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SIST EN 2399:2008

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ICS 49.025.10

English Version

Aerospace series - Heat resisting steel FE-PA2601  
(X4NiCrTiMoV26-15) -  $R_m \geq 900$  MPa - Bars for forged bolts -  
 $D \leq 25$  mm

Série aérospatiale - Acier résistant à chaud FE-PA2601  
(X4NiCrTiMoV26-15) -  $R_m \geq 900$  MPa - Barres pour  
boulonnerie matricée -  $D \leq 25$  mm

Luft- und Raumfahrt - Hochwarmfester Stahl FE-PA2601  
(X4NiCrTiMoV26-15) -  $R_m \geq 900$  MPa - Stangen zum  
Warmstauchen für Schrauben -  $D \leq 25$  mm

This European Standard was approved by CEN on 29 February 2008.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION  
COMITÉ EUROPÉEN DE NORMALISATION  
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

## Foreword

This document (EN 2399:2008) has been prepared by the Aerospace and Defence Industries Association of Europe - Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD, prior to its presentation to CEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2008, and conflicting national standards shall be withdrawn at the latest by October 2008.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

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## Introduction

This standard is part of the series of EN metallic material standards for aerospace applications. The general organization of this series is described in EN 4258.

This standard has been prepared in accordance with EN 4500-3.

## 1 Scope

This standard specifies the requirements relating to:

Heat resisting steel FE-PA2601 (X4NiCrTiMoV26-15)  
 $R_m \geq 900$  MPa  
 Bars for forged bolts  
 $D \leq 25$  mm

for aerospace applications.

## 2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 2002-16, Aerospace series — *Metallic materials — Test methods — Part 16: Non-destructive testing — Penetrant testing* <sup>1)</sup>

EN 2344, Aerospace series — *Round bars, machined in heat resisting alloys — Diameter  $10 \text{ mm} \leq D \leq 180 \text{ mm}$  — Dimensions*

EN 2398, Aerospace series — *Heat resisting steel FE-PA2601 (X6NiCrTiMoV26-15) —  $R_m \geq 900$  MPa — Bars for machined bolts —  $D \leq 25$  mm*

EN 2951, Aerospace series — *Metallic materials — Test method — Micrographic determination of content of non-metallic inclusions* <sup>1)</sup>

EN 4050-4, Aerospace series — *Test method for metallic materials — Ultrasonic inspection of bars, plates, forging stock and forgings — Part 4: Acceptance criteria* <sup>1)</sup>

EN 4258, Aerospace series — *Metallic materials — General organization of standardization — Links between types of EN standards and their use*

EN 4500-3, Aerospace series — *Metallic materials — Rules for drafting and presentation of material standards — Part 3: Specific rules for heat resisting alloys* <sup>1)</sup>

EN 4700-2, Aerospace series — *Steel and heat resisting alloys — Wrought products — Technical specification — Part 2: Bar and section* <sup>1)</sup>

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<sup>1)</sup> Published as ASD Prestandard at the date of publication of this standard.

**EN 2399:2008 (E)**

1	Material designation	Heat resisting steel FE-PA2601 (X4NiCrTiMoV26-15)															
2	Chemical composition %	Element	C	Si	Mn	P	S	Al	B <sup>a</sup>	Cr	Mo	Ni	Pb <sup>a</sup>	Ti	V	Fe	
		min.	–	–	–	–	–	–	–	(30)	13,5	1,0	24,0	–	1,9	0,10	Base
		max.	0,08	1,0	2,0	0,020	0,015	0,35	(100)	16,0	1,5	27,0	(50)	2,3	0,50		
3	Method of melting	Consumable electrode remelted <sup>b</sup>															
4.1	Form	Bars for upset forging <sup>c</sup>															
4.2	Method of production	–															
4.3	Limit dimension(s)	mm	$D \leq 25$														
5	Technical specification	EN 4700-2															

6.1	Delivery condition	Softened, cold worked <sup>d</sup> and ground														
	Heat treatment	900 °C ± 10 °C / t = 1 h / air cool or faster cold worked <sup>d</sup>														
6.2	Delivery condition code	K														
7	Use condition	Softened, cold worked, ground, solution treated and precipitation treated														
	Heat treatment	Delivery condition + 980 °C ± 10 °C / t = 1 h / air cool or faster + 720 °C ± 10 °C / t ≥ 16 h / air cool														

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8.1	Test sample(s)	See EN 4700-2																
8.2	Test piece(s)	See EN 4700-2																
8.3	Heat treatment	Delivery condition Condition of use																
9	Dimensions concerned	mm	$D \leq 25$															
10	Thickness of cladding on each face	%	–															
11	Direction of test piece	L																
12	Temperature	$\theta$	°C	Room temperature														
13	Proof stress	R <sub>p0.2</sub>	MPa	–										≥ 590				
14	T Strength	R <sub>m</sub>	MPa	–										≥ 900				
15	Elongation	A	%	–										≥ 13				
16	Reduction of area	Z	%	–										≥ 20				
17	Hardness	–													248 ≤ HB ≤ 341			
18	Shear strength	R <sub>c</sub>	MPa	–														
19	Bending	k	–	–														
20	Impact strength	–																
21	Temperature	$\theta$	°C	–										650				
22	Time		h	–										≥ 23				
23	C Stress	$\sigma_a$	MPa	–										–				
24	Elongation	a	%	–										–				
25	Rupture stress	$\sigma_R$	MPa	–										480 <sup>e</sup>				
26	Elongation at rupture	A	%	–										≥ 4,5 for tr ≤ 48 h ≥ 2,5 for tr > 48 h				
27	Notes (see line 98)	a, b, c, d, e																

34	Grain size	–	–	EN 4700-2
		7	–	$G \geq 5$
44	External defects	–	See EN 4700-2	
			Material to be subjected to dye penetrant examination and assessment	
		1	See EN 2002-16. Dye penetrant inspection	
		7	See EN 4700-2	
50	Cleanliness inclusion content (micro cleanliness)	–	EN 4700-2	
		1	See EN 2951	
		7	Category 4	
61	Internal defects	–	EN 4700-2	
		1	See EN 4050-4	
		6	A or D may be tested either on the products or at an earlier stage of manufacturing	
		7	Class 3	
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95	Marking inspection	–	See EN 4700-2	
96	Dimensional inspection	–	See EN 4700-2	
		7	EN 2344	
98	Notes	–	<p><sup>a</sup> Bracketed figures indicate composition expressed as parts per million (p.p.m.). The method of analysis for lead shall be agreed between manufacturer and purchaser.</p> <p><sup>b</sup> The method of melting required shall be agreed between manufacturer and purchaser.</p> <p><sup>c</sup> Bars for machining are defined by EN 2398.</p> <p><sup>d</sup> After the softening treatment, all bars shall be reduced 15 % to 25 % in cross section during final drawing or rolling at a temperature of not more than 870 °C.</p> <p><sup>e</sup> Combination notched/unnotched test piece; rupture shall occur in the unnotched portion of test piece. Stress may be increased after 48 h to promote rupture.</p>	
99	Typical use	–	Bolts and nuts for airframe and engine uses.	

100	-	Product qualification	-	See EN 4700-2
				Qualification programme to be agreed between manufacturer and purchaser.
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