ARMI | MBH
ANALYTICAL LTD

ISO Certified · 9001 · 17025 · 17043 · 17034

# *Certificate of Analysis*

# MBH-13X NSC4 G

Nitrogen Stainless Steel (Chill-Cast)

## Certified Reference Material

**Certified Values listed in wt.% with associated uncertainties**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Al** | **0.26** ± 0.01 | **C** | **0.470** ± 0.004 | **Co** | **0.238** ± 0.003 | **Cr** | **31.7** ± 0.2 |
| **Cu** | **0.208** ± 0.007 | **Mn** | **7.78** ± 0.06 | **Mo** | **1.31** ± 0.02 | **N** | **0.90** ± 0.01 |
| **Nb** | **2.37** ± 0.04 | **Ni** | **7.52** ± 0.05 | **S** | **0.0065** ± 0.0006 | **Si** | **1.53** ± 0.03 |
| **V** | **0.224** ± 0.006 | **W** | **0.208** ± 0.005 | | | | |

### Description and Intended Use

This **Certified Reference Material** is covered under the scope of accreditation to **ISO 17034** by LGC Standards - Manchester, NH. As an ISO 17034 certified reference material, appropriate use of this material will fulfill the certified reference material and traceability requirements for use in **ISO 17025** certified laboratories. This CRM may come in the form of a solid disk or chips. The intended use of this CRM may include, but is not limited to, the calibration of instruments and the validation of analytical methods.

### Instructions for Use

1. The test surface is on the opposite side of the labeled surface, which includes the material identification. 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.
2. The minimum sample size for chips should be individually evaluated based on the analytical technique used; this would typically be greater than 0.1 grams.
3. The material should be stored in a cool, dry location when not in use.
4. Chips are not recommended for gas analysis.

The following data represents all pertinent information reported as it applies to the chemical characterization of this material.

| | Al | C | Co | Cr | Cu | Mn | Mo | N | Nb | Ni | S | Si | V | W | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.2187 | 0.4553 | 0.2306 | 30.620 | 0.1843 | 7.5935 | 1.2150 | 0.8715 | 2.2140 | 7.4033 | 0.0043 | 1.4565 | 0.2011 | 0.1900 | | |
| 2 | 0.2295 | 0.4630 | 0.2309 | 30.890 | 0.1890 | 7.6186 | 1.2520 | 0.8718 | 2.2303 | 7.4100 | 0.0056 | 1.4830 | 0.2120 | 0.1954 | | |
| 3 | 0.2327 | 0.4642 | 0.2310 | 31.253 | 0.1892 | 7.7030 | 1.2525 | 0.8927 | 2.3493 | 7.4120 | 0.0056 | 1.4844 | 0.2140 | 0.2030 | | |
| 4 | 0.2334 | 0.4647 | 0.2343 | 31.607 | 0.1973 | 7.7063 | 1.3017 | 0.8970 | 2.3550 | 7.4570 | 0.0060 | 1.4980 | 0.2170 | 0.2047 | | |
| 5 | 0.2415 | 0.4670 | 0.2350 | 31.636 | 0.2011 | 7.7220 | 1.3050 | 0.9000 | 2.3663 | 7.4620 | 0.0063 | 1.4983 | 0.2201 | 0.2050 | | |
| 6 | 0.2448 | 0.4690 | 0.2360 | 31.685 | 0.2040 | 7.7390 | 1.3080 | 0.9096 | 2.3690 | 7.4720 | 0.0063 | 1.5060 | 0.2210 | 0.2060 | | |
| 7 | 0.2525 | 0.4697 | 0.2369 | 31.760 | 0.2073 | 7.7800 | 1.3110 | 0.9143 | 2.3740 | 7.4800 | 0.0063 | 1.5183 | 0.2210 | 0.2078 | | |
| 8 | 0.2582 | 0.4700 | 0.2373 | 31.770 | 0.2090 | 7.7910 | 1.3118 | 0.9169 | 2.3750 | 7.4840 | 0.0064 | 1.5400 | 0.2215 | 0.2083 | | |
| 9 | 0.2627 | 0.4701 | 0.2380 | 31.789 | 0.2101 | 7.8027 | 1.3160 | 0.9170 | 2.3880 | 7.4928 | 0.0065 | 1.5460 | 0.2240 | 0.2090 | | |
| 10 | 0.2730 | 0.4720 | 0.2385 | 31.790 | 0.2118 | 7.8030 | 1.3240 | 0.9200 | 2.4119 | 7.5100 | 0.0070 | 1.5470 | 0.2259 | 0.2137 | | |
| 11 | 0.2732 | 0.4760 | 0.2399 | 31.792 | 0.2123 | 7.8180 | 1.3270 | 0.9433 | 2.4130 | 7.5150 | 0.0071 | 1.5600 | 0.2282 | 0.2141 | | |
| 12 | 0.2755 | 0.4780 | 0.2401 | 31.800 | 0.2205 | 7.8325 | 1.3363 | | 2.4210 | 7.5200 | 0.0077 | 1.5830 | 0.2296 | 0.2165 | | |
| 13 | 0.2842 | 0.4813 | 0.2417 | 31.819 | 0.2210 | 7.8380 | 1.3384 | | 2.4450 | 7.6343 | 0.0079 | 1.5834 | 0.2357 | 0.2165 | | |
| 14 | 0.2876 | 0.4830 | 0.2444 | 31.897 | 0.2213 | 7.8510 | 1.3395 | | 2.4491 | 7.6491 | 0.0092 | 1.5995 | 0.2370 | 0.2228 | | |
| 15 | 0.3040 | | 0.2460 | 31.950 | 0.2224 | 7.8785 | 1.3400 | | | 7.6500 | 0.0064 | 1.6034 | 0.2381 | | | |
| 16 | 0.3130 | | 0.2514 | 32.438 | 0.2350 | 8.0487 | 1.3889 | | | 7.6905 | 0.0060 | | 0.2410 | | | |
| 17 | | | | | | | | | | | 0.0064 | | | | | |
| 18 | | | | | | | | | | | | | | | | |
| Mean | 0.2615 | 0.4702 | 0.2383 | 31.66 | 0.2085 | 7.783 | 1.310 | 0.9049 | 2.369 | 7.515 | 0.0065 | 1.534 | 0.2242 | 0.2081 | | |
| STDV. | 0.0275 | 0.0075 | 0.0057 | 0.425 | 0.0140 | 0.107 | 0.041 | 0.0213 | 0.070 | 0.092 | 0.0011 | 0.046 | 0.0107 | 0.0086 | | |
| **Certified** | **0.26** | **0.470** | **0.238** | **31.7** | **0.208** | **7.78** | **1.31** | **0.90** | **2.37** | **7.52** | **0.0065** | **1.53** | **0.224** | **0.208** | | |
| $U_{CRM}$ | 0.01 | 0.004 | 0.003 | 0.2 | 0.007 | 0.06 | 0.02 | 0.01 | 0.04 | 0.05 | 0.0006 | 0.03 | 0.006 | 0.005 | | |
| Methods | I,W,A | C | I,W,A | I,W | I,W,A | I,W,A | I | F | I,W,A | I,W,A | C,I | I,W | I,W,A | I,W,A | | |

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

## Certification Laboratories

| | | | |
|---|---|---|---|
| Element - Teeside | Middlesbrough, England | TUV Nord-Czech | Brno, Czech Republic |
| Sheffield Analytical Services | Sheffield, England | Metals Technology (Testing) Ltd | Sheffield, England |
| AMG Superalloys UK Ltd | Rotherham, England | Laboratory Testing, Inc | Hatfield, PA |
| Mineral & Metallurgical Laboratories | Bangalore, India | Tec-Eurolab | Campogalliano, Italy |
| Instytut Metalurgii Zelaza | Gliwice, Poland | Universal Scientific Laboratory Pty Ltd | Sydney, Australia |
| Luo Yang Copper Co | Luo Yang, He Nan, China | Genitest Inc | Montreal, Canada |
| Raghavendra SpectroMet Laboratory | Bangalore, India | TCR Engineering Services Ltd | Mumbai, India |
| Anchorcert Analytical | Birmingham, England | Shanghai Jinyi Test Tech Co | Shanghai, China |
| Analyticka Laborator Lithea sro | Brno, Czech Republic | Scrooby's Analytical Services | Benoni, South Africa |

Much of the analytical work performed to assess this material has been carried out by laboratories with proven competence, as indicated by their accreditation to ISO 17025. It is an implicit requirement for this accreditation that analytical work should be performed with due traceability, via an unbroken chain of comparisons, each with stated uncertainty, to primary standards such as the mole, or to nationally- or internationally-recognised reference materials. Of the individual results herein, some have traceability (to the mole) via primary analytical methods. Some are traceable to substances of known stoichiometry. Most have traceability via commercial solutions. Furthermore, some results have additional traceability to NIST standards, as part of the analytical calibration or process control.

## Homogeneity and Uncertainty

"Uncertainty" values, as reported adjacent to certified concentration values, are based on a 95% Confidence Interval. These estimated uncertainties include the combined effects of method imprecision, material inhomogeneity, and any bias between methods. Homogeneity data from experimental XRF results are reflected in both the overall statistics and certified data. Homogeneity samples are selected by a systematic sampling procedure. The number of samples may be determined by equation 1, where $N_{prod}$ is the number of units produced and $N_{min}$ is the number of samples used for homogeneity testing. These samples are arranged in a simple randomized design such that each sample is analyzed multiple times by XRF. Homogeneity may also be determined within sample using an applied version of ASTM E826. A single factor ANOVA is used to calculated uncertainty due to inhomogeneity ($U_{hom}$). Uncertainty of the material is calculated by equation 2, where $H=U_{hom}$, S= Standard deviation, t= t-value at 95% CI, and n= number of observations.

1. $N_{min} = \max(10, \sqrt[3]{N_{prod}})$

2. $U_{CRM} = \frac{\sqrt{H^2 + S^2}}{\sqrt{n}} * t$

## Expiration

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

Kimberly Halkiotis, Global Product Manager

ARMI | MBH - LGC Standards Industrial Sector