

UNITED STATES DEPARTMENT OF COMMERCE  
WASHINGTON

National Bureau of Standards  
Certificate of Analyses

Standard Sample 101 d  
18 Chromium-9 Nickel Steel

ANALYST	C	Mn	P	S		Si	Cu	Ni	Cr	V	Mo	Co	Sn	N
	Direct combustion	Persulfate-Arsenite	Alkali-Molybdate	Gravimetric (direct oxidation and precipitation after reduction of iron)	Combustion Iodate titration	Perchloric acid dehydration	H <sub>2</sub> S-CuS-CuO	Weighed as nickel dimethylglyoxime	FeSO <sub>4</sub> -KMnO <sub>4</sub> titration		Photometric	Zinc oxide-Alpha nitroso-beta naphthol		Distillation-titration
1.....	0.055	<sup>a</sup> 0.737	<sup>b</sup> 0.021 { <sup>c</sup> 0.020}	0.017	<sup>d</sup> 0.016 { <sup>e</sup> 0.015}	<sup>f</sup> 0.469	<sup>g</sup> 0.186	9.03	<sup>h</sup> 18.65	<sup>i</sup> 0.049	0.108	<sup>j</sup> 0.058	<sup>k</sup> 0.009	<sup>l</sup> 0.024
2.....	.054	<sup>m</sup> .74	<sup>n</sup> 0.021		<sup>o</sup> 0.015	.461	<sup>p</sup> .182	<sup>q</sup> 9.07	<sup>r</sup> 18.69	<sup>s</sup> 0.050	.109	<sup>t</sup> 0.053	<sup>u</sup> 0.009	.023
3.....	.055	.737	.021		.016	.474	<sup>v</sup> .18	9.07	18.69	.050	.114	.060	<sup>w</sup> 0.008	.023
4.....	.057	<sup>x</sup> 0.735	.020		<sup>y</sup> 0.016	.466	<sup>z</sup> .186	9.06	<sup>aa</sup> 18.69	<sup>ab</sup> 0.052	.109	<sup>ac</sup> 0.055	<sup>ad</sup> 0.011	<sup>ae</sup> 0.022
5.....	.053	<sup>af</sup> 0.738	.020		.015	.47	<sup>ag</sup> 0.191	<sup>ah</sup> 9.05	<sup>ai</sup> 18.66	.050	.101	.063	<sup>aj</sup> 0.009	<sup>ak</sup> 0.025
6.....	.06	<sup>al</sup> 0.74	.024		<sup>am</sup> 0.016	<sup>an</sup> 0.477		9.01	<sup>ao</sup> 18.68	.046	.104	.066	.012	.027
7.....	.057	<sup>ap</sup> 0.74	<sup>aq</sup> 0.022		.017	.463	<sup>ar</sup> 0.182	<sup>as</sup> 9.05	<sup>at</sup> 18.69	<sup>au</sup> 0.052	.113	.058	<sup>av</sup> 0.008	.027
<sup>o</sup> .....	.056	<sup>aw</sup> 0.734	<sup>ax</sup> 0.019	.018		<sup>ay</sup> 0.476	<sup>az</sup> 0.185	9.03	<sup>ba</sup> 18.62	<sup>bb</sup> 0.047	.105	<sup>bc</sup> 0.056	<sup>bd</sup> 0.009	.024
.....	.053	<sup>ba</sup> 0.74	<sup>bb</sup> 0.022		<sup>bc</sup> 0.014	<sup>bd</sup> 0.477	<sup>be</sup> 0.187	<sup>bf</sup> 9.06	18.71	.045	<sup>bg</sup> 0.115 { <sup>bh</sup> 0.116}	<sup>bh</sup> 0.055	.008	.024
10.....	.056	<sup>bi</sup> 0.746	<sup>bj</sup> 0.019		<sup>bk</sup> 0.016	<sup>bl</sup> 0.473	<sup>bm</sup> 0.184	<sup>bn</sup> 9.07	<sup>bo</sup> 18.72	.045	.12			.023
Averages.....	0.056	0.739	0.020	0.017	0.016	0.471	0.184	9.05	18.68	0.049	0.110	0.058	0.009	0.024
General average.....	0.056	0.739	0.020	0.016	0.016	0.471	0.184	9.05	18.68	0.049	0.110	0.058	0.009	0.024

<sup>a</sup> Chromium removed by precipitation with NaHCO<sub>3</sub>.  
<sup>b</sup> Gravimetric method (weighed as Mg<sub>3</sub>P<sub>2</sub>O<sub>7</sub> after removal of arsenic).  
<sup>c</sup> Molybdenum-blue photometric method. See J. Research NBS 26, 405 (1941) RP1386.  
<sup>d</sup> 1-g sample burned in oxygen at 1,425° C and sulfur dioxide absorbed in starch-iodine solution. Iodine liberated from iodide by titration, during the combustion, with standard KIO<sub>3</sub> solution. Titer based on 93 percent of the theoretical factor.  
<sup>e</sup> Evolution with HCl (sp gr 1.18) ZnS-iodine (theoretical sulfur titer).  
<sup>f</sup> Double dehydration with intervening filtration.  
<sup>g</sup> Diethyldithiocarbamate photometric method. See J. Research NBS 47, 380 (1951) RP2265.  
<sup>h</sup> Persulfate oxidation and potentiometric titration with ferrous ammonium sulfate.

<sup>i</sup> Nitric acid oxidation, potentiometric titration with ferrous ammonium sulfate.  
<sup>j</sup> Nitroso-R photometric method.  
<sup>k</sup> Sulfide-iodine method. See BSJ J. Research 8, 309 (1932) RP415.  
<sup>l</sup> Sulfuric acid digestion for 4 hours of a 0.5 g sample. See J. Research NBS 43, 201 (1949) RP2021.  
<sup>m</sup> CrO<sub>2</sub>Cl<sub>2</sub>-persulfate-photometric method.  
<sup>n</sup> CuCNS precipitation, CuCl<sub>2</sub> photometric method.  
<sup>o</sup> Dimethylglyoxime precipitate titrated with cyanide.  
<sup>p</sup> Titrating solution standardized with a standard steel.  
<sup>q</sup> Persulfate oxidation, titration with FeSO<sub>4</sub>-K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>, ortho-phenanthroline indicator.  
<sup>r</sup> Nitric acid oxidation, potentiometric titration with FeSO<sub>4</sub>-K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>.  
<sup>s</sup> Thiocyanate-photometric method. See Anal. Ed. 19, 236 (1947).  
<sup>t</sup> Finished by electrolysis.

<sup>u</sup> Ether extraction-CrO<sub>2</sub>Cl<sub>2</sub> volatilization-ZnO-alpha nitroso-beta naphthol.  
<sup>v</sup> Vacuum fusion.  
<sup>w</sup> Chromium removed as CrO<sub>2</sub>Cl<sub>2</sub>.  
<sup>x</sup> H<sub>2</sub>S-alpha benzoinoxime-CuO method.  
<sup>y</sup> Dimethylglyoxime precipitate ignited to NiO.  
<sup>z</sup> Perchloric acid oxidation.  
<sup>aa</sup> Solution in HClO<sub>4</sub>.  
<sup>ab</sup> CrO<sub>2</sub>Cl<sub>2</sub>-periodate photometric method.  
<sup>ac</sup> Sulfuric acid dehydration.  
<sup>ad</sup> Direct titration with cyanide.  
<sup>ae</sup> Phosphotungstovanadate-photometric method. See Anal. Chem. 21, 606 (1949).  
<sup>af</sup> H<sub>2</sub>S-MoO<sub>3</sub>.  
<sup>ag</sup> Chromium removed as PbCrO<sub>4</sub>.  
<sup>ah</sup> Alkali standardized by the use of acid potassium phthalate and the ratio 23NaOH:1P.  
<sup>ai</sup> Analyst 2 reported 0.02 percent niobium.

List of Analysts

1. Ferrous Laboratory, National Bureau of Standards. Analysis by J. I. Shultz, H. Jacobson, R. K. Bell, B. B. Bendigo, and L. A. Machlan.
2. Rustless Division, Armco Steel Corp., Baltimore, Md. Analysis by A. J. Reed, C. J. Yoder, and H. M. Putsché.
3. E. O. Waltz, Republic Steel Corp., Steel Division, Canton, Ohio.
4. Frankford Arsenal Laboratory, Frankford Arsenal, Philadelphia, Pa.
5. E. R. Vance, The Timken Roller Bearing Co., Canton, Ohio.
6. The Ohio State University, Columbus, Ohio. Analysis by W. T. Buckingham, R. B. Orndorff, T. R. Breitenbach, J. C. Lavery, H. Wohlgemuth, and J. Fontaine, Columbus, Ohio.
7. D. P. Bartell, Allegheny Ludlum Steel Corp., Pittsburgh, Pa.
8. M. D. Cooper, Research Laboratories Division, General Motors Corp., Detroit, Mich.
9. W. F. Knospe, United States Steel Corp., South Chicago Works, Chicago, Ill.
10. G. L. Ivory, United States Steel Corp., Duquesne Works, Duquesne, Pa.

The Steel for the preparation of this standard was furnished by the Rustless Division, Armco Steel Corporation.

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A. V. ASTIN, Director.