

CERTIFIED REFERENCE MATERIAL CERTIFICATE OF CHEMICAL ANALYSIS

REFERENCE – MRC N° TL-1100
Steel 36NiCrMo16-DIN 1.6773
LABORATORY MEANS (4 values) – Mass content %

| Line n° | C | Si | Mn | P | S | Cr | Mo | Ni | Cu | N | Sn | Co |
|----------------------|--------|--------|--------|--------|--------|--------|--------|-------|--------|--------|--------|--------|
| 1 | 0,3390 | 0,2770 | 0,6058 | 0,0105 | 0,0035 | 1,627 | 0,3067 | 3,645 | 0,1701 | 0,0107 | 0,0080 | 0,0248 |
| 2 | 0,3400 | 0,2770 | 0,6061 | 0,0115 | 0,0039 | 1,642 | 0,3100 | 3,689 | 0,1720 | 0,0110 | 0,0082 | 0,0268 |
| 3 | 0,3450 | 0,2815 | 0,6100 | 0,0116 | 0,0042 | 1,645 | 0,3205 | 3,711 | 0,1735 | 0,0111 | 0,0083 | 0,0270 |
| 4 | 0,3473 | 0,2815 | 0,6158 | 0,0119 | 0,0043 | 1,648 | 0,3299 | 3,716 | 0,1742 | 0,0115 | 0,0085 | 0,0279 |
| 5 | 0,3475 | 0,2840 | 0,6235 | 0,0126 | 0,0047 | 1,650 | 0,3340 | 3,730 | 0,1744 | 0,0116 | 0,0085 | 0,0282 |
| 6 | 0,3482 | 0,2850 | 0,6250 | 0,0127 | 0,0049 | 1,655 | 0,3360 | 3,739 | 0,1760 | 0,0116 | | 0,0295 |
| 7 | 0,3489 | 0,2900 | 0,6275 | 0,0130 | 0,0049 | 1,658 | 0,3376 | 3,753 | 0,1769 | 0,0121 | | 0,0300 |
| 8 | 0,3495 | 0,2956 | 0,6295 | 0,0130 | 0,0050 | 1,667 | 0,3400 | 3,756 | 0,1779 | 0,0122 | | 0,0300 |
| 9 | 0,3498 | | 0,6400 | 0,0131 | 0,0051 | 1,686 | 0,3410 | 3,761 | 0,1784 | 0,0130 | | 0,0304 |
| 10 | 0,3505 | | 0,6425 | 0,0141 | 0,0052 | 1,686 | 0,3466 | 3,765 | 0,1790 | | | |
| 11 | 0,3520 | | 0,6500 | | 0,0054 | 1,692 | 0,3574 | | 0,1835 | | | |
| 12 | 0,3530 | | 0,6658 | | 0,0056 | 1,715 | 0,3590 | | 0,1850 | | | |
| 13 | 0,3550 | | | | 0,0057 | | | | | | | |
| 14 | 0,3558 | | | | 0,0060 | | | | | | | |
| M_M | 0,3487 | 0,2839 | 0,6284 | 0,0124 | 0,0049 | 1,664 | 0,3349 | 3,727 | 0,1767 | 0,0116 | 0,0083 | 0,0283 |
| S_M | 0,0049 | 0,0063 | 0,0185 | 0,0010 | 0,0007 | 0,02 6 | 0,0163 | 0,038 | 0,0044 | 0,0007 | 0,0002 | 0,0019 |
| S_W | 0,0028 | 0,0059 | 0,0033 | 0,0004 | 0,0003 | 0,014 | 0,0044 | 0,017 | 0,0030 | 0,0003 | 0,0003 | 0,0003 |

| Line n° | Al |
|----------------------|--------|
| 1 | 0,0345 |
| 2 | 0,0348 |
| 3 | 0,0355 |
| 4 | 0,0355 |
| 5 | 0,0377 |
| 6 | 0,0380 |
| 7 | 0,0395 |
| 8 | 0,0400 |
| 9 | 0,0413 |
| 10 | |
| M_M | 0,0374 |
| S_M | 0,0025 |
| S_W | 0,0007 |

| As | Ti | V | W |
|--------|---------|--------|--------|
| 0,0050 | 0,0018 | 0,0038 | 0,0185 |
| 0,0067 | 0,0019 | 0,0039 | 0,0261 |
| 0,0075 | 0,0021 | 0,0039 | 0,0293 |
| 0,0079 | 0,0031 | 0,0041 | 0,0352 |
| 0,0081 | 0,0036 | 0,0045 | 0,0370 |
| 0,0091 | 0,0042 | 0,0051 | |
| 0,0091 | | 0,0057 | |
| 0,0095 | | 0,0062 | |
| 0,0105 | | | |
| 0,0106 | | | |
| 0,0084 | 0,0028 | 0,0046 | 0,0292 |
| 0,0017 | 0,0010 | 0,0009 | 0,0074 |
| 0,0003 | 0,00002 | 0,0002 | 0,0023 |

M_M : Mean of intralaboratory means
S_M : Standard deviation of intralaboratory means
S_W : Intralaboratory standard deviation

The laboratory mean values have been examined statistically with the Cochran and Grubbs Test to eliminate outlying values.

Values given in italic are for information only and are not certified.

Additional values for information: B ~ 2 ppm, Ca ~ 25 ppm, Mg ~ 5 ppm, Nb ~ 20 ppm, Zr ~ 15 ppm

CERTIFIED VALUES – Mass content in %

| Element | C | Si | Mn | P | S | Cr | Mo | Ni | Cu | N |
|----------------------|--------|--------|--------|--------|--------|-------|--------|-------|--------|--------|
| M_M | 0,3487 | 0,2839 | 0,6284 | 0,0124 | 0,0049 | 1,664 | 0,3349 | 3,727 | 0,1767 | 0,0116 |
| C (95%) | 0,0029 | 0,0054 | 0,0118 | 0,0008 | 0,0004 | 0,017 | 0,0104 | 0,027 | 0,0028 | 0,0006 |

| Element | Sn | Co | Al |
|----------------------|--------|--------|--------|
| M_M | 0,0083 | 0,0283 | 0,0374 |
| C (95%) | 0,0003 | 0,0015 | 0,0019 |

C(95%) : half-width confidence interval = $\frac{t \times s_M}{\sqrt{n}}$ where t is the appropriate Student's t value and n is the number of acceptable mean values
For further information regarding the confidence interval for the certified value see ISO Guide 35 : 2006 sections 6.1 et 10.5.2.

METHODS USED

| Element | Line n° | Methods |
|---------|-------------------------------------|---|
| C | 1,2,3,4,5,6,8,9,10,11,12,13,14 7 | Combustion + Infrared (Comb/IR) Reduction fusion + Thermal conductivity (Fusion/Cond th) |
| Si | 1,2,3,4,5,6,7,8 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) |
| Mn | 1,2,3,4,5,6,7,8,9,11,12 10 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) Molecular Absorption Spectrometry (MAS) |
| P | 1,2,3,5,6,7,8,9,10 4 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) Molecular Absorption Spectrometry (MAS) |
| S | 1,2,4,5,6,7,8,9,10,12,13,14 3,11 | Combustion + Infrared (Comb/IR) Reduction fusion + Thermal conductivity (Fusion/Cond th) |
| Cr | 1,2,3,4,5,6,8,9,10,11,12 7 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) Titration (Titr) |
| Mo | 1,2,3,4,5,6,7,8,9,10,11,12 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) |
| Ni | 1,2,3,5,6,7,8,9,10 4 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) Molecular Absorption Spectrometry (MAS) |
| Cu | 1,2,4,5,6,7,8,9,10,11,12 3 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) Molecular Absorption Spectrometry (MAS) |
| N | 2,3,4,5,6,7,8,9 1 | Reduction fusion + Thermal conductivity (Fusion/Cond th) Combustion + Infrared (Comb/IR) |
| Sn | 2,3,4,5 1 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) Atomic Absorption Spectrometry (AAS) |
| Co | 1,2,3,4,5,6,7,8,9 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) |
| Al | 1,2,3,4,5,6,7,8,9 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) |

| | | |
|----|----------------------------|---|
| As | 1,2,4,6,7,8,9,10 3 5 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) Atomic Absorption Spectrometry (AAS) Inductively Coupled Plasma + Mass Spectrometry (ICP/MS) |
| Ti | 1,2,3,4,5,6 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) |
| V | 1,2,3,4,5,6,7,8 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) |
| W | 1,2,4,5 3 | Inductively Coupled Plasma + Optical Emission Spectrometry (ICP/OES) Inductively Coupled Plasma + Mass Spectrometry (ICP/MS) |

DESCRIPTION OF THE SAMPLE

The steel TL-1100 is a disc of 20 mm high and 40 mm diameter.

INTENDED USE - STABILITY

The solid (disc) sample TL-1100 is intended for establishing and checking the calibration of instruments, such as Optical Emission Spectrometers and X-ray Spectrometers, for the analysis of samples of similar materials.

For best analytical results, use the same method for preparing the analytical surface on all reference materials as you use for production specimens.

The entire thickness of the disc can be used. It is recommended to avoid overheating the sample during surface preparation.

If the sample is stored and / or used in a normal environment [protected from heat, corrosive atmosphere, excessive humidity ...], the chemical composition of this sample does not undergo any evolution, whatever the duration of storage.

SAFETY NOTICE

A Material Safety Data Sheet (MSDS) is not required for this material. This material will not release or otherwise result in exposure to a hazardous chemical, under normal conditions of use.

TRACEABILITY

The traceability of CRM TL-1100 has been established in accordance with the ISO Guides 30-35 and the International vocabulary of basic and general terms in metrology.

The assigned values for each material are achieved by inter-laboratory characterization, each laboratory using the method of their choice, details of which are given above. These methods are either stoichiometric analytical techniques or methods which are calibrated against pure metals or stoichiometric compounds. Most methods used were either international or national standard methods or methods which are technically equivalent.

PARTICIPATING LABORATORIES

| | |
|--|---------------------------------|
| A2M INDUSTRIE | FR- 42490 FRAISSES |
| ACCIAIERIE BERTOLI SAFAU | FR- 57070 METZ |
| ACIERIE ET FONDERIE DE LA HAUTE SAMBRE | FR- 59145 BERLAIMONT |
| ACIERIES HACHETTE ET DRIOUT | FR- 52115 SAINT DIZIER Cedex |
| AMETEK | FR- 78990 ELANCOURT |
| APAVE SUDEUROPE SAS | FR- 69160 TASSIN LA DEMI LUNE |
| ARCELORMITTAL ATLANTIQUE ET LORRAINE DUNKERQUE | FR- 59760 GRANDE SYNTHE |
| ARCELORMITTAL MEDITERRANEE | FR- 13776 FOS-SUR-MER Cedex |
| ARCELORMITTAL RESEARCH | FR- 57283 MAIZIERES LES METZ |
| ASCOMETAL FOS SUR MER | FR- 13270 FOS-SUR-MER |
| ASCOVAL | FR- 59880 SAINT SAULVE |
| AUBERT ET DUVAL FIRMINY | FR- 42704 FIRMINY |
| AUBERT ET DUVAL LES ANCIZES | FR- 63770 LES ANCIZES |
| BRAMMER STANDARD | US- 77069 HOUSTON |
| BUREAU VERITAS LABORATOIRES | FR- 95310 SAINT-OUEN L'AUMONE |
| CEA Saclay | FR- 91191 GIF SUR YVETTE |
| CETIM NANTES | FR- 44308 NANTES Cedex 3 |
| CETIM SAINT-ETIENNE | FR- 42952 SAINT-ETIENNE Cedex 1 |
| CRITT-MDTS | FR- 08000 CHARLEVILLE-MEZIERES |
| ENVIFORM a.s. | CZ- 73961 TRINEC |
| EVANS ANALYTICAL GROUP | FR- 31170 TOURNEFEUILLE |
| FRAMATOME-CENTRE TECHNIQUE LE CREUSOT | FR- 71205 LE CREUSOT |
| FONDERIE ET ACIERIE DE DENAIN | FR- 59220 DENAIN |
| INDUSTEEL BELGIUM | BE- 6030 CHARLEROI |
| INDUSTEEL FRANCE LE CREUSOT | FR- 71201 LE CREUSOT CEDEX |
| INDUSTEEL FRANCE RIVE DE GIER | FR- 42803 RIVE-DE-GIER CEDEX |
| INSTITUTE FOR CERTIFIED REFERENCE MATERIALS (ICRM) | RU- 620057 EKATERINBURG |
| INSTYTUT METALURGII ZELAZA (IMZ) | PL - 44100 GLIWICE |
| LABORATOIRE METALLURGIQUE DE L'EST | FR- 54340 POMPEY |
| LABORATOIRES POURQUERY | FR- 69354 LYON CEDEX 07 |
| LES BRONZES INDUSTRIES | FR- 57360 AMNEVILLE |
| LUXCONTROL | LU- 4004 ESCH SUR ALZETTE |
| METALCONTROL | FR- 77100 MEAUX |
| TECHLAB | FR- 57072 METZ CEDEX 3 |

REFERENCES

- ISO 5725-2 : Accuracy (trueness and precision) of measurement methods and results – Part 2 : Basic method for the determination of repeatability and reproducibility of a standard measurement method
- ISO GUIDE 35 : Reference Materials – General and statistical principles for certification
- E826-85 : Standard practice for testing homogeneity of Materials for the Development of Reference Materials

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