

UNITED STATES DEPARTMENT OF COMMERCE
WASHINGTON

National Bureau of Standards
Certificate of Analyses
Standard Sample 111B
Nickel-Molybdenum Steel

ANALYST	C	Mn	P	S		Si	Cu	Ni	Cr	V	Mo		Al			
	Direct combustion	Bismuthate (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	Evolution with HCl (sp. gr. 1.18) ZnS-Iodine (theoretical sulfur titre) ^b	Sulfuric acid dehydration	H ₂ S-CuS-CuO	Weighted as nickel dimethylglyoxime	FeSO ₄ -KMnO ₄ titration	Gravimetric	Colorimetric	Total	
1	0.191	0.707	0.011	0.011	0.014	0.013	0.012	0.304	0.025	1.81	0.074	0.002	0.257	.254	0.043	
2	.194	.695	.012	.012	.014	.015	.012	.299	.032	1.82	.070	.002	.247	.246		
3	.196	.711	.012	.012	.015	.013	.015	.309	.039	1.80	.070		.265			
4	.194		.012	.012	.015	.013	.013	.303	.025	1.81			.249			
	.193	.715	.014	.015	.017	.017		.298	.028	1.81	.065		.262	.040		
	.189	.705	.013	.013	.016			.294	.031	1.83	.070	.002	.254	.248	.044	
7	.193	.705	.012	.012	.015	.015		.31	.031	1.81	.070	.003	.255	.25	.047	
8	.192	.708	.013	.013	.014	.014		.297	.027	1.82	.072	.004	.259	.260		
9	.197	.699	.012	.012	.014	.014		.307	.026	1.81	.066	.003	.262		.041	
Average	0.193	0.705	0.706	0.012	0.012	0.015	0.015	0.013	0.302	0.028	1.81	0.070	0.003	0.256	0.254	0.043
General average	0.193	0.706	0.012			0.014		0.302	0.028	1.81	0.070	0.003	0.255		0.043	

^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 23 NaOH:1P.
^b Value obtained by standardizing the titrating solution by means of sodium oxalate through KMnO₄ and Na₂S₂O₃ and use of the ratio 21:18.
^c Potentiometric titration.
^d Molybdenum-blue photometric method. See J. Research NBS 26, 405 (1941). RP1336.
^e 1-g sample burned in oxygen at 1,400° C. and sulfur dioxide 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.
^f Double dehydration with intervening filtration.
^g Diethylthiocarbamate photometric method. See J. Research NBS 47, (1951). RP2265.

^h Chromium separated from the bulk of the iron in a 10-g sample by NaHCO₃ hydrolysis, oxidized with persulfate, and titrated potentiometrically with ferrous ammonium sulfate.
ⁱ Vanadium separated as in (h), oxidized with HNO₃ and titrated potentiometrically with ferrous ammonium sulfate.
^j Alpha-benzoinoxime method. See BS J. Research 9, 1 (1932) RP453.
^k NaHCO₃-NaOH-Al₂O₃. See ASTM method E 30-47.
^l Titrating solution standardized by use of a standard steel.
^m Burned at 2,200° F. with tin.
ⁿ Sulfuric-nitric acid dehydration.
^o H₂S-α-benzoinoxime-CuO.
^p Dimethylglyoxime precipitate ignited to nickel oxide.
^q Vanadium co-precipitated with phosphomolybdate, reduced with H₂O, and titrated with KMnO₄.

^r H₂S-MoO₃ method.
^s Evolution with diluted hydrochloric acid (1+1).
^t Perchloric acid dehydration.
^u Dimethylglyoxime-diethylthiocarbamate photometric method.
^v Perchloric acid photometric method.
^w Burned at 2,400-2,500° F.
^x KI-Na₂S₂O₃ titration.
^y Dimethylglyoxime-KCN titration method.
^z Bicarbonate-NaOH-AlPO₄ method.
^{aa} Finished by electrolysis.
^{ab} FeSO₄-(NH₄)₂S₂O₈-KMnO₄ titration method.
^{ac} Mercury cathode-Aluminum photometric method.
^{ad} Mercury cathode-S-hydroxyquinoline method.
^{ae} Differential titration with KMnO₄ using o-phenanthroline indicator.
^{af} H₂O₂-NaF photometric method.
^{ag} Analyst 9 also reported 0.014 percent Al₂O₃ and 0.005 percent nitrogen.

List of Analysts

1. Ferrous Laboratory, National Bureau of Standards, John L. Hague in charge. Analysis by J. I. Shultz, E. D. Brown, and J. R. Baldwin.
2. R. F. Lab, D. R. Burrier, and A. C. Hale, Copperweld Steel Co., Warren, Ohio.
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6. Sydney Partington and A. Dobrovich, The Detroit Testing Laboratory, Detroit, Mich.
7. E. R. Vance, The Timken Roller Bearing Co., Steel and Tube Division, Canton, Ohio.
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The steel for the preparation of this standard was furnished by the United States Steel Co.

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A. V. ASTIN, Acting Director.