

# Analytical Reference Materials International

## Certificate of Analysis Certified Reference Material



Grade: Alloy 400 / UNS N04400

Part Number (Q.A. NO.): IARM 51C

Certificate Date: 11/28/2007

Certificate No.: 51C-11282007-IARM-F

Revision Date: 02/12/2008

### 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 and are reported as % wt. unless otherwise noted.
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 "±Estimated Uncertainty" is enclosed by a parentheses ( ) below the individual element's concentration and is based on a Confidence Interval at 95%. Included in this estimated uncertainty, are the combined effects of method imprecision, material inhomogeneity, and any bias between methods.

**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> 0.13 (0.01)	<u>Boron</u> 0.122 (0.003)	<u>Carbon</u> 0.019 (0.001)	<u>Cobalt</u> 0.36 (0.01)	<u>Chromium</u> 31.6 (0.1)	<u>Copper</u> 2.17 (0.01)	<u>Iron</u> <0.0005	<u>Lead</u>
<u>Magnesium</u> 0.0096 (0.0001)	<u>Manganese</u> 1.01 (0.01)	<u>Molybdenum</u> 0.072 (0.003)	<u>Nitrogen</u> 0.0004 (0.0002)	<u>Niobium</u> 0.003 (0.001)	<u>Nickel</u> 64.4 (0.1)	<u>Oxygen</u> (0.002)	<u>Phosphorus</u> 0.010 (0.0003)
<u>Silicon</u> 0.11 (0.01)	<u>Sulfur</u> 0.005 (0.0004)	<u>Tantalum</u> (0.01)	<u>Tin</u> (0.001)	<u>Titanium</u> 0.026 (0.001)	<u>Tungsten</u> 0.021 (0.001)	<u>Vanadium</u> 0.002 (0.001)	<u>Zirconium</u> 0.002 (0.001)

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

ATI Allvac - Lockport, NY  
Bodycote Testing - Portland, OR  
Colonial Metals Co. - Columbia, PA  
IMR Test Labs - Lansing, NY  
Latrobe Specialty Steel Co. - Latrobe, PA  
SGS Lakefield - Lakefield, ON

Bodycote Testing - Los Angeles, CA  
Carpenter Technology Corporation - Reading, PA  
Huntington Alloys Corporation - Huntington, WV  
Laboratory Testing, Inc. - Hatfield, PA  
Outokumpu Stainless OY - Tornio Finland  
Special Metals IncoTest - Hereford, UK

**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: IARM 51B, 202A, BS CS5, 400B, 400C, RV 9892B, 052944, LECO 501-501, 501-503, 501-504, 501-643, NIST 882, NIST 160B, HAS 400M, 400T, 805B, ALPHA AR645, AR881, LECO 501-550, 502-256, NIST 162A, 3102A, 3103A, 3107, 3112A, 3113, 3126A, 3128, 3131A, 3134, 3137, 3139A, 3151, 3155, 3161A, 3162A, 3163, 3165, 3169, LECO 501-503, 501-643, ALPHA AR511, HAS 400T, BCS 351, 454/1, 462/1, LECO 501-551, 502-102, IARM 51B, NIST 162, NA 1B, 2B, 3B, BS 200-2, 400C, LECO 501-501, 501-503, 501-643, IARM 51A, 57A, 190A, CPI4400 10M121, 10M343, 1000373, 5M651, 10M633, 10M691, ALPHA AR873, LECO501-506, 501-550, NIST 362, C1248, BS 400B, 400C, IARM 27D, 51A, 51B, LECO 502-257, ALPHA AR1648, IARM 51B, NIST 3103A, 3165, IARM 51A, 51B

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.**

The following data and accompanying statements represent all pertinent information reported in the ILAP as it applies to the chemical characterization of this material as of 02/12/2008.

51C	Al	B	C	Co	Cr	Cu	Fe	Mg	Mn	Mo	N	Nb	Ni	O	P
1	0.140	<0.0005	0.130	0.0195	0.342	31.84	2.170	0.0094	1.02	0.080	0.0005	0.0046	64.60	0.0026	0.0099
2	0.137	0.00042	0.1162	0.0187	0.3900	31.485	2.209	0.0095	1.014	0.0748	0.0007	0.0027	64.539	0.0034	0.0102
3	0.1352	0.0026	0.1243	0.020	0.364	31.4767	2.1300	0.0095	1.001	0.069	0.0004	0.0029	64.3017	0.0006	0.0098
4	0.133	<0.0005	0.1233	0.0185	0.3609	31.65	2.219	0.0096	1.0264	0.0671	0.0001	0.0010	64.24	0.00077	0.0108
5	0.1274	0.0139	0.118	0.019	0.364	31.5127	2.1585	0.0094	1.034	0.0755	0.000275	0.0034	64.538	0.0024	0.0090
6	0.137	<0.0005	0.1233	0.02058	0.3593	31.78	2.184	0.0098	0.9965	0.0749	0.00020	0.0043	64.26	0.0017	0.0095
7	0.1259	0.0006	0.1240	0.0181	0.35285	31.4218	2.1665	0.0097	1.004	0.0774	0.0003	0.0030	64.36	0.00075	0.0102
8	0.1292		0.1180	0.0202	0.3627	31.58	2.136		1.004	0.0728	0.00014	0.0045	64.257	0.0015	0.0101
9	0.133		0.120	0.0190	0.341	31.70	2.181		1.035	0.0738	0.0006	0.0003	64.402		0.010
10	0.117		0.1254	0.020	0.353	31.636	2.187		1.019	0.0640		0.007	64.40		0.0099
11	0.137		0.1190	0.0180	0.386	31.606	2.143		0.992	0.076		0.0032	64.302		
12	0.152		0.1199		0.370	31.454	2.185		1.00	0.0634					
13	0.138				0.3584	31.80	2.17		0.9980						
14						31.735	2.153								
Mean	0.1340	0.0044	0.1218	0.0192	0.3619	31.6198	2.1709	0.0096	1.0111	0.0724	0.0004	0.0034	64.3818	0.0017	0.0099
STDV.	0.0083	0.0064	0.0039	0.0009	0.0143	0.1376	0.0258	0.0002	0.0146	0.0053	0.0002	0.0018	0.1270	0.0010	0.0005
Certified	0.13		0.122	0.019	0.36	31.6	2.17	0.0096	1.01	0.072	0.0004	0.003	64.4	(0.002)	0.010
95% C.I.	0.01		0.003	0.001	0.01	0.1	0.01	0.0001	0.01	0.003	0.0002	0.001	0.1		0.0003
Methods	X,I,O		C,O	X,I,O	X,I,O	X,W,I,O	X,I,O	I,O	X,I,O	X,I,O	F	X,I,O	X,W,I,O	F	X,I,O

Legend: W = Classical, C = Combustion, F = Fusion, A = AA or GFAA, I = ICP or DCP, D = DC Arc, O = OE, X = XRF, G = GDMS, H = Hollow Cathode OE

51C	S	Si	Ta	Ti	V	W	Ag	As	Bi	Ca	La	Pb	Sb	Sn	Zr
1	0.0050	0.100	0.0120	0.025	0.0034	0.0201	<0.0001	0.0019	<0.0001	0.00016		0.0003	0.0017	0.0004	0.0019
2	0.00537	0.114	0.00067	0.0258	0.0016	0.0216	0.0033	0.0018	0.00005	0.0005		0.000321	0.0044	0.0005	0.0013
3	0.0042	0.0960	0.0131	0.027	0.0025	0.0191	0.0002	0.0024	<0.00003			0.00033	0.0005	0.0015	0.0034
4	0.0055	0.113	0.01017	0.0246	0.002	0.021	0.00024	0.0031				0.0003	0.00012	0.0006	0.0022
5	0.0056	0.129	0.0024	0.027	0.0005	0.02074									0.0033
6	0.0047	0.1035	0.0027	0.0245	0.0018	0.0172									0.00202
7	0.0056	0.1050		0.0242	0.0021	0.0213									0.0013
8	0.0050	0.10800		0.0270	0.0031	0.023									0.0017
9	0.0054	0.1286		0.0264	0.0028										
10	0.0043	0.1186		0.025											
11		0.110		0.0287											
12		0.114													
13		0.108													
14		0.1160													
Mean	0.0051	0.1117	0.0068	0.0259	0.0022	0.0205	0.0012	0.0023	0.0001	0.0003		0.0003	0.0017	0.0008	0.0021
STDV.	0.0005	0.0096	0.0055	0.0014	0.0009	0.0017	0.0018	0.0006		0.0002		0.0000	0.0019	0.0005	0.0008
Certified	0.005	0.11	(0.01)	0.026	0.002	0.021		(0.002)				<0.0005	(0.002)	(0.001)	0.002
95% C.I.	0.0004	0.01		0.001	0.001	0.001									0.001
Methods	X,C,O	X,W,I,O	X,I,O	X,I,O	X,I,O	X,I,O		H,I				X,H,A	H,A,I	X,H,I,O	X,I,O

Legend: W = Classical, C = Combustion, F = Fusion, A = AA or GFAA, I = ICP or DCP, D = DC Arc, O = OE, X = XRF, G = GDMS, H = Hollow Cathode OE

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.

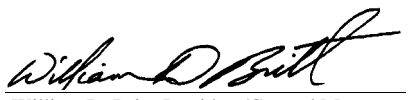
**Reference Material (RM):** A material or substance with one or more properties, which are sufficiently well established to be used for calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

**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 (ILAP):** 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 and heat. The majority of materials are in wrought condition; other methods of manufacture are utilized as a less desirable resort. ILAP samples are taken by removing a section, a minimum of, every one-twelfth of total length from the entire bar. A portion of the section is converted to chips and thin (pin) disk for analysis by classical wet chemistry, ICP, AA, and combustion procedures, and the balance remains as a thick disk for OES and X-Ray analysis. Each member of the ILAP is furnished a sample pack from a specific location on the batch bar. This systematic sampling procedure results in the homogeneity being reflected as a product of the overall statistics and certified data. This method of homogeneity testing is in accordance with ISO Guide 34, regarding the systematic selection and testing of a representative number of units for the assessment of homogeneity.

Certified by:   
 William D. Britt, President/General Manager  
 Analytical Reference Materials International

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