Analytical Reference Materials International

Certificate of Analysis Certified Reference Material



Grade: EnviroBrass 2-2 / UNS C89520

Part Number (Q.A. NO.): IARM 227A

Certificate Date: **08/12/2002** Certificate No.: **227A-08122002-IARM-F** Revision Date: **11/06/2007**

Interpretation of Data

- 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>Silver</u> 0.004 (0.001)	Aluminum 0.002 (0.0004)	<u>Antimony</u> <0.01	Arsenic 0.003 (0.001)	Bismuth 2.3 (0.05)	Carbon 0.003 (0.001)	Cobalt 0.001 (0.0003)
<u>Chromium</u> (0.001)	Copper 85.9 (0.2)	<u>Iron</u> 0.060 (0.002)	Manganese 0.001 (0.0004)	Nickel 0.53 (0.01)	<u>Nitrogen</u> (0.0002)	Oxygen 0.0013 (0.0003)
Phosphorus 0.003 (0.001)	<u>Lead</u> 0.042 (0.002)	Sulfur 0.005 (0.0005)	Selenium 1.21 (0.02)	Silicon 0.002 (0.0004)	<u>Tin</u> 5.1 (0.04)	Zinc 4.70 (0.02)

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

Anderson Laboratories, Inc. - Greendale, WI AY Mc Donald Mfg. Co. - Dubuque, IA Colonial Metals Co. - Columbia, PA Gamma Foundries Co. - Richmond Hill, ON Neptune Technology Group Inc. - Tallassee, AL Sipi-Metals Corp - Chicago, IL

The Federal Metal Co. - Bedford, OH

Applied Research Laboratories - Dearborn, MI Bodycote Materials Testing - Portland, OR Concast Metal Products Co. - Mars, PA I. Schumann & Company - Bedford, OH NSL Analytical Services - Cleveland, OH Special Metals IncoTest - Hereford, UK

Atlas Pacific Corporation - Colton, CA California Metal-X - Los Angeles, CA Crucible Research - Pittsburgh, PA Laboratory Testing, Inc. - Hatfield, PA

Riverside Brass & Aluminum Foundry Ltd. - New Hamburg, ON Stork Materials Testing and Inspection - Huntington Beach, 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: NIST 131G, LECO 501-550, 502-403, BAM 376, BAS 54.03-4, BNF C11.02-1, C11.03-0, BS 903, 903B, 314B, CC905, CKD 320, 321, CTIF 4583, 4873, UE14, UE15.1, UE40, Federal STD-1, STD-2, STD-3, MBH 14953-C, 14954-B, 14956-B, 14958-B, 17866-K, 17868-S, 17869-K, 17870-K, 17870-S, 32X/PB5-H, 32X/SEB1-A, 32X/SEB2-A, 32X/SEB3-A, 32X/SEB4-A, 32X/SEB4-A, 32X/SEB4-A, 32X/SEB4-A, 32X/SEB4-A, 32X/SEB4-A, 32X/SEB5-A, 32X/SEB6-A, NIST 124A, 13F, C1252, BAM 22X/SEB1-A, 32X/SEB5-A, 32X/SEB5-A, 32X/SEB6-A, NIST 124A, 13F, C1252, BAM 222, MBH 178700, BCS 207/2, IARM 92A, CTIF VE10-VE51, BNFC 71.31, 71.32, 71.33, 71.34, MBH 32XPB11, #31062-691807, #3149-690912, NIST 3102A, 3103A, 3105A, 3106, 3112A, 3113, 3126A, 3128, 3132, 3136, 3139A, 3149, 3161A, 3168A, BCS 301/1, 304/1, 374, 385, 642, BAM 376, BS 932E, CTIF CA-27, SPEX 3112A, VHG 3101A, 3106, 3113, 3126A, 3132, 3136, 3139A, 3149, 3161A, 3168A, BCS 301/1, 304/1, 374, 385, 642, BAM 376, BS 932E, CTIF CA-27, SPEX 3112A, VHG 3101A, 3106, 3113, 3126A, 3132, 3136, 3139A, 3149, 3161A, 3168A, BCS 301/1, 304/1, 374, 385, 642, BAM 376, BS 932E, CTIF CA-27, SPEX 3112A, VHG 3101A, 3106, 3113, 3126A, 3132, 3136, 3139A, 3149, 3161A, 3168A, BCS 301/1, 304/1, 374, 385, 642, BAM 376, BS 932E, CTIF CA-27, SPEX 3112A, VHG 3101A, 3106, 3113, 3126A, 3132, 3136, 3139A, 3149, 3161A, 3168A, BCS 301/1, 304/1

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 11/06/2007.

227A	Ag	Al	As	Be	Bi	С	Co	Cr	Cu	Fe	Mn	Ni	P	Pb	S
1	0.0055	0.0030	0.0040	< 0.0010	2.13	0.00137	0.0015	0.0020	86.07	0.069	0.0016	0.538	0.004	0.044	0.0063
2	0.0034	0.0011	0.00064	0.0010	2.48	0.0026	0.0017	0.001	85.995	0.055	0.0010	0.53	0.0015	0.046	0.0041
3	0.005	0.003	0.0017	0.0008	2.45	0.0035	0.001	0.0012	85.68	0.061	0.001	0.5593	0.0032	0.03867	0.0054
4	0.0032	0.003	0.0065	0.00004	2.279	0.0022	0.0017	0.0018	85.62	0.0683	0.0001	0.519	0.0015	0.040	0.0045
5	0.0035	0.0019	0.0007	< 0.001	2.340	0.0026	0.0012	0.0006	86.258	0.065	0.001	0.5325	0.0007	0.042	0.0044
6	0.004	0.0020	0.005	< 0.0002	2.29	0.0028	0.0011	0.0007	86.11	0.057	0.0019	0.515	0.0026	0.050	0.0045
7	0.003	0.001	0.0038	< 0.0001	2.366	0.0028	0.0015	0.0022	85.52	0.0649	0.0010	0.528	0.001	0.0435	0.0046
8		0.0015	0.0010		2.262				86.22	0.058	0.001	0.541	0.0013	0.044	0.0041
9		0.0019	0.0024		2.51				85.625	0.060	0.002	0.539	0.0030	0.046	0.0055
10		0.0020	0.0007		2.117				86.05	0.057	0.00083	0.528	0.0034	0.035	0.0039
11		0.0018	0.004		2.177					0.056		0.569	0.005	0.042	0.0054
12		0.0013	0.005		2.47					0.059		0.521	0.0038	0.0428	0.0058
13		0.0015	0.0036		2.380					0.0530		0.544	0.001	0.0459	0.0052
14		0.002			2.42					0.059		0.57	0.0059	0.039	0.003
15		0.00207			2.21					0.060		0.53	0.0033	0.039	0.0030
16		0.0037			2.305					0.055		0.530	0.0035	0.035	0.0048
17					2.40					0.048		0.523		0.0454	0.005
18					2.281					0.0597		0.5356		0.041	0.0068
19					2.34					0.063		0.526	İ	0.038	0.0036
20		İ	1		2.458	1				0.059		0.525		0.04402	
21		1	1	1		1		1		0.06858	1	0.51537			1
22										0.0618		0.553			
23	l	1	1	1	l	1		1	1	0.0634	1	0.503	l	l	
(0.0007		0.000			
	0.0000	0.0000	0.0030	0.0000	0.0004	0.0000	0.0014	0.0014	05.04.40	0.0000	0.0044	0.5007	0.0000	0.0404	0.0047
Mean	0.0039	0.0020		0.0006	2.3334	0.0026			85.9148	0.0600	0.0011	0.5337	0.0028	0.0421	0.0047
STDV.	0.0010	0.0008	0.0019	0.0005	0.1164	0.0007	0.0003	0.0006	0.2748	0.0051	0.0006	0.0167	0.0015	0.0039	0.0010
Certified	0.004	0.002	0.003		2.3	0.003	0.001	(0.001)	85.9	0.060	0.001	0.53	0.003	0.042	0.005
95% C.I.	0.001	0.0004	0.001		0.05	0.001	0.0003		0.2	0.002	0.0004	0.01	0.001	0.002	0.0005
Methods	X,I,O	X,I,O	X,I,O	I,O	X,W,A,I,O	C,I	I,O	X,D,I,O	X,W,I,O	X,W,I,O	X,D,I,O	X,W,I,O	X,I,O	X,W,I,O	X,C,I,O
r			Methods: V	V = Classical,	C = Combustio	n, F = Fusion			or DCP, D = D		E, X = XRF, G	=GDMS			
227A	Se	Si	Sn	Zn	Cd	Mg	Mo	0	N	В	Ti	Te	Zr	Sb	
1				211	Ou .							10			
1 1	1.17	0.0024	5.23	4.74	0.001	<0.0010	<0.0010	0.0016	<0.0001	<0.0001	<0.005	<0.0001	<0.0010	0.0024	
2	1.17 1.21	0.0024 0.0010										<0.0001 <0.001			
		0.0024	5.23	4.74	0.001	<0.0010	<0.0010	0.0016	< 0.0001	<0.0001	< 0.005	< 0.0001	< 0.0010	0.0024	
2	1.21	0.0024 0.0010	5.23 5.090	4.74 4.69	0.001 0.0004	<0.0010 <0.001	<0.0010 <0.0001	0.0016 0.0013	<0.0001 0.0001	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001	<0.0010 <0.0001	0.0024 0.0095	
3	1.21 1.290	0.0024 0.0010 0.002	5.23 5.090 4.938	4.74 4.69 4.636	0.001 0.0004 0.00027	<0.0010 <0.001 <0.0001	<0.0010 <0.0001	0.0016 0.0013 0.0010	<0.0001 0.0001 0.0001	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967	
2 3 4	1.21 1.290 1.222	0.0024 0.0010 0.002 0.001	5.23 5.090 4.938 5.050	4.74 4.69 4.636 4.733	0.001 0.0004 0.00027 <0.001	<0.0010 <0.001 <0.0001 <0.001	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144	<0.0001 0.0001 0.0001 0.00001	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045	
2 3 4 5	1.21 1.290 1.222 1.22	0.0024 0.0010 0.002 0.001 0.0008	5.23 5.090 4.938 5.050 5.073	4.74 4.69 4.636 4.733 4.732	0.001 0.0004 0.00027 <0.001 0.0023	<0.0010 <0.001 <0.0001 <0.0001 0.0002	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015	
2 3 4 5 6	1.21 1.290 1.222 1.22 1.174	0.0024 0.0010 0.002 0.001 0.0008 0.001	5.23 5.090 4.938 5.050 5.073 5.11	4.74 4.69 4.636 4.733 4.732 4.76	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015 0.006	
2 3 4 5 6 7	1.21 1.290 1.222 1.22 1.174 1.238	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018	5.23 5.090 4.938 5.050 5.073 5.11 5.112	4.74 4.69 4.636 4.733 4.732 4.76 4.687	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015 0.006 0.013	
2 3 4 5 6 7	1.21 1.290 1.222 1.22 1.174 1.238 1.26	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020	5.23 5.090 4.938 5.050 5.073 5.11 5.112 5.156	4.74 4.69 4.636 4.733 4.732 4.76 4.687 4.783	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015 0.006 0.013	
2 3 4 5 6 7 8	1.21 1.290 1.222 1.22 1.174 1.238 1.26 1.183	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015	5.23 5.090 4.938 5.050 5.073 5.11 5.112 5.156 5.23	4.74 4.69 4.636 4.733 4.732 4.76 4.687 4.783 4.700	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015 0.006 0.013 0.013	
2 3 4 5 6 7 8 9	1.21 1.290 1.222 1.22 1.174 1.238 1.26 1.183 1.133	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015 0.0021	5.23 5.090 4.938 5.050 5.073 5.11 5.112 5.156 5.23 5.127	4.74 4.69 4.636 4.733 4.732 4.76 4.687 4.783 4.700	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015 0.006 0.013 0.013 0.0040 0.0054	
2 3 4 5 6 7 8 9 10	1.21 1.290 1.222 1.22 1.174 1.238 1.26 1.183 1.133	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015 0.0021	5.23 5.090 4.938 5.050 5.073 5.11 5.112 5.156 5.23 5.127 5.17	4.74 4.69 4.636 4.733 4.732 4.76 4.687 4.783 4.700 4.704	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015 0.006 0.013 0.013 0.0040 0.0054	
2 3 4 5 6 7 8 9 10 11	1.21 1.290 1.222 1.22 1.174 1.238 1.26 1.183 1.133 1.30 1.183	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015	5.23 5.090 4.938 5.050 5.073 5.11 5.112 5.156 5.23 5.127 5.167 5.06	4.74 4.69 4.636 4.733 4.732 4.76 4.687 4.783 4.700 4.704 4.704 4.74	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015 0.006 0.013 0.013 0.0040 0.0054 0.009	
2 3 4 5 6 7 8 9 10 11 12 13	1.21 1.290 1.222 1.22 1.174 1.238 1.26 1.183 1.133 1.30 1.183	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015	5.23 5.090 4.938 5.050 5.073 5.11 5.112 5.156 5.23 5.127 5.17 5.06 5.073	4.74 4.69 4.636 4.733 4.732 4.76 4.687 4.783 4.700 4.704 4.74 4.759 4.66	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0015 0.0015 0.006 0.013 0.013 0.0040 0.0054 0.009 0.012	
2 3 4 5 6 7 8 9 10 11 12 13	1.21 1.290 1.222 1.22 1.174 1.238 1.26 1.183 1.133 1.30 1.183 1.30	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015	5.23 5.090 4.938 5.050 5.073 5.11 5.112 5.156 5.23 5.127 5.17 5.06 5.073 5.20	4.74 4.69 4.636 4.733 4.732 4.76 4.687 4.783 4.700 4.704 4.74 4.759 4.66 4.61	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015 0.0013 0.013 0.0040 0.0054 0.009 0.012 0.0013	
2 3 4 5 6 7 8 8 9 10 11 12 13 13 14 15	1.21 1.290 1.222 1.22 1.174 1.238 1.26 1.183 1.133 1.130 1.183 1.30 1.19	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015	5.23 5.090 4.938 5.050 5.073 5.11 5.112 5.156 5.23 5.127 5.06 5.073 5.073 5.073	4.74 4.69 4.636 4.733 4.732 4.76 4.887 4.700 4.704 4.704 4.774 4.759 4.66 4.61	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0015 0.0015 0.0015 0.0013 0.013 0.0040 0.0054 0.009 0.012 0.0013 0.011 0.011	
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	1,21 1,290 1,222 1,22 1,174 1,238 1,26 1,183 1,30 1,183 1,30 1,183 1,30 1,19 1,207	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015	5.23 5.090 4.938 5.050 5.073 5.11 5.112 5.156 5.23 5.127 5.17 5.06 5.073 5.20 5.09 5.136	4.74 4.69 4.636 4.733 4.732 4.76 4.687 4.783 4.700 4.704 4.74 4.759 4.66 4.61 4.61 4.650 4.69	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0015 0.0015 0.0015 0.0013 0.013 0.0040 0.0054 0.009 0.012 0.0013	
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17	1.21 1.290 1.292 1.222 1.174 1.238 1.26 1.183 1.130 1.183 1.30 1.183 1.207 1.207	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015	5.23 5.090 4.938 5.050 5.073 5.11 5.112 5.156 5.23 5.127 5.17 5.06 5.073 5.20 5.20 5.23 5.245	4.74 4.69 4.636 4.733 4.732 4.76 4.687 4.783 4.700 4.704 4.74 4.759 4.66 4.61 4.650 4.69 4.658	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0015 0.0015 0.0015 0.0013 0.013 0.0040 0.0054 0.009 0.012 0.0013 0.011 0.011	
2 3 4 4 5 6 7 8 9 10 11 12 13 14 15 16 17	1.21 1.290 1.222 1.222 1.174 1.238 1.183 1.133 1.130 1.183 1.30 1.19 1.207 1.219 1.134	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015	5.23 5.090 4.938 5.050 5.073 5.11 5.112 5.156 5.23 5.127 5.06 5.073 5.20 5.09 5.09 5.245 5.06 5.245	4.74 4.69 4.636 4.733 4.732 4.76 4.687 4.700 4.704 4.704 4.759 4.66 4.61 4.650 4.69 4.62 4.62 4.713	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0015 0.0015 0.0015 0.0013 0.013 0.0040 0.0054 0.009 0.012 0.0013 0.011 0.011	
2 3 4 4 5 6 6 7 8 9 10 11 12 12 13 14 15 16 17 18 19 20	1.21 1.290 1.222 1.22 1.174 1.238 1.26 1.183 1.133 1.30 1.19 1.207 1.219 1.219	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015	5.23 5.23 5.095 5.093 5.073 5.11 5.112 5.156 5.23 5.127 5.17 5.09 5.073 5.20 5.09 5.136 5.20 5.136 5.20 5.136 5.20 5.146 5.20 5.156 5.20 5.20 5.20 5.20 5.20 5.20 5.20 5.20 5.20 5.20 5.20 5.24 5.20 5.24 5.	4,74 4,63 4,636 4,733 4,732 4,76 4,687 4,704 4,704 4,704 4,704 4,704 4,704 4,66 4,66 4,66 4,61 4,62 4,713 4,62 4,713 4,713	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0015 0.0015 0.0015 0.0013 0.013 0.0040 0.0054 0.009 0.012 0.0013 0.011 0.011	
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18	1.21 1.290 1.292 1.222 1.174 1.238 1.183 1.183 1.130 1.183 1.190 1.207 1.219 1.134 1.219 1.134 1.219	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015	5.23 5.090 4.938 5.050 5.073 5.111 5.112 5.156 5.23 5.175 5.06 5.073 5.20 5.073 5.155 5.20 5.073 5.151 4.95 5.245 5.06 5.151 4.95 5.245 5.25 5.265 5.265 5.27	4.74 4.69 4.636 4.733 4.732 4.76 4.687 4.700 4.704 4.704 4.759 4.66 4.61 4.650 4.69 4.62 4.62 4.713	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0015 0.0015 0.0015 0.0013 0.013 0.0040 0.0054 0.009 0.012 0.0013 0.011 0.011	
2 3 4 5 6 7 8 9 10 11 11 12 13 14 15 16 17 18 18 19 20 21 22	1.21 1.290 1.222 1.22 1.174 1.238 1.26 1.183 1.133 1.30 1.183 1.207 1.219 1.219 1.219 1.216 1.22 1.1398	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015	5.23 5.993 4.938 5.050 5.073 5.11 5.112 5.127 5.06 5.23 5.127 5.06 5.20 5.09 5.09 5.136 5.245 5.06 5.245 5.06 5.245 5.156 5.245 5.156 5.245 5.156 5.257 5.27 5.28 5.29 5.20 5	4,74 4,63 4,636 4,733 4,732 4,76 4,687 4,704 4,704 4,704 4,704 4,704 4,704 4,66 4,66 4,66 4,61 4,62 4,713 4,62 4,713 4,713	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0015 0.0015 0.0015 0.0013 0.013 0.0040 0.0054 0.009 0.012 0.0013 0.011 0.011	
2 3 4 4 5 6 7 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21	1.21 1.290 1.292 1.222 1.174 1.238 1.183 1.183 1.130 1.183 1.190 1.207 1.219 1.134 1.219 1.134 1.219	0.0024 0.0010 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0015	5.23 5.090 4.938 5.050 5.073 5.111 5.112 5.156 5.23 5.175 5.06 5.073 5.20 5.073 5.155 5.20 5.073 5.151 4.95 5.245 5.06 5.151 4.95 5.245 5.25 5.265 5.265 5.27	4,74 4,63 4,636 4,733 4,732 4,76 4,687 4,704 4,704 4,704 4,704 4,704 4,704 4,66 4,66 4,66 4,61 4,62 4,713 4,62 4,713 4,713	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002	<0.0010 <0.001 <0.0001 <0.0001 0.0002 0.0082	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.00144 0.0010	<0.0001 0.0001 0.0001 0.00001 0.0004	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0015 0.0015 0.0015 0.0013 0.013 0.0040 0.0054 0.009 0.012 0.0013 0.011 0.011	
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23	1.21 1.290 1.292 1.222 1.174 1.238 1.183 1.183 1.130 1.183 1.190 1.207 1.219 1.134 1.219 1.134 1.229 1.138	0.0024 0.0010 0.002 0.002 0.001 0.0008 0.001 0.0018 0.0020 0.0020 0.0020 0.0015 0.0020 0.0015	5.23 5.090 4.938 5.050 5.073 5.111 5.112 5.156 5.23 5.127 5.06 5.27 5.07 5.07 5.07 5.09 5.156 5.20 5.09 5.156 5.21 5.156 5.21 5.156 5.21 5.156 5.21 5.156 5.21 5.156 5.21 5.156 5.21 5.156 5.22 5.156 5.21 5.156 5.22 5.156 5.24 5.156 5.25 5.26 5.27 5.156 5.27 5.156 5.28 5.156 5.29 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.2	4,74 4,636 4,636 4,733 4,766 4,687 4,700 4,700 4,704 4,704 4,74 4,759 4,66 4,61 4,63 4,63 4,63 4,63 4,63 4,63 4,63 4,63	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002 <0.0020	<.0011 <0.001 <0.0001 <0.0001 <0.001 <0.001 <0.0002 <0.0002 <0.0001	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.0014 0.0010 0.0015	<0.0001 0.0001 0.0001 0.0001 0.00004 <0.001	<0.0001 <0.001	<0.005 <0.0001 0.002	<.0.001 <0.001 0.003 <0.001 <0.003	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015 0.006 0.013 0.0040 0.0054 0.009 0.012 0.0013 0.011 0.011 0.0011 0.0014	
2 3 4 5 6 7 8 9 10 111 12 13 14 15 16 17 18 19 20 21 22 23	1.21 1.290 1.292 1.222 1.174 1.238 1.26 1.183 1.133 1.30 1.183 1.30 1.19 1.207 1.219 1.134 1.216 1.22 1.1398 1.29	0.0024 0.0010 0.002 0.001 0.0001 0.0018 0.0021 0.0021 0.0021 0.0021 0.0021 0.0015	5.23 5.993 4.938 5.050 5.073 5.111 5.112 5.156 5.23 5.127 5.06 5.27 5.09 5.156 5.20 5.09 5.156 5.24 5.156 5.245 5.06 5.245 5.25 5.25 5.25 5.26 5.27 5.27 5.29 5.20	4,74 4,69 4,636 4,733 4,732 4,76 4,687 4,700 4,704 4,74 4,75 4,66 4,61 4,65 4,65 4,65 4,65 4,65 4,65 4,65 4,65	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002 <0.0020	<.0010 <0.001 <0.001 <0.001 <0.001 <0.001 <0.002 <0.0001	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.0010 0.0014 0.0015	<0.0001 0.0001 0.0001 0.0001 0.0004 <0.001 <0.0004 <0.001 <0.0004 <0.001 <0.0002	<0.0001 <0.001	<0.005 <0.0001	<0.0001 <0.001 0.003 <0.001	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015 0.006 0.013 0.0040 0.0054 0.009 0.012 0.0013 0.011 0.0013 0.011 0.0014 0.00034	
2 3 4 5 6 6 7 8 9 10 111 12 13 14 15 16 17 18 19 20 21 22 23	1.21 1.290 1.292 1.22 1.174 1.238 1.26 1.183 1.133 1.30 1.183 1.30 1.19 1.207 1.219 1.134 1.216 1.22 1.156	0.0024 0.0010 0.002 0.002 0.001 0.0018 0.0015 0.0026 0.0015 0.0026 0.0015 0.0016	5.23 5.090 4.938 5.050 5.073 5.11 5.112 5.156 5.23 5.127 5.06 5.20 5.136 5.20 5.136 5.245 5.06 5.245 5.06 5.151 5.06 5.20 5.151 5.07 5.09 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.157 5.00	4,74 4,69 4,636 4,733 4,76 4,68 4,704 4,704 4,704 4,74 4,704 4,74 4,75 4,69 4,69 4,69 4,69 4,639 4,699	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002 <0.0020	<.0011 <0.001 <0.0001 <0.0001 <0.001 <0.001 <0.0002 <0.0002 <0.0001	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.0010 0.00144 0.0010 0.0010 0.0010 0.0010	<0.0001 0.0001 0.0001 0.0001 0.0004 <0.001 <0.001 <0.001 <0.001 <0.001 <0.0002 <0.0002	<0.0001 <0.001	<0.005 <0.0001 0.002	<.0.001 <0.001 0.003 <0.001 <0.003	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015 0.0013 0.0040 0.0054 0.009 0.012 0.0013 0.0040 0.009 0.012 0.0014 0.0004 0.00034	
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 Mean STDV.	1.21 1.290 1.290 1.292 1.222 1.174 1.238 1.26 1.183 1.130 1.183 1.30 1.183 1.30 1.183 1.30 1.183 1.30 1.19 1.207 1.219 1.134 1.216 1.222 1.1398 1.229 1.156	0.0024 0.0010 0.002 0.001 0.001 0.0018 0.0020 0.0015 0.0015 0.0021 0.0015 0.0016 0.0016 0.0016 0.0016 0.0016 0.0016 0.0016 0.0016 0.0016 0.0016 0.0016	5.23 5.993 4.938 4.938 5.050 5.073 5.111 5.112 5.156 5.23 5.127 5.06 5.073 5.20 5.09 5.136 5.245 5.09 5.156 5.245 5.09 5.151 5.151 5.22 5.245 5.25 5.25 5.26 5.27 5.27 5.28 5.29 5.29 5.20 5.20 5.20 5.21 5.22 5.23 5.245 5.25 5.26 5.27 5.27 5.28 5.29 5.29 5.20 5.20 5.21 5.22 5.23 5.24 5.25 5.25 5.26 5.27 5.27 5.20 5.20 5.21 5.22 5.24 5.25 5.25 5.26 5.27 5.27 5.27 5.28 5.29 5.29 5.20 5.20 5.21 5.21 5.22 5.23 5.24 5.25 5.25 5.26 5.27 5.27 5.27 5.28 5.29 5.29 5.20 5.20 5.21 5.21 5.22 5.22 5.23 5.24 5.25 5.25 5.26 5.27 5.27 5.27 5.27 5.27 5.28 5.29 5.29 5.20	4,74 4,636 4,636 4,733 4,76 4,687 4,76 4,687 4,700 4,704 4,704 4,704 4,704 4,704 4,61 4,650 4,650 4,658 4,65	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002 <0.0020	<.0010 <0.001 <0.001 <0.001 <0.001 <0.001 <0.002 <0.0001	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.0010 0.0010 0.0015	<0.0001 0.0001 0.0001 0.0001 0.0004 <0.001 <0.0004 <0.001 <0.0004 <0.001 <0.0002	<0.0001 <0.001	<0.005 <0.0001 0.002	<.0.001 <0.001 0.003 <0.001 <0.003	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015 0.006 0.013 0.0040 0.0054 0.009 0.012 0.0013 0.011 0.0013 0.011 0.0014 0.00034	
2 3 4 5 6 6 7 8 9 10 111 12 13 14 15 16 17 18 19 20 21 22 23	1.21 1.290 1.292 1.22 1.174 1.238 1.26 1.183 1.133 1.30 1.183 1.30 1.19 1.207 1.219 1.134 1.216 1.22 1.156	0.0024 0.0010 0.002 0.002 0.001 0.0018 0.0015 0.0026 0.0015 0.0026 0.0015 0.0016	5.23 5.090 4.938 5.050 5.073 5.11 5.112 5.156 5.23 5.127 5.06 5.20 5.136 5.20 5.136 5.245 5.06 5.245 5.06 5.151 5.06 5.20 5.151 5.07 5.09 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.156 5.20 5.157 5.00	4,74 4,69 4,636 4,733 4,76 4,68 4,704 4,704 4,704 4,74 4,704 4,74 4,75 4,69 4,69 4,69 4,69 4,639 4,699	0.001 0.0004 0.00027 <0.001 0.0023 <0.0002 <0.0020	<.0010 <0.001 <0.001 <0.001 <0.001 <0.001 <0.002 <0.0001	<0.0010 <0.0001	0.0016 0.0013 0.0010 0.0010 0.00144 0.0010 0.0010 0.0010 0.0010	<0.0001 0.0001 0.0001 0.0001 0.0004 <0.001 <0.001 <0.001 <0.001 <0.001 <0.0002 <0.0002	<0.0001 <0.001	<0.005 <0.0001 0.002	<.0.001 <0.001 0.003 <0.001 <0.003	<0.0010 <0.0001 <0.001	0.0024 0.0095 0.001967 0.0045 0.0015 0.0013 0.0040 0.0054 0.009 0.012 0.0013 0.0040 0.009 0.012 0.0014 0.0004 0.00034	

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

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

<u>Certifying Body:</u> 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.

<u>Certified Reference Material (CRM):</u> 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 Certificate No.: 227A-08122002-IARM-F Certificate Date: 08/12/2002

Revision Date/No.: 11/06/2007