



# ARMI

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## Certificate of Analysis

# IARM Fe316LP-18

Additive Manufacturing Powder (-270M+16µ) Stainless Steel 316L / UNS S31603

## Certified Reference Material

Certified Values listed in wt.% with associated uncertainties

<b>Al</b>	<b>0.006 ± 0.005</b>	<b>C</b>	<b>0.006 ± 0.001</b>	<b>Co</b>	<b>0.006 ± 0.003</b>	<b>Cr</b>	<b>17.9 ± 0.2</b>
<b>Cu</b>	<b>0.0031 ± 0.0005</b>	<b>Mn</b>	<b>1.56 ± 0.03</b>	<b>Mo</b>	<b>2.81 ± 0.05</b>	<b>N</b>	<b>0.081 ± 0.009</b>
<b>Ni</b>	<b>13.9 ± 0.2</b>	<b>O</b>	<b>0.043 ± 0.007</b>	<b>P</b>	<b>0.011 ± 0.003</b>	<b>S</b>	<b>0.0041 ± 0.0002</b>
<b>Si</b>	<b>0.29 ± 0.02</b>	<b>V</b>	<b>0.006 ± 0.005</b>				

Indicative Values listed in ppm

As (10)	B (<50)	Bi (<10)	Ca (<50)	Cd (<50)	Ce (<20)	Fe (63.3%)
H (<10)	Hf (<10)	Mg (<50)	Nb (10)	Pb (<100)	Pd (<10)	Sb (<50)
Se (<50)	Sn (<50)	Ta (<50)	Ti (<80)	W (<120)	Y (<10)	Zn (<100)
Zr (<50)						

### 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 will come in the form of powder. The intended use of this CRM may include, but is not limited to, the calibration of instruments and the validation of analytical methods. The following particle size distribution is provided by the manufacturer and should be used for information only.

Test	Units	Result
Mesh +200	wt %	0
Mesh +230	wt %	0
Mesh +270	wt %	1
Microtrac 90th %	microns	54
Microtrac 50th %	microns	38
Microtrac 10th %	microns	24
Microtrac -125µ	volume %	100
Microtrac -88µ	volume %	100
Microtrac -62µ	volume %	98
Microtrac -44µ	volume %	69
Microtrac -31µ	volume %	27
Microtrac -22µ	volume %	6
Microtrac -16µ	volume %	2.2
Microtrac -11µ	volume %	1
Microtrac -7.8µ	volume %	0
Tap Density	g/cc	4.9
Flow Rate	sec/50g	13.5
Apparent Density	g/cc	4.22

### Instructions for Use

1. The minimum sample size should be individually evaluated based on the analytical technique used; this would typically be greater than 0.1 grams.
2. The material should be stored in a cool, dry location when not in use.

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	Ni	O	P	S	Si	V	As	B
1	0.001	0.00363	0.0025	17.41	0.0025	1.499	2.67	0.064	13.52	0.02347	0.0073	0.00376	0.267	0.0021	0.00089	0.00028
2	0.00173	0.0044	0.004	17.68	0.0026	1.544	2.76	0.07	13.64	0.0392	0.00731	0.0039	0.276	0.004	0.000997	0.00165
3	0.006	0.0044	0.0041	17.823	0.003	1.546	2.78	0.0786	13.85	0.043	0.00897	0.004	0.28	0.005	0.0017	0.0037
4	0.007	0.00454	0.005	17.84	0.0034	1.55	2.787	0.08047	13.958	0.0448	0.009	0.004	0.28	0.006	<0.001	<0.001
5	0.01	0.0048	0.005	17.94	0.00366	1.55	2.79	0.0827	13.97	0.0459	0.0099	0.004	0.2853	0.0067	<0.001	<0.001
6	0.013	0.0056	0.00527	17.95	0.0037	1.55	2.806	0.0862	14.00	0.046	0.0101	0.00402	0.286	0.0146	<0.005	<0.005
7		0.008	0.0082	17.98		1.56	2.851	0.09197	14.02	0.0469	0.011	0.0041	0.3062			
8		0.0081	0.009	18.007		1.563	2.851	0.094	14.0567	0.052	0.011	0.00423	0.313			
9		0.00859	0.013	18.07		1.58	2.8768		14.087		0.013	0.0046	0.3442			
10				18.183		1.675	2.89		14.329		0.0216	0.004867				
11																
Mean	0.006	0.006	0.006	17.9	0.0031	1.56	2.81	0.081	13.9	0.043	0.011	0.0041	0.29	0.006	0.0010	0.002
STDV.	0.005	0.002	0.003	0.2	0.0005	0.04	0.06	0.01	0.2	0.009	0.004	0.0003	0.02	0.004	0.0004	0.002
<b>Certified</b>	<b>0.006</b>	<b>0.006</b>	<b>0.006</b>	<b>17.9</b>	<b>0.0031</b>	<b>1.56</b>	<b>2.81</b>	<b>0.081</b>	<b>13.9</b>	<b>0.043</b>	<b>0.011</b>	<b>0.0041</b>	<b>0.29</b>	<b>0.006</b>	<b>(0.001)</b>	<b>(&lt;0.005)</b>
U <sub>CRM</sub>	0.005	0.001	0.003	0.2	0.0005	0.03	0.05	0.009	0.2	0.007	0.003	0.0002	0.02	0.005		
Methods	I,IM	C	I,IM	I,W,IM	I,IM	I,IM	I,IM	F	I,IM	F	I,IM	I,C	I,IM	I,IM	I,IM,A	I,IM

  

	Bi	Ca	Cd	Ce	Fe	H	Hf	Mg	Nb	Pb	Pd	Sb	Se	Sn	Ta	Ti
1	0.005	0.0007	<0.001	<0.002	62.957	0.00028	<0.001	<0.0005	0.000167	0.0003	<0.001	0.0000767	<0.0001	0.00009	0.00009	0.00084
2	<0.001	0.0008	<0.002		63.71	0.00043		<0.001	0.00026	0.002		0.00013	<0.001	0.00014	<0.001	0.003
3	<0.001	0.005	<0.005			0.000644		<0.001	0.00015	<0.001		0.00045	<0.001	0.0009	<0.001	0.008
4		<0.001				0.0007		<0.001	<0.001	<0.01		<0.001	<0.005	<0.001	<0.001	<0.001
5		<0.005				0.001		<0.005	<0.001			<0.001		<0.001	<0.002	<0.001
6		<0.005				<0.0001			<0.001			<0.001		<0.001	<0.002	<0.002
7									<0.002			<0.005		<0.005	<0.005	<0.005
8									<0.005							<0.005
9									<0.005							<0.005
10																
Mean		0.002			63.3	0.0006			0.001			0.002		0		0.004
STDV.		0.002			0.5	0.0003			0.0007			0.003		0.0005		0.004
	<b>(&lt;0.001)</b>	<b>(&lt;0.005)</b>	<b>(&lt;0.005)</b>	<b>(&lt;0.002)</b>	<b>(63.3)</b>	<b>(&lt;0.001)</b>	<b>(&lt;0.001)</b>	<b>(&lt;0.005)</b>	<b>(0.001)</b>	<b>(&lt;0.01)</b>	<b>(&lt;0.001)</b>	<b>(&lt;0.005)</b>	<b>(&lt;0.005)</b>	<b>(&lt;0.005)</b>	<b>(&lt;0.005)</b>	<b>(&lt;0.008)</b>
Methods	I,IM	I,IM	I,IM	I	I	F	IM	I,IM	I,IM	I,IM,A	IM	I,IM,A	I,IM,A	I,IM,A	I,IM	I,IM

  

	W	Y	Zn	Zr
1	0.00033	<0.001	0.0009	0.0000633
2	0.00051		<0.0005	0.0027
3	0.00091		<0.001	<0.001
4	0.003		<0.001	<0.001
5	0.01		<0.005	<0.002
6	0.012		<0.01	<0.005
Mean	0.004		0	0
STDV.	0.005		0.002	
	<b>(&lt;0.012)</b>	<b>(&lt;0.001)</b>	<b>(&lt;0.01)</b>	<b>(&lt;0.005)</b>
Methods	I,IM	IM	I,IM	I,IM

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

Applied Technical Services, Inc.	Marietta, GA	Connecticut Metallurgical, Inc.	East Hartford, CT
Dirats Laboratories	Westfield, MA	EAG Laboratories, Inc.	Liverpool, NY
IMR Test Labs	Lansing, NY	Laboratory Testing, Inc.	Hatfield, PA
LGC Standards	Manchester, NH	Luvak Laboratories	Boylston, MA
Massachusetts Materials Research, Inc.	West Boylston, MA	NSL Analytical Services, Inc.	Cleveland, OH
SGS MSI	Melrose Park, IL		

Certification laboratories have demonstrated performance and traceability by utilizing a variety of test methods all under the scope of ISO 17025. Some of the specific CRMs and SRMs used in the analysis of the material covered by this certificate are:

IARM 241A    IARM 4C    IARM 5B    IARM 5C    IARM 6D    NBS 160A    NBS 184    NBS 856    Nist 1155A

### 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 ICP 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 ICP. Homogeneity may also be determined within sample using an applied version of ASTM E826. A single factor ANOVA is used to calculate 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

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