UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON 25, D. C.

National Bureau of Standards
Certificate of Analyses
Standard Sample 50c
TUNGSTEN—CHROMIUM—VANADIUM STEEL

ANALYST	C	Mn	P		S		Si	Cu	Ni	Cr	V	Mo	W	Sn	As	N
	Direct combustion	Persulfate-Arsenite	Gravimetric (weighed as $Mg_2P_2O_7$ after removal of arsenic)	Alkali-Molybdate	Gravimetric (direct oxidation and final precipitation after reduction of iron)	Combustion Iodate titration	Perchloric acid dehydration	H_2S-CuS-CuO	Weighed as nickel dimethylglyoxime	$FeSO_4$-$KMnO_4$ titration	HNO_3 oxidation, potentiometric titration	Colorimetric				Distillation-titration
1	0.714	[a] 0.340	0.022		0.007	[b] 0.008	[c] 0.316	[d] 0.080	0.066	[e] 4.11	1.16	0.082	[f] 18.46	[g] 0.017	[h] 0.023	[i] 0.012
2	.725	[j,k] .343	.022	[l] .022	.010	[m,l] .010	[n] .310	[o] .074	.064	4.13	1.17	.083	[f] 18.39	.020	[p] .018	
3	.726	[q,k] .349		.020		[b] .010	[n] .322	[d] .084	.068	4.11	1.16	.083	18.49	[r] .021	[h] .027	
4	.724	[s,l] .341	[t] .020	.023	.012	[l] .012	[n] .28	.08	.070	[e,l] 4.15	[l] 1.14	[u] .10	18.32	[g,l] .012		
5	.714	[q] .337		[v] .022	.010	.011	[n] .316	[d] .080	[w] .070	4.12	1.19	.090	[x] 18.40	[g] .022	[y] .017	
6	.718	[k] .339 [z] .341		[l] .023	.011	[a1] .009	.323	[b1] .077	.075	4.13	[c1] 1.17	.075	[f] 18.54			
7	.713	[k] .348		[l] .024		[l] .007	[n] .309	[d] .077	.077	4.11	1.16	.079	18.54			
8	.719	[l] .34	.024	.025	.009	[l] .009	[d1] .312 .321	[d] .076	.067	4.14	1.16	.078	[f] 18.40	[g] .016	[e1] .029	
9	.718	[q,z] .33		.019	.009		.30	[f1] .086	[g1] .066	4.15	[h1] 1.13	.078	[i1] 18.47	[g] .019	.021	
10	.722	[q] .35		.023		.008	[d1] .314	[f1] .078 [j1] .075	[g1] .063	[e] 4.13	1.14	.073	[f] 18.44	[k1] .017 [g] .016		.011
Average	0.719	0.342	0.022	0.022	0.010	0.009	0.311	0.079	0.069	4.13	1.16	0.082	18.44	0.018	0.022	0.012
General average	0.719	0.342	0.022		0.010		0.311	0.079	0.069	4.13	1.16	0.082	18.44	0.018	0.022	0.012

[a] Potentiometric titration.
[b] 1-g sample burned in oxygen at 1450° 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.
[c] Double dehydration with intervening filtration.
[d] Diethyldithiocarbamate photometric method. See J. Research NBS **47**, 380 (1951) RP2265.
[e] Persulfate oxidation, potentiometric titration with ferrous ammonium sulfate.
[f] Tungsten precipitation by acid digestion and cinchonine. Ignited WO_3 corrected for silicon, iron, chromium, vanadium, and molybdenum.
[g] Sulfide-iodine method. See BS J. Research **8**, 309 (1932) RP415.
[h] Distillation-molybdenum blue photometric method. See J. Research NBS **24**, 7 (1940) RP1267.
[i] Sulfuric acid digestion for 3 hours of a 1-g sample. See J. Research NBS **43**, 201 (1949) RP2021.
[j] Bismuthate—$FeSO_4$–$KMnO_4$.
[k] Chromium separated with ZnO.
[l] Titrating solution standardized by the use of a standard steel.
[m] Sulfur gases absorbed in H_2O_2 and titrated with sodium borate.
[n] Nitric-hydrochloric acid digestion.
[o] Neo-cuproine colorimetric method.
[p] Distillation-As_2S_3-Ag_3AsO_4-KCNS titration method.
[q] Periodate photometric method.
[r] Polarographic method.
[s] Potentiometric titration with $HgNO_3$.
[t] Weighed as ammonium phosphomolybdate.
[u] H_2S-MoS_3-MoO_3.
[v] Molybdenum-blue photometric method. See J. Research NBS **26**, 405 (1941) RP1386.
[w] Dimethylglyoxime precipitate titrated with cyanide.
[x] Hydroquinone photometric method.
[y] Distillation-titration with standard $KMnO_4$.
[z] Chromium volatilized as CrO_2Cl_2.
[a1] Sulfur gases absorbed in neutral H_2O_2 and titrated with NaOH.
[b1] Copper precipitated with $Na_2S_2O_3$.
[c1] $FeSO_4$-$(NH_4)_2S_2O_8$-$KMnO_4$ method.
[d1] H_2SO_4 dehydration.
[e1] Distillation-titration with standard $KBrO_3$.
[f1] Finished by electrolysis.
[g1] Dimethylglyoxime photometric method.
[h1] Vanadium oxidized with $KMnO_4$.
[i1] Major portion of tungsten precipitated by hydrolysis and cinchonine in HCl-HNO_3-$HClO_4$ solution. Alpha-benzoinoxime added. WO_3 corrected for Mo, V, NaOH and NH_4OH insolubles.
[j1] 2, 2′ biquinoline colorimetric method.
[k1] H_2S-SnS_2-SnO_2.
Analyst 5 reported 0.035 percent cobalt.

List of Analysts

1. Ferrous Laboratory, National Bureau of Standards. J. I. Shultz, in charge. Analysis by E. June Maienthal, R. E. McIntyre, and Lorna J. Tregoning.
2. A. B. Cargill, Allegheny Ludlum Steel Corporation, Dunkirk, N. Y.
3. W. L. Emerson, The Cleveland Twist Drill Company, Cleveland, Ohio.
4. E. F. Nunemacher, A. R. Uhl, Henry Disston Division, H. K. Porter Company, Inc., Philadelphia, Pa.
5. O. L. VanValkenburgh, S. M. Dibble, Crucible Steel Company of America, Sanderson-Halcomb Works, Syracuse, N. Y.
6. H. A. Burkhardt, Atkins Saw Division, Borg-Warner Corporation, Indianapolis, Ind.
7. E. Jackman, J. Sernasie, G. Laidlaw, Atlas Steels Limited, Welland, Canada.
8. W. F. Zollinger, Bethlehem Steel Company, Inc., Bethlehem, Pa.
9. J. J. Furey, Electro Metallurgical Company, Niagara Works, Niagara Falls, N. Y.
10. M. J. Noll, A. L. Sloan, J. O. Strauss, Carpenter Steel Company, Reading, Pa.

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A. V. ASTIN, *Director.*