding or machining.)	When the depth of the dent is less than 1 % of the external-cylinder diameter and when the diameter <sup>1)</sup> of the dent is greater than 30 times its depth.		When the depth of the dent exceeds 1 % of the external-cylinder diameter or when the diameter <sup>1)</sup> of the dent is less than 30 × its depth.	In all cases, the wall thickness shall be verified at the imperfection area and shall not be less than the guaranteed minimum wall thickness. 1) If the dent is not circular, the largest dimension shall be taken as diameter.
3 S	Dent containing cut or gouge	A depression in the wall (see item 2 S) which contains a cut or gouge (See item 4 S). (See Figure A.4.)			All cylinders with such imperfections.	
4 S	Cut, gouge, groove, metallic, or scale impression	An impression in the wall where metal has been removed, displaced, or redistributed with a depth of greater than 3 % of the guaranteed minimum wall thickness (see Figure A.5).	When the depth does not exceed 5 % of the guaranteed minimum wall thickness and there are no sharp notches longer than 10 times the guaranteed minimum wall thickness.	External surface imperfection in excess of Level 1. They can be dressed provided that the remaining wall thickness below defect is greater than the guaranteed minimum wall thickness.	Internal surface imperfection in excess of Level 1. External surface imperfection in excess of Level 1 which has not been repaired or cannot be repaired.	
5 S	Excessive grinding or machining	A local reduction of wall thickness by grinding or machining or other mechanical metal removal process.			When the wall thickness is reduced to below the guaranteed minimum wall thickness.	When it results in the formation of a dent or grinding mark, treat it as “dent” (item 2 S) or “cut” (item 3 S).

Table A.1 (continued)

Pos	Type of imperfection	Description	Decision at the time of inspections and follow-up actions			Note
			Level 1 imperfection Acceptable	Level 2 imperfection Reject and repair if possible (for repairs, see A.2.2)	Level 3 imperfection Reject and render unserviceable	
6 S	Lamination	A layering of the material with a surface-breaking imperfection sometimes, appearing as a discontinuity, crack, lap, or bulge at the surface (see Figure A.6).		External imperfection: all cylinders with such imperfection.	Internal imperfection: all cylinders with such imperfection.	Laminations can exist within the entire surface of the cylinder and can appear as bulge or blister on the surface.
7 S	Blister					Not applicable for steel.
8 S	Crack	A split or separation in the metal, typically appearing as a line on the surface.		When removable within thickness tolerance, i.e. the remaining wall thickness below defect is greater than the guaranteed minimum wall thickness.	When not removable within the thickness tolerance.	
9 S	Neck cracks and tap marks	A split or separation in the material, typically appearing as lines usually running down/up vertically the thread and across the thread. (see Figure A.8). They shall not be confused with tap marks/thread machining marks typically appearing as straight line (see Figure A.9).	Only cylinders with tap marks.		All cylinders with neck cracks.	Unlike tap marks, cracks can appear on the top face of the cylinder neck.

Table A.1 (continued)

Pos	Type of imperfection	Description	Decision at the time of inspections and follow-up actions			Note
			Level 1 imperfection Acceptable	Level 2 imperfection Reject and repair if possible (for repairs, see A.2.2)	Level 3 imperfection Reject and render unserviceable	
10 S	Internal shoulder folds	Metal flows in the shoulder area creating a visual groove. The groove of the fold will always be in longitudinal direction which can propagate into the threaded part of the neck (see Figure A.10, key 1). Folds can be the initiation point for cracks, which can propagate into the cylindrical machined or threaded area of the shoulder (see Figure A.8, key 3).	Folds which are clearly visible as open depressions where no oxides have been trapped into the metal shall be accepted, provided that the peaks are smooth and the bottom (valley) of the depression is rounded. Minor sharp folds are acceptable, provided they do not adversely affect the safety of the cylinder (see Figure A.11).	Folds in excess of Level 1 which can be removed by a machining operation until the lines of oxide are no longer visible and provided that the remaining thickness meets the design criteria (see Figure A.10, key 2).	Repaired Level 2 folds where the lines are still visible.	
11 S	a) Features on internal-base surface on cylinders made from tube b) Other base features	Splits (resembling cracks), porosity, and remaining oxides on the central surface of the cylinder base (e.g. in star form, see Figure A.12). Splits, cracks, porosity, tool-marks, and scale impressions of the cylinder base.		When removable within the thickness tolerance.	When not removable within the thickness tolerance.	
12 S	"Orange peel" surface	A mottled, rough, and slightly wavy appearance on the internal surface due to discontinuous metal flow (see Figure A.13).	Tool marks and scale impressions provided they have been shown not to adversely affect the safety or performance of the cylinder. If no cracks are visible in the orange peel surface.	Features in excess of Level 1 and when removable within the thickness tolerance.	When not removable within the thickness tolerance. If cracks are visible in the orange peel surface.	

Table A.1 (continued)

Pos	Type of imperfection	Description	Decision at the time of inspections and follow-up actions			Note
			Level 1 imperfection Acceptable	Level 2 imperfection Reject and repair if possible (for repairs, see A.2.2)	Level 3 imperfection Reject and render unserviceable	
13 S	Damaged internal neck threads or missing threads	Damaged neck threads, e.g. with dents, cuts, burrs, and chipped stripped, or missing threads. For chipped threads see Figure A.12.	All tap marks. Superficial damage which has been shown not to adversely affect the safety or performance of the cylinder.	Features in excess of Level 1 and when the design permits it, threads can be retapped/reworked and rechecked by the appropriate thread gauge and carefully visually re-examined. The required number of effective threads shall be present.	Features in excess of Level 1 and not repaired or inappropriate number of effective threads.	In case of doubt, the visual inspection can be augmented (see A.2.1).
14 S	Pitting	Small holes in the metal due to chemical or water attack (see Figure A.13).		All pits regardless of size can be removed, provided that the requirements of A.2.2 are met.	All cylinders with such imperfections which are not repaired or the remaining wall thickness is less than the guaranteed minimum wall thickness.	
15 S	Non-conformity with the design drawing and/or technical specification	A feature at the time of visual inspection that does not conform with the design drawing and/or technical specification.		All such cylinders can be repaired or be accepted, provided that the cylinder complies with the type approval and is acceptable to all parties concerned.	All cylinders not meeting Level 2. Such cylinders can be rerouted to another design drawing and/or technical specification, provided that they meet the type approval.	
16 S	Neck ring not secure	A neck ring is loose by manual handling.		All cylinders presenting such an imperfection can be repaired.	All cylinders presenting such an imperfection and are not repaired.	
17 S	Lubrication marks, striation					Not applicable for steel.

Table A.1 (continued)

Pos	Type of imperfection	Description	Decision at the time of inspections and follow-up actions			Note
			Level 1 imperfection Acceptable	Level 2 imperfection Reject and repair if possible (for repairs, see A.2.2)	Level 3 imperfection Reject and render unserviceable	
18 S	Internal contamination	Visual foreign matters such as loose particles, liquids, paint, lubricants, and turnings.	Discolouration (thin oxide layer) which is not detrimental to the intended gas service.	All cylinders with visually internal contamination. Such cylinders can be cleaned.	All cylinders with such imperfections which are not repaired.	The cause of the contamination shall be determined.
19 S	Internal ridge or rib	A raised surface with sharp corners at its base (see Figure A.17).		When corners can be rounded by internal blasting.	All cylinders with such imperfections which are not repaired.	



Table A.2 — Cosmetic manufacturing imperfections for seamless steel cylinders

Pos	Type of imperfection	Description	Decision at the time of inspections and follow-up actions			Note
			Level 1 imperfection Acceptable	Level 2 imperfection Reject and repair if possible (for repairs see A.2.2)	Level 3 imperfection Reject and render unserviceable	
20 S	External ridge or rib	A raised surface with rounded or sharp corners at its base (see Figure A.17).	NOTE As these imperfections are not safety- or performance related, they are deemed acceptable.			This is not a harmful imperfection. However, ribs could be confused with weldment during the use of the cylinder.

Table A.3 — Safety- and performance-related manufacturing imperfections and their evaluation for seamless aluminium alloy cylinders

Pos	Type of imperfection	Description	Decision at the time of inspections and follow-up actions			Note
			Level 1 imperfection Acceptable	Level 2 imperfection Reject and repair if possible (for repairs see A.2.2)	Level 3 imperfection Reject and render unserviceable	
1 A	Bulge	A visible swelling of the wall (see Figure A.2).			All cylinders with such an imperfection.	The cause of such a failure shall be identified.
2 A	Dent (flat)	A visible depression in the wall that has neither penetrated nor removed metal and is greater in depth than 1 % of the outside diameter (see Figure A.3). (See also excessive grinding or machining.)	When the depth of the external cylinder diameter and when the diameter <sup>1)</sup> of the dent is greater than 30 times its depth and when external dent is not visible on the internal surface.		When the depth of the dent exceeds 2 % of the external cylinder diameter or when the diameter <sup>1)</sup> of the dent is less than 30 × its depth or when the external dent is visible on the internal surface.	In all cases, the wall thickness shall be verified at the imperfection area. 1) If the dent is not circular, the largest dimension shall be taken as diameter.
3 A	Dent containing cut or gouge	A depression in the wall (see item 2 A) which contains a cut or gouge (item 4 A). (See Figure A.4.)			All cylinders with such imperfections.	
4 A	Cut, gouge, groove, metallic, or scale impression	An impression in the wall where metal has been removed, displaced, or redistributed of a depth of greater than 2 % of the guaranteed minimum wall thickness (see Figure A.5).	When the depth does not exceed 5 % of the guaranteed minimum wall thickness, there are no sharp notches, and the length is less than five times the guaranteed minimum wall thickness.	External surface imperfection in excess of Level 1. They can be dressed, provided that the remaining wall thickness below defect is greater than the guaranteed minimum wall thickness.	Internal surface imperfection in excess of Level 1. External surface imperfection in excess of Level 1 which has not been repaired or cannot be repaired.	
5 A	Excessive grinding or machining	A local reduction of the wall thickness by grinding, machining or other mechanical metal removal process.			When the wall thickness is reduced to below the guaranteed minimum wall thickness.	When it results in the formation of a dent or grinding mark, treat it as “dent” (item 2 A) or “cut” (item 3 A).

Table A.3 (continued)

Pos	Type of imperfection	Description	Decision at the time of inspections and follow-up actions			Note
			Level 1 imperfection Acceptable	Level 2 imperfection Reject and repair if possible (for repairs see A.2.2)	Level 3 imperfection Reject and render unserviceable	
6 A	Lamination	A layering of the material with a surface breaking imperfection, sometimes appearing as a discontinuity, crack, lap, or bulge at the surface (see Figure A.6).		External imperfection: all cylinders with such imperfection.	Internal imperfection: all cylinders with such imperfection.	Laminations can exist within the entire surface of the cylinder and can appear as bulge or blister on the surface.
7 A	Blister	A small bulge on the wall containing a continuous layer of inclusions (see Figure A.7).		External imperfection: all cylinders with such imperfection where blister is greater than 5 % of the guaranteed minimum wall thickness. Not necessary to repair if clearly insignificant to cylinder performance.	Internal imperfection: all cylinders with such imperfection where blister is greater than 2 mm in diameter.	
8 A	Crack	A split or separation in the metal typically appearing as a line on the surface.		When removable within thickness tolerance, i.e. the remaining wall thickness below defect is greater than the guaranteed minimum wall thickness.	When not removable within the thickness tolerance.	
9 A	Neck cracks and tap marks	A split or separation in the material typically appearing as lines usually running down/up vertically the thread and across the thread (see Figure A.8). They shall not be confused with tap marks/thread machining marks typically appearing as straight line (see Figure A.9).	Only cylinders with tap marks.		All cylinders with neck cracks.	Unlike tap marks, cracks can appear on the top face of the cylinder neck.

Table A.3 (continued)

Pos	Type of imperfection	Description	Decision at the time of inspections and follow-up actions			Note
			Level 1 imperfection Acceptable	Level 2 imperfection Reject and repair if possible (for repairs see A.2.2)	Level 3 imperfection Reject and render unserviceable	
10 A	Internal shoulder folds	Metal flows in the shoulder area creating a visual groove. The groove of the fold will always be in longitudinal direction, which can propagate into the threaded part of the neck (see Figure A.10, key 1). Folds can be the initiation point for cracks, which can propagate into the cylindrical machined or threaded area of the shoulder (see Figure A.8, key 3).	Folds which are clearly visible as open depressions where no oxides have been trapped into the metal shall be accepted, provided that the peaks are smooth and the bottom (valley) of the depression is rounded. Minor sharp folds are acceptable, provided they do not adversely affect the safety of the cylinder (see Figure A.11).	Folds in excess of Level 1 which can be removed by a machining operation until the lines of oxide are no longer visible and provided that the remaining thickness meets the design criteria (see Figure A.10, key 2).	Repaired Level 2 folds where the lines are still visible.	
11 A	a) Features on internal base surface b) Other base features	Splits (resembling cracks), porosity, and remaining oxides on the central surface of the cylinder base (e.g. in star form, see Figure A.12). Splits, cracks, porosity, tool marks, or impressions in the cylinder base.		When removable within the thickness tolerance.	When not removable within the thickness tolerance.	
12 A	"Orange peel" surface				When not removable within the thickness tolerance.	Not applicable for aluminium.

Table A.3 (continued)

Pos	Type of imperfection	Description	Decision at the time of inspections and follow-up actions			Note
			Level 1 imperfection Acceptable	Level 2 imperfection Reject and repair if possible (for repairs see A.2.2)	Level 3 imperfection Reject and render unserviceable	
13 A	Damaged internal neck threads or missing threads	Damaged neck threads, e.g. with dents, cuts, burrs, and chipped stripped, or missing threads. For chipped threads, see Figure A.14.	All tap marks. Superficial damage which has been shown not to adversely affect the safety or performance of the cylinder.	Features in excess of Level 1 and when the design permits it, threads can be retapped/reworked and rechecked by the appropriate thread gauge and carefully visually re-examined. The required number of effective threads shall be present.	Features in excess of Level 1 and not repaired or inappropriate number of effective threads.	In case of doubt, the visual inspection can be augmented (see A.2.1).
14 A	Pitting	Small holes in the metal due to chemical or water attack (see Figure A.15).		All pits regardless of size can be removed, provided that the requirements of A.2.2 are met.	All cylinders with such imperfections which are not repaired or the remaining wall thickness is less than the guaranteed minimum wall thickness.	
15 A	Non-conformity with the design drawing and/or technical specification	A feature at the time of visual inspection that does not conform with the design drawing and/or technical specification.		All such cylinders can be repaired or be accepted, provided that the cylinder complies with the type approval and is acceptable to all parties concerned.	All cylinders not meeting Level 2. Such cylinders can be rerouted to another design drawing and/or technical specification, provided that they meet the type approval.	
16 A	Neck ring not secure	A neck ring is loose by manual handling.		All cylinders presenting such an imperfection can be repaired.	All cylinders presenting such an imperfection and are not repaired.	
17 A	Lubrication marks, striation	Marks on the surface of the cylinder formed during the extrusion process (see Figure A.16).	Marks which do not adversely affect the safety or performance of the cylinder.	Marks in excess of Level 1 can be removed, provided that the requirements of A.2.2 are met.	All cylinders with such imperfections which are not repaired or the remaining wall thickness is less than guaranteed minimum wall thickness.	

Table A.3 (continued)

Pos	Type of imperfection	Description	Decision at the time of inspections and follow-up actions			Note
			Level 1 imperfection Acceptable	Level 2 imperfection Reject and repair if possible (for repairs see A.2.2)	Level 3 imperfection Reject and render unserviceable	
18 A	Internal contamination	Visual foreign matters such as loose particles, liquids, paint, lubricants, and turnings.	Discolouration (thin oxide layer) which is not detrimental to the intended gas service.	All cylinders with visual internal contamination. Such cylinders can be cleaned.	All cylinders with such imperfections which are not repaired.	The cause of the contamination shall be determined.
19 A	Internal ridge or rib	A raised surface with sharp corners at its base (see Figure A.17).		When corners can be rounded by internal blasting.	All cylinders with such imperfections which are not repaired.	

Table A.4 — Cosmetic manufacturing imperfections for seamless aluminium alloy cylinders

Pos	Type of imperfection	Description	Decision at the time of inspections and follow-up actions			Note
			Level 1 imperfection Acceptable	Level 2 imperfection Reject and repair if possible (for repairs see A.2.2)	Level 3 imperfection Reject and render unserviceable	
20 A	External ridge or rib	A raised surface with rounded or sharp corners at its base (see Figure A.17).	As these imperfections are not safety or performance related, they are deemed acceptable.			This is not a harmful imperfection. However, ribs could be confused with weldment during the use of the cylinder.



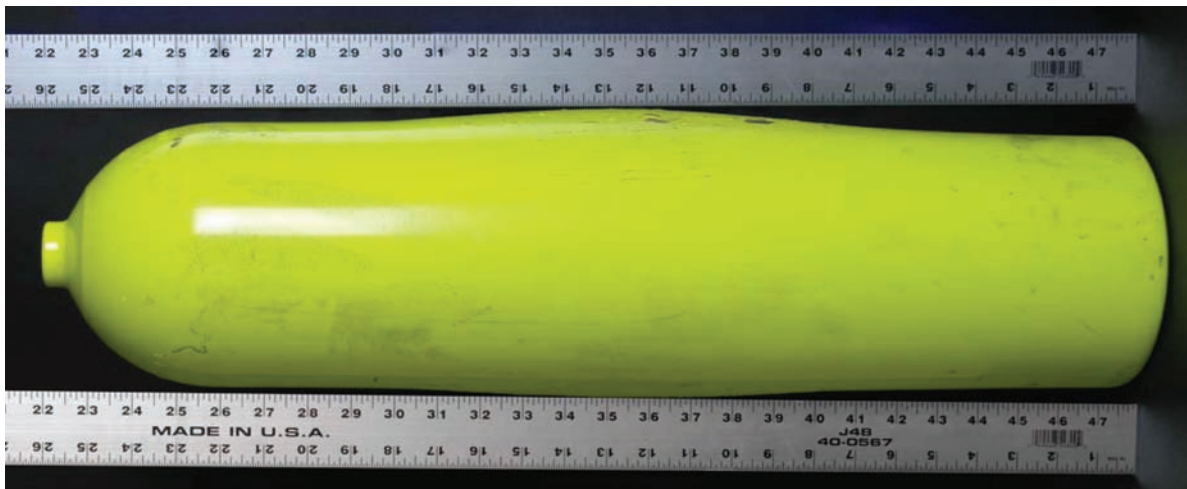


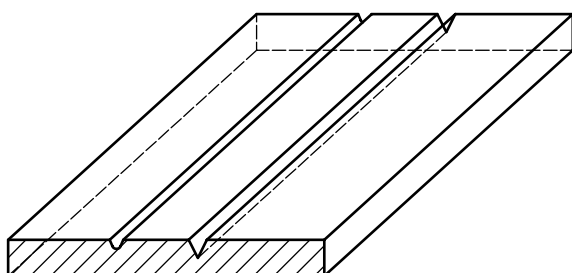
Figure A.2 — Bulge



Figure A.3 — Dent



Figure A.4 — Dent containing cut or gouge



a) Groove, cut



b) Metallic or scale impression

Figure A.5



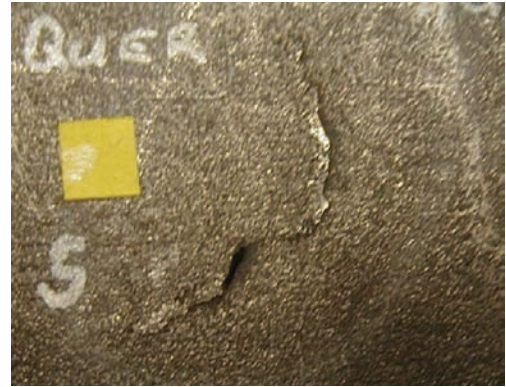
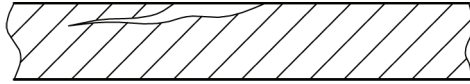
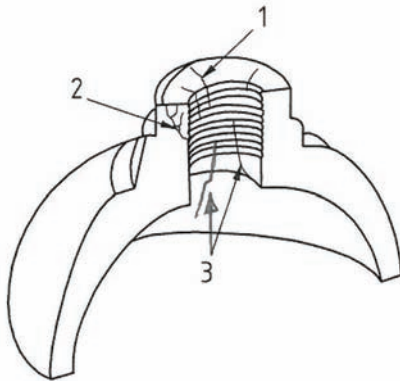


Figure A.6 — Lamination



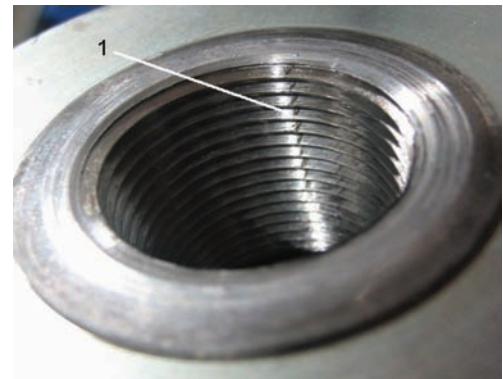
Figure A.7 — Blister (aluminium)



**Key**

- 1 cylinder neck cracks
- 2 cross section of cylinder neck
- 3 neck crack/shoulder crack

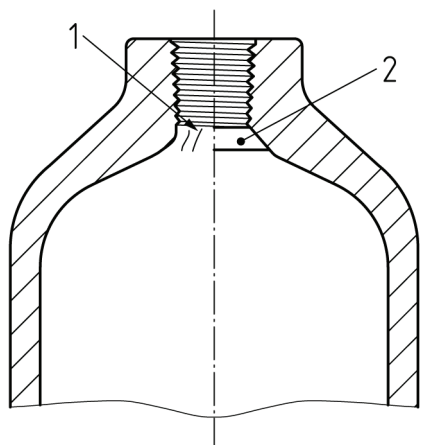
Figure A.8 — Neck cracks



**Key**

- 1 tap mark

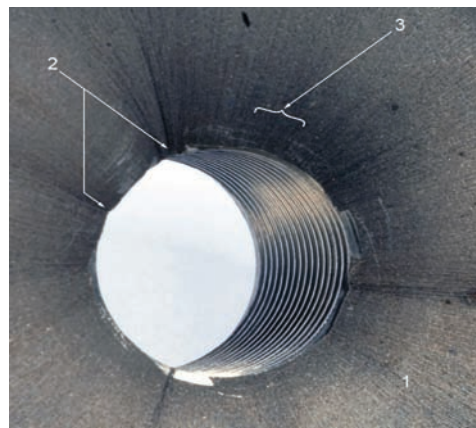
Figure A.9 — Tap marks



**Key**

- 1 folds or cracks
- 2 after machining

**Figure A.10 — Cylinder shoulder folds or cracks before and after machining**



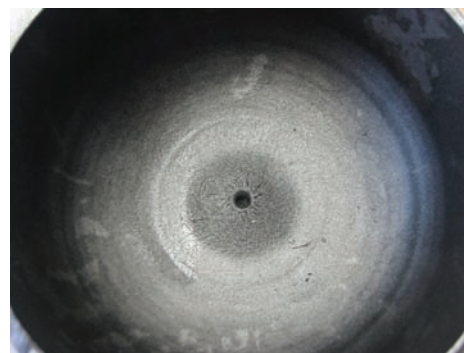
**Key**

- 1 area of fine/small folds
- 2 minor sharp folds
- 3 rounded depressions (valley)

**Figure A.11 — Shoulder folds**



**Figure A.12 — Features on cylinder base made from tube**



**Figure A.13 — “Orange peel”**



**Figure A.14 — Chipped thread**



Figure A.15 — Pitting

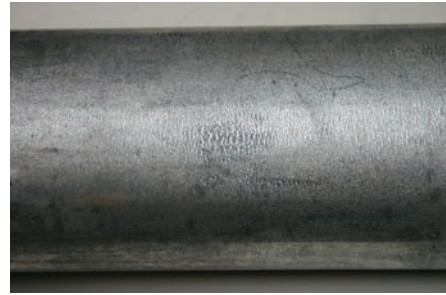


Figure A.16 — Lubrication marks, striation

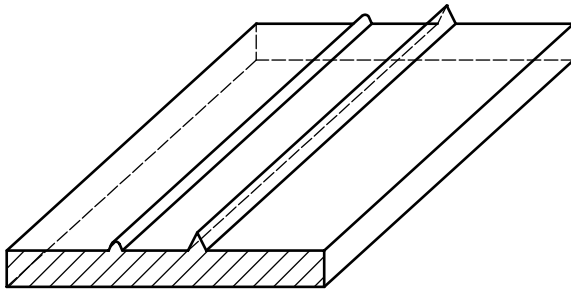


Figure A.17 — Rib

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- [4] ISO 7866, *Gas cylinders — Refillable seamless aluminium alloy gas cylinders — Design, construction and testing*

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