

**1.máje 432, CZ-735 31 Bohumín, Czech Republic** e-mail: <u>info@spl-labmat.cz</u>, <u>www.spl-labmat.cz</u>, phone: +420 596 014 627

### **CERTIFICATE OF CHEMICAL ANALYSIS No 09 – 19**

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

# SPL CM-12C

Element	<i>Value</i> [%wt.]	Uncertainty [%wt.]
С	0.0389	0.0017
Mn	0.275	0.003
Si	3.770	0.150
Р	0.0103	0.0006
S	0.0110	0.0004
Cu	0.175	0.004
Cr	0.081	0.002
Ni	0.046	0.002
Al	0.145	0.005
Mo	0.0128	0.0011

### **CERTIFIED VALUES – Mass content in %wt.**

Element	Value [%wt.]	Uncertainty [%wt.]					
W	0.004						
V	0.0271	0.0014					
Ti	0.0128	0.0004					
Со	0.0044	0.0006					
As	0.0030	0.0007					
Sn	0.0055	0.0010					
B	0.0033	0.0002					
Nb	0.0066	0.0005					
Ca	0.0010	0.0002					
Ν	0.0056	0.0005					

#### **PARTICIPATING LABORATORIES:**

ARCELORMITTAL, Ostrava, Czech Republic
DUNAFERR LABOR NONPROFIT, Dunaújváros, Hungary
ENVIFORM, Třinec, Czech Republic
GO STEEL, Frýdek-Místek, Czech Republic
INSTITUTE FOR CRM (ICRM), Yekaterinburg, Russia
SES INSPEKT, Tlmače, Slovakia
ŠKODA AUTO, Mladá Boleslav, Czech Republic
U. S. STEEL KOŠICE – LABORTEST, Košice, Slovakia
VÍTKOVICE TESTING CENTER, Ostrava, Czech Republic
VOESTALPINE STAHL DONAWITZ, Leoben-Donawitz, Austria
ŽĎAS, Žďár nad Sázavou, Czech Republic

#### CM-12C - ANALYTICAL DATA:

Method	C	Method	Mn	Method	Si	Method	P	Method	S	Method	Cu	Method	Cr	Method	Ni	Method	AI	Method	Мо
AFS	0.0320							AES	0,0100										
AES	0.0327							AES	0,0100				а С						
AES	0.0336							AES	0,0100										
AES	0,0340							IR+TCM	0,0101		1								
IR+TCM	0,0350							IR+TCM	0,0102										
AES	0,0378							IR+TCM	0,0106										
AES	0,0380							IR+TCM	0,0106										
AES	0,0382	AES	0,269			AES	0,0090	IR+TCM	0,0107	AES	0,165	AES	0,079	AES	0,035*			AES	0,0096
AES	0,0382	AES	0,270			AES	0,0094	IR+TCM	0,0110	AES	0,167	AES	0,079	AES	0,042	AES	0,130	AES	0,0107
IR+TCM	0,0389	AES	0,270			ICP	0,0097	AES	0,0110	AES	0,168	AES	0,079	AES	0,044	AES	0,138	AES	0,0120
IR+TCM	0,0390	AES	0,275	6		AES	0,0097	AES	0,0112	AES	0,170	AES	0,080	AES	0,045	AES	0,138	AES	0,0123
IR+TCM	0,0390	AES	0,275	AES	3,441	AES	0,0100	AES	0,0113	AES	0,174	AES	0,080	AES	0,045	ICP	0,143	AES	0,0124
AES	0,0392	ICP	0,276	AES	3,670	AES	0,0100	IR+TCM	0,0113	AES	0,177	ICP	0,081	AES	0,045	AES	0,143	AES	0,0128
IR+TCM	0,0395	AES	0,276	ICP	3,730	AES	0,0105	AES	0,0118	AES	0,177	AES	0,082	AES	0,046	AES	0,149	ICP AFO	0,0129
IR+TCM	0,0409	AES	0,277	AES	3,733	AES	0,0110	AES	0,0118	AES	0,178	AES	0,082	AES	0,046	AES	0,150	AES	0,0131
AES	0,0412	AES	0,277	AES	3,771	AES	0,0110	IR+TCM	0,0119	AES	0,178	AES	0,082	AES	0,047	AES	0,151	AES	0,0135
IR+TCM	0,0412	AES	0,277	AES	3,830	AES	0,0110	IR+TCM	0,0120	ICP	0,180	AES	0,084	AES	0,049	AES	0,151	AES	0,0136
IR+TCM	0,0434	AES	0,279	AES	3,966	AES	0,0112	AES	0,0122	AES	0,180	AES	0,084	AES	0,050	AES	0,152	AES	0,0156
IR+TCM	0,0447	AES	0,283	AES	4,014	AES	0,0116	AES	0,0122	AES	0,183	AES	0,085	ICP	0,051	AES	0,155	AEO	0,0105
	C		Mn		Si		P		S		Cu		Cr		Ni		AI		Мо
Value	0.0389		0.275		3.770		0,0103		0,0110		0,175		0,081		0,046		0,145		0,0128
S	0.0035		0.004		0.178		0,0008		0,0008		0,006		0,002		0,003		0,007		0.0017
	0.0017		0.003		0.150		0.0006		0,0004		0,004		0,002		0,002		0,005		0,0011
											6-		B		Nb		C2	Manual	N
Method	w	Method	v	Method	Ti	Method	Co	Method	As	Method	Sn	Method	В	Method	Nb	Method	Ca	Method	N
Method	w	Method	V	Method	Ti	Method	Co	Method	As	Method	Sn	Method	В	Method	Nb	Method	Ca	Method	N
Method	W	Method	V	Method	Ti	Method	Co	Method	As	Method	Sn	Method	В	Method	Nb	Method	Ca	Method	N
Method	w	Method	V	Method	Ti	Method	Co	Method	As	Method	Sn	Method	B	Method	Nb	Method	Ca	Method	N
Method	W	Method	V	Method	Ti	Method	Co	Method	As	Method	Sn	Method	В	Method	Nb	Method	Ca	Method	N
Method	W	Method	V	Method	Ti	Method	Co	Method	As	Method	Sn	Method	В	Method	Nb	Method	Ca	Method	N
Method	W	Method AES	V 0,0246 0.0248	Method AES	Ti 0,0120 0.0123	Method	Co	Method	As	Method	Sn	Method	В	Method	Nb 0,0041*	Method	Ca	Method	N
Method	w	Method AES AES	V 0,0246 0,0248 0,0258	AES AES ICP	0,0120 0,0123 0,0124	Method	Co	Method	As	Method	<u>Sn</u> 0,0040	Method	В	Method AES AES	Nb 0,0041* 0,0057	Method	Ca	Method	N 0,0051
Method	W	Method AES AES AES AES	V 0,0246 0,0248 0,0258 0,0258	Method AES AES ICP AES	Ti 0,0120 0,0123 0,0124 0,0125	Method	Co	Method	As 0,0016	Method AES AES	<u>Sn</u> 0,0040 0,0044	Method	В	Method AES AES AES	Nb 0,0041* 0,0057 0,0060	Method	Ca	Method AES IR+TCM	N 0,0051 0,0054
Method	W	Method AES AES AES AES AES	V 0,0246 0,0248 0,0258 0,0258 0,0258	Method AES AES ICP AES AES	Ti 0,0120 0,0123 0,0124 0,0125 0,0126	Method	Co 0,0034	Method AES AES	As	Method AES AES AES	0,0040 0,0044 0,0049	Method	B 0,0030	Method AES AES AES	Nb 0,0041* 0,0057 0,0060 0,0060	Method	Ca	AES IR+TCM IR+TCM	0,0051 0,0054 0,0056
Method	W	Method AES AES AES AES AES AES	V 0,0246 0,0248 0,0258 0,0258 0,0250	Method AES AES ICP AES AES	0,0120 0,0123 0,0124 0,0125 0,0126 0,0126	Method AES ICP	0,0034 0,0035	Method AES AES AES	As 0,0016 0,0021 0,0027	Method AES AES AES AES	0,0040 0,0044 0,0049 0,0050	Method AES AES	0,0030 0,0032	Method AES AES AES AES AES	Nb 0,0041* 0,0057 0,0060 0,0062	Method	Ca 0,0009	AES IR+TCM IR+TCM IR+TCM	N 0,0051 0,0054 0,0056 0,0056
Method	W	Method AES AES AES AES AES AES AES	V 0,0246 0,0248 0,0258 0,0258 0,0250 0,0260	Method AES AES ICP AES AES AES	Ti 0,0120 0,0123 0,0124 0,0125 0,0126 0,0127	Method AES ICP AES	0,0034 0,0035 0,0042	AES AES AES ICP	As 0,0016 0,0021 0,0027	Method AES AES AES AES AES	Sn 0,0040 0,0044 0,0049 0,0050 0,0051	Method AES AES AES	B 0,0030 0,0032 0,0032	Method AES AES AES AES AES AES	Nb 0,0041* 0,0057 0,0060 0,0062 0,0065	Method AES AES	Ca	AES IR+TCM IR+TCM IR+TCM	N 0,0051 0,0054 0,0056 0,0056 0,0058
Method	W	Method AES AES AES AES AES AES AES AES	V 0,0246 0,0248 0,0258 0,0258 0,0258 0,0250 0,0270	Method AES AES ICP AES AES AES AES AES	0,0120 0,0123 0,0124 0,0126 0,0126 0,0126 0,0127 0,0128	Method AES ICP AES AES	0,0034 0,0035 0,0042	Method AES AES AES ICP AES	As 0,0016 0,0021 0,0027 0,0027	Method AES AES AES AES AES AES ICP	0,0040 0,0044 0,0049 0,0050 0,0051	Method AES AES AES AES	B 0,0030 0,0032 0,0032	Method AES AES AES AES AES AES AES	Nb 0,0041* 0,0057 0,0060 0,0062 0,0065 0,0070	Method AES AES AES	Ca	AES IR+TCM IR+TCM IR+TCM IR+TCM AES	N 0,0051 0,0054 0,0056 0,0058 0,0058
Method AES AFS	W 0,0012 0.0026	Method AES AES AES AES AES AES AES AES AES	V 0,0246 0,0248 0,0258 0,0258 0,0258 0,0250 0,0270 0,0274 0,0274	Method AES AES ICP AES AES AES AES AES	0,0120 0,0123 0,0124 0,0125 0,0126 0,0126 0,0127 0,0128 0,0132	Method AES ICP AES AES	0,0034 0,0035 0,0042 0,0044	AES AES AES ICP AES AES	As 0,0016 0,0021 0,0027 0,0027 0,0030 0,0032	Method AES AES AES AES AES ICP AES	Sn 0,0040 0,0044 0,0050 0,0051 0,0052 0,0062	Method AES AES AES AES AES	B 0,0030 0,0032 0,0032 0,0032	Method AES AES AES AES AES AES AES AES	Nb 0,0041* 0,0057 0,0060 0,0062 0,0065 0,0070	Method AES AES AES AES	Ca 0,0009 0,0009 0,0010 0,0010	AES IR+TCM IR+TCM IR+TCM IR+TCM IR+TCM	N 0,0051 0,0054 0,0056 0,0056 0,0050 0,0060
Method AES AES AFS	W 0,0012 0,0026 0,0026	Method AES AES AES AES AES AES AES AES AES AES	V 0,0246 0,0248 0,0258 0,0250 0,0250 0,0270 0,0274 0,0277	Method AES AES AES AES AES AES AES AES	Ti 0,0120 0,0123 0,0124 0,0125 0,0126 0,0127 0,0128 0,0132 0,0132	AES AES AES AES AES	0,0034 0,0035 0,0042 0,0044 0,0056	Method AES AES AES ICP AES AES AES	As 0,0016 0,0021 0,0027 0,0030 0,0032 0,0032	Method AES AES AES AES AES ICP AES AES	Sn 0,0040 0,0044 0,0049 0,0050 0,0051 0,0050 0,0050	Method AES AES AES AES AES AES	B 0,0030 0,0032 0,0032 0,0032 0,0034	Method AES AES AES AES AES AES AES AES	0,0041* 0,0057 0,0060 0,0062 0,0065 0,0070 0,0070 0,0071	Method AES AES AES AES AES AES	0,0009 0,0009 0,0010 0,0010	AES IR+TCM IR+TCM IR+TCM IR+TCM AES IR+TCM AES	N 0,0051 0,0054 0,0056 0,0056 0,0050 0,0060 0,0060
Method AES AES AES AES	0,0012 0,0026 0,0040	Method AES AES AES AES AES AES AES AES AES AES	V 0.0246 0.0248 0.0258 0.0258 0.0250 0.0270 0.0277 0.0294 0.0302	Method AES AES AES AES AES AES AES AES AES	Ti 0,0120 0,0123 0,0124 0,0125 0,0126 0,0127 0,0128 0,0132 0,0134 0,0134	Method AES ICP AES AES AES AES	0,0034 0,0035 0,0042 0,0044 0,0048 0,0050	Method AES AES AES ICP AES AES AES AES	As	Method AES AES AES AES ICP AES AES AES	0,0040 0,0044 0,0049 0,0050 0,0050 0,0050 0,0070	Method AES AES AES AES AES AES AES	B 0,0030 0,0032 0,0032 0,0032 0,0034 0,0034	Method AES AES AES AES AES AES AES AES AES	Nb 0,0041* 0,0057 0,0060 0,0062 0,0065 0,0070 0,0070 0,0071	Method AES AES AES AES AES AES	0,0009 0,0009 0,0010 0,0010 0,0010 0,0010	AES IR+TCM IR+TCM IR+TCM IR+TCM AES IR+TCM AES AES	N 0,0051 0,0054 0,0056 0,0058 0,0060 0,0066 0,0066 0,0066
Method AES AES AES AES AES	W 0,0012 0,0026 0,0040 0,0040	Method AES AES AES AES AES AES AES AES ICP AES	V 0,0246 0,0248 0,0258 0,0258 0,0250 0,0270 0,0274 0,0224 0,0302 0,0312	AES AES ICP AES AES AES AES AES AES AES AES	Ti 0,0120 0,0123 0,0124 0,0126 0,0126 0,0127 0,0128 0,0132 0,0132 0,0134 0,0134	AES ICP AES AES AES AES AES	0,0034 0,0035 0,0042 0,0044 0,0048 0,0050 0,0050	Method AES AES AES AES AES AES AES AES	As	Method AES AES AES AES AES AES AES AES AES	Sn 0,0040 0,0044 0,0050 0,0051 0,0052 0,0060 0,0079 0,0079 0,0076	Method AES AES AES AES AES AES AES AES	0,0030 0,0032 0,0032 0,0032 0,0034 0,0035 0,0034	Method AES AES AES AES AES AES AES AES AES AES	Nb 0,0041* 0,0057 0,0060 0,0062 0,0070 0,0070 0,0070 0,0071 0,0072 0,0076	AES AES AES AES AES AES AES AES	0,0009 0,0009 0,0010 0,0010 0,0011 0,0014*	AES IR+TCM IR+TCM IR+TCM IR+TCM AES AES AES	N 0,0051 0,0054 0,0056 0,0058 0,0050 0,0060 0,0060 0,0060 0,0075 0,0075
Method AES AES AES AES AES	W 0,0012 0,0026 0,0040 0,0040	Method AES AES AES AES AES AES AES AES ICP AES AES AES	V 0,0246 0,0248 0,0258 0,0258 0,0258 0,0250 0,0274 0,0277 0,0294 0,0302 0,0312	AES AES ICP AES AES AES AES AES AES AES AES	0,0120 0,0123 0,0124 0,0125 0,0126 0,0126 0,0122 0,0122 0,0134 0,0134 0,0134 0,0134	AES ICP AES AES AES AES AES	0,0034 0,0035 0,0042 0,0044 0,0050 0,0050	AES AES AES AES AES AES AES AES AES	As	AES AES AES AES AES AES AES AES AES AES	Sn 0,0040 0,0044 0,0050 0,0051 0,0052 0,0060 0,0079 0,0070 0,0070 Sn	Method AES AES AES AES AES AES AES AES	B 0,0030 0,0032 0,0032 0,0032 0,0034 0,0035 0,0036 B	Method AES AES AES AES AES AES AES AES AES AES	Nb	AES AES AES AES AES AES AES AES	Ca 0,0009 0,0010 0,0010 0,0011 0,00114 Ca	AES IR+TCM IR+TCM IR+TCM IR+TCM AES AES AES	N 0,0051 0,0054 0,0056 0,0058 0,0058 0,0059 0,0060 0,0060 0,0060 0,0075 0,0075 0,0078
Method AES AES AES AES AES	W 0,0012 0,0026 0,0040 0,0040 0,0079 W	Method AES AES AES AES AES AES AES AES AES AES	V 0,0246 0,0248 0,0258 0,0258 0,0258 0,0250 0,0274 0,0271 0,0274 0,0302 0,0312 V	Method AES AES AES AES AES AES AES AES AES AES	Ti 0,0120 0,0123 0,0124 0,0125 0,0126 0,0127 0,0128 0,0134 0,0134 0,0134 0,0134 0,0134	AES ICP AES AES AES AES AES	0,0034 0,0035 0,0042 0,0044 0,0050 0,0050 0,0050 0,0051 C0	AES AES AES ICP AES AES AES AES AES	As	AES AES AES AES AES AES AES AES AES AES	0,0040 0,0044 0,0049 0,0050 0,0051 0,0052 0,0070 0,0070 0,0076 0,0076 0,0076 0,0075	AES AES AES AES AES AES AES AES AES	B 0,0030 0,0032 0,0032 0,0034 0,0034 0,0035 B 0,0035	AES AES AES AES AES AES AES AES AES AES	Nb 0.0041* 0.0057 0.0060 0.0065 0.0072 0.0071 0.0072 0.0077 0.0072 Nb	Method AES AES AES AES AES AES AES	0,0009 0,0009 0,0010 0,0010 0,0010 0,0014 Ca 0,0014	AES IR+TCM IR+TCM IR+TCM IR+TCM AES AES	N 0,0051 0,0054 0,0058 0,0058 0,0058 0,0060 0,0060 0,0060 0,0078 N 0,0056
AES AES AES AES AES AES Value	W 0,0012 0,0026 0,0040 0,0040 0,0079 W 0,004	Method AES AES AES AES AES AES AES AES AES AES	V 0,0246 0,0248 0,0258 0,0258 0,0258 0,0270 0,0274 0,0277 0,0294 0,0312 V 0,0271 0,0294	Method AES AES ICP AES AES AES AES AES AES AES AES	Ti 0,0120 0,0123 0,0124 0,0126 0,0126 0,0126 0,0122 0,0132 0,0134 0,0134 0,0134 0,0134 0,0128 0,0120	AES AES AES AES AES AES AES	0,0034 0,0035 0,0042 0,0048 0,0050 0,0050 0,0051 Co 0,0044 0,0044	Method AES AES AES ICP AES AES AES AES	As 0,0016 0,0021 0,0027 0,0033 0,0040 0,0044 As 0,0030 0,0030	AES AES AES AES AES AES AES AES AES	0,0040 0,0040 0,0044 0,0050 0,0050 0,0079 0,0079 0,0079 0,0116' Sn 0,0055 0,0055	AES AES AES AES AES AES AES	B 0,0030 0,0032 0,0032 0,0034 0,0034 0,0035 0,0036 B 0,00033	AES AES AES AES AES AES AES AES AES ICP	Nb           0,0041*           0,0057           0,0060           0,0060           0,0060           0,0070           0,0070           0,0070           0,0070           0,0070           0,0076           Nb           0,00066           0,00066	AES AES AES AES AES AES AES	0,0009 0,0009 0,0010 0,0010 0,0011 0,0014 Ca 0,0011 0,0001	AES IR+TCM IR+TCM IR+TCM IR+TCM IR+TCM AES AES AES	N 0,0051 0,0054 0,0056 0,0056 0,0058 0,0060 0,0060 0,0060 0,0066 0,0075 0,0075 0,0075 0,0075

Value - reference value,  $s_M$  - 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 Guide 35 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 inter-laboratory study of the expert laboratories listed below by spectrometric methods and alternative methods (combustion, thermoevolution, wet-way) standard methods, with measurements metrological **traceabled** to adequate CRMs.
- **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  $\pm$  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

Issued in Bohumín in August 2019

SPL-LABMAT s.r.o. 1. máje 432 735 31 Bohumín, CZ ICO: 06480870, DIČ: CZ06480870 www.spl-labmat.cz e-mail: info@spl-labmat.cz