U. S. DEPARTMENT OF COMMERCE

National Bureau of Standards

Certificate of Analyses

OF

STANDARD SAMPLE 133

CHROMIUM-MOLYBDENUM STEEL

ANALYST	C	Mn		P		S		Si	Cu	Ni	Cr	V	Mo		N
	Direct combustion	Bismuthate ($FeSO_4$-$KMnO_4$)	Persulfate-Arsenite	Gravimetric (weighed as $Mg_2P_2O_7$; after removal of arsenic)	Alkali-Molybdate [a]	Gravimetric (direct oxidation and precipitation after reduction of iron)	Combustion	Perchloric acid dehydration	H_2S-CuS-CuO	Weighed as nickel dimethylglyoxime	$FeSO_4$-$KMnO_4$ titration		Gravimetric	Colorimetric	
1	0.116	[b] 0.802	[c] 0.800	0.020	[d] 0.020	0.362		[e] 0.434	0.060	0.292	[f] 13.60	[g] 0.018	[h] 0.554	0.549	[i] 0.046
2	.118		[c] .785		[i] .021	.352	[k] 0.373	.440	[l] .058	.28	[m] 13.59	.024		.565	[n] .043
3	.116		[b] .782		.023	.357		.431		.283	13.59	.025	[o] .554		
4	.122		[b] .814	[p] .023	.024	[q] .354		.431	[l] .061	[r] .276	[m] 13.54	[g] .016	[h] .568		[s] .047
5	.115	.814	[b] .792		.022		[k] .369	.433	[t] .058	[r] .30	13.57	[u] .020	[v] .569	.567	[s] .047
6	.116		[c] .793	.019	[i] .019	.348	[w] .349	[e] .436	[x] .061	[y] .291	13.60	[z] .020	[v] .571	.573	[z1] .047
7	.120	[z2] .784			.022			[e] .438	.069	[y] .281	[m] 13.57	[z3] .021		.57	[z1] .044
	.110	[b] .807	[c] .808		.022	[q] .353	[k] .362	[e] .436	[l] .064	.287	13.55	[u] .021	[h] .551		[z4] .046
9	.122		[c] .798	.021	.022	.354	[k, w] .353	.433	[x] .060	.304	13.61	.014	[v] .535		.048
10	.123		[b] .80		[i] .023	.363	[w] .358	.428	[l] .057	[y] .285	[m] 13.62			.562	[s] .043
11	.121		[c] .798		.022	[q] .348	[z5] .347	.420	[t] .065	[y] .27	[f] 13.60	[g] .024	[h] .540		.046
Averages	**0.118**	**0.802**	**0.797**	**0.021**	**0.022**	**0.355**	**0.359**	**0.433**	**0.061**	**0.286**	**13.59**	**0.020**	**0.555**	**0.564**	**0.046**
General averages	**0.118**	**0.799**		**0.022**		**0.356**		**0.433**	**0.061**	**0.286**	**13.59**	**0.020**	**0.559**		**0.046**

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

[b] Chromium removed by precipitation with ZnO.

[c] Chromium volatilized as CrO_2Cl_2.

[d] Colorimetric method. See J. Research NBS **26**, 405 (1941) RP1386.

[e] Double dehydration.

[f] Persulfate oxidation, potentiometric titration with ferrous ammonium sulfate standardized with recrystallized potassium dichromate.

[g] Nitric acid oxidation, potentiometric titration with ferrous ammonium sulfate solution standardized with recrystallized potassium dichromate.

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

[i] Determination made by Vernon C. Holm by the vacuum fusion method. See BS J. Research **7**, 375 (1931) RP346.

[j] Titrating solution standardized by use of a standard steel.

[k] Sulfur dioxide absorbed in starch-iodide solution and titrated with KIO_3 solution standardized with standard steels.

[l] KI-$Na_2S_2O_3$ titration.

[m] Perchloric acid oxidation.

[n] Solution-distillation method. Sample dissolved in dilute sulfuric acid.

[o] Weighed as $PbMoO_4$.

[p] Weighed as ammonium phosphomolybdate.

[q] Meineke's method.

[r] Glyoxime precipitate ignited and weighed as NiO.

[s] Solution-distillation method. Sample dissolved in dilute HCl.

[t] H_2S-alpha benzoinoxime-CuO.

[u] Vanadium separated by electrolysis with a mercury cathode, and finally titrated with potassium permanganate solution.

[v] Molybdenum precipitated with H_2S and weighed as MoO_3.

[w] Sulfur gases absorbed in NaOH-H_2O_2 solution, and excess NaOH titrated with H_2SO_4.

[x] Finished by electrolysis.

[y] Glyoxime precipitate titrated with NaCN.

[z] Vanadium precipitated with cupferron, and determined by ammonium persulfate-permanganate method.

[z1] Dissolved in H_2SO_4-H_3PO_4. Selenium added and solution fumed. Distillation-titration method.

[z2] Chromium removed by precipitation with $PbNO_3$.

[z3] Chromium separated as $PbCrO_4$. Vanadium determined by differential titration with $FeSO_4$-$KMnO_4$ using o-phenanthroline indicator.

[z4] C. M. Johnson's method. See Iron Age, p. 11, July 26, 1934.

[z5] Sulfur gases absorbed in neutral H_2O_2 solution, titrated with standard NaOH solution.

*LIST OF ANALYSTS

1. Ferrous laboratory, National Bureau of Standards. John L. Hague in charge. Analysis by John P. Hewlett, Jr.
2. E. O. Waltz, Republic Steel Corporation, United Steel Division, Canton, Ohio.
3. E. B. Welch, Firth-Sterling Steel Co., McKeesport, Pa.
4. D. P. Bartell, Allegheny Ludlum Steel Corporation, Brackenridge, Pa.
5. E. R. Vance, Timken Roller Bearing Co., Timken Steel & Tube Division, Canton, Ohio.
   L. P. Chase, Carnegie-Illinois Steel Corporation, South Works, Chicago, Ill.
7. W. D. Brown, Carnegie-Illinois Steel Corporation, Duquesne Works, Duquesne, Pa.
8. Armco Research Laboratories, Middletown, Ohio. Arba Thomas, chief chemist. Analysis by C. S. Mills, J. F. Woodruff, L. Ikenberry and E. Scherrer.
9. A. C. Parsons, Bethlehem Steel Co., Lackawanna Plant, Lackawanna, N. Y.
10. O. L. Van Valkenburgh, Crucible Steel Co. of America, Halcomb Steel Division, Syracuse, N. Y.
11. W. J. Boyer, Rustless Iron & Steel Corp., Baltimore, Md.

The steel for the preparation of this standard was furnished by the Republic Steel Corporation

WASHINGTON, April 18, 1944.

LYMAN J. BRIGGS, *Director*.

U. S. GOVERNMENT PRINTING OFFICE 586782