LGC ARMI

Certificate of Analysis

IARM Ni244H-18

Nickel Alloy 244H

Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

Al	**0.23** ± 0.02	**As**	**0.0009** ± 0.0002	**B**	**0.002** ± 0.002	**C**	**0.052** ± 0.002
Co	**0.005** ± 0.003	**Cr**	**6.9** ± 0.1	**Cu**	**0.013** ± 0.002	**Fe**	**39.9** ± 0.1
Mg	**0.0014** ± 0.0003	**Mn**	**10.9** ± 0.1	**Mo**	**0.003** ± 0.001	**N**	**0.0087** ± 0.0007
Nb	**0.70** ± 0.06	**Ni**	**41.1** ± 0.3	**O**	**0.0009** ± 0.0007	**P**	**0.003** ± 0.002
S	**0.0038** ± 0.0007	**Sb**	**0.00012** ± 0.00004	**Si**	**0.16** ± 0.02	**Sn**	**0.0003** ± 0.0003
Ti	**0.20** ± 0.01	**V**	**0.004** ± 0.003	**Zr**	**0.0008** ± 0.0008		

Indicative Values listed in ppm

Ag	(<5)	Au	(<1)	Ba	(<1)	Be	(<1)	Bi	(<50)	Br	(<1)	Ca	(3)
Cd	(<50)	Ce	(<1)	Cl	(<1)	Cs	(<1)	Dy	(<1)	Er	(<1)	Eu	(<1)
F	(<1)	Ga	(10)	Gd	(<1)	Ge	(10)	H	(<3)	Hf	(<50)	Hg	(<1)
Ho	(<1)	I	(<1)	In	(<1)	Ir	(<1)	K	(<1)	La	(<5)	Li	(<1)
Lu	(<1)	Na	(<1)	Nd	(<1)	Os	(<1)	Pb	(<250)	Pd	(<10)	Pr	(<1)
Pt	(<1)	Rb	(<1)	Re	(<50)	Rh	(<1)	Ru	(<1)	Sc	(<1)	Se	(<10)
Sm	(<1)	Sr	(<20)	Ta	(10)	Tb	(<1)	Te	(<1)	Th	(<1)	Tl	(<1)
Tm	(<1)	U	(<1)	W	(20)	Y	(<10)	Yb	(<1)	Zn	(<3)		

Description and Intended Use

This CRM may come in the form of a solid disk, chips, or powder. 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 certified for Oxygen analysis.

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

	Al	As	B	C	Co	Cr	Cu	Fe	Mg	Mn	Mo	N	Nb	Ni	O	P
1	0.17	0.00065	0.00017	0.04624	0.0019	6.51	0.009	39.58	0.000657	10.40	0.0003	0.008	0.4982	40.64	0.000155	0.0011
2	0.201	0.0007	0.00018	0.05	0.002	6.649	0.01	39.71	0.00093	10.78	0.0024	0.00803	0.692	40.7557	0.000367	0.0012
3	0.2056	0.0008	0.0005	0.0503	0.00241	6.91	0.01	39.7267	0.0012	10.8171	0.00253	0.0081	0.70	40.758	0.0004	0.0014
4	0.22	0.0009	0.0013	0.0513	0.0029	6.9267	0.011	39.757	0.0013	10.84	0.0033	0.0082	0.7065	41.0432	0.0004	0.0016
5	0.2269	0.00093	0.0014	0.0521	0.003	6.97	0.0113	39.90	0.0013	10.8633	0.00363	0.0083	0.70767	41.05	0.0005	0.0027
6	0.23083	0.0013	0.0034	0.05274	0.004	6.98	0.0115	39.94	0.0013	10.93	0.0039	0.00831	0.71067	41.0535	0.0008	0.003
7	0.231		0.0052	0.05345	0.0045	7.0068	0.012	39.9547	0.00168	10.94	0.004	0.00849	0.711	41.46	0.00165	0.003267
8	0.233			0.054	0.01	7.07633	0.0121	39.98	0.0018	10.99	0.0042	0.0086	0.714	41.70	0.00263	0.0037
9	0.236			0.0544	0.01	7.0766	0.01337	40.0657	0.0019	11.00		0.00907	0.726			0.004
10	0.24			0.0549	0.0118	7.092	0.014	40.19	0.002	11.028		0.0097	0.82			0.00415
11	0.2494			0.057			0.015					0.0114				0.008
12	0.26						0.01633									
13							0.018									
14																
15																
Mean	0.23	0.0009	0.002	0.052	0.005	6.9	0.013	39.9	0.0014	10.9	0.003	0.0087	0.70	41.1	0.0009	0.003
STDV.	0.02	0.0002	0.002	0.003	0.004	0.2	0.003	0.2	0.0004	0.2	0.001	0.001	0.08	0.4	0.0008	0.002
Certified	**0.23**	**0.0009**	**0.002**	**0.052**	**0.005**	**6.9**	**0.013**	**39.9**	**0.0014**	**10.9**	**0.003**	**0.0087**	**0.70**	**41.1**	**0.0009**	**0.003**
U_{CRM}	0.02	0.0002	0.002	0.002	0.003	0.1	0.002	0.1	0.0003	0.1	0.001	0.0007	0.06	0.3	0.0007	0.002
Methods	I,X,G	I,A,G	I,G	C	I,X,G	I,W,X	I,X,G	I,X	I,G	I,X	I,X,G	F,C,I	I,X	I,X	F,C	I,X,G

	S	Sb	Si	Sn	Ti	V	Zr	Ag	Au	Ba	Be	Bi	Br	Ca	Cd	Ce
1	0.00148	0.00008	0.085	0.000185	0.1601	0.0004	0.000057	0.000004	<0.00001	<0.000005	<0.0000005	0.0000032	<0.000005	0.00005	<0.00002	<0.000005
2	0.0032	0.000106	0.0861	0.0001867	0.17	0.00185	0.00012	<0.00001	<0.00005	<0.00003	<0.00001	<0.000005	<0.00005	0.0001	<0.00005	<0.00001
3	0.0033	0.00011	0.1592	0.0002	0.1887	0.002	0.0005	<0.00005				<0.00001		0.0004	<0.001	
4	0.00342	0.00012	0.15967	0.00024	0.19	0.0021	0.001	<0.0005				<0.001		0.00055	<0.005	
5	0.00345	0.00012	0.1605	0.00033	0.19	0.0028	0.0014					<0.005		<0.0005		
6	0.003807	0.0002	0.164	0.0009	0.192	0.0028	0.002							<0.001		
7	0.00381		0.17		0.194	0.003167								<0.005		
8	0.0039		0.17		0.202	0.0032								<0.005		
9	0.004		0.175		0.2056	0.0072										
10	0.004267		0.1776		0.208	0.015										
11	0.0043		0.183		0.21											
12	0.0043		0.185		0.23											
13	0.0046															
14	0.0058															
15																
Mean	0.0038	0.00012	0.16	0.0003	0.20	0.004	0.0008							0.0003		
STDV.	0.0009	0.00004	0.03	0.0003	0.02	0.004	0.0008							0.0002		
Certified	**0.0038**	**0.00012**	**0.16**	**0.0003**	**0.20**	**0.004**	**0.0008**	**(<0.0005)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.005)**	**(<0.0001)**	**(0.0003)**	**(<0.005)**	**(<0.0001)**
U_{CRM}	0.0007	0.00004	0.02	0.0003	0.01	0.003	0.0008									
Methods	C,X,G	I,A	I,X	I,A	I,X	I,X,G	I,G	A,I,G	G	G	G	A,G,I	G	G,I	G,I	G

	Cl	Cs	Dy	Er	Eu	F	Ga	Gd	Ge	H	Hf	Hg	Ho	I	In	Ir
1	0.0000013	<0.000001	<0.000001	<0.000001	<0.000001	<0.00001	0.0008	<0.000001	0.00028	0.0002	0.01	<0.00001	<0.000001	<0.000001	<0.00001	<0.000005
2	<0.000001	<0.00001	<0.000005	<0.000005	<0.000005	<0.00001	0.001	<0.000005	0.00078	0.0003	<0.000001	<0.00005	<0.000005	<0.00001	<0.00001	<0.00001
3											<0.00001					
4											<0.001					
5											<0.002					
6											<0.005					
7																
8																
9																
10																
Mean							0.0010		0.0010							
STDV.							0.0001		0.0004							
Certified	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(0.001)**	**(<0.0001)**	**(0.001)**	**(<0.0003)**	**(<0.005)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**
U_{CRM}																
Methods	G	G	G	G	G	G	G	G	G	F	I,X,G	G	G	G	G	G

	K	La	Li	Lu	Na	Nd	Os	Pb	Pd	Pr	Pt	Rb	Re	Rh	Ru	Sc
1	0.000034	<0.000001	<0.0000005	<0.000005	0.000035	<0.000005	<0.00001	0.00001	<0.00001	<0.000005	<0.00001	<0.0001	<0.000001	<0.00001	<0.00001	<0.000005
2	<0.000005	<0.00001	<0.00001	<0.000001	<0.000001	<0.000001	<0.000005	0.00004	<0.00005	<0.000001	<0.00001	<0.0001	<0.00001	<0.00001	<0.0001	<0.00001
3		<0.0005						0.000083	<0.001				<0.002			
4								0.00011					<0.005			
5								0.0243								
6								<0.001								
7																
8																
9																
10																
Mean																
STDV.																
Certified	**(<0.0001)**	**(<0.0005)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.025)**	**(<0.001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.005)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**
U_{CRM}																
Methods	G	G,I	G	G	G			A,G,I	G,I			G	G,I	G	G	G

	Se	Sm	Sr	Ta	Tb	Te	Th	Tl	Tm	U	W	Y	Yb	Zn		
1	<0.00005	<0.000005	<0.0005	0.00069	<0.000005	<0.00001	<0.000001	<0.000005	<0.000005	0.000001	0.00045	<0.0005	<0.000005	0.00022		
2	<0.0002	<0.000001	<0.002	0.00069	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	<0.000001	0.00047	<0.0005	<0.000001	0.00032		
3	<0.001			0.00083							0.000620	<0.001		<0.001		
4				0.000877							0.0013			<0.001		
5				0.0033							0.0026					
6				<0.001							0.0068					
7				<0.001							<0.001					
8				<0.002							<0.001					
9				<0.005							<0.005					
10				<0.01							<0.01					
Mean				0.001							0.002			0.0003		
STDV.				0.001							0.003			0.00007		
Certified	**(<0.001)**	**(<0.0001)**	**(<0.002)**	**(0.001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(<0.0001)**	**(0.002)**	**(<0.001)**	**(<0.0001)**	**(0.0003)**		
U_{CRM}																
Methods	G,I		G	I,X						G	I,X	G,I		G,I		

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

Connecticut Metallurgical Inc.	East Hartford, CT	Laboratory Testing Inc.	Hatfield, PA
EAG Laboratories	Liverpool, NY	Luvak, Inc.	Boylston, MA
Massachusetts Materials Research, Inc.	West Boylston, MA	Northern Analytical Laboratory, Inc.	Londonderry, NH
Huntington Alloys, Special Metals Corporation	Huntington, WV	VHG Labs	Manchester, NH
Haynes International, Inc.	Kokomo, IN	IMR Test Labs	Lansing, NY
Dirats Laboratories	Westfield, MA	NSL Analytical Services, Inc.	Cleveland, OH

Certification laboratories have demonstrated performance and traceability by utilizing test methods under the scope of ISO 17025 or have shown competence through a proficiency testing program. Some of the specific CRMs and SRMs used in the analysis of the material covered by this certificate are:

NIST 349A NIST 361 NIST 362 NIST 363 NIST 1187 IARM 55B IARM 63B IARM 7C

Homogeneity and Uncertainty

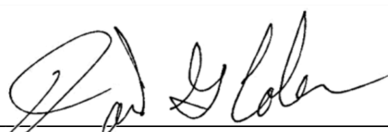
"Uncertainty" values, as reported adjacent to certified concentration values, are based on a 95% Confidence Interval. These estimated uncertainties include the combined effects of method imprecision, material inhomogeneity, and any bias between methods. Homogeneity data from experimental XRF results 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.



David Coler, General Manager

Analytical Reference Materials International