

AIPS
Airbus Process Specification
Manufacturing of pipes

Published and distributed by
AIRBUS S.A.S.
ENGINEERING DIRECTORATE
31707 BLAGNAC Cedex
FRANCE

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1 Scope

This Airbus Process Specification defines the Engineering requirements for manufacturing of pipes for all fluid systems.

The purpose of this specification is to give design and quality requirements to manufacturers. This specification does not give detailed instructions; these are given in the Process Instructions (PI) / Airbus Process Instruction (API) and the Work Instructions.

This specification shall not be used as an inspection document.

It shall be applied when mentioned in the relevant standard, material specification or Definition Dossier.

2 Normative references

Only normative references cited in the text are listed hereafter.

The latest issue of the publication referenced shall be used.

| | |
|----------------|---|
| AIPS 03-01-015 | Blanking of pipes, hoses and components |
| AIPS 07-01-006 | Electrical bonding |
| AIPS 09-01-002 | Cleaning with liquid non aqueous agents including vapour phase |
| AIPS 09-01-003 | Cleaning with aqueous cleaning agents |
| AIPS 09-01-014 | Final cleaning of hydraulic pipes |
| AS4059 | Cleaning and packing of hydraulic components |
| AP2253 | Validation and technical qualification of manufacturing process |
| EN9102 | Aerospace series - Quality systems - First article inspection |
| AS9102 | Aerospace - First Article Inspection Requirement |

3 Definition, applicability and limitations

3.1 Definition

Pipes are used for conveying liquid or gaseous fluids in power and distribution systems such as hydraulic, fuel, oxygen, potable water and waste water systems.

3.2 Applicability and limitations

This Airbus specification is applicable when invoked by the drawing directly or through another document for the purpose given in the scope. When processing to AIPS 03-01-010 is required it shall be invoked on the drawing.

Any damage as well as wrinkles, dents, ovality etc., reduces the lifetime of the pipes. Therefore, the manufacturing of pipes shall be done with utmost care.

4 Engineering requirements

Engineering requirements are minimum requirements to ensure optimal performance of the manufacturing process. All Engineering requirements have to be met and controlled in production.

4.1 Cutting to final length, facing and deburring

The cutting lengths of the straight pipe section are defined in the manufacturing drawings.

Cutting to final length is carried out according to the manufacturing document (current coordinates) or master pipe.

If the required length of the straight pipe section is not indicated in the manufacturing document, it shall be determined during first production. Changed length, due to installation of end fittings, shall be accounted for.

Unless otherwise specified in the manufacturing documents, the admissible length deviation to the sample pipe shall be $\pm 0,5$ mm.

For each pipe the manufacturers material batch shall be documented (traceability).

Cut the pipe squarely, meeting the tolerances specified in Table 1.

A deformation of pipe ends during cutting is not permitted.

When cutting titanium pipes, a burning out of the cutting zone and sparkles burning the pipe must be avoided by all means. This is achieved e.g. by liquid cooling.



Figure 1: Admissible deviations after cutting

Table 1: Max. admissible deviations after cutting

| Pipe size | Nominal pipe diameter d_n | | Max. admissible deviation b | |
|-------------|-----------------------------|----------------|-------------------------------|--------|
| | [mm] | [inch] | [mm] | [inch] |
| up to -6 | up to 9,52 | up to .375 | 0,08 | .003 |
| -8 to -12 | 12,70 to 19,05 | .500 to .750 | 0,13 | .005 |
| -16 to -36 | 25,40 to 57,15 | 1.000 to 2.250 | 0,30 | .012 |
| -40 to -44 | 63,50 to 69,85 | 2.500 to 2.750 | 0,38 | .015 |
| -48 to -52 | 76,20 to 82,55 | 3.000 to 3.250 | 0,46 | .018 |
| -56 to -60 | 88,90 to 95,25 | 3.500 to 3.750 | 0,51 | .020 |
| -64 to -68 | 101,60 to 107,95 | 4.000 to 4.250 | 0,58 | .023 |
| -72 to -76 | 114,30 to 120,65 | 4.500 to 4.750 | 0,66 | .026 |
| -80 to -104 | 127,00 to 165,10 | 5.000 to 6.500 | 0,76 | .030 |

Facing and deburring of the pipe ends shall be carried out with suitable machines.

The requirements of the relevant process specifications for pipe connections shall be taken into account.

If for cutting no corrosion-protective oils or lubricants have been applied, it is sufficient to blow out the pipes with compressed air.

4.2 Cleanliness of tubes

Corrosion-protective oils or lubricants applied by the pipe assembly manufacturer shall be removed with cleaning agents per AIPS 09-01-002 or AIPS 09-01-003 prior to manufacture.

Because of system cleanliness, greases and lubricants for bending have to be approved and qualified products. These products shall be removable with the cleaning process according to AIPS 09-01-002 or AIPS 09-01-003.

For hydraulic pipes the required cleanliness level has to be met. If not defined differently on the drawing, cleanliness to AS4059 Class 7 or better is required for all pipes in the hydraulic system.

4.3 Bending of pipes

Prior to bending inspect the pipes for exterior damage. The pipes shall be bent according to the drawing and/or master sample.

The bending mandrels shall be thoroughly cleaned depending on their duration of use to detect any damage. Any adhering chips and broken off material between moveable links shall be removed.

The interior side of pipes shall be provided with a sufficient amount of qualified lubricant (bending oil/bending grease). If wrinkle flatteners are used, the pipes shall also be lubricated on the exterior side in the flattener area.

Re-work of sharp bends/wrinkles by flattening is not permitted (danger of cracks due to cold hardening).

It is not admissible to use a filling compound, e.g. cerobend, colophony or sand, for pipe bending. If the Design department issues a special permission for this procedure, component-specific process and test specifications shall be prepared.

To avoid irregular cold hardening of the pipe material in the bending area, each bend has to be formed in one continuous movement without interruption and chattering. Pipes with visible chatter marks shall be scrapped.

Optimum speeds (in degree per second) are to be determined by manufacturing tests and to be documented in the pipe bending card or in the bending program.

Pipes which are bent helically by an angle $> 180^\circ$ are called coiled pipes. The bending process should be executed continuously without interruption.

4.4 Welding of pipes

Where applicable, welding of pipes has to be carried out according to the manufacturing drawings and the relevant process specifications.

4.5 Heat treatment of pipes

Where applicable, heat treatment has to be carried out according to the manufacturing drawings and the relevant process specifications.

4.6 Surface protection

4.6.1 Chemical treatment

The chemical treatment required per manufacturing drawings, including appropriate post-treatment to this procedure (e.g. rinsing, drying), has to be carried out.

4.6.2 Painting

If painting is required according to the manufacturing documents, pipes shall be blanked and, depending on the type of pipe connection, the pipe ends shall be sufficiently masked. The length of masking is given in the relevant process specification. On locations where bonding points per AIPS 07-01-006 are required, the pipes shall also be masked prior to painting. The size and position of the masking depends on the instructions given in the manufacturing document and/or the master pipe.

4.7 Assembly of pipe fittings

Pipe end-fittings shall be installed to the pipes as required by the manufacturing drawings and according to the relevant process specification.

4.8 Cleaning after attachments of sleeves/unions

All pipes shall be cleaned per AIPS09-01-014.

4.9 Pressure testing

Pressure testing shall be carried out according to the relevant process specifications or manufacturing drawings.

Note: On hydraulic pipes the pressure testing is required only for the first manufacturing batch of a given pipe P/N if not specified otherwise on the manufacturing drawings.

4.10 Blanking of pipes ends

The finished pipe ends shall be blanked with caps per AIPS 03-01-015 to avoid contamination inside the pipes.

4.11 Identification

The identification of pipes is done according to the relevant manufacturing documents and process specifications.

4.12 Storage and transportation

All pipes ready to be installed are packed individually in transparent plastic bags, the ends of which can be welded or tied. Pipe packages shall be designed to prevent deterioration during shipment and water collection during storage.

The pipes shall be stored and transported in such a way that they cannot be deformed, damaged or contaminated.

5 Technical qualification

The Technical Qualification shall be performed, according to AP2253.

To qualify the manufacturing process the tests listed below shall be performed:

- Dye penetrant crack test,
- Ovality, scratches and bulge of pipe measurements,
- Measurement of spring back after bending (accuracy of bending)
- Measurement of creeping of bended tubes
- Visual inspection of inner surface
- Measurement of min. wall thickness after bending
- Surface condition roughness after bending (inner/outer condition)
- Static and dynamic pressure testing according to ISO7169 (Proof pressure test, Pressure impulse test, Burst pressure test, Pressure up to rupture)
- Examination of the attachment zone (pipe/fitting) – Longitudinal micro-section

A Qualification Test Plan shall be proposed by the supplier and shall be agreed with the relevant Airbus engineering department.

6 First part qualification

A First Article inspection shall be performed according to AS9102 and EN9102 based on the manufacturing process frozen on the Industrial Dossier.

7 Series production inspection

The shop shall perform the following series production inspections under serial conditions.

7.1 Quality requirements

The following inspections of the pipe assemblies is the responsibility of the Quality department.

- Pipe lengths (see chapter 7.3)
- Ovality and surface damages (see chapter 7.2.1)
- The pipe interior has to be subjected to a visual inspection (see chapter 7.2)
- Inspection of pipe equipment (see chapter 7.4)
- Pipe assembly surface protection and identification (see chapter 7.5)

7.2 Inspection for deviating geometries and surface condition

The pipes shall be checked to be in accordance with the dimensional requirements of the manufacturing drawings. Deviating geometries and damage to the surfaces must not exceed the specified limits (see 7.2.1.2).

7.2.1 Ovality and surface damages

7.2.1.1 Ovality

Unless otherwise specified in the manufacturing drawings, the following acceptance values are binding for determining the ovality δ :

$$\delta = \frac{d_{\max} - d_{\min}}{d} \times 100 \%$$

δ : ovality [%]
 d_{\max} : max. outer pipe diameter ¹⁾
 d_{\min} : min. outer pipe diameter ¹⁾
 d : outer pipe diameter (outside the bend radius)

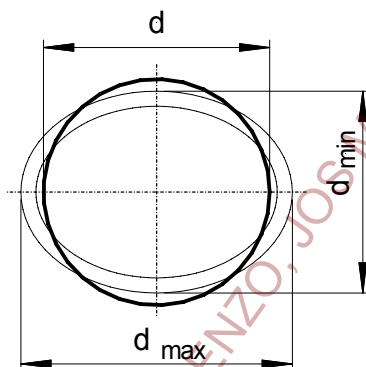


Figure 2: Determination of ovality δ

¹⁾Bend radius $\geq 60^\circ$: one measurement point (middle of bend radius – maximum ovality shall be in the middle of bend radius).

Bend radius $< 60^\circ$: one measurement point (middle of bend radius).

The admissible ovality for hydraulic pipes is $\leq 3 \%$ (titanium alloy, CRES and aluminium alloy).

For non-hydraulic pipes the admissible ovality is $\leq 5 \%$ (titanium alloy, CRES and aluminium alloy).

7.2.1.2 Surface damages

Deviations shall be determined with suitable measuring equipment (e.g. wrinkles and notches by templates).

Table 2: Admissible failure of surface damage (interior and exterior), for hydraulic pipes

| Type of damage | Admissible failure for CRES, aluminium and titanium alloy pipes | Reference value |
|---------------------------------|---|---------------------------------------|
| Wrinkle, dent/bulge, impression | 1 % ¹⁾ | outer pipe diameter d |
| Notch, groove, scratch, etc. | 3 % | Wall thickness (measured at pipe end) |

¹⁾ For -16 ABS 5004 titanium alloy pipes, the admissible failure for dent/bulge is 1,4 %.

Table 3: Admissible failure of surface damage (interior and exterior), for non-hydraulic pipes

| Type of damage | Nominal pressure | Max. admissible depth/height for Al alloys, CRES, titanium | Reference value |
|---------------------------------|-----------------------------|--|------------------------|
| Wrinkle, dent/bulge, impression | $P_n \geq 20$ bar (290 psi) | $\leq 1\%$ | Nominal pipe diameter |
| | $P_n < 20$ bar (290 psi) | $\leq 2\%$ | |
| Notch, groove, scratch, etc. | $P_n \geq 20$ bar (290 psi) | $\leq 3\%$ | Nominal wall thickness |
| | $P_n < 20$ bar (290 psi) | $\leq 6\%$ | |

7.3 Pipe length inspection

The pipe length specified in the design documents is inspected with the pipe measuring equipment or by insertion into the template or by comparison with the master pipe. End stops in the templates determine the pipe length.

7.4 Inspection of pipe equipment

The pipe equipment (connection pieces, conical nipples, union nuts etc.) is to be checked for compliance with the design documents (standard, material, surface protection). Union nuts must have sufficient clearance.

7.5 Surface protection and identification of pipes

Surface protection and pipe identification have to be checked for compliance with the manufacturing drawings. Surface protection and identification shall not be damaged.

8 Rework

The following is applicable, if during quality control or installation of pipes it is detected that the pipes shall be bent again:

Re-bending of pipes in the aircraft is not permitted. Re-bending may only be done at work places equipped with appropriate tools and shall be carried out only by trained personnel.

Pipe re-bending may be done up to a certain degree. The resulting ovality at the bend shall not exceed the values indicated in Table 4.

Only limited pipe re-bending may be done.

Table 4: Admissible re-bending of pipes

| Pipe material | Admissible re-bending | Maximum ovality δ d at bend |
|---|-----------------------|------------------------------------|
| Titanium alloy (DOP \leq 206 bar / \leq 3000psi) | $\pm 2^\circ$ | $\leq 2 \%$ |
| Aluminium alloy and CRES | | $\leq 3 \%$ |
| Titanium alloy (DOP $>$ 206 bar / $>$ 3000psi) | not allowed | - |
| DOP = Design operating pressure | | |

After re-bending a visual inspection has to be carried out per 7.1.

If the pipes are treated with surface protection an inspection must be carried out per 7.4.

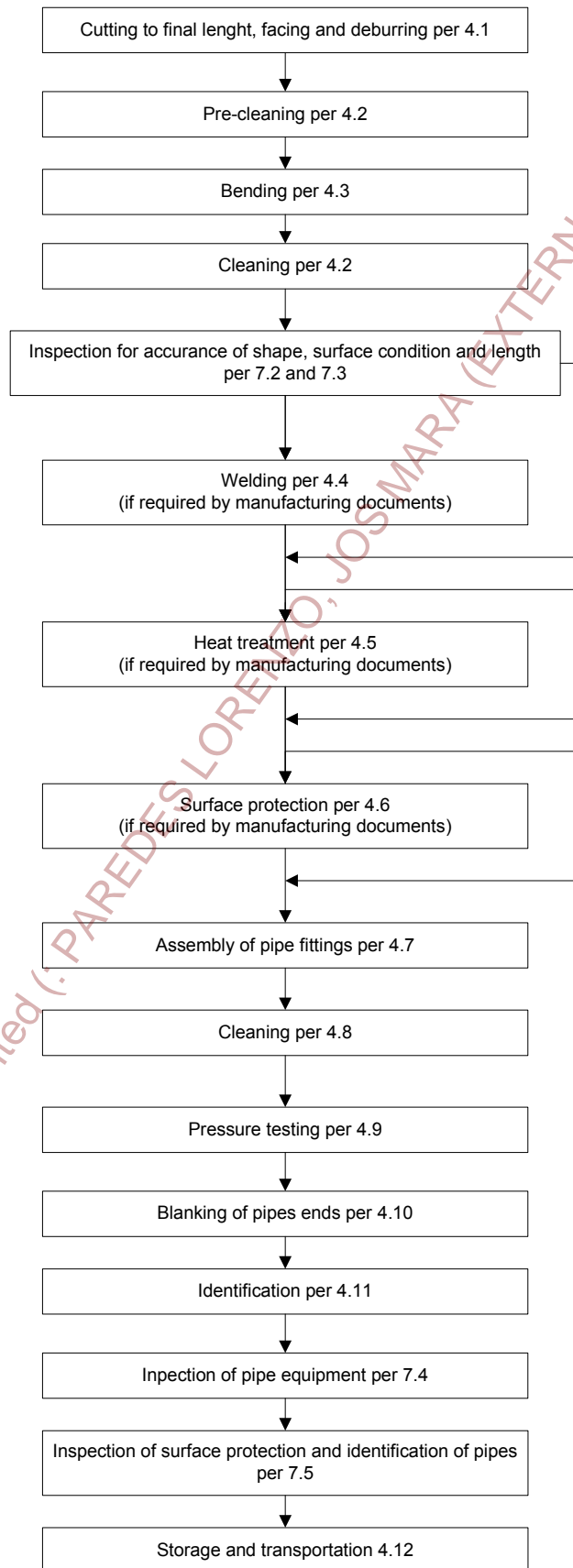
9 Environment, health and safety

Process shall be in line with Airbus environmental policy.

Banned substances, as per relevant Airbus procedure, shall not be applied.

Hazardous materials shall comply with rules defined in relevant Airbus procedure.

Annex A : Process Flow chart



RECORD OF REVISIONS

| Issue | Clause modified | Description of modification |
|------------|-----------------|-----------------------------|
| 1 08/01 | | New standard. |
| 2 11/09 | | Complete revision |
| | | |