

UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON

National Bureau of Standards
Certificate of Analyses

Standard Sample 170
Basic Open-Hearth Steel, 0.04% Carbon

ANALYST	C	Mn	P	S	Si	Cu	Ni	Cr	V	Mo	Ti	Al	Sn				
	Direct combustion	Bismutate (FeSO ₄ -KMnO ₄)	Persulfate-Arsenite	Gravimetric (weighed as Mg ₂ P ₂ O ₇ after removal of arsenic)	Alkali-Molybdate ^a	Gravimetric (direct oxidation and precipitation after reduction of iron)	Combustion	Sulfuric acid dehydration	H ₂ S-CuS-CuO	Weighed as nickel dimethylglyoxime	FeSO ₄ -KMnO ₄ titration	Colorimetric	Gravimetric	Colorimetric	Total		
1	0.035		^b 0.230	0.011	^c 0.012		^d 0.033	^e 0.062	^f 0.102	0.040	^g 0.039	^h 0.002	0.006	ⁱ 0.237	0.227	^j 0.026	^k 0.019
2	.034	0.225	0.226		^c 0.012	0.031	^m 0.033	ⁿ 0.063	^o 0.107	^p 0.042	.037	.002	.007	.224	.225	.023	^q 0.018
3	.035		0.218	.014	.013	.032	^r 0.034	^s 0.059	^t 0.098	.044	.036	^u 0.004	.007		.230		
4	.034		0.225		0.013	.032	^r 0.034	.061	.100	.037	.036	.004	^v 0.007	.237	.246		
5	.034		.225	.011	.013	.031	^v 0.035	^w 0.060	.105	.038	.038		^w 0.006	.234		^x 0.026	^k 0.019
6	.036	.226			.015		^r 0.032	^s 0.058	^t 0.098	.041	^v 0.041	^x 0.002	.007		.245		
7	.034		0.222	.013	.013		^r 0.035	^s 0.063	^t 0.103	^u 0.040	.036	.003	.004		.231		^z 0.021
8	.040		0.230		.011		.033	^s 0.060	^t 0.102	^u 0.043	.038	.003	.007		.23	^{aa} 0.030	^z 0.018
9	.032		.232		.010	.032		.055	.101	.041	.038	.003	.007		.222	.028	.015
10			0.226						^{ab} 0.101		.037				.221		
Average	0.035	0.226	0.226	0.012	0.012	0.032	0.034	0.060	0.102	0.041	0.038	0.003	0.006	0.233	0.231	0.027	0.018
General average	0.035	0.226		0.012		0.033		0.060	0.102	0.041	0.038	0.003	0.006	0.231		0.027	0.018

^a Precipitated at 40° C., washed with a 1-percent solution of KNO₃ and titrated with alkali standardized by the use of acid potassium phthalate and the ratio 23NaOH to 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 absorbed in starch-iodine solution. Iodine liberated from iodide by titration, during the combustion, with standard KIO₃ solution based on 93 percent of the theoretical factor.
^e Double dehydration with intervening filtration.
^f Diethylthiocarbamate photometric method. See J. Research NBS 47, 380 (1951). RP2265.
^g Chromium separated from the bulk of iron in a 10-g sample by hydrolytic precipitation with NaHCO₃. Persulfate oxidation and potentiometric titration with ferrous ammonium sulfate.
^h Vanadium separated as in (g). Nitric acid oxidation and potentiometric titration with ferrous sulfate.

ⁱ 5-g sample dissolved in diluted H₂SO₄ and titanium precipitated with cupferron. Ignited precipitate treated with HClO₄-HF, re-ignited and fused in Na₂S₂O₇. Melt dissolved in tartaric sulfuric acid solution, and the H₂S group removed. Iron removed as sulfide in ammoniacal-tartrate solution. Filtrate acidified and titanium precipitated with cupferron. Ignited precipitate corrected for V₂O₅.
^j NaHCO₃-NaOH-Al₂O₃ method. See A. S. T. M. method E30-47.
^k Sulfide-iodine method. See B. S. J. Research 8, 309 (1932) RP415.
^l Titrating solution standardized by use of a standard steel.
^m Combustion gases absorbed in neutral H₂O₂ solution titrated with Na₂CO₃.
ⁿ Silico-molybdate colorimetric method. See Anal. Chem., 21, 589 (1949).
^o Same value by the diethylthiocarbamate photometric method.

^p Dimethylglyoxime photometric method.
^q Tin separated as sulfide, distilled as the bromide and titrated with iodate.
^r Iodate solution standardized on standard steels.
^s Perchloric acid dehydration.
^t Finished by electrolysis.
^u Sulfide-lead molybdate method.
^v SO₂ oxidized with H₂O₂. Titration with sodium tetraborate standardized on a standard steel.
^w Alpha-benzoinoxime-MoO₃ method.
^x NaHCO₃-H₂S-8-hydroxyquinoline method.
^y Chromium oxidized with perchloric acid. Arsenite-permanganate titration using osmic acid as a catalyzer.
^z Strychnine colorimetric method.
^{aa} KI-Na₂S₂O₃ titration.
^{ab} Tin separated as sulfide, reduced with Stanredue and titrated with iodate.
^{ac} Colorimetric.
^{ad} Aluminon colorimetric method.

List of Analysts

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| 1. Ferrous Laboratory, National Bureau of Standards, J. L. Hague in charge. Analysis by J. I. Shultz, J. R. Baldwin, E. D. Brown, C. T. Litsey and C. H. Schreyer. | 6. Chemical Laboratory, Norfolk Naval Shipyard, R. S. Gibbs in charge. Analysis by P. L. DeHaven and J. B. Fay, Jr., Portsmouth, Va. |
| 2. Ross L. Harbaugh, Inland Steel Co., East Chicago, Ind. | 7. Oscar C. Backstrom, United States Steel Co., Clairton Works, Clairton, Pa. |
| 3. W. F. Schniepp, Alan Wood Steel Co., Conshohocken, Pa. | 8. W. R. Sayre, United States Steel Co., Edgar Thomson Works, Braddock, Pa. |
| 4. I. Stead, Emil Sadewasser and E. H. Tull, The Youngstown Sheet and Tube Co., East Chicago, Ind. | 9. W. B. Coleman and Co., Philadelphia, Pa. Analysis by R. F. Stoudt. |
| 5. L. C. Flickinger, The Youngstown Sheet and Tube Co., Youngstown, Ohio. | 10. William Eaton, Keokuk Electro-Metals Company, Keokuk, Iowa. |

The steel for the preparation of this standard was furnished by the Inland Steel Company.

WASHINGTON, D. C., September 25, 1953.

A. V. ASTIN, Director.