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CERTIFICATE OF CHEMICAL ANALYSIS No 05 – 23

DUCTILE CAST IRON for solid sample spectrometry, combustion and wet-way methods

SPL-L5 (PT 31/4A)

CERTIFIED VALUES – Mass content in %wt.

Element	*Value* [%wt.]	*Uncertainty* [%wt.]
C	**3.833**	0.020
Mn	**0.407**	0.003
Si	**1.659**	0.025
P	**0.0461**	0.0014
S	**0.0123**	0.0006
Cu	**0.380**	0.004
Cr	**0.477**	0.004
Ni	**0.545**	0.005
Al	**0.036**	0.002
Mo	**0.208**	0.002
W	**0.0172**	0.0013
V	**0.183**	0.002

Element	*Value* [%wt.]	*Uncertainty* [%wt.]
Ti	**0.071**	0.002
Co	**0.0248**	0.0008
As	**0.0030**	0.0006
Sn	**0.0243**	0.0011
B	**0.0217**	0.0005
Ca	*0.0003*	
Nb	**0.0109**	0.0009
Pb	**0.0026**	0.0004
Zn	**0.0117**	0.0008
Ce	**0.0087**	0.0016
Mg	**0.0247**	0.0016

PARTICIPATING LABORATORIES:

ACEMSA, Spain
AZTERLAN, Spain
CELSA HUTA OSTROWIEC, Poland
COGNOR S.A. - Ferrostal Łabędy, Poland
COMTES, Czech Republic
DUNAFERR Labor Nonprofit, Hungary
ENVIFORM, Czech Republic
ESAB CZ, Czech Republic
GONTERMANN-PEIPERS, Germany
LIBERTY Częstochowa, Poland
MS UTILITIES & SERVICES, Czech Republic
OBLF, Germany
SSAB, Sweden
ŠKODA AUTO, Czech Republic
TATA STEEL IJMUIDEN, Netherlands
TÜV NORD Czech, Czech Republic
ÚJV Řež, Czech Republic
VOESTALPINE STAHL, Austria
VÚHŽ-Foundry, Czech Republic
ZPS - SLÉVÁRNA, Czech Republic

SPL-L5 - ANALYTICAL DATA:

Method	C	Method	Mn	Method	Si	Method	P	Method	S	Method	Cu	Method	Cr	Method	Ni
AES	**3,749**														
AES	**3,757**							AES	**0,0077**						
AES	**3,789**							IR	**0,0087**						
AES	**3,789**							AES	**0,0093**						
IR	**3,795**							XRF	**0,0103**						
XRF	**3,796**							AES	**0,0104**						
IR	**3,805**	ICP	**0,342***	ICP	**1,451***	ICP	**0,0374**	ICP	**0,0110**			AES	**0,461**	AES	**0,520**
IR	**3,806**	AES	**0,396**	XRF	**1,573**	AES	**0,0394**	IR	**0,0113**	ICP	**0,367**	AES	**0,461**	AAS	**0,521**
IR	**3,808**	ICP	**0,400**	Gravim.	**1,578**	AES	**0,0412**	XRF	**0,0114**	AES	**0,370**	AES	**0,464**	AES	**0,524**
ICP	**3,814**	AES	**0,400**	AES	**1,587**	ICP	**0,0414**	AES	**0,0116**	ICP	**0,371**	AES	**0,465**	AES	**0,529**
AES	**3,820**	AES	**0,401**	AES	**1,587**	XRF	**0,0423**	IR	**0,0118**	XRF	**0,371**	AES	**0,467**	XRF	**0,529**
IR	**3,821**	AES	**0,402**	AES	**1,604**	AES	**0,0448**	IR	**0,0118**	AES	**0,373**	AES	**0,468**	AES	**0,534**
AES	**3,823**	AES	**0,403**	XRF	**1,616**	ICP	**0,0449**	IR	**0,0119**	AES	**0,374**	ICP	**0,468**	AES	**0,535**
AES	**3,825**	AES	**0,404**	XRF	**1,632**	AES	**0,0450**	AES	**0,0122**	XRF	**0,374**	AAS	**0,470**	ICP	**0,536**
IR	**3,826**	AES	**0,405**	AES	**1,641**	ICP	**0,0451**	IR	**0,0122**	AAS	**0,377**	AES	**0,473**	XRF	**0,542**
AES	**3,827**	XRF	**0,405**	AES	**1,643**	XRF	**0,0456**	AES	**0,0122**	AES	**0,377**	AES	**0,474**	AES	**0,543**
AES	**3,830**	AES	**0,405**	ICP	**1,643**	XRF	**0,0459**	AES	**0,0122**	ICP	**0,377**	AES	**0,475**	XRF	**0,544**
IR	**3,831**	AES	**0,405**	AES	**1,644**	XRF	**0,0460**	XRF	**0,0123**	AES	**0,378**	AES	**0,476**	AES	**0,545**
IR	**3,836**	XRF	**0,406**	AES	**1,647**	AES	**0,0460**	AES	**0,0124**	AES	**0,378**	ICP	**0,477**	ICP	**0,546**
IR	**3,839**	ICP	**0,407**	Gravim.	**1,668**	AES	**0,0462**	IR	**0,0125**	XRF	**0,380**	AES	**0,478**	AES	**0,547**
IR	**3,845**	AES	**0,407**	AES	**1,672**	AES	**0,0466**	IR	**0,0126**	ICP	**0,380**	AES	**0,478**	AES	**0,547**
IR	**3,846**	AES	**0,408**	AES	**1,672**	AES	**0,0478**	IR	**0,0126**	AES	**0,381**	AES	**0,479**	ICP	**0,549**
AES	**3,854**	AES	**0,408**	AES	**1,672**	AES	**0,0484**	AES	**0,0129**	AES	**0,382**	AES	**0,480**	AES	**0,550**
IR	**3,858**	AES	**0,408**	AES	**1,673**	AES	**0,0484**	IR	**0,0131**	AES	**0,382**	AES	**0,484**	AES	**0,551**
IR	**3,862**	AES	**0,409**	AES	**1,675**	AES	**0,0486**	AES	**0,0134**	AES	**0,382**	AES	**0,485**	XRF	**0,553**
XRF	**3,862**	XRF	**0,409**	AES	**1,679**	AES	**0,0487**	XRF	**0,0137**	AES	**0,383**	AES	**0,485**	AES	**0,553**
AES	**3,866**	AES	**0,410**	AES	**1,681**	Photom.	**0,0488**	AES	**0,0140**	AES	**0,384**	AES	**0,486**	AES	**0,554**
AES	**3,870**	XRF	**0,410**	AES	**1,687**	AES	**0,0488**	IR	**0,0142**	AES	**0,385**	XRF	**0,486**	AES	**0,555**
IR	**3,872**	AES	**0,411**	AES	**1,694**	AES	**0,0494**	IR	**0,0145**	AES	**0,386**	AES	**0,486**	AES	**0,557**
IR	**3,879**	AAS	**0,413**	AES	**1,695**	AES	**0,0500**	AES	**0,0146**	AES	**0,387**	ICP	**0,491**	AES	**0,562**
AES	**3,885**	AES	**0,413**	AES	**1,735**	AES	**0,0504**	IR	**0,0147**	AES	**0,389**	XRF	**0,496**	ICP	**0,563**
AES	**3,901**	AES	**0,414**	AES	**1,760**	AES	**0,0518**	IR	**0,0147**	AES	**0,395**	XRF	**0,521***	AES	**0,564**
IR	**3,914**	AES	**0,415**	XRF	**1,780**	AES	**0,0671***	AES	**0,0155**	AES	**0,397**	ICP	**0,526***	AES	**0,568**
	C		**Mn**		**Si**		**P**		**S**		**Cu**		**Cr**		**Ni**
Value	**3,833**		**0,407**		**1,659**		**0,0461**		**0,0123**		**0,380**		**0,477**		**0,545**
s_M	0,038		0,005		0,052		0,0035		0,0018		0,007		0,009		0,013
U	**0,020**		**0,003**		**0,025**		**0,0014**		**0,0006**		**0,004**		**0,004**		**0,005**

Method	Al	Method	Mo	Method	W	Method	V	Method	Ti	Method	Co	Method	As	Method	Sn
		ICP	**0,185***			AES	**0,176**	AES	**0,066**						
		AES	**0,197**			AES	**0,176**	AES	**0,068**						
		AES	**0,200**			AES	**0,177**	ICP	**0,068**						
		AES	**0,201**			AES	**0,177**	AES	**0,068**						
AAS	**0,030**	AES	**0,201**			ICP	**0,180**	AES	**0,069**					AES	**0,0198**
AES	**0,030**	ICP	**0,201**			AES	**0,180**	AES	**0,069**					AES	**0,0210**
AES	**0,033**	AES	**0,202**			AES	**0,180**	AES	**0,070**					AES	**0,0210**
AES	**0,033**	AES	**0,203**			AES	**0,180**	XRF	**0,070**	ICP	**0,0215**			ICP	**0,0221**
AES	**0,033**	AES	**0,203**			AES	**0,181**	XRF	**0,070**	AES	**0,0217**			XRF	**0,0228**
AES	**0,033**	AES	**0,203**			AES	**0,181**	Photom.	**0,070**	ICP	**0,0221**			AES	**0,0230**
AES	**0,034**	AES	**0,205**			AES	**0,182**	AES	**0,070**	AES	**0,0223**			XRF	**0,0231**
AES	**0,034**	AES	**0,205**	AES	**0,0132**	AES	**0,182**	AES	**0,070**	AES	**0,0238**	AES	**0,0010**	AES	**0,0231**
AES	**0,034**	AES	**0,206**	AES	**0,0135**	AES	**0,182**	AES	**0,071**	AES	**0,0240**	AES	**0,0013**	AES	**0,0232**
AES	**0,035**	AES	**0,206**	AES	**0,0141**	XRF	**0,183**	AES	**0,071**	AES	**0,0245**	AES	**0,0021**	AES	**0,0234**
AES	**0,035**	XRF	**0,207**	AES	**0,0155**	AES	**0,183**	AES	**0,071**	AES	**0,0247**	ICP	**0,0022**	XRF	**0,0238**
AES	**0,035**	AES	**0,208**	AES	**0,0159**	ICP	**0,183**	AES	**0,071**	AES	**0,0249**	ICP	**0,0023**	AES	**0,0239**
AES	**0,036**	AES	**0,209**	XRF	**0,0169**	AES	**0,183**	XRF	**0,072**	ICP	**0,0250**	AES	**0,0024**	ICP	**0,0240**
AES	**0,036**	XRF	**0,209**	AES	**0,0174**	XRF	**0,184**	XRF	**0,072**	AES	**0,0250**	XRF	**0,0028**	AES	**0,0244**
AES	**0,038**	AES	**0,210**	AES	**0,0174**	AES	**0,186**	AES	**0,073**	AES	**0,0252**	AES	**0,0028**	ICP	**0,0250**
AES	**0,038**	AES	**0,212**	AES	**0,0177**	XRF	**0,188**	AES	**0,073**	AES	**0,0254**	AES	**0,0028**	AES	**0,0250**
AES	**0,039**	AES	**0,213**	AES	**0,0179**	XRF	**0,188**	AES	**0,073**	AES	**0,0260**	AES	**0,0031**	AES	**0,0253**
AES	**0,039**	AES	**0,214**	ICP	**0,0179**	ICP	**0,188**	ICP	**0,073**	AES	**0,0260**	XRF	**0,0035**	AES	**0,0256**
ICP	**0,040**	ICP	**0,214**	AES	**0,0182**	AES	**0,189**	ICP	**0,074**	AES	**0,0260**	AES	**0,0036**	AES	**0,0256**
AES	**0,041**	ICP	**0,214**	AES	**0,0189**	AES	**0,189**	AES	**0,074**	XRF	**0,0264**	AES	**0,0036**	AES	**0,0257**
AES	**0,043**	XRF	**0,215**	AES	**0,0190**	AES	**0,190**	AES	**0,075**	XRF	**0,0267**	ICP	**0,0039**	AES	**0,0285**
ICP	**0,045**	AES	**0,218**	XRF	**0,0190**	AAS	**0,192**	AES	**0,076**	AES	**0,0272**	AES	**0,0047**	AES	**0,0296**
ICP	**0,046**	AAS	**0,220**	AES	**0,0226**	AES	**0,192**	AES	**0,082***	AES	**0,0272**	AES	**0,0054**	AES	**0,0296**
	Al		**Mo**		**W**		**V**		**Ti**		**Co**		**As**		**Sn**
Value	**0,036**		**0,208**		**0,0172**		**0,183**		**0,071**		**0,0248**		**0,0030**		**0,0243**
s_M	0,004		0,006		0,0024		0,005		0,002		0,0018		0,0011		0,0025
U	**0,002**		**0,002**		**0,0013**		**0,002**		**0,002**		**0,0008**		**0,0006**		**0,0011**

Method	B	Method	Ca	Method	Nb	Method	Pb	Method	Zn	Method	Ce	Method	Mg
				AES	**0,0086**								
				AES	**0,0090**	AES	**0,0017**	AES	**0,0080**				
				AES	**0,0091**	AES	**0,0018**	AES	**0,0105**				
AES	**0,0200**			AES	**0,0092**	ICP	**0,0019**	AES	**0,0105**			AES	**0,0199**
AES	**0,0208**			AES	**0,0096**	XRF	**0,0020**	AES	**0,0107**			AES	**0,0203**
AES	**0,0210**			XRF	**0,0098**	AES	**0,0020**	XRF	**0,0107**			AES	**0,0206**
AES	**0,0215**			ICP	**0,0099**	ICP	**0,0021**	AES	**0,0108**	AES	**0,0051**	AES	**0,0227**
AES	**0,0215**			AES	**0,0100**	AES	**0,0021**	XRF	**0,0108**	AES	**0,0058**	AES	**0,0244**
AES	**0,0217**			AES	**0,0105**	ICP	**0,0022**	AES	**0,0109**	AES	**0,0072**	AES	**0,0247**
AES	**0,0218**			AES	**0,0108**	AES	**0,0024**	AES	**0,0110**	AES	**0,0073**	AES	**0,0248**
AES	**0,0219**	AES	**0,0001**	AES	**0,0108**	AES	**0,0027**	AES	**0,0121**	ICP	**0,0081**	AES	**0,0250**
AES	**0,0221**	AES	**0,0002**	AES	**0,0110**	AES	**0,0027**	AES	**0,0123**	AES	**0,0081**	AES	**0,0253**
ICP	**0,0223**	AES	**0,0002**	AES	**0,0120**	AES	**0,0030**	AES	**0,0124**	AES	**0,0082**	AES	**0,0256**
AES	**0,0224**	AES	**0,0003**	AES	**0,0123**	AES	**0,0030**	AES	**0,0130**	AES	**0,0086**	AES	**0,0264**
AES	**0,0226**	AES	**0,0003**	AES	**0,0123**	AES	**0,0032**	XRF	**0,0131**	ICP	**0,0093**	ICP	**0,0265**
AES	**0,0226**	AES	**0,0004**	AES	**0,0124**	AES	**0,0032**	AES	**0,0134**	AES	**0,0106**	AES	**0,0270**
AES	**0,025***	XRF	**0,0005**	AES	**0,0142**	XRF	**0,0036**	AES	**0,0135**	AES	**0,0126**	AES	**0,0270**
AES	**0,0253***	AES	**0,0011**	ICP	**0,0154**	ICP	**0,0040**	AES	**0,0148**	AES	**0,0134**	AES	**0,0302**
	B		**Ca**		**Nb**		**Pb**		**Zn**		**Ce**		**Mg**
Value	**0,0217**		*0,0003*		**0,0109**		**0,0026**		**0,0117**		**0,0087**		**0,0247**
s_M	0,0008				0,0019		0,0007		0,0016		0,0025		0,0028
U	**0,0005**				**0,0009**		**0,0004**		**0,0008**		**0,0016**		**0,0016**

COMMENTS:

Value – reference value, s_M – standard deviation of intralaboratory means (* - result excluded as outlier)

U – Uncertainty of the reference value $U \geq \pm \frac{t_{5;0,05}}{\sqrt{n}} \cdot s_M$ 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 cast iron 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 31/4A** - 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.

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