UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON, D. C.

National Bureau of Standards
Certificate of Analyses

Standard Sample 134A
Molybdenum—Tungsten—Chromium—Vanadium Steel

ANALYST	C	Mn	P	S		Si	Cu	Ni	Cr	V	Mo		W	
	Direct combustion	Persulfate-Arsenite	Alkali-Molybdate	Gravimetric (direct oxidation and final precipitation after reduction of iron)	Combustion Iodate titration	Perchloric acid dehydration	Colorimetric	Colorimetric	Persulfate oxidation	HNO_3 oxidation, potentiometric titration in presence of tungsten	Gravimetric	Colorimetric	Gravimetric	Colorimetric
1	0.804	[a,b] 0.218	[c] 0.019	0.006	[d] 0.005	[e] 0.329	[f] 0.099	[g] 0.089	[b] 3.65	[b] 1.24	[h] 8.32		[i] 2.03	[j] 2.05
2	.808	[a,k] .213, [l] .217	[m] .021		.008	.329	[n] .099	[o] .091, .087	3.68	1.24	[p] 8.36	8.29	1.98	[q] 1.98
3	.811	[l] .221	[r] .020	.006	.008	.330	[n] .099	.086	[s] 3.68	1.23		8.36		[q] 2.05
4	.806	[t,k] .217	[k] .017, [u] .018	.006	[v] .006	.321	[f] .102	[o,k] .092	3.69	[b] 1.25		8.41		[q] 1.98
5	.807	[t,k] .223	[w,k] .016	.008	[v,k] .007	[x] .327	[n] .098	.086	[s] 3.67	[k] 1.25		8.38		[q] 1.97
6	.802	[t] .223	.018		.008	[y] .316	[z] .109	[o] .082	[s] 3.68	1.25		8.39	[i] 2.01	
7	.812	[t,l] .219, [b,k] .215	.020		[d] .007	.320	[f] .101	[z1] .090	[b] 3.69	1.26	[z2] 8.32	8.31	2.06	[q] 1.99
8	.808	[t] .22	.018		.006	[y] .325	[z3] .104	[g] .09	[z4] 3.69	1.25	[z2] 8.34	8.37	1.97	1.98
9	.813	[l] .209	[u] .018	.008	[d] .008	[x,e] .313	[z5] .095	.090	[b] 3.64	[z6] 1.25	[z7] 8.36		[z7] 1.99	
Average	0.808	0.218	0.018	0.007	0.007	0.323	0.101	0.088	3.67	1.25	8.34	8.36	2.01	2.00
General average	0.808	0.218	0.018	0.007		0.323	0.101	0.088	3.67	1.25	8.35		2.00	

[a] Chromium separated by hydrolytic precipitation with $NaHCO_3$.
[b] Potentiometric titration.
[c] Molybdate—$Mg_2P_2O_7$.
[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] Weighed as nickel dimethylglyoxime.
[h] Alpha-benzoinoxime method after removal of tungsten by acid digestion. Corrected for molybdenum occluded in tungsten, and the main molybdenum precipitate corrected for ammonia insoluble and tungsten. See BS J. Research 9, 1 (1932) RP453.
[i] Tungsten precipitated by acid digestion and cinchonine. Ignited WO_3 corrected for silicon, iron, chromium, vanadium, and molybdenum.
[j] Dithiol photometric method.
[k] Titrating solution standardized by the use of a standard steel.
[l] Periodate-photometric method.
[m] Tungsten removed, and phosphorus precipitated as the molybdate in hot nitric acid solution.
[n] Diethyldithiocarbamate photometric method.
[o] Dimethylglyoxime precipitate titrated with cyanide.
[p] Molybdenum precipitated with alpha-benzoinoxime, reprecipitated as MoS_3, ignited, and weighed as MoO_3.
[q] Hydroquinone photometric method.
[r] Molybdenum-blue photometric method. See J. Research NBS 26, 405 (1941) RP1386.
[s] Perchloric acid oxidation.
[t] Chromium separated with ZnO.
[u] Molybdenum-blue photometric method.
[v] Combustion gases absorbed in $NaOH$–H_2O_2. Solution titrated with H_2SO_4.
[w] Tungsten removed and vanadium reduced. Phosphorus precipitated at 60° C, washed with a 1-percent solution of KNO_3 and titrated with alkali.
[x] Nitric-sulfuric acid dehydration.
[y] Hydrochloric-nitric acid dehydration.
[z] Copper-ammonia-complex photometric method.
[z1] Polarographic method.
[z2] MoS_3–MoO_3 method.
[z3] H_2S–CuS–CuO.
[z4] Chromium oxidized by permanganate.
[z5] Neo-Cuproine photometric method.
[z6] Phosphotungstovanadate photometric method (Anal. Chem. 21, 605 (1949).
[z7] W and Mo, in a 1.5-g sample, precipitated with cinchonine plus alpha-benzoinoxime. Precipitate ignited and fused with $KHSO_4$. Melt dissolved in HCl–HF. Solution placed on an anion exchange column and W and Mo separated by selective elution. W precipitated with cinchonine and weighed as WO_3. Mo precipitated with alpha-benzoinoxime and weighed as MoO_3.

Analyst 3 reported 0.065 percent cobalt.
Analyst 7 reported 0.012 percent tin.

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 L. A. Machlan.
2. C. H. Bryant, Vulcan Crucible Steel Co., Division of H. K. Porter Co., Inc., Aliquippa, Pa.
3. O. L. Van Valkenburgh, S. M. Dibble, Crucible Steel Co. of America, Sanderson-Halcomb Works, Syracuse, N. Y.
4. J. M. Henderson, Latrobe Steel Co., Latrobe, Pa.
5. R. H. Van Tyne, Firth Sterling Inc., Pittsburgh, Pa.
6. C. M. Carlisle, Jessop Steel Co., Washington, Pa.
7. W. L. Emerson, The Cleveland Twist Drill Co., Cleveland, Ohio.
8. J. F. Connor, Braeburn Alloy Steel Corporation, Braeburn, Pa.
9. M. D. Cooper, A. H. Jones, R. E. Kohn, W. R. Lee, R. B. Loranger, General Motors Corporation, Research Staff, Detroit, Michigan.

The steel for the preparation of this standard was furnished by Universal-Cyclops Steel Corporation, Titusville, Pa.

WASHINGTON, D. C., May 6, 1957.

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