# Analytical Reference Materials International

## *Certificate of Analysis*
## *Certified Reference Material*

Grade: **AISI 347 / UNS S34700**

Part Number (Q.A. NO.): **IARM 8I**

Certificate Date: **07/24/2017** Certificate No.: **8I-07242017-IARM-F** Revision Date: **10/11/2017**

**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.** **Chips are not certified for Oxygen analysis.**
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!**

| Aluminum | Antimony | Arsenic | Boron | Calcium | Carbon | Chromium | Cobalt | Copper |
|---|---|---|---|---|---|---|---|---|
| 0.0030 | (<0.002) | (<0.008) | (0.0005) | (<0.001) | 0.0424 | 17.08 | 0.301 | 0.441 |
| (0.0008) | | | | | (0.0009) | (0.06) | (0.009) | (0.006) |
| **Lead** | **Manganese** | **Molybdenum** | **Nickel** | **Niobium** | **Nitrogen** | **Oxygen** | **Phosphorus** | **Selenium** |
| (<0.03) | 1.395 | 0.416 | 9.01 | 0.60 | 0.052 | (0.004) | 0.0352 | (<0.001) |
| | (0.007) | (0.005) | (0.04) | (0.01) | (0.001) | | (0.0008) | |
| **Silicon** | **Sulfur** | **Tantalum** | **Tin** | **Titanium** | **Tungsten** | **Vanadium** | **Zinc** | **Zirconium** |
| 0.38 | 0.0118 | (<0.005) | 0.012 | 0.008 | 0.060 | 0.057 | (<0.001) | (<0.005) |
| (0.01) | (0.0006) | | (0.003) | (0.002) | (0.004) | (0.003) | | |

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

Anderson Laboratories, Inc. - Greendale, WI
Carpenter Technology, Athens Operations - Tanner, AL
Chicago Spectro Service Laboratories - Chicago, IL
Crucible Industries - Syracuse, NY
Exova Burlington Lab - Burlington, ON
Laboratorio Prove Materiali S. Marco srl - Schio, Italy
Laboratory Testing, Inc. - Hatfield, PA
Latrobe Specialty Metals - Latrobe, PA
TimkenSteel Corporation - Canton, OH

**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:

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ALPHA AR 667 | BAS 409/1 | BS 189 | CZECH 189A | IARM 6A | JSS 173-4 | JSS 655-11 | NIST 101G | NIST 123B | NIST 1764A | NIST C1287 |
| ALPHA AR 874 | BAS 410/2 | BS 316 | ECRM0971 | IARM 6B | JSS 174-4 | JSS ST01 | NIST 1152 | NIST 1260 | NIST 1765 | NIST C1288 |
| ALPHA AR1652 | BAS 421 | BS 347C | ELTRA A1100-1004 | IARM 6C | JSS 175-4 | JSS ST01-5 | NIST 1154 | NIST 1261 | NIST 1766 | NIST C1289 |
| ALPHA AR654 | BAS 422 | BS 3952 | IARM 152A | IARM 6D | JSS 190-1 | JSS ST02-5 | NIST 1155 | NIST 1261A | NIST 1767 | NIST C2400 |
| ALPHA AR871 | BAS 465/1 | BS 4142SE | IARM 152B | IARM 6E | JSS 191-1 | JSS ST03-5 | NIST 1160 | NIST 1262 | NIST 2166 | NIST C2401 |
| BAS 401/1 | BAS 466/1 | BS 81N | IARM 154A | IARM 8A | JSS 192-1 | JSS ST04-5 | NIST 1161 | NIST 1262B | NIST 339 | SU 304-1 |
| BAS 401/2 | BAS 467/1 | BS 84J | IARM 16C | IARM 8B | JSS 193-1 | JSS ST05-5 | NIST 1162 | NIST 1263 | NIST 345A | SU 304-2 |
| BAS 402/1 | BAS 65 | BS 98 | IARM 21A | IARM 8C | JSS 194-1 | LECO 501-502 | NIST 1163 | NIST 1264 | NIST 361 | SU 304-3 |
| BAS 403/1 | BCS467-1 | BS CA316-4 | IARM 21B | IARM 8D | JSS 195-1 | LECO 501-503 | NIST 1164 | NIST 1754 | NIST 444 | SU 304-5 |
| BAS 404/1 | BCS474 | CZECH 181A | IARM 2C | IARM 8E | JSS 650-11 | LECO 501-645 | NIST 1171 | NIST 1760 | NIST C1151 | SU 304-7 |
| BAS 405/1 | BCS475 | CZECH 186A | IARM 302B | IARM 8F | JSS 651-11 | LECO 502-328 | NIST 1172 | NIST 1761 | NIST C1152 | |
| BAS 406/1 | BNS 15B | CZECH 187A | IARM 327A | IARM 8G | JSS 652-11 | LECO 502-459 | NIST 1185 | NIST 1762 | NIST C1153 | |
| BAS 407/2 | BS 13B | CZECH 187B | IARM 4C | IARM 9A | JSS 653-11 | MBH 12X353 | NIST 121D | NIST 1763 | NIST C1154 | |
| BAS 408/1 | BS 156 | CZECH 188A | IARM 5G | JSS 172-4 | JSS 654-11 | NBS 1155 | NIST 1230 | NIST 1764 | NIST C1173 | |

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.**

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**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 10/11/2017.**

| 8I | Al | Sb | As | B | Ca | C | Cr | Co | Cu | Pb | Mn | Mo | Ni | Nb | N | O |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0014 | 0.0019 | 0.0071 | 0.0001 | 0.00061 | 0.0395 | 16.9210 | 0.27920 | 0.422 | 0.0006 | 1.375 | 0.3999 | 8.8670 | 0.578 | 0.050 | 0.002 |
| 2 | 0.002 | | 0.008 | 0.0001 | 0.0007 | 0.0404 | 17.0222 | 0.2906 | 0.4250 | 0.001 | 1.38 | 0.407 | 8.9483 | 0.580 | 0.0501 | 0.0025 |
| 3 | 0.00209 | | | 0.00034 | | 0.0409 | 17.0228 | 0.2917 | 0.43529 | 0.0218 | 1.3849 | 0.4110 | 8.950 | 0.581 | 0.05148 | 0.00289 |
| 4 | 0.003 | | | 0.0006 | | 0.0410 | 17.03 | 0.292 | 0.4371 | | 1.3902 | 0.411 | 8.953 | 0.584 | 0.0517 | 0.005 |
| 5 | 0.0032 | | | 0.0012 | | 0.042 | 17.04 | 0.293 | 0.438 | | 1.396 | 0.4119 | 8.97 | 0.5854 | 0.052 | 0.0054 |
| 6 | 0.0040 | | | <0.0005 | | 0.042 | 17.081 | 0.295 | 0.439 | | 1.397 | 0.415 | 9.00 | 0.5875 | 0.0529 | |
| 7 | 0.004 | | | | | 0.043 | 17.089 | 0.300 | 0.444 | | 1.398 | 0.4171 | 9.046 | 0.6001 | 0.053 | |
| 8 | 0.004 | | | | | 0.04317 | 17.10 | 0.301 | 0.4443 | | 1.40 | 0.418 | 9.053 | 0.604 | 0.0532 | |
| 9 | 0.0045 | | | | | 0.0432 | 17.145 | 0.310 | 0.4448 | | 1.4004 | 0.418 | 9.0532 | 0.6052 | 0.054 | |
| 10 | 0.005 | | | | | 0.0434 | 17.156 | 0.31 | 0.450 | | 1.403 | 0.418 | 9.056 | 0.612 | | |
| 11 | | | | | | 0.044 | 17.240 | 0.317 | 0.45 | | 1.405 | 0.42053 | 9.062 | 0.6378 | | |
| 12 | | | | | | 0.044 | | 0.32844 | 0.451 | | 1.4133 | 0.425 | 9.11 | 0.642 | | |
| 13 | | | | | | 0.0444 | | | 0.452 | | | 0.43 | | 0.6430 | | |
| 14 | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | |
| Mean | 0.0033 | 0.002 | 0.008 | 0.0005 | 0.0007 | 0.0424 | 17.08 | 0.301 | 0.441 | 0.008 | 1.395 | 0.416 | 9.01 | 0.60 | 0.052 | 0.004 |
| STDV. | 0.0012 | | 0.001 | 0.0005 | 0.0001 | 0.0015 | 0.08 | 0.014 | 0.010 | 0.012 | 0.011 | 0.008 | 0.07 | 0.02 | 0.001 | 0.002 |
| **Certified** | **0.0030** | **(<0.002)** | **(<0.008)** | **(0.0005)** | **(<0.001)** | **0.0424** | **17.08** | **0.301** | **0.441** | **(<0.03)** | **1.395** | **0.416** | **9.01** | **0.60** | **0.052** | **(0.004)** |
| 95% C.I. | 0.0008 | | | | | 0.0009 | 0.06 | 0.009 | 0.006 | | 0.007 | 0.005 | 0.04 | 0.01 | 0.001 | |
| Methods | X,O,I | X | X,O | O,I | O | O,C | X,W,O,I | X,O,I | X,O,I | O | ,X,O | X,O,I | X,O,I | X,O,I | X,O,I,F | X,I,F |

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

| 8I | P | Se | Si | S | Ta | Sn | Ti | W | V | Zn | Zr |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.0331 | <0.001 | 0.3303 | 0.0105 | 0.0044 | 0.006 | 0.0020 | 0.054 | 0.0478 | 0.0009 | 0.0017 |
| 2 | 0.0334 | | 0.358 | 0.0105 | 0.005 | 0.0073 | 0.006 | 0.055 | 0.054 | | 0.0022 |
| 3 | 0.034 | | 0.362 | 0.0107 | <0.001 | 0.011 | 0.0069 | 0.057 | 0.054 | | 0.005 |
| 4 | 0.0346 | | 0.367 | 0.0109 | | 0.0117 | 0.0080 | 0.0581 | 0.0547 | | |
| 5 | 0.035 | | 0.369 | 0.0114 | | 0.012 | 0.008 | 0.0585 | 0.055 | | |
| 6 | 0.035 | | 0.374 | 0.012 | | 0.0138 | 0.008 | 0.0609 | 0.056 | | |
| 7 | 0.0353 | | 0.375 | 0.012 | | 0.014 | 0.008 | 0.063 | 0.0562 | | |
| 8 | 0.036 | | 0.3758 | 0.0121 | | 0.0141 | 0.009 | 0.0699 | 0.057 | | |
| 9 | 0.036 | | 0.378 | 0.01224 | | 0.017 | 0.012 | | 0.058 | | |
| 10 | 0.0361 | | 0.3906 | 0.0128 | | | | | 0.0587 | | |
| 11 | 0.0364 | | 0.3929 | 0.0128 | | | | | 0.0599 | | |
| 12 | 0.0371 | | 0.395 | 0.0134 | | | | | 0.060 | | |
| 13 | | | 0.4121 | | | | | | 0.0672 | | |
| 14 | | | | | | | | | | | |
| 15 | | | | | | | | | | | |
| Mean | 0.0352 | | 0.38 | 0.0118 | 0.0047 | 0.012 | 0.008 | 0.060 | 0.057 | 0.001 | 0.003 |
| STDV. | 0.0012 | | 0.02 | 0.0010 | 0.0004 | 0.003 | 0.003 | 0.005 | 0.004 | | 0.002 |
| **Certified** | **0.0352** | **(<0.001)** | **0.38** | **0.0118** | **(<0.005)** | **0.012** | **0.008** | **0.060** | **0.057** | **(<0.001)** | **(<0.005)** |
| 95% C.I. | 0.0008 | | 0.01 | 0.0006 | | 0.003 | 0.002 | 0.004 | 0.003 | | |
| Methods | X,O,I | X | X,O,I | O,C | X,O | X,O,I | X,O,I | X,O,I | X,O,I | X | X,O |

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

The International Standards Organization (ISO) definitions, expressed in ISO Guide 30–1992 list the following:

**Certifying Body:** Any technically competent body (organization or firm, public or private) that issues a reference material certificate, which provides the information, detailed in ISO Guide 31. The only generally accepted certifying body in the United States for primary standards - Standard Reference Materials (SRM) is the U. S. Department of Commerce, National Institute of Standards & Technology, (NIST), Gaithersburg, MD. All other certifying bodies in the United States produce Reference Materials (RM) or Certified Reference Materials (CRM).

**Reference Material (RM):** Material or substance one or more of whose property values are sufficiently homogeneous and well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

**Certified Reference Material (CRM):** Reference material, accompanied by a certificate, one or more of whose property values are certified by a procedure, which establishes its traceability to an accurate realization of the unit in which the property values are expressed, and for which each certified value is accompanied by an uncertainty at a stated level of confidence.

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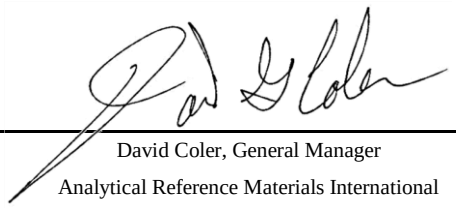
**Inter-Laboratory Analysis Program (ILAP):** Although ASTM Standard E691-87 applies to inter-laboratory studies to "Determine the Precision of a Single Test Method", it is also a well thought out and logical plan for conducting an inter laboratory program involving multiple techniques. Therefore, the 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 and OE instrument procedures.

**Expiration of Certification:** The certification of this IARM is valid indefinitely, within the uncertainty specified, provided the IARM is handled and stored in accordance with the instructions stated on this certificate. The certification is nullified if the IARM is damaged, contaminated, otherwise modified, or used in a manner for which it was not intended.

**Instructions for Use:** The test surface is the side opposite to the labeled surface, which includes the IARM number. The entire thickness of the unit is certified. However, the user is cautioned not to measure disks less than 2 mm thick when using X-ray fluorescence spectrometry. Each packaged disk has been prepared by finishing the test surface using a lathe. The user must determine the correct surface preparation procedure for each analytical technique. The user is cautioned to use care when either resurfacing the disk or performing additional polishing as these processes may contaminate the surface. When not in use, the material should be stored in a cool, dry location. This material was tested using both the solid disks and chips prepared from the disks. The certified values are considered representative of the overall average composition of the material. Chips are not to be used for Oxygen analysis.

**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. 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.



David Coler, General Manager

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LGC ARMI ISO 9001:2008

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