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CERTIFICATE OF CHEMICAL ANALYSIS No 06 – 20

STEEL for solid sample spectrometry, combustion and wet-way methods

SPL CM-5D (PT 28/1B)

CERTIFIED VALUES – Mass content in %wt.

Element	*Value* [%wt.]	*Uncertainty* [%wt.]
C	**1.140**	0.006
Mn	**1.425**	0.007
Si	**0.521**	0.007
P	**0.0284**	0.0011
S	**0.0277**	0.0007
Cu	**0.157**	0.002
Cr	**2.455**	0.018
Ni	**0.451**	0.006
Al	**0.086**	0.003
Mo	**0.137**	0.003
W	**0.028**	0.003

Element	*Value* [%wt.]	*Uncertainty* [%wt.]
V	**0.113**	0.002
Ti	**0.040**	0.001
Co	**0.0237**	0.0005
As	**0.0243**	0.0012
Sn	**0.0200**	0.0007
B	**0.0021**	0.0002
Nb	**0.035**	0.002
Pb	**0.0134**	0.0014
Zr	**0.072**	0.003
N	**0.0168**	0.0009

PARTICIPATING LABORATORIES:

ARCELORMITTAL Warszawa, Poland
BOSMAL, Poland
BRITISH STEEL, United Kingdom
COGNOR S.A. - Ferrostal Łabędy, Poland
COMTES FHT, Czech Republic
DUNAFERR Labor Nonprofit, Hungary
FERONA, Czech Republic
JSC Moldova Steel Works, Moldova
MS UTILITIES & SERVICES, Czech Republic
OCAS NV, Belgium
PRECHEZA, Czech Republic
SES Inspekt, Slovakia
SSAB EMEA AB, Sweden
SSAB Special Steels, Sweden
SUNNINGWELL INTERNATIONAL, Poland
ŠKODA AUTO, Czech Republic
U. S. STEEL Košice – Labortest, Slovakia
ÚJV Řež, Czech Republic
VÁLCOVNY TRUB Chomutov, Czech Republic
VOESTALPINE STAHL, Austria
VÚHŽ, Czech Republic
ZPS - SLÉVÁRNA, Czech Republic
ŽĎAS, Czech Republic

CM-5D – ANALYTICAL DATA

Method	C	Method	Mn	Method	Si	Method	P	Method	S	Method	Cu	Method	Cr
AES	**1,104**												
AES	**1,110**							AES	**0,0238**				
AES	**1,118**	AES	**1,400**					AES	**0,0242**	XRF-m.	**0,098***	AES	**2,014***
IR	**1,120**	AES	**1,400**	AES	**0,456***			AES	**0,0245**	AES	**0,140**	ICP	**2,272***
AES	**1,121**	AES	**1,402**	ICP	**0,462***	ICP	**0,0208**	XRF-m.	**0,0256**	ICP	**0,143**	AES	**2,308***
IR	**1,122**	AES	**1,402**	ICP	**0,486**	XRF	**0,0229**	AES	**0,0260**	AES	**0,147**	AES	**2,333**
AES	**1,123**	AES	**1,405**	XRF	**0,490**	XRF	**0,0239**	AES	**0,0260**	AES	**0,149**	AES	**2,374**
AES	**1,126**	AES	**1,410**	AES	**0,497**	ICP	**0,0245**	AES	**0,0262**	AES	**0,153**	ICP	**2,393**
AES	**1,127**	AES	**1,411**	XRF	**0,498**	ICP	**0,0252**	AES	**0,0263**	AES	**0,154**	XRF-m.	**2,406**
IR	**1,132**	AES	**1,413**	AES	**0,504**	AES	**0,0264**	AES	**0,0264**	AES	**0,154**	AES	**2,411**
IR	**1,134**	AES	**1,414**	AES	**0,507**	AES	**0,0271**	AES	**0,0266**	AES	**0,154**	AES	**2,418**
AES	**1,134**	AES	**1,414**	AES	**0,508**	AES	**0,0272**	AES	**0,0271**	AES	**0,155**	AES	**2,419**
IR	**1,136**	AES	**1,414**	AES	**0,511**	AES	**0,0273**	AES	**0,0274**	AES	**0,155**	AES	**2,420**
AES	**1,138**	AES	**1,416**	AES	**0,512**	AES	**0,0274**	AES	**0,0274**	XRF	**0,156**	AES	**2,421**
IR	**1,138**	ICP	**1,419**	ICP	**0,512**	AES	**0,0275**	IR	**0,0274**	AES	**0,156**	AES	**2,427**
AES	**1,139**	AES	**1,420**	AES	**0,515**	AES	**0,0282**	IR	**0,0275**	AES	**0,156**	ICP	**2,428**
AES	**1,140**	XRF	**1,421**	AES	**0,516**	AES	**0,0282**	AES	**0,0275**	AES	**0,156**	AES	**2,437**
IR	**1,140**	AES	**1,422**	AES	**0,520**	AES	**0,0283**	AES	**0,0278**	ICP	**0,156**	AES	**2,450**
IR	**1,142**	AES	**1,424**	AES	**0,521**	AES	**0,0285**	AES	**0,0279**	AES	**0,157**	AES	**2,462**
IR	**1,142**	AES	**1,424**	AES	**0,522**	AES	**0,0287**	AES	**0,0279**	AES	**0,157**	XRF-m.	**2,468**
IR	**1,143**	AES	**1,425**	AES	**0,525**	AES	**0,0289**	IR	**0,0281**	AES	**0,158**	XRF	**2,469**
IR	**1,144**	XRF	**1,428**	AES	**0,525**	AES	**0,0289**	IR	**0,0284**	AES	**0,158**	XRF	**2,473**
AES	**1,145**	AES	**1,428**	AES	**0,525**	AES	**0,0292**	IR	**0,0284**	AES	**0,158**	AES	**2,473**
AES	**1,147**	AES	**1,430**	AES	**0,526**	AES	**0,0294**	IR	**0,0284**	AES	**0,158**	AES	**2,482**
IR	**1,147**	AES	**1,430**	AES	**0,526**	AES	**0,0294**	AES	**0,0288**	AES	**0,158**	AES	**2,483**
AES	**1,149**	AES	**1,431**	AES	**0,526**	AES	**0,0301**	IR	**0,0288**	XRF	**0,159**	AES	**2,485**
AES	**1,152**	AES	**1,433**	AES	**0,527**	AES	**0,0303**	IR	**0,0290**	ICP	**0,159**	AES	**2,496**
AES	**1,153**	ICP	**1,433**	AES	**0,533**	AES	**0,0304**	IR	**0,0292**	AES	**0,159**	AES	**2,498**
AES	**1,155**	AES	**1,434**	AES	**0,540**	AES	**0,0307**	IR	**0,0292**	XRF-m.	**0,159**	AES	**2,504**
IR	**1,157**	XRF-m.	**1,446**	AES	**0,542**	AES	**0,0312**	AES	**0,0292**	AES	**0,160**	AES	**2,505**
AES	**1,176**	XRF-m.	**1,461**	AES	**0,545**	AES	**0,0322**	IR	**0,0299**	AES	**0,161**	AES	**2,509**
AES	**1,179**	ICP	**1,463**	AES	**0,548**	AES	**0,0324**	AES	**0,0300**	AES	**0,165**	AES	**2,518**
AES	**1,180**	AES	**1,463**	XRF-m.	**0,552**	AES	**0,0325**	AES	**0,0304**	AES	**0,171**	AES	**2,518**
AES	**1,256***	AES	**1,478**	AES	**0,558**	AES	**0,0341**	AES	**0,0330**	AES	**0,171**	AES	**2,523**

	C		Mn		Si		P		S		Cu		Cr
Value	**1,140**		**1,425**		**0,521**		**0,0284**		**0,0277**		**0,157**		**2,455**
s_M	0,018		0,019		0,018		0,0029		0,0019		0,006		0,048
U	**0,006**		**0,007**		**0,007**		**0,0011**		**0,0007**		**0,002**		**0,018**

Method	Ni	Method	Al	Method	Mo	Method	W	Method	V	Method	Ti	Method	Co
AES	**0,417**			AES	**0,120**			ICP	**0,099***				
AES	**0,425**			AES	**0,123**			ICP	**0,105**				
ICP	**0,427**	AES	**0,070**	AES	**0,125**			AES	**0,106**			XRF	**0,0188***
AES	**0,433**	AES	**0,073**	ICP	**0,125**			ICP	**0,107**			AES	**0,0207**
AES	**0,433**	ICP	**0,079**	AES	**0,131**			AES	**0,108**			AES	**0,0222**
AES	**0,439**	XRF	**0,080**	AES	**0,131**			XRF-m.	**0,108**			AES	**0,0222**
AES	**0,439**	AES	**0,082**	AES	**0,132**	AES	**0,014**	AES	**0,109**	XRF	**0,031***	ICP	**0,0224**
XRF	**0,441**	AES	**0,082**	AES	**0,132**	AES	**0,019**	AES	**0,109**	AES	**0,034**	AES	**0,0227**
AES	**0,444**	AES	**0,082**	AES	**0,133**	AES	**0,020**	AES	**0,111**	AES	**0,035**	AES	**0,0229**
AES	**0,445**	AES	**0,082**	AES	**0,133**	AES	**0,023**	AES	**0,112**	AES	**0,037**	AES	**0,0230**
ICP	**0,445**	AES	**0,082**	AES	**0,134**	AES	**0,023**	XRF	**0,112**	ICP	**0,038**	AES	**0,0232**
XRF-m.	**0,447**	AES	**0,083**	XRF	**0,135**	AES	**0,024**	AES	**0,113**	XRF	**0,038**	ICP	**0,0232**
AES	**0,447**	AES	**0,084**	XRF-m.	**0,135**	AES	**0,025**	AES	**0,113**	AES	**0,038**	AES	**0,0233**
AES	**0,447**	AES	**0,084**	ICP	**0,135**	AES	**0,025**	AES	**0,113**	AES	**0,038**	AES	**0,0234**
AES	**0,448**	ICP	**0,084**	AES	**0,138**	AES	**0,025**	AES	**0,113**	AES	**0,039**	AES	**0,0236**
AES	**0,450**	AES	**0,085**	AES	**0,138**	AES	**0,025**	AES	**0,113**	AES	**0,039**	AES	**0,0236**
AES	**0,452**	AES	**0,086**	AES	**0,139**	AES	**0,026**	AES	**0,113**	ICP	**0,040**	AES	**0,0236**
AES	**0,452**	AES	**0,086**	AES	**0,139**	AES	**0,026**	AES	**0,113**	AES	**0,040**	AES	**0,0239**
AES	**0,452**	AES	**0,086**	AES	**0,139**	AES	**0,027**	AES	**0,114**	AES	**0,040**	AES	**0,0240**
AES	**0,454**	AES	**0,087**	XRF-m.	**0,140**	AES	**0,027**	AES	**0,114**	AES	**0,040**	AES	**0,0240**
AES	**0,455**	XRF	**0,088**	AES	**0,140**	AES	**0,028**	AES	**0,115**	AES	**0,040**	AES	**0,0240**
XRF	**0,457**	AES	**0,088**	AES	**0,140**	AES	**0,029**	AES	**0,116**	AES	**0,040**	AES	**0,0242**
AES	**0,457**	AES	**0,089**	AES	**0,140**	AES	**0,029**	AES	**0,116**	AES	**0,041**	ICP	**0,0243**
ICP	**0,459**	AES	**0,091**	AES	**0,140**	AES	**0,029**	AES	**0,116**	AES	**0,041**	AES	**0,0243**
AES	**0,459**	AES	**0,091**	AES	**0,141**	AES	**0,030**	AES	**0,117**	AES	**0,041**	AES	**0,0244**
AES	**0,460**	AES	**0,091**	AES	**0,142**	XRF	**0,032**	XRF	**0,117**	AES	**0,041**	AES	**0,0246**
XRF-m.	**0,462**	AES	**0,092**	AES	**0,142**	ICP	**0,033**	AES	**0,117**	AES	**0,041**	AES	**0,0248**
AES	**0,463**	AES	**0,092**	XRF	**0,142**	AES	**0,035**	XRF-m.	**0,117**	AES	**0,041**	AES	**0,0250**
AES	**0,464**	AES	**0,092**	ICP	**0,144**	AES	**0,035**	AES	**0,118**	AES	**0,042**	AES	**0,0250**
AES	**0,470**	AES	**0,095**	AES	**0,145**	AES	**0,036**	AES	**0,118**	AES	**0,042**	AES	**0,0250**
AES	**0,487**	AES	**0,097**	AES	**0,146**	AES	**0,038**	AES	**0,119**	AES	**0,044**	AES	**0,0251**
AES	**0,488**	XRF-m.	**0,106**	AES	**0,149**	ICP	**0,042**	AES	**0,119**	XRF-m.	**0,063***	XRF	**0,0256**

	Ni		Al		Mo		W		V		Ti		Co
Value	**0,451**		**0,086**		**0,137**		**0,028**		**0,113**		**0,040**		**0,0237**
s_M	0,015		0,007		0,007		0,006		0,004		0,002		0,0011
U	**0,006**		**0,003**		**0,003**		**0,003**		**0,002**		**0,001**		**0,0005**

Method	As	Method	Sn	Method	B	Method	Nb	Method	Pb	Method	Zr	Method	N
												AES	**0,0119***
						AES	**0,029**					AES	**0,0128***
		XRF-m.	**0,0168**			AES	**0,032**					TCM	**0,0148**
		AES	**0,0174**			XRF	**0,032**					TCM	**0,0150**
		XRF	**0,0179**			XRF	**0,032**	AES	**0,0081**			TCM	**0,0150**
		ICP	**0,0181**			AES	**0,033**	AES	**0,0086**			AES	**0,0152**
XRF	**0,0128***	ICP	**0,0183**			AES	**0,033**	AES	**0,0092**			TCM	**0,0152**
AES	**0,0189**	AES	**0,0189**			XRF-m.	**0,033**	AES	**0,0095**			AES	**0,0155**
ICP	**0,0200**	AES	**0,0193**	ICP	**0,0008***	XRF-m.	**0,034**	AES	**0,0100**			TCM	**0,0156**
AES	**0,0221**	AES	**0,0196**	AES	**0,0018**	AES	**0,034**	AES	**0,0112**			TCM	**0,0157**
AES	**0,0222**	AES	**0,0196**	AES	**0,0018**	AES	**0,034**	AES	**0,0113**			TCM	**0,0162**
ICP	**0,0224**	AES	**0,0197**	AES	**0,0020**	AES	**0,035**	AES	**0,0121**			AES	**0,0163**
AES	**0,0228**	AES	**0,0201**	AES	**0,0020**	ICP	**0,035**	AES	**0,0123**	AES	**0,065**	AES	**0,0165**
AES	**0,0237**	AES	**0,0202**	AES	**0,0020**	AES	**0,035**	ICP	**0,0124**	AES	**0,067**	AES	**0,0166**
AES	**0,0239**	AES	**0,0202**	AES	**0,0021**	ICP	**0,035**	AES	**0,0128**	XRF-m.	**0,069**	AES	**0,0167**
AES	**0,0240**	AES	**0,0203**	AES	**0,0021**	AES	**0,035**	AES	**0,0132**	AES	**0,069**	AES	**0,0168**
AES	**0,0243**	AES	**0,0204**	AES	**0,0021**	AES	**0,036**	AES	**0,0136**	ICP	**0,069**	TCM	**0,0169**
AES	**0,0244**	XRF	**0,0207**	AES	**0,0021**	AES	**0,036**	AES	**0,0138**	AES	**0,069**	AES	**0,0174**
AES	**0,0245**	AES	**0,0207**	AES	**0,0021**	AES	**0,036**	AES	**0,0141**	XRF-m.	**0,072**	AES	**0,0175**
AES	**0,0248**	AES	**0,0208**	AES	**0,0021**	AES	**0,036**	AES	**0,0156**	AES	**0,073**	AES	**0,0177**
AES	**0,0249**	AES	**0,0208**	AES	**0,0022**	AES	**0,036**	AES	**0,0156**	AES	**0,073**	AES	**0,0179**
AES	**0,0252**	AES	**0,0210**	AES	**0,0022**	AES	**0,036**	XRF	**0,0159**	AES	**0,074**	AES	**0,0180**
AES	**0,0256**	AES	**0,0210**	AES	**0,0022**	AES	**0,036**	AES	**0,0164**	AES	**0,074**	AES	**0,0183**
AES	**0,0258**	AES	**0,0210**	AES	**0,0023**	AES	**0,036**	AES	**0,0166**	AES	**0,074**	AES	**0,0185**
AES	**0,0275**	AES	**0,0212**	AES	**0,0024**	AES	**0,038**	AES	**0,0171**	AES	**0,074**	AES	**0,0186**
AES	**0,0276**	AES	**0,0217**	AES	**0,0024**	AES	**0,040**	ICP	**0,0186**	AES	**0,075**	AES	**0,0186**
AES	**0,0281**	AES	**0,0218**	AES	**0,0024**	AES	**0,045***	ICP	**0,0198**	AES	**0,078**	AES	**0,0188**
AES	**0,0283**	ICP	**0,0229**	AES	**0,0035***	AES	**0,045***	XRF-m.	**0,0589***	AES	**0,083**	AES	**0,0190**

	As		Sn		B		Nb		Pb		Zr		N
Value	**0,0243**		**0,0200**		**0,0021**		**0,035**		**0,0134**		**0,072**		**0,0168**
s_M	0,0025		0,0014		0,0002		0,002		0,0032		0,004		0,0013
U	**0,0012**		**0,0007**		**0,0002**		**0,002**		**0,0014**		**0,003**		**0,0009**

COMMENTS:

Value – reference value, $\mathbf{s_M}$ – standard deviation of intralaboratory means (* - result excluded as outlier)

U – Uncertainty of the reference value $U = \pm \frac{t_{5;0,05}}{\sqrt{n}} \cdot s_M$ in the sense of the ISO Guide to the Expression of the Uncertainty of Measurement (1993), dependent on the standard deviation of the laboratory results.

Certified fully compliant with the ISO 17034 definition of Reference Material – with the characterization for determining the property values and their associated uncertainties.

Intended for calibration, matrix-match verification and statistical process control of low alloy steel spectrometric analysis from a plane of solid sample. They may not substitute CRM in a statement of metrological traceability, method validation. A single analysis area of at least 4 mm in diameter defines the minimum sample intake. They may be used for combustion and wet-way methods too.

Manufactured by casting to a special ingot with discarding of the parts, which have been suspected inhomogenous and the rest has been machined to the samples of the ultimate size.

Supplied as discs 37 mm in diameter and 25 mm of standard height.

Homogeneity (random and trend, within- and between- samples) was tested by various analytical techniques of adequate repeatability. Its uncertainty contribution, when statistically significant, was combined to the ultimate uncertainty statement. The RM are stable by a nature of material.

Characterised by results from SPL proficiency test **PT 28/1B** - laboratories by various spectrometric methods (AES spark, glow discharge, XRF) and alternative methods (combustion, thermoevolution, wet-way) standard methods, with measurements metrological traceabled to adequate CRM (CZ 2001, 2003 - 2008, 2015-2024, BAS, Brammer Standard). Identity of PT participating laboratories is confidential.

Certified values in % m/m, tabulated below in bold, are robust means of a minimum five accepted laboratory means. They are rounded to the same digit as their uncertainty statement.

Uncertainty is expressed as a ± half width interval combined from the standard uncertainty, expanded by the coverage factor k = 2 (corresponding to 95% level of confidence). It does not exceed 1,5 multiple of the typical uncertainty of the matching CRM.

Non-certified values in regular without the uncertainty statement do not meet the requirements for certification and are intended for the matrix information.

User instruction: the surface of the specimens and RM should be prepared in a similar manner in accordance with manufacturer´s instructions of spectrometers. It is recommended to storage of RM in dry and non-corrosive conditions.

Produced by: SPL-LABMAT s.r.o. ,

Responsible person: Martin Bogumský

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