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CERTIFICATE OF ANALYSIS

IMZ 103D

CERTIFIED REFERENCE MATERIAL
LOW ALLOY STEEL

Analysis listed as percent by weight [% m/m]

	Certified value	Expanded uncertainty		Certified value	Expanded uncertainty
C	0.54	± 0.01	Cu	0.263	± 0.004
Si	0.43	± 0.01	V	0.187	± 0.001
Mn	0.77	± 0.03	Ti	0.20	± 0.01
P	0.060	± 0.003	Nb	0.042	± 0.002
S	0.050	± 0.002	Al	0.021	± 0.001
Cr	0.573	± 0.005	N	0.0044	± 0.0013
Ni	0.59	± 0.01	B	0.010	± 0.001
Mo	0.180	± 0.004	Sn	0.003	± 0.001
Co	0.010	± 0.001	As	0.005	± 0.001

the expanded uncertainty bases on statistical evaluation of the contributions the interlaboratory certification analysis and the material homogeneity

Certificate Number: IMZ 103D-081223
Certificate revision history on page 4

Analysis	Al	*	As	*	B	*	C	*	Co	*	Cr	*	Cu	*	Mn	*
1	0,017	17	0,0037	7	0,0086	5	0,53	5	0,009	14	0,5538	5	0,2469	7	0,74	5
2	0,0195	5	0,0040	5	0,00923	7	0,5300	2	0,0090	7	0,5557	5	0,25	7	0,7453	5
3	0,0195	5	0,0040	5	0,0093	5	0,5338	5	0,0093	7	0,560	7	0,2531	5	0,7493	5
4	0,0200	7	0,0041	7	0,0094	5	0,535	2	0,0094	5	0,5668	7	0,26	5	0,7498	5
5	0,02	7	0,0041	5	0,0094	5	0,536	5	0,0099	5	0,57	10	0,26	17	0,75	7
6	0,0201	5	0,0044	5	0,0095	5	0,537	2	0,0099	5	0,5701	7	0,260	5	0,76	17
7	0,0203	5	0,0045	1	0,0101	7	0,538	2	0,0099	5	0,5703	5	0,2618	5	0,7619	5
8	0,0209	5	0,0045	7	0,0104	5	0,5382	2	0,010	1	0,570	5	0,2618	5	0,7626	5
9	0,021	14	0,00492	7	0,0105	5	0,5383	5	0,0100	5	0,572	5	0,2628	7	0,764	14
10	0,0210	5	0,005	5	0,0105	7	0,5384	5	0,010	7	0,574	5	0,263	7	0,7690	7
11	0,021	5	0,005	5	0,0113	5	0,5385	5	0,0100	5	0,575	1	0,263	5	0,7728	7
12	0,02195	7	0,0050	5	0,0128	5	0,5386	2	0,011	5	0,577	14	0,2652	7	0,776	5
13	0,022	5	0,0055	5			0,540	2	0,011	5	0,579	5	0,2660	5	0,786	5
14	0,023	5					0,5440	2	0,0111	7	0,58	5	0,267	14	0,787	1
15	0,0231	7					0,5457	2	0,01124	7	0,58	5	0,269	1	0,789	7
16	0,0243	7					0,5474	2			0,58	17	0,2695	5	0,79	5
17							0,55	5			0,58	7	0,27	5	0,792	1
18							0,551	2			0,581	1	0,273	1	0,8047	7
19											0,5988	7				
Average[1]	0,0210		0,0045		0,00993		0,5388		0,0100		0,5733		0,2632		0,7692	
SD[2]	0,0014		0,0005		0,00081		0,0043		0,0007		0,0075		0,0046		0,0184	
u characterization[3]	0,00042		0,00018		0,0003		0,00126		0,00024		0,00216		0,00136		0,00543	
u homogeneity[4]	0,00030		0,00033		0,00019		0,0038		0,0004		0,00099		0,0015		0,015	
Certified value[5]	0,021		0,005		0,010		0,54		0,010		0,573		0,263		0,77	
Expanded uncertainty[6]	0,001		0,001		0,001		0,01		0,001		0,005		0,004		0,03	

Analysis	Mo	*	N	*	Nb	*	Ni	*	P	*	S	*	Sb**	*	Si	*
1	0,17	17	0,0035	5	0,0386	7	0,566	7	0,0494	7	0,0409	5	0,0002	5	0,40	17
2	0,17	7	0,0036	5	0,039	5	0,5703	5	0,053	7	0,0460	2	0,001	5	0,4043	7
3	0,1706	7	0,0040	3	0,039	5	0,5704	5	0,0568	7	0,04655	7	0,0018	5	0,4154	7
4	0,1732	5	0,0042	3	0,0399	5	0,5706	7	0,058	1	0,04755	2	0,0020	5	0,420	7
5	0,1736	5	0,0042	5	0,0402	7	0,5813	5	0,0580	5	0,048	2	0,00282	7	0,42	7
6	0,176	12	0,00426	3	0,0403	5	0,589	1	0,058	5	0,048	17	0,003	17	0,422	5
7	0,1768	5	0,00445	3	0,042	5	0,59	5	0,0590	5	0,0494	2	0,0035	7	0,4245	5
8	0,1775	5	0,0048	5	0,042	5	0,59	17	0,0596	5	0,0496	2	0,0037	7	0,4250	5
9	0,178	1	0,0048	5	0,0425	5	0,590	12	0,060	5	0,0499	5	0,0048	7	0,43	1
10	0,1784	5	0,0052	3	0,043	1	0,5903	5	0,0617	5	0,050	5	< 0,003	5	0,43	5
11	0,18	1	0,0056	5	0,043	17	0,592	1	0,063	5	0,050	5			0,43	5
12	0,18	5			0,043	5	0,596	14	0,0630	5	0,0504	2			0,4305	7
13	0,182	14			0,0431	5	0,600	5	0,0631	7	0,0509	2			0,4372	5
14	0,183	5			0,045	5	0,60	7	0,064	17	0,053	5			0,438	5
15	0,185	5			0,04600	7	0,603	5	0,067	5	0,0533	5			0,44	8
16	0,1896	7					0,603	5	0,06832	7	0,0534	5			0,440	5
17	0,19	7					0,6037	7			0,0537	2			0,445	5
18	0,19	5					0,6069	7			0,0538	2				
19	0,1904	7					0,6189	5			0,054	1				
20											0,0543	2				
Average[1]	0,1795		0,0044		0,0417		0,5909		0,0603		0,0504		0,0026		0,4278	
SD[2]	0,0066		0,0006		0,0021		0,0133		0,0040		0,0029		0,0013		0,0101	
u characterization[3]	0,00189		0,00023		0,0007		0,00383		0,00126		0,00080		0,00055		0,00306	
u homogeneity[4]	0,00041		0,0006		0,00046		0,00047		0,00093		0,00073		0,00032		0,00088	
Certified value[5]	0,180		0,0044		0,042		0,59		0,060		0,050				0,43	
Expanded uncertainty[6]	0,004		0,0013		0,002		0,01		0,003		0,002				0,01	

Analysis	Sn	*	Ti	*	V	*	W**	*
1	0,0013	5	0,185	17	0,180	5	0,0009	7
2	0,0017	7	0,186	5	0,1815	7	0,0012	7
3	0,0017	5	0,19	1	0,185	5	0,00175	7
4	0,00195	5	0,190	1	0,185	17	0,0027	5
5	0,002	5	0,19	7	0,1851	5	0,0030	5
6	0,0021	7	0,1916	7	0,1852	5	0,003	7
7	0,0024	5	0,192	7	0,1857	5	0,003	5
8	0,00269	7	0,1960	5	0,1858	7	0,0043	5
9	0,0029	7	0,197	5	0,1859	5	0,005	5
10	0,003	5	0,1996	7	0,1860	5		
11	0,0031	1	0,20	5	0,187	5		
12	0,004	5	0,2023	7	0,188	1		
13	0,0048	5	0,2023	5	0,19	1		
14	0,006	17	0,2051	5	0,190	5		
15			0,2052	5	0,19	10		
16			0,2073	5	0,19	7		
17			0,210	5	0,191	7		
18					0,2061	7		
Average[1]	0,0026		0,1970		0,1867		0,0028	
SD[2]	0,0009		0,0077		0,0023		0,0013	
u characterization[3]	0,00028		0,00234		0,0007		0,00056	
u homogeneity[4]	0,00006		0,0017		0,00030		0,00033	
Certified value[5]	0,003		0,20		0,187			
Expanded uncertainty[6]	0,001		0,01		0,001			

* - analytical method used
** - informative value

All values are based on recommendations of the ISO GUIDE 35:2017(E) standard:

1. **Average** is calculated according to Algorithm A (Guide clause A.2.3.4: Robust statistics);
2. **Standard deviation** is calculated according to Algorithm A (Guide clause A.2.3.4: Robust statistics);
3. **Uncertainty of material characterization** is based on the data obtained from the analysis performer by Network of competent labs (Guide clause 9.5) and calculated according to Guide clause B.5.2;
4. **Uncertainty associated with homogeneity** of material is calculated in agreement with Guide clause 7.11 (Uncertainty evaluation from homogeneity studies);
5. **Certified value** is the average value rounded to one or two significant digits of expanded uncertainty;
6. **Expanded uncertainty** is an geometric average of u characterization and u homogeneity multiplied by coverage factor k = 2.

Certification Process: Both preparation of this Reference Material and certification process were prepared according to requirements PN-EN 17034 and ISO GUIDE 35:2017(E)

Chemical Analysis: Chemical analyses were carried out on chips prepared by milling and also for bulk samples. Single values in the above table are the means obtained by individual laboratories. The following methods were used for analysis:

1 – wavelength dispersive x-ray fluorescence spectrometry,
2 – combustion and infra-red detection,
3 – high temperature extraction and thermo-conductivity detection,
5 – spark atomic emission spectrometry,
7 – inductive coupled plasma atomic emission spectrometry,
8 – gravimetry,
10 –titrimetry,
12 – spectrophotometry,
14 – flame atomic emission spectrometry,
17 – energy dispersive x-ray fluorescence spectrometry.

Participating Laboratories:

- ArcelorMittal, Dąbrowa Górnicza, PCA accreditation AB 1449, ISO 17025, (Poland)
- Bundesanstalt für Materialforschung und -prüfung (BAM), DAKKs accreditation D-PL-11075-14-00, ISO 17025, (Germany)
- Cognor S.A. Oddział HSJ, Stalowa Wola, Zakładowe Laboratorium Badawczo-Doświadczalne, UDT LBU-301/22-22, (Poland)
- Dunaferr Labor Nonprofit Kft., Dunaújváros, NAH accreditation NAH-1-1798/2021, ISO 17025, (Hungary)
- Enviform a.s., Třinec, Testing Laboratory Nr 1371, CAI accreditation, ISO 17025, (Czech Republic)
- Lithea, Ltd., (Czech Republic)
- OnderzoeksCentrum voor de Aanwending van Staal, Zelzate, (Belgium)
- Sieć Badawcza Łukasiewicz - Górnośląski Instytut Technologiczny, Gliwice, PCA accreditation AB 554, ISO 17025, (Poland)
- Sieć Badawcza Łukasiewicz - Instytut Metali Nieżelaznych, Gliwice, PCA accreditation AB 274, ISO 17025, (Poland)
- TECHLAB, St Julien-les-Metz, (France)
- Vitkovice Testing Center, Ostrava, Testing Laboratory Nr 1036, CAI accreditation, ISO 17025, (Czech Republic)

Homogeneity: The homogeneity of this Reference Material was evaluated in accordance with guidelines of ISO GUIDE 35:2017(E). Optical emission spectrometry with spark excitation method was used

Traceability: This Reference Material was found traceable to the following CRMs:
AR 645, AR 659, AR 876, AR 1653, BAS 055-2, BAS 087-1, BS 14B, BS 33F, BS61G, BS 73C, BS 8620C, BS 316D, BS 316E, BS 316F, BS 700C, BS 1762, BS 4340 A, BS 4820A, BCS161/3, BCS 224, BCS 239/3, BCS 331, BCS/SS 403/2, BCS/SS 404/2, BCS 432, BCS 451, ČKD 165B, ČKD 166, ČKD 168B, ČKD 170, ČKD 171B, ČKD 180B, ČKD 189A, DDR Nr 85, E281-1, Eltra 92400-3040, EURONORM 85, EURONORM 86, EURONORM 87, IMZ 1.21/1, IMZ 51/1, IMZ 55/1, IMZ 72, IMZ 74A, IMZ 75A, IMZ 103, IMZ 103A, IMZ 115, IMZ 116, IMZ 117, IMZ 124, IPT 12A, IPT 75A, Leco 501-501, Leco 501-502, Leco 501-505, Leco 501-510, MBH 12x353G, MBH 12x354B, MBH 12x356B, MBH 12xLA3, MBH 12x357B MBH 12x357D, MBH 12x86200A, MBH 12x15504, N500 CMINCS HS 11702-4, NIST 1761, NIST 1763, SPL 184A, SPL LA-3F, Vítkovice 3-1-33; 3-1-18 ČSMU, 2004A CMI, pure reagents Merck Certipur, Na_2CO_3, K_2SO_4.

Production of melt: This material was manufactured by Steelworks Baildon, Katowice (Poland)

Available form: Discs approximately 38 mm in diameter and 20 mm high

Intended use: This Reference Material is intended for use in spark atomic emission and X-ray spectrometric methods.
Note: In optical emission spectrometry with spark excitation it is recommended to avoid using the central part of the surface (diameter approx. 5 mm) due to possible segregation of material

Validity of certification: The certification of IMZ 103D is valid indefinitely within the uncertainty specified provided this Reference Material is stored in dry place and in environment free from chemical or other aggressive vapours. Periodic recertification is not required. The certification is nullified if this Reference Material is damaged, contaminated or otherwise modified

Safety: This Reference Material and packing does not contain substances which can directly influence health

Storage: This Reference Material should be stored in dry place and in environment free from chemical or other aggressive vapours

Inquiries regarding this Reference Material should be directed to rm@git.lukasiewicz.gov.pl

Approved by
Director of the Institute

Prof. Dr. Hab. Eng. Adam Zieliński

Certificate issue date: 8 December 2023