Metal and Quality LLC

CERTIFICATE OF ANALYSIS

Reference Materials CH021 – CH026

Set for Spectral Analysis of High Chromium Cast Iron

APPLICABILITY

Reference Materials CH021 - CH026 are intended for calibration of analytical instruments at spectral analysis high-chromium cast iron by OES and XRF methods

CERTIFIED VALUES AND UNCERTAINTIES (mass fraction in %)

	C	Si	Mn	P	S	Cr	Ni	Ti	Cu	Al	V	Mo
CH021	**3.93**	**0.52**	**3.66**	**0.064**	**0.009**	**9.07**	**5.86**	**0.093**	**0.369**	**0.168**	**0.61**	**4.42**
	0.06	**0.02**	**0.09**	**0.003**	**0.001**	**0.18**	**0.13**	**0.007**	**0.017**	**0.029**	**0.03**	**0.12**
CH022	**2.90**	**0.43**	**1.76**	**0.033**	**0.018**	**14.85**	**2.19**	**0.078**	**2.53**	**0.053**	**0.45**	**2.65**
	0.06	**0.02**	**0.05**	**0.002**	**0.001**	**0.17**	**0.07**	**0.005**	**0.05**	**0.015**	**0.03**	**0.06**
CH023	**2.33**	**0.98**	**0.43**	**0.023**	**0.073**	**23.45**	**0.715**	**0.38**	**0.054**	**0.255**	**0.288**	**1.46**
	0.04	**0.06**	**0.02**	**0.004**	**0.005**	**0.24**	**0.017**	**0.02**	**0.002**	**0.037**	**0.015**	**0.08**
CH024	**2.01**	**2.18**	**1.22**	**0.102**	**0.037**	**27.84**	**0.222**	**0.099**	**0.88**	**0.096**	**0.164**	**3.86**
	0.03	**0.06**	**0.04**	**0.011**	**0.004**	**0.36**	**0.009**	**0.009**	**0.03**	**0.036**	**0.009**	**0.22**
CH025	**1.80**	**2.70**	**0.387**	**0.030**	**0.026**	**35.14**	**1.77**	**0.117**	**1.23**	**0.351**	**0.044**	**0.302**
	0.05	**0.06**	**0.021**	**0.004**	**0.002**	**0.32**	**0.07**	**0.020**	**0.03**	**0.028**	**0.004**	**0.015**
CH026	**1.62**	**1.14**	**0.305**	**0.050**	**0.032**	**35.87**	**3.63**	**0.013**	**0.288**	**0.059**	**0.067**	**0.96**
	0.04	**0.06**	**0.018**	**0.003**	**0.004**	**0.31**	**0.11**	**0.002**	**0.019**	**0.018**	**0.007**	**0.06**

Uncertainties C(95%) estimated as the half-width confidence interval of Student's t-distribution: $C(95\%) = t \cdot s(M) / \sqrt{n}$

S(M) - standard deviation of the mean values of laboratories, n - number of means values of participated laboratories

SPECIFICATION Reference materials was made as fast-crystallized cast blocks of 35 x 35 mm, thickness of 15 - 18 mm

TRACEABILITY The characterization of material has been achieved by means interlaboratory experiment in which laboratories used standardized analysis methods and certified reference materials of their choice

METHODS USED C, S - Infrared absorption, Coulometric, OES; Si - Gravimetric, Photometric, ICP OES, OES, XRF; Cr - Titrimetric, ICP OES, OES, XRF; Ti - Photometric, ICP OES, OES, XRF; V - Potentiometric, ICP OES, OES, XRF; Mn - Photometric, FAAS, ICP OES, OES, XRF; Al - Photometric, FAAS, ICP OES, OES; Ni - Photometric, FAAS, ICP OES, OES, XRF; P - Extraction-photometric, Colorimetric, ICP OES, OES, XRF; Mo - Photometric, ICP OES, OES, XRF; Cu - FAAS, ICP OES, OES, XRF

CERTIFICATE VALIDITY June 2034

PARTICIPATING LABORATORIES

Asovstal Iron & Steel Works, Ukraine
Dneprospetsstal (DSS) PJSC, Ukraine
Ilyich Iron and Steel Works OJSC, Ukraine
Institute for Ferrous Metallurgy (IMZ), Poland
Krivoy Rog Mechanical Repair Plant OJSC, Ukraine
Nasosenergomash Sumy JSC, Ukraine
Ukrainian Special Steels Institute (USSI) SE
Zaporozhye Steel Works LLC, Ukraine
Zaporozhye Titanium & Magnesium Combine LLC, Ukraine

Analysis Results

		C	Si	Mn	P	S	Cr	Ni	Ti	Cu	Al	V	Mo
	1	3.840	0.489	3.48	0.058	0.0070	8.80	5.63	0.080	0.336	0.132	0.539	4.19
	2	3.856	0.496	3.50	0.059	0.0078	8.85	5.64	0.085	0.340	0.141	0.563	4.20
	3	3.856	0.496	3.52	0.061	0.0082	8.85	5.70	0.086	0.350	0.150	0.580	4.43
	4	3.880	0.520	3.58	0.061	0.0083	8.90	5.90	0.086	0.354	0.150	0.590	4.44
	5	3.896	0.520	3.59	0.064	0.0090	8.91	5.91	0.090	0.356	0.190	0.590	4.50
CH021	6	3.900	0.523	3.68	0.065	0.0106	8.98	5.94	0.092	0.360	0.203	0.610	4.50
	7	3.950	0.530	3.71	0.066	0.0110	9.24	5.95	0.098	0.380	0.210	0.615	4.53
	8	4.000	0.532	3.71	0.066	0.0110	9.26	5.97	0.098	0.380		0.649	4.60
	9	4.000	0.540	3.72	0.070		9.33	6.14	0.100	0.380		0.650	
	10	4.100	0.590	3.83	0.070		9.56		0.115	0.403		0.680	
	11			3.90						0.420			
Average		**3.928**	**0.524**	**3.66**	**0.064**	**0.0091**	**9.07**	**5.86**	**0.093**	**0.369**	**0.168**	**0.607**	**4.42**
S(M)		**0.083**	**0.029**	**0.14**	**0.004**	**0.0016**	**0.26**	**0.17**	**0.010**	**0.026**	**0.032**	**0.043**	**0.15**
	1	2.750	0.378	1.68	0.029	0.0150	14.50	2.03	0.065	2.45	0.031	0.401	2.55
	2	2.800	0.390	1.70	0.030	0.0160	14.56	2.10	0.072	2.48	0.033	0.416	2.58
	3	2.800	0.406	1.74	0.030	0.0170	14.72	2.10	0.076	2.49	0.040	0.430	2.58
	4	2.860	0.410	1.74	0.030	0.0174	14.73	2.15	0.076	2.50	0.040	0.430	2.59
	5	2.893	0.434	1.75	0.031	0.0180	14.85	2.17	0.078	2.51	0.060	0.440	2.65
CH022	6	2.930	0.440	1.76	0.033	0.0180	14.90	2.19	0.080	2.52	0.066	0.460	2.70
	7	2.946	0.450	1.79	0.033	0.0190	14.92	2.20	0.080	2.57	0.073	0.490	2.70
	8	2.960	0.458	1.83	0.033	0.0196	15.00	2.25	0.085	2.58	0.077	0.490	2.71
	9	2.960	0.460	1.87	0.037	0.0200	15.07	2.31	0.090	2.65		0.490	2.80
	10	2.975	0.470		0.040		15.30	2.36				0.500	
	11	3.040											
Average		**2.901**	**0.430**	**1.76**	**0.033**	**0.0178**	**14.85**	**2.19**	**0.078**	**2.53**	**0.053**	**0.455**	**2.65**
S(M)		**0.089**	**0.032**	**0.06**	**0.003**	**0.0016**	**0.24**	**0.10**	**0.007**	**0.06**	**0.018**	**0.036**	**0.08**
	1	2.280	0.91	0.382	0.0175	0.068	22.90	0.69	0.350	0.050	0.188	0.250	1.31
	2	2.290	0.93	0.400	0.0180	0.069	23.14	0.69	0.360	0.050	0.190	0.270	1.32
	3	2.300	0.94	0.410	0.0180	0.071	23.18	0.70	0.360	0.051	0.250	0.277	1.35
	4	2.300	0.96	0.420	0.0190	0.073	23.45	0.70	0.380	0.052	0.250	0.290	1.50
	5	2.320	0.98	0.428	0.0244	0.078	23.50	0.71	0.381	0.054	0.271	0.290	1.51
CH023	6	2.320	0.98	0.435	0.0260	0.080	23.51	0.72	0.390	0.055	0.280	0.299	1.51
	7	2.320	1.04	0.450	0.0280		23.67	0.73	0.394	0.056	0.300	0.300	1.51
	8	2.326	1.13	0.450	0.0290		23.75	0.74	0.400	0.057	0.310	0.308	1.55
	9	2.334		0.454	0.0308		23.92	0.75	0.441	0.058		0.310	1.59
	10	2.500		0.456									
Average		**2.329**	**0.98**	**0.429**	**0.0234**	**0.0733**	**23.45**	**0.71**	**0.384**	**0.054**	**0.255**	**0.288**	**1.46**
S(M)		**0.062**	**0.07**	**0.025**	**0.0053**	**0.005**	**0.32**	**0.02**	**0.027**	**0.003**	**0.046**	**0.020**	**0.11**
	1	1.960	2.05	1.10	0.076	0.0280	27.06	0.209	0.085	0.820	0.047	0.149	3.33
	2	1.970	2.15	1.16	0.089	0.0300	27.30	0.215	0.086	0.820	0.062	0.156	3.61
	3	1.975	2.16	1.19	0.092	0.0330	27.46	0.215	0.088	0.850	0.087	0.160	3.61
	4	1.980	2.17	1.19	0.100	0.0350	27.84	0.220	0.100	0.870	0.120	0.160	3.84
	5	1.985	2.17	1.21	0.107	0.0370	27.89	0.224	0.103	0.870	0.129	0.160	3.93
CH024	6	1.990	2.20	1.22	0.107	0.0370	27.94	0.230	0.107	0.875	0.130	0.167	3.99
	7	2.010	2.21	1.23	0.115	0.0383	28.20	0.240	0.111	0.885		0.180	4.08
	8	2.010	2.33	1.24	0.117	0.0400	28.34		0.111	0.901		0.180	4.14
	9	2.090		1.24	0.118	0.0430	28.49			0.920			4.20
	10	2.100		1.28		0.0463				0.940			
	11			1.33									
Average		**2.007**	**2.18**	**1.22**	**0.102**	**0.0368**	**27.84**	**0.222**	**0.099**	**0.875**	**0.096**	**0.164**	**3.86**
S(M)		**0.049**	**0.08**	**0.06**	**0.014**	**0.0056**	**0.48**	**0.011**	**0.011**	**0.039**	**0.036**	**0.011**	**0.29**
	1	1.720	2.55	0.345	0.023	0.0220	34.86	1.70	0.095	1.170	0.330	0.037	0.272
	2	1.730	2.68	0.350	0.024	0.0240	34.90	1.73	0.100	1.180	0.330	0.037	0.280
	3	1.757	2.70	0.360	0.030	0.0240	34.93	1.73	0.107	1.190	0.336	0.041	0.281
	4	1.770	2.71	0.376	0.031	0.0242	34.95	1.78	0.111	1.214	0.340	0.041	0.290
	5	1.770	2.71	0.386	0.033	0.0250	35.03	1.79	0.111	1.230	0.370	0.042	0.300
CH025	6	1.780	2.73	0.390	0.033	0.0260	35.50	1.89	0.147	1.240	0.400	0.043	0.310
	7	1.850	2.75	0.400	0.034	0.0270	35.80		0.151	1.240		0.047	0.310
	8	1.850	2.79	0.403	0.036	0.0290				1.260		0.049	0.313
	9	1.891		0.420		0.0320				1.295		0.050	0.320
	10	1.900		0.437						1.301		0.050	0.340
Average		**1.802**	**2.70**	**0.387**	**0.030**	**0.0259**	**35.14**	**1.77**	**0.117**	**1.232**	**0.351**	**0.044**	**0.302**
S(M)		**0.065**	**0.07**	**0.030**	**0.005**	**0.0030**	**0.36**	**0.07**	**0.022**	**0.045**	**0.028**	**0.005**	**0.021**
	1	1.540	1.02	0.283	0.043	0.0260	35.25	3.50	0.010	0.260	0.034	0.053	0.855
	2	1.560	1.05	0.290	0.045	0.0280	35.36	3.51	0.010	0.270	0.042	0.058	0.880
	3	1.585	1.10	0.290	0.046	0.0280	35.88	3.60	0.011	0.270	0.063	0.064	0.925
	4	1.590	1.13	0.290	0.047	0.0304	35.90	3.69	0.012	0.270	0.065	0.064	0.960
	5	1.599	1.14	0.300	0.051	0.0330	35.99	3.73	0.013	0.273	0.076	0.064	0.960
CH026	6	1.620	1.16	0.306	0.051	0.0340	36.10	3.74	0.014	0.280	0.076	0.067	0.980
	7	1.640	1.20	0.314	0.052	0.0350	36.11		0.016	0.280		0.072	0.980
	8	1.650	1.22	0.316	0.052	0.0420	36.34		0.018	0.310		0.076	0.980
	9	1.683	1.23	0.360	0.054					0.325		0.083	1.154
	10	1.700			0.055					0.340			
Average		**1.617**	**1.14**	**0.305**	**0.050**	**0.0321**	**35.87**	**3.63**	**0.013**	**0.288**	**0.059**	**0.067**	**0.964**
S(M)		**0.052**	**0.07**	**0.023**	**0.004**	**0.0051**	**0.38**	**0.11**	**0.003**	**0.027**	**0.018**	**0.009**	**0.085**

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