



# Certificate of Analysis

## Standard Reference Material 1154

### 19 Cr-10 Ni Steel

ANALYST	C	Mn	P	S	Si	Cu	Ni	Cr	V	Mo
	Direct combustion	Persulfate-arsenite	Molybdenum-blue photometric	Combustion-iodate titration	Perchloric acid dehydration		Weighed as nickel dimethylglyoxime			Photometric
1.....	0.092	<sup>a, b</sup> 1.75	0.040	<sup>e</sup> 0.029	<sup>d</sup> 1.09	<sup>e</sup> 0.562	10.22	<sup>f</sup> 19.55	<sup>g</sup> 0.062	0.464
2.....	.096	<sup>h</sup> 1.76	<sup>i</sup> 0.038	.032	<sup>d</sup> 1.09	<sup>f</sup> 0.566	10.27	<sup>f</sup> 19.60	<sup>k</sup> 0.058	<sup>l</sup> 0.468
3.....	.097	<sup>m</sup> 1.74	<sup>i</sup> 0.035	.035	<sup>d</sup> 1.10		<sup>n</sup> 10.25	<sup>o</sup> 19.60	{ <sup>p</sup> 0.064 <sup>q</sup> 0.059}	.466
4.....	.096	1.72	.038	.033	1.08	.563	10.21	19.57	.064	.461
5.....	.089	<sup>m</sup> 1.73	.038	.034	<sup>r, d</sup> 1.08	<sup>s</sup> .551	10.29	<sup>t</sup> 19.59	<sup>u</sup> 0.060	<sup>v</sup> 0.457
Average.....	0.094	1.74	0.038	0.033	1.09	0.560	10.25	19.58	0.061	0.463

<sup>a</sup> Chromium removed by precipitation with NaHCO<sub>3</sub>.  
<sup>b</sup> Potentiometric titration.  
<sup>c</sup> 1-g sample burned in oxygen at 1450 °C and sulfur dioxide absorbed in starch-iodide solution. Iodine is liberated from iodide by titration, during the combustion, with standard KIO<sub>3</sub> solution. Titer is based on 93 percent of the theoretical factor.  
<sup>d</sup> Double dehydration with intervening filtration.  
<sup>e</sup> Diethylthiocarbamate photometric method. See J. Res. NBS 47, 380 (1951) RP2265.

<sup>f</sup> Persulfate oxidation, potentiometric titration with ferrous ammonium sulfate.  
<sup>g</sup> Nitric acid oxidation, potentiometric titration with ferrous ammonium sulfate.  
<sup>h</sup> Chromium volatilized as CrO<sub>2</sub>Cl<sub>2</sub>.  
<sup>i</sup> Alkali-molybdate method.  
<sup>j</sup> H<sub>2</sub>S-electrolytic method.  
<sup>k</sup> Ether-cupferron-FeSO<sub>4</sub>·(NH<sub>4</sub>)<sub>2</sub>S<sub>2</sub>O<sub>8</sub>-KMnO<sub>4</sub>.  
<sup>l</sup> H<sub>2</sub>S-alpha benzoinoxime-MoO<sub>3</sub> method.  
<sup>m</sup> Periodate photometric method.

<sup>n</sup> Dimethylglyoxime precipitate titrated with cyanide.  
<sup>o</sup> Persulfate oxidation, titration with FeSO<sub>4</sub>-KMnO<sub>4</sub>.  
<sup>p</sup> FeSO<sub>4</sub>·(NH<sub>4</sub>)<sub>2</sub>S<sub>2</sub>O<sub>8</sub>-KMnO<sub>4</sub> method.  
<sup>q</sup> Spectrographic method.  
<sup>r</sup> Sulfuric acid dehydration.  
<sup>s</sup> 2,2' biquinoline photometric method.  
<sup>t</sup> Persulfate oxidation, titration with FeSO<sub>4</sub>-K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>.  
<sup>u</sup> Nitric acid oxidation, titration with FeSO<sub>4</sub>-K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>.  
<sup>v</sup> Alpha benzoinoxime gravimetric method.

### List of Analysts

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SIZE: Samples are disks, 1¼ in. in diameter and ¾ in. thick.

PREPARATION AND TESTING: The material for this standard was melted under an argon cover in a 1000-lb induction furnace in the NBS Foundry, and then cast into a single ingot. The ingot was processed by the Naval Weapons Plant by forging to a slab having one dimension of the cross section four times that of the other dimension. After cropping top and bottom, 15 and 5 percent respectively, the slab was cut lengthwise and the center section corresponding to one-fourth of the original ingot was discarded. The two slab portions were hot rolled to oversize rods and, after annealing, were centerless ground to size.

The homogeneity of the material was established at the National Bureau of Standards and General Motors Corporation by metallographic studies, by optical emission and x-ray spectrochemical analysis, and by chemical analysis.

Samples for chemical analysis were prepared in the form of millings cut from the cross section of the finished samples.

## Supplemental Information

Other Elements: In addition to the certified elements, the following are present at the approximate concentrations listed:

Ti	Nb	Ta	Al	Zr	Co	Sn	Pb	As	B
0.48 <sup>a</sup>	0.26 <sup>b</sup>	0.04 <sup>c</sup>	0.03 <sup>d</sup>	0.02 <sup>e</sup>	0.12 <sup>f</sup>	0.02 <sup>g</sup>	0.01 <sup>h</sup>	0.03 <sup>i</sup>	0.000 <sup>j</sup>

<sup>a</sup> Ion-exchange. H<sub>2</sub>O<sub>2</sub> photometric method at NBS.

<sup>b</sup> Average of spectrographic method and ion-exchange-hydroquinone photometric method at NBS.

<sup>c</sup> Average of spectrographic methods at American Cast Iron Pipe Co., and NBS; and ion-exchange-pyrogalllic acid photometric method at NBS.

<sup>d</sup> Average of spectrographic methods at General Motors Corp., and NBS; and polarographic method at NBS.

<sup>e</sup> Ion-exchange. H<sub>2</sub>O<sub>2</sub>-phosphate gravimetric method.

<sup>f</sup> Average of photometric methods at General Motors Corp., and NBS; and spectrographic method at NBS.

<sup>g</sup> Average of sulfide-iodate volumetric method at General

Motors Corp., and spectrographic and polarographic methods at NBS.

<sup>h</sup> Average of spectrographic methods at General Motors Corp., and NBS; and polarographic method at NBS.

<sup>i</sup> Average of photometric methods at General Motors Corp., and NBS; and spectrographic method at NBS.

<sup>j</sup> Distillation-curcumin photometric method at NBS.