

**PRODUCTS FOR THE AIRCRAFT AND
AEROSPACE INDUSTRY**



BUTTING



Longitudinally welded pipes

Produced continuously from coil in sizes of 15 mm – 762 mm OD and wall thicknesses up to 16 mm

From plate: in sizes of 33.7 mm – 3,000 mm OD and wall thicknesses up to 60 mm

Pipes in special shapes

In random length up to 24 m with circumferential welds



Clad pipes

Mechanically bonded BuBi®-pipes in sizes of 114.3 mm – 660 mm OD

Metallurgically clad pipes

In random length up to 24 m with circumferential welds



Vessel construction

Up to 6,000 mm OD: complete prefabrication at the mill

Above 6,000 mm OD: prefabrication at the mill and assembly on site



Pre-fabrication

Piping components ready for assembly

Pipe bends acc. to drawings, piping segments, isometric drawings



Fittings

Tees, reducers, special fittings

Pipe bends acc. to DIN 2605

Collars acc. to DIN 2642

Elbows with long radii



Piping technology

Pipes with special tolerances, e.g. furnace rollers, jackets for pumps

Pipes with special surface requirements e.g. for the pharmaceutical industry, architecture

Further processing of pipes using forming, grinding, Laser cutting, e.g. jackets for pumps, valves and lamps

Special products, e.g. BUTTING HeRo® (an uncooled furnace roller)



Assemblies

Vessels

Linepipes

Special constructions, equipment

Photographs
 • Cover: Ariane 5 (Photograph by courtesy of CNES)
 • EPS Upper Stage (Photograph by courtesy of Astrium)
 • inside: Rutzen & Scherer, H. Butting, S. Schneider, S. Wilke, Firmenarchiv
 • Aerial photograph: Stuttgarter Luftbild Elsäßer GmbH



Surface treatment

Pickling (also on subcontract basis)

Blasting, peening (also on subcontract basis)

Grinding (also on subcontract basis)



Services

Expert technical and metallurgical guidance

CAD-facilities, isometric drawings

Metallurgical testing and non-destructive testing

Special thanks to the following companies for kindly providing us with photographs: CNES, Astrium

Edition 2005

Products for the aircraft and aerospace industry

Since 1975 BUTTING has been producing piping spools for the aerospace industry. It all started with the prototype production of an elbow in aluminium to be used in the main fuel feedlines of the second stage of ARIANE 1.

In 1983 BUTTING started the prototype production and subsequent series production of the hot gas pressurisation lines and fuel feedlines (Booster Piping) in material grade No. 1.4571 for the ARIANE 4 PAL Booster for which specially designed measuring and testing equipment was built. The required semi-finished products like pipes, elbows and flanges were also ordered and completed together with the relevant measuring and testing equipment.



**Model of the space station ISS
(Photograph by courtesy of Astrium)**

In 1990 the family business received the order for the pipe work to the engine of the ARIANE 5 – main stage as semi-finished products. In 1992 ERNO-Raumfahrt-technik placed an order for the prototype production and subsequent series production of the complete piping system for the ARIANE 5 – upper stage EPS. The prefabrication of these sets had to be highly consistent as to the geometrical

form and the welding had to be done in a closed welding system. Later the piping sets had to fit in a corresponding upper stage simulating model which was used as an assembly test and inspection jig also provided by BUTTING.

Besides the use of own products for the fabrication of complete piping installations, BUTTING also buys materials from other approved manufacturers to be included in the scope of this work. Examples of products supplied to the aircraft and aerospace industry are:

- From 1984 until 2005 production of piping for ARIANE 4 PAL-Booster
- ARIANE 4 PAL – semi-finished parts in grade 1.4571 (Booster piping)
- ARIANE 4 PAL engine struts in grade 1.4571
- ARIANE 4 – Second stage – pipeline 8 assembly in grade AZ5G T4
- ARIANE 4 – First stage – pipes 146 x 2 mm in grade 1.4462
- Since 1993 ARIANE 5 EPS – piping systems in grades 1.4544.9/1.4546.9
- Since 2002 ARIANE 5 ESC-A piping system in grade 1.4435
- ATV pipelines for oxygen system 12 x 0.5 mm, 6.35 x 1.24 mm and 9.53 x 1.24 mm in grade 1.4404
- AIRBUS aircraft drainmast pipelines 12 x 0.5 mm in grades 1.4544.9/1.4546.9
- Sample pipes for Bleed-Air-Piping 101.6 x 0.6 mm in grade 3.7034.1
- ARIANE 5 EPC-semi finished parts in grades 1.4404/1.4435

The products used in the aircraft and aerospace industry are subject to very stringent requirements regarding precision and dimensional accuracy, hence specially designed forming and fabrication equipment is used at BUTTING. Also during forming specific material properties and surface conditions are taken into account.

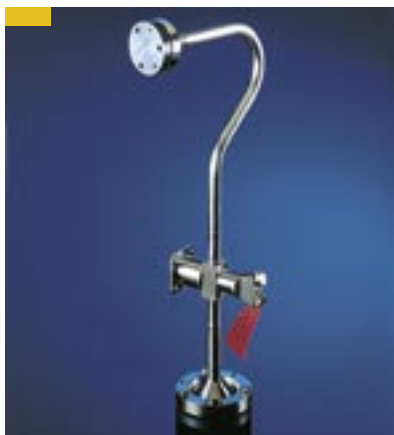
Tanks and feedlines for test equipment P4.2 for DLR, Lampoldshausen



Piping component with pyro valve and burst disk for the residual gas emission in the fuel system of ARIANE 5, EPS-upper stage, in grades 1.4544.9, 1.4546.9, Z4CMN21-06-09, dimension 12 x 2.0 mm



Piping component for the fuel feedlines in ARIANE 4, PAL BOOSTER, grade 1.4571, size 168 x 1.7 mm (with bellows)



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Piping components

The production of the piping components is based on the customer's drawings and specifications. Appropriate quality plans and testing plans are prepared by our qualified and experienced staff. There are also stringent requirements for the surface condition of the final product. Hence adequate testing is imperative (e. g. by endoscope) to prove freedom from particles and non-metallic inclusions on the inside surface. The results of the testing regarding surface conditions and roughness values, especially in the weld area, are documented.

Dimensional accuracy is one of the special features of these components besides most stringent requirements for the quality of the weld. Generally quality of the weld acc. to DIN 29 595 (aircraft and aerospace industry – fusion welded metallic components – technical requirements) class 1 is prescribed. Considerable testing is therefore required to prove the quality, e. g. hydrostatic testing, helium leakage test and dye penetrant testing (see also chapter on Quality Assurance). Valid approvals acc. to DIN 19 591 for fusion welding are necessary to qualify for the production of a weld. BUTTING is approved by the SLV Schweißtechnische Lehr- und Versuchsanstalt (Institute of welding and research). The welders must be qualified acc. to DIN 29 591, all available at BUTTING.

Engineering

A further challenge for BUTTING is the production of the ARIANE 5 ESC-A Equipped lines, including the engineering. BUTTING will also be solely responsible for the material requisition (semi-finished

Piping component used as pressure gas and refueling line in ARIANE 4, PAL BOOSTER, material grade 1.4571, size 88 × 4.0 mm/83 × 1.7 mm (with bellow)



ARIANE 5 EPS feedlines 40 × 2.0 mm/3.18 × 0.51 mm, material grade 1.4546.9

products, e. g. pipes, flat products, bars, machining tools and flexible tubes) in accordance with the high purity and quality standards.

Welding

The welding of stainless steel pipes requires

- selection of processes preventing ingress of oxygen
- selective heat input
- root protection

- shrink stresses and heat stresses must be taken into account
- most careful weld edge preparation (freedom from grease and dirt)

Besides various welding processes used for the production of longitudinally welded pipes (e. g. Submerged Arc Welding, Laser Welding) BUTTING also uses TIG orbital welding in a closed welding system for diameters from 3.0 mm and above, or qualified manual welding for the production of piping components requiring inside and outside surfaces to be free from tinting.

ARIANE 5 ESC-A upper stage, elbow 97 × 3.5 mm, material grade 1.4435



Piping component used as aircraft drain pipe for Airbus, Drainmast, material grades 1.4544.9, 1.4546.9, size 12 × 0.5 mm/3/8"



Piping component used as emission device in the fuel system of ARIANE 5, EPS-upper stage, material grade 1.4544.9, 1.4546.9, size 22 × 1.0 mm/16 × 2.0 mm



Piping component for the ARIANE 5 main stage EPC, in material grade 1.4435, elbow size 191 × 3.0 mm, 90°, made of two halves



Material selection

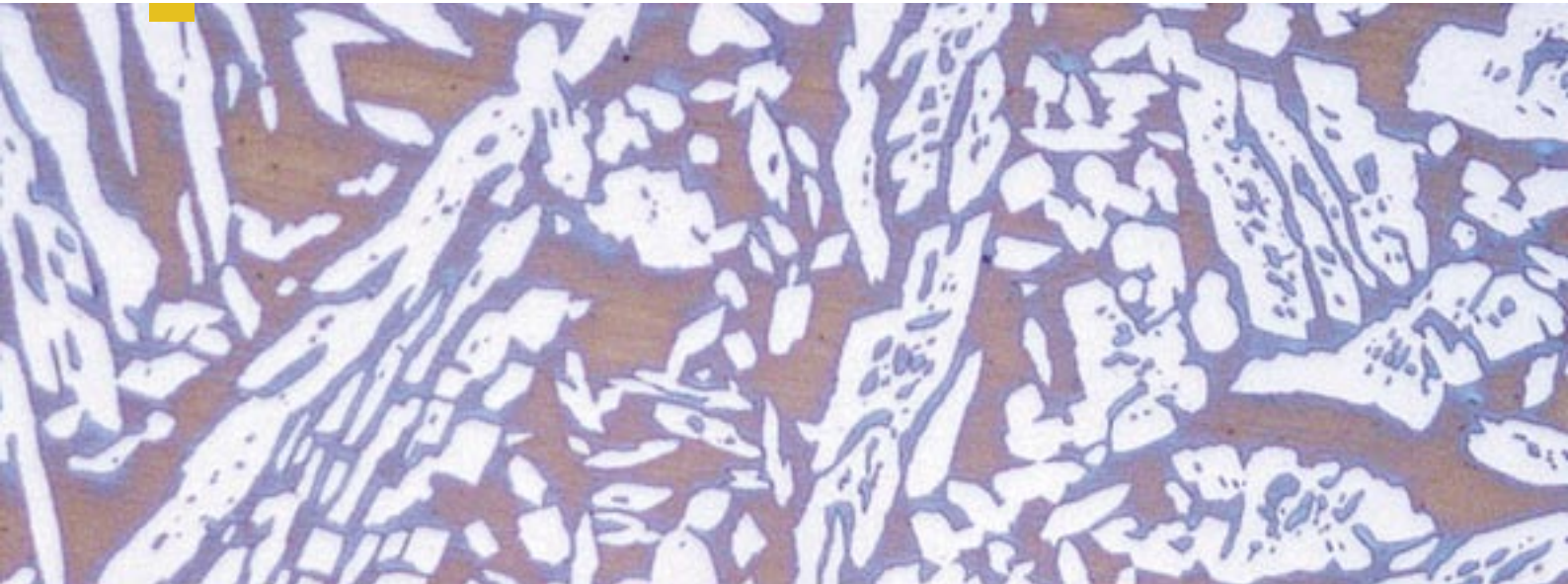
The choice of materials is dependent on the metallurgical requirements, specific circumstances, media etc.

The following table lists the material grades preferably used by the aircraft and aerospace industry.



Dimensional control of the ARIANE 5 EPS piping – upper stage

Structure of a duplex transition zone (material grade 1.4462 – e. g. ARIANE 4 PAL Booster tanks)



Werkstoff-Nr.	Grade	Standard analyses						
		C ≤	Si ≤	Mn ≤	Cr	Mo	Ni	other elements
1.4541	X6CrNiTi18-10	0.08	1.0	2.0	17.0 – 19.0		9.0 – 12.0	Ti ≥ 5 × C up to 0.70
1.4546	X5CrNiNb18-10	0.08	1.0	2.0	17.0 – 19.0		9.0 – 11.5	Nb ≥ 10 × C
1.4306	X2CrNi19-11	0.03	1.0	2.0	18.0 – 20.0		10.0 – 12.0	N ≤ 0.11
1.4544		0.08	1.0	2.0	17.0 – 19.0		9.0 – 11.5	Ti ≥ 5 × C
1.4404	X2CrNiMo17-12-2/X2CrNiMo17-13-2	0.03	1.0	2.0	16.5 – 18.5	2.0 – 2.5	10.0 – 13.0	N ≤ 0.11
1.4435	X2CrNiMo18-14-3	0.03	1.0	2.0	17.0 – 19.0	2.5 – 3.0	12.5 – 15.0	N ≤ 0.11
1.4571	X6CrNiMoTi17-12-2	0.08	1.0	2.0	16.5 – 18.5	2.0 – 2.5	10.5 – 13.5	Ti ≥ 5 × C up to 0.70
1.4462	X2CrNiMoN22-5-3	0.03	1.0	2.0	21.0 – 23.0	2.5 – 3.5	4.5 – 6.5	N = 0.10 0.22
3.7034	Titanium Grade II	Fe ≤ 0.25; C ≤ 0.08; N₂ ≤ 0.06; O₂ ≤ 0.25; H₂ ≤ 0.0125						
	Z2CN18-10	0.02			18.0		10.0	
	Z4CMN21-09-06	0.04		9.0	21.0		6.0	

Cleaning and packing

The requirements for cleanliness of the piping components for the aircraft and aerospace industry are very high. Therefore BUTTING produces the relevant piping components in a separate workshop. In order to guarantee freedom from internal surface irregularities and residual and foreign matters, a visual inspection is carried out using a video endoscope having a diameter of 6 mm and a length of 7.5 metres. If required, the cleaning of the piping components is carried out in a cleanroom < Class 100000 by rinsing using filtered liquids at a controlled room atmosphere. It is possible to determine the purity of the rinsing agent, i. e. quantity and size of the particles in accordance with the relevant requirements, as well as the non vaporizable residual matters of the testing

Inspection/measuring equipment for upper stage simulation model ARIANE 5, EPS-piping



Works in the cleanroom; ARIANE 5 EPS feedlines

liquid used, and a relevant test report can be provided. The cleaning of the piping components is followed by drying. For this purpose the components are evacuated and flushed with filtered dry nitrogen (2 microns). The proof of freedom from alcohol is provided as well.

After completion of the testing, inspection and cleaning, the material can be packed under cleanroom conditions using sabotage safe packing in accordance with the customer's instructions and requirements. The traceability of all handling and cleaning operations, including packing of the piping components is thus ensured.



Inspection/measuring equipment for ARIANE 4, PAL-BOOSTER piping



Despatch of piping components using special containers

Approved worldwide

The Quality Management System of BUTTING is approved by Germanischer Lloyd according to DIN EN ISO 9001:2000. BUTTING also holds approvals from classification companies and third party inspectorates, like Bureau Veritas and BDLI QSF-B and renowned companies.



BUTTING complies with many testing and accreditation requirements:

- TÜV acc. to AD2000-Merkblatt W0/HPO and TRD 100/201
- Competence certificate acc. to DIN 18 800 part 7
- Approval acc. to HPO and DIN EN 729-2 and DGRL 97/23/EG
- Approval according to the water supply rules (WHG) § 19 I
- Approval acc. to AECMA EASE (European Aerospace Supplier Evaluation) DIN EN 9100
- Accreditation of the laboratory acc. to DIN EN ISO/IEC 17025 : 2000 etc.

Radioscopic examination (Real time radiography)



BUTTING also holds the following approvals:

- Weld procedure qualification acc. to AQUAP
- Specifications KTA 1401, QSP 4a and AVS D100/50 for nuclear plants
- Approval by Germanischer Lloyd for the welding of materials in defence engineering

A great number of testing installations

As regards **non-destructive testing**, the following equipment is available at BUTTING:

- Radiography
- Radioscopy
- Eddy-current testing
- Ultrasonic testing
- Hydrostatic pressure testing
- Endoscope
- X-ray flash device
- Surface roughness measurements
- Dye-penetrant testing and Magnetic particle inspection
- Helium leakage test
- Cleanliness test

- Tensile tests
- Hot tensile tests
- Bend tests
- Charpy-impact tests, also at low temperatures
- Technological testing
- Metallographic examinations
- Spectroscopic analyses

Tensile test



The following **destructive tests** are performed in the internal laboratory:

- Corrosion tests
- Hardness tests
- Ferrite determination



Corrosion test



Aerial view of BUTTING Knesebeck



BUTTING

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