

UNITED STATES DEPARTMENT OF COMMERCE  
WASHINGTON, D.C. 20234

National Bureau of Standards  
Certificate of Analyses

Standard Sample 345  
16 Chromium-4 Nickel Steel  
(Cu Precipitation Hardening)

ANALYST	C	Mn	P	S	Si	Cu	Ni	Cr	V	Mo	Nb	Ta	Co	
	Direct combustion	Persulfate-Arsenite	Photometric	Gravimetric (direct oxidation and final precipitation after reduction of iron)	Combustion Iodate titration	Perchloric acid dehydration	H <sub>2</sub> S-electrolytic method	Weighed as nickel dimethylglyoxime	FeSO <sub>4</sub> -KMnO <sub>4</sub> titration	HNO <sub>3</sub> oxidation, potentiometric titration	Photometric		Photometric Nitroso-R-salt	
1.....	0.049	<sup>a</sup> 0.225	<sup>b</sup> 0.018 <sup>c</sup> 0.019	0.012	<sup>d</sup> 0.012	<sup>e</sup> 0.607 <sup>f</sup> 0.611	3.46	4.26	<sup>g</sup> 16.04	0.041	0.123	<sup>h</sup> 0.227	<sup>i</sup> 0.002	0.086
.....	<sup>j</sup> 0.048 <sup>k</sup> 0.047	<sup>l</sup> 0.22	<sup>m</sup> 0.018	.....	.....	.....	<sup>n</sup> 3.43	4.22	16.05	0.039	<sup>o</sup> 0.114 <sup>p</sup> 0.115	<sup>q</sup> 0.23	.....	<sup>r</sup> 0.089
.....	<sup>s</sup> 0.048	<sup>t</sup> 0.224	<sup>u</sup> 0.018	.....	.....	.....	<sup>v</sup> 3.45	<sup>w</sup> 4.24	<sup>x</sup> 16.02	0.044	<sup>y</sup> 0.128	<sup>z</sup> 0.239	.....	<sup>aa</sup> 0.084
.....	<sup>ab</sup> 0.046	<sup>ac</sup> 0.225	<sup>ad</sup> 0.020	.....	.....	.....	<sup>ae</sup> 3.44	<sup>af</sup> 4.24	<sup>ag</sup> 16.01	0.045	<sup>ah</sup> 0.125	<sup>ai</sup> 0.235	.....	<sup>aj</sup> 0.092
.....	<sup>ak</sup> 0.049	<sup>al</sup> 0.22	<sup>am</sup> 0.017	.....	.....	.....	<sup>an</sup> 3.42	<sup>ao</sup> 4.21	16.02	0.044	<sup>ap</sup> 0.118	<sup>aq</sup> 0.23	.....	<sup>ar</sup> 0.088
6.....	0.053	<sup>aw</sup> 0.229	<sup>ax</sup> 0.017 <sup>ay</sup> 0.016	.....	.....	.....	3.43	4.27	16.05	<sup>az</sup> 0.037	<sup>ba</sup> 0.125	<sup>bb</sup> 0.234	.....	<sup>bc</sup> 0.090
7.....	0.047	<sup>bd</sup> 0.22	<sup>be</sup> 0.019	.....	.....	.....	<sup>bf</sup> 3.46	<sup>bg</sup> 4.23	<sup>bh</sup> 16.05	0.040	<sup>bi</sup> 0.125	<sup>bj</sup> 0.226	<sup>bk</sup> 0.002	0.092
8.....	<sup>bl</sup> 0.047 <sup>bm</sup> 0.045	<sup>bn</sup> 0.228	<sup>bo</sup> 0.019	.....	.....	.....	<sup>bn</sup> 3.47	4.26	<sup>bu</sup> 16.06 <sup>bv</sup> 16.02	<sup>bw</sup> 0.041	<sup>bx</sup> 0.122	<sup>by</sup> 0.235 <sup>bz</sup> 0.226	<sup>ca</sup> 0.002	0.089
Average.....	0.048	0.224	0.018	0.012	0.012	0.610	3.44	4.24	16.04	0.041	0.122	0.231	0.002	0.089
General average.....	0.048	0.224	0.018	0.012	0.610	3.44	4.24	16.04	0.041	0.122	0.231	0.002	0.089	

<sup>a</sup> Chromium removed by precipitation with NaHCO<sub>3</sub>.  
<sup>b</sup> Molybdenum-blue photometric method. See J. Res. NBS 26, 405 (1941) RP1386.  
<sup>c</sup> Gravimetric method (weighed as Mg<sub>2</sub>P<sub>2</sub>O<sub>7</sub> after removal of arsenic).  
<sup>d</sup> 1-g sample burned in oxygen at 1,425 °C and sulfur dioxide absorbed in starch-iodide 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> Double dehydration with intervening filtration.  
<sup>f</sup> Sulfuric acid dehydration.  
<sup>g</sup> Persulfate oxidation, potentiometric titration with ferrous ammonium sulfate.  
<sup>h</sup> Ion-exchange. Hydroquinone photometric method. See J. Res. NBS 62, 1 (1959) RP2923.  
<sup>i</sup> Ion-exchange. Pyrogalllic acid photometric method. See (h).  
<sup>j</sup> Conductometric method.  
<sup>k</sup> Chromium volatilized as Cr<sub>2</sub>OCl<sub>2</sub>.

<sup>l</sup> KIO<sub>3</sub> photometric method.  
<sup>m</sup> Ammonium molybdate photometric method. Color complex extracted into isobutyl alcohol.  
<sup>n</sup> H<sub>2</sub>S—KI—Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> titration.  
<sup>o</sup> Alpha-benzoinoxime gravimetric method.  
<sup>p</sup> Niobium separated with H<sub>2</sub>SO<sub>4</sub> and determined photometrically with hydroquinone.  
<sup>q</sup> Chromium removed with ZnO.  
<sup>r</sup> Molybdenum-blue photometric method.  
<sup>s</sup> Diethyldithiocarbamate photometric method.  
<sup>t</sup> Dimethylglyoxime precipitate titrated with cyanide.  
<sup>u</sup> Perchloric acid oxidation.  
<sup>v</sup> Niobium separated with H<sub>2</sub>SO<sub>4</sub> and determined photometrically with H<sub>2</sub>O<sub>2</sub>.  
<sup>w</sup> Titrating solution standardized by use of a standard steel.  
<sup>x</sup> Persulfate oxidation, potentiometric titration with FeSO<sub>4</sub>-K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>.  
<sup>y</sup> Niobium precipitated with cupferron, hydrolyzed with H<sub>2</sub>SO<sub>4</sub> and determined photometrically with H<sub>2</sub>O<sub>2</sub>.

<sup>z</sup> Tetraphenylarsonium chloride complex photometric method.  
<sup>aa</sup> Titrated with arsenite-nitrite solution.  
<sup>ab</sup> CuCNS precipitation—CuCl<sub>2</sub> photometric method.  
<sup>ac</sup> Cupferron separation—HNO<sub>3</sub> oxidation, potentiometric titration with FeSO<sub>4</sub>.  
<sup>ad</sup> ZnO—α nitroso β naphthol—KCN titration.  
<sup>ae</sup> Alkali-molybdate method.  
<sup>af</sup> Dimethylglyoxime—electrolytic method.  
<sup>ag</sup> Niobium and tantalum precipitated with H<sub>2</sub>SO<sub>4</sub> ignited to the oxides and niobium determined by difference as the oxide.  
<sup>ah</sup> Pyrogalllic acid photometric method.  
<sup>ai</sup> Cupferron separation—H<sub>2</sub>O<sub>2</sub>-HF photometric method.  
<sup>aj</sup> Ion-exchange—tannic acid—Nb<sub>2</sub>O<sub>5</sub> gravimetric method.  
<sup>ak</sup> Niobium precipitated with H<sub>2</sub>SO<sub>4</sub> and determined by the KCNS photometric method.  
<sup>al</sup> Ion-exchange. Pyrogalllic acid photometric method.

List of Analysts

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The steel for the preparation of this standard was furnished by the Baltimore Works of the Armco Steel Corporation.  
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A. V. ASTIN, Director.