U. S. Department of Commerce
John T. Connor, Secretary
National Bureau of Standards
A. V. Astin, Director

Certificate of Analysis

Standard Reference Material 72 F

Chromium-Molybdenum Steel

ANALYST	C	Mn	P		S		Si	Cu	Ni	Cr	V	Mo		N	
	Direct combustion	Persulfate-Arsenite	Gravimetric (weighed as $Mg_2P_6O_{17}$ after removal of arsenic)	Alkali-Molybdate [a]	Gravimetric (direct oxidation and precipitation after reduction of iron)	Combustion Iodate titration	Perchloric acid dehydration	Photometric	Weighed as nickel dimethylglyoxime	$FeSO_4$-$KMnO_4$ titration		Gravimetric	Photometric	Distillation-titration	
1	0.296	[b]0.547	0.013	[c]0.013	0.023	[d]0.023	[e]0.254	[f]0.062	0.057	[g]0.892	[h]0.005	[i]0.181	0.180	[j]0.010	
2	.303	[k].54		.016	.026	.025	[l,e].26	[m].061	.056	.892	.003		.183	.011	
3	[n].303	[k].546	.013	.014	.024	.025	[e].256	[o].064	[p].055	[q].885	[r].004		.182	.008	
4	.302	[k].552		[p].013		[k].023	.257	[s].058	[p].056	.893	[t].010		.183		
5	[n].308	[u].538	.013	.013	.024	.024	[l].251	[v].063	.050	.90	.005	[i].19		[w].008	
6	.301	[k].553	.013	.014	.025	.022 / [x].023	[l,e].258	[y].064	.055	.883		[i].180	.184	[j].012	
	.294	[z].547		.013	.024	.024	.254	[z1].06	.06	[q].90	[z2].004	[z3].186	.186	.008	
	.303	[k].540		.016		[k].027	[l,e].259	[m].061	[p].054	.881	[z4].004		.185	[w].008	
Average	0.301	0.545	0.013	0.014	0.024	0.024	0.256	0.062	0.055	0.891	0.005	0.184	0.183	0.009	
General average	0.301	0.545	0.014		0.024		0.256	0.062	0.055	0.891	0.005	0.184		0.009	

[a] Precipitated at 40 °C, washed with a 1-percent solution of KNO_3 and titrated with alkali standardized by the use of acid potassium phthalate and the ratio 23 NaOH:1P.

[b] Potentiometric titration.

[c] Molybdenum-blue photometric method. See J. Research NBS **26,** 405 (1941) RP1386.

[d] 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_3 solution. Titer based on 93 percent of the theoretical factor.

[e] Double dehydration with intervening filtration.

[f] Diethyldithiocarbamate photometric method. See J. Research NBS **47,** 380 (1951) RP2265.

[g] Chromium separated from the bulk of the iron in a 10-g sample by hydrolytic precipitation with $NaHCO_3$, oxidized with persulfate, and titrated potentiometrically with ferrous ammonium sulfate.

[h] Vanadium separated as in (g), oxidized with HNO_3, and titrated potentiometrically with ferrous ammonium sulfate.

[i] Alpha-benzoinoxime method. See BS J. Research **9,** 1(1932) RP453.

[j] Sulfuric acid digestion for 4 hr of a 0.5-g sample. See J. Research NBS **43,** 201 (1949) RP2021.

[k] Titrating solution standardized with a standard steel.

[l] Sulfuric acid dehydration.

[m] H_2S-electrolysis method.

[n] Gaseometric method.

[o] Diethyldithiocarbamate photometric method.

[p] Photometric method.

[q] Perchloric acid oxidation.

[r] Vanadium separated with cupferron and determined by $FeSO_4$-$(NH_4)_2S_2O_8$-$KMnO_4$ method.

[s] Copper-ammonia complex photometric method.

[t] Nitric acid oxidation, potentiometric titration with ferrous ammonium sulfate.

[u] Potentiometric titration with $HgNO_3$.

[v] Neocuproine photometric method.

[w] Distillation-photometric with Nessler's reagent.

[x] Sulfur gases absorbed in H_2O_2 and titrated with sodium borate.

[y] H_2S-CuS-CuO.

[z] Chromium removed by ZnO precipitation.

[z1] H_2S-alpha-benzoinoxime-CuO method.

[z2] Mercury cathode-$FeSO_4$-$KMnO_4$ method.

[z3] H_2S-MoS_3-MoO_3.

[z4] $NaHCO_3$ hydrolysis followed by double cupferron precipitation. Vanadium determined by H_2O_2-photometric method.

Analyst 1 obtained a value of 0.024-percent sulfur by evolution (HCl, sp. gr. 1.18, ZnS-iodine, theoretical sulfur titer). This is not a certified value, and is for information only.

List of Analysts

1. Ferrous Laboratory, National Bureau of Standards. J. I. Shultz in charge. Analysis by R. E. McIntyre, E. June Maienthal, J. R. Spann, and A. Skapars.
2. J. Henderson, United States Steel Corp., Edgar Thomson Works, Braddock, Pa.
3. W. M. Davidson, National Tube Division, United States Steel Corp., Ellwood Works, Ellwood City, Pa.
4. W. H. Wooding, Industrial Test Laboratory, Philadelphia Naval Base, Philadelphia, Pa.
5. C. L. Abbott, Bethlehem Steel Corp., Lackawanna Plant, Lackawanna, N. Y.
6. E. W. Polley, The Youngstown Sheet and Tube Co., Youngstown, Ohio.
7. E. R. Vance, The Timken Roller Bearing Co., Canton, Ohio.
8. D. P. Robertson, Weirton Steel Co., Weirton, W. Va.

The steel for the preparation of this standard was furnished by the United States Steel Corporation.

HINGTON, D. C. 20234
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W. Wayne Meinke, Chief,
Office of Standard Reference Materials.

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