

ANALYTICAL REFERENCE MATERIALS INTERNATIONAL

CERTIFICATE OF ANALYSIS

Grade: **AISI 440C**

Part Number (Q.A. NO.): **IARM 13B**

Certification Date: **05/30/1998**

Certificate No.: **13B-053098-ARM-F**

INTERPRETATION OF DATA

1. Certified values listed below reflect analysis results submitted by qualified analytical laboratories using a combination of methods and instrumentation that emulate actual methods and instrumental techniques currently utilized in the analytical community.
2. Any data reported and enclosed by a **parentheses ()** is a "**best estimate**" and is **NOT CERTIFIED**. This data could not be quantified sufficiently for certification. It was however, reported by enough laboratories to be considered as potentially present in the matrix of the material being examined.
3. The "Inter-laboratory Analysis Program" (ILAP) utilized in the establishment of the data are an ongoing program with permanent membership. Certain elements may be selected by a consensus of the members for more extensive testing. Therefore the data in **brackets []** indicates **further testing is in process**.
4. The "**Confidence Interval at 95%**" is enclosed by a **parentheses ()** below the individual element's concentration.

IMPORTANT: A "USER REGISTRATION CARD" ACCOMPANIES ALL SHIPMENTS. THIS CARD SHOULD BE COMPLETED IMMEDIATELY UPON RECEIPT OF MATERIALS WITH THE APPROPRIATE USER INFORMATION. THIS IS THE ONLY WAY IN WHICH ARMI CAN GUARANTEE CUSTOMER UPDATES OR POSSIBLE DATA MODIFICATIONS!

<u>Aluminum</u> 0.004 (0.0014)	<u>Boron</u> 0.003 (0.0014)	<u>Carbon</u> 1.02 (0.0077)	<u>Cobalt</u> 0.016 (0.0025)	<u>Chromium</u> 16.78 (0.0612)	<u>Copper</u> 0.030 (0.0029)	<u>Manganese</u> 0.39 (0.0046)	<u>Molybdenum</u> 0.48 (0.0079)
<u>Nitrogen</u> 0.0290 (0.0006)	<u>Niobium</u> 0.003 (0.0014)	<u>Nickel</u> 0.14 (0.0031)	<u>Oxygen</u> 0.0053 (0.0006)	<u>Phosphorus</u> 0.015 (0.0008)	<u>Sulfur</u> 0.001 (0.0002)	<u>Silicon</u> 0.72 (0.0184)	<u>Tin</u> 0.004 (0.0013)
<u>Titanium</u> 0.002 (0.0009)	<u>Vanadium</u> 0.041 (0.0018)	<u>Tungsten</u> 0.003 (0.003)					

The laboratories participating in the "Inter-Laboratory Analysis Program" (ILAP) and certification of this material are as follows:

Allegheny Ludlum Corp., Brackenridge, PA
Allegheny Ludlum Corp., Lockport, NY
Anderson Laboratories, Inc., Greendale, WI
Armco Advance Materials Co., Butler, PA

Armco Research & Technology, Middletown, OH
Chicago Spectro Service Laboratories, Chicago, IL
Laboratory Testing, Inc., Dublin, PA
Lockheed Martin Astronautics, Littleton, CO

Metal Analysis Inc., Huntington Park, CA
Metallurgical Testing Corp., City of Industry, CA
Precision Rolled Products, Inc., Florham Park, NJ
Southern California Edison, San Clemente, CA

TRACEABILITY: All members of the "Inter-Laboratory Analysis Program" (ILAP) listed above validate test methods and instrument performance utilizing SRMs produced by the National Institute of Standards and Technology, (NIST) as well as other CRMs and RMs produced by recognized Certifying Bodies from around the world. The specific SRMs, CRMs and RMs applicable to the material covered by this certificate are:

BS CS 2-1; NIST 11H, 133b, 348A, 293, 123b; LECO 501-553; SRM 3161, IARM 13A, ARMI 13A; LECO CS 3&4, TC436, 501-644; ARL 8660, NIST 51b, 337a; IARM 13A, BS154

A specific line of traceability is established to NIST and other Certifying Bodies for those elements that are noted as "Certified Values" on the Certificates of Analyses referenced above.

SEE REVERSE SIDE FOR STATISTICAL DATA AND ADDITIONAL INFORMATION REGARDING THIS MATERIAL

P.O. Box 2246 ? Evergreen, Colorado 80439 ? Telephone (303) 216-2621 ? FAX (303) 216-2649

THE FOLLOWING DATA AND ACCOMPANYING STATEMENTS REPRESENT ALL PERTINENT INFORMATION REPORTED IN THE INTER-LABORATORY PROGRAM AS IT APPLIES TO THE CHEMICAL CHARACTERIZATION OF THIS MATERIAL AS OF 05/30/1998.

13B	Al	B	C	Co	Cr	Cu	Mn	Mo	N	Nb	Ni	O	P	S	Si	Sn	Ti	V	W
1	0.006	0.008	1.04	0.021	16.92	0.04	0.40	0.499	0.0303	0.006	0.15	0.0063	0.017	0.001	0.78	0.007	0.0050	0.0464	0.005
2	0.0054	0.0011	1.038	0.020	16.908	0.035	0.401	0.493	0.0297	0.0055	0.150	0.00605	0.016	0.001	0.752	0.0056	0.004	0.0430	0.003
3	0.0053	0.0005	1.026	0.02	16.896	0.0345	0.400	0.481	0.0294	0.004	0.15	0.0060	0.016	0.0009	0.752	0.0053	0.003	0.0426	0.003
4	0.005	0.0005	1.023	0.019	16.88	0.0342	0.40	0.48	0.0291	0.0039	0.149	0.0058	0.0151	0.0006	0.732	0.004	0.003	0.042	0.0022
5	0.0042	0.0003	1.022	0.018	16.79	0.033	0.397	0.479	0.0287	0.003	0.144	0.0055	0.015	0.0005	0.73	0.004	0.0020	0.042	
6	0.0027	0.0002	1.021	0.0164	16.76	0.030	0.394	0.478	0.0286	0.002	0.143	0.0051	0.015	0.0005	0.72	0.003	0.002	0.042	
7	0.002		1.013	0.015	16.758	0.03	0.39	0.471	0.0284	0.002	0.143	0.0046	0.0146	0.0004	0.72	0.003	0.0015	0.04	
8	0.002		1.011	0.0150	16.75	0.030	0.388	0.470	0.0283	0.0013	0.142	0.0045	0.0144	0.0004	0.711	0.0026	0.0011	0.040	
9	0.002		1.011	0.014	16.74	0.03	0.387	0.47	0.0281	0.001	0.140	0.0040	0.01	0.0002	0.701	0.0017	0.001	0.040	
10	0.0004		1.01	0.014	16.711	0.026	0.386	0.461			0.14		0.014	0.0002	0.701	0.0009	0.001	0.039	
11			1.005	0.010	16.67	0.0257	0.385	0.46			0.137		0.01		0.687		0.0009	0.039	
12				0.0088	16.63	0.025	0.38	0.46					0.012		0.683			0.035	
13						0.023									0.676				
MEAN	0.0035	0.0015	1.0200	0.0159	16.7844	0.0305	0.3923	0.4752	0.0290	0.0032	0.1444	0.0053	0.0147	0.0006	0.7188	0.0037	0.0022	0.0409	0.0033
STDV.	0.0019	0.0029	0.0114	0.0039	0.0963	0.0048	0.0072	0.0124	0.0007	0.0018	0.0047	0.0008	0.0013	0.0003	0.0304	0.0019	0.0014	0.0028	0.0012
CERTIFIED	0.004		1.02	0.016	16.78	0.030	0.39	0.48	0.0290	0.003	0.14	0.0053	0.015	0.001	0.72	0.004	0.002	0.041	(0.003)
95% C.I.	0.0014		0.0077	0.0025	0.0612	0.0029	0.0046	0.0079	0.0006	0.0014	0.0031	0.0006	0.0008	0.0002	0.0184	0.0013	0.0009	0.0018	

The International Standards Organization (ISO) definitions, expressed in ISO Guide 30-1981-(E) list the following:

CERTIFYING BODY: A technically competent body (organization or firm, public or private) that issues a Reference Material Certificate. The only generally accepted certifying body in the United States is the U. S. Department of Commerce, National Institute of Standards & Technology, (NIST), Gaithersburg, MD.


REFERENCE MATERIAL (RM): A material or substance with one or more properties which are sufficiently well established to be used for calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

CERTIFIED REFERENCE MATERIAL (CRM): A reference material with one or more properties whose values are certified by a technically valid procedure accompanied by or traceable to a certificate or other documentation, which is issued by a Certifying Body.

INTER-LABORATORY ANALYSIS PROGRAM: Although ASTM Standard E691-87 applies to inter-laboratory studies to "Determine the Precision of a Single Test Method", it is also a well thought out and logical plan for conducting an inter-laboratory program involving multiple techniques. Therefore, the planning, conducting, analyzing, protocol and treatment of data resulting from this inter-laboratory program were performed utilizing the guidelines established in ASTM E691-87.

METHODS OF ANALYSIS: In view of the fact that the "Inter-Laboratory Analysis Program" entails a wide variety of materials, no single analytical method would provide optimum data results. Therefore the methods utilized were a combination of ASTM Standard Methods for classical wet chemistry, ICP, AA, Optical Emission and X-Ray spectrometric methods. The determinations for Carbon, Sulfur, Nitrogen and Oxygen are the result of combustion instrument procedures.

SELECTION OF MATERIALS: A "batch" or "series" is defined as a single bar of one continuous length. The majority of materials are in wrought condition. Other methods of manufacture are utilized as a last resort, only in the case of those materials being unavailable in wrought condition. "Batch" samples are taken by removing a one inch cross section for every thirteen inches of total length from the entire bar. Twenty-five percent of the one inch cross section is converted to chips for analysis by classical wet chemistry, ICP, AA, and combustion procedures and seventy-five percent remains in a solid disk form for OES and X-Ray analysis where applicable. Each member of the ILAP is furnished both a solid sample and the corresponding supply of chips from a specific location on the batch bar. This massive sampling procedure results in the homogeneity being reflected as a product of the overall statistics and certified data. To insure that there are no gross abnormalities in the batch homogeneity, effective with materials certified after 10/20/91, specific homogeneity testing is being performed utilizing applicable sections, determined by the ILAP program management, for homogeneity test procedures as outlined in ASTM E-826-87, NBS Handbook 91, "Experimental Statistics", as well as other established practices for determination of practical homogeneity.

Certified by: 
R. Dan Brown, President
Analytical Reference Materials International

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Revision Date/No.: N/A