

**Metal and Quality, LLC**  
**CERTIFICATE OF ANALYSIS**  
**Reference Materials**  
**DSZU C014-1, DSZU C014-2**  
**Stainless Steel**



**INFORMATION** Reference Materials DSZU C014-1 and DSZU C014-2 are intended for calibration of measuring instruments when determining the chemical composition of stainless steels with non-ferrous metal impurities using optical emission spectrometry

**MANUFACTURER** Metal and Quality, LLC

**CERTIFIED VALUES**

| C014-1             | C      | Si    | Mn    | P      | S      | Cr    | Ni   | Mo     | Ti     | Al    | Cu    | W     | V     | N     | As     | Pb      | Sn     | Sb     |
|--------------------|--------|-------|-------|--------|--------|-------|------|--------|--------|-------|-------|-------|-------|-------|--------|---------|--------|--------|
| Mass fraction, %   | 0.0054 | 0.052 | 0.004 | 0.0022 | 0.0039 | 17.10 | 9.16 | 0.0021 | 0.0019 | 0.070 | 0.037 | 0.007 | 0.006 | 0.021 | 0.0020 | 0.00034 | 0.0013 | 0.0019 |
| Uncertainty C(95%) | 0.0010 | 0.004 | -     | 0.0004 | 0.0009 | 0.09  | 0.06 | 0.0007 | 0.0004 | 0.005 | 0.003 | 0.002 | 0.002 | 0.003 | 0.0003 | 0.00008 | 0.0002 | 0.0002 |
| C014-2             | C      | Si    | Mn    | P      | S      | Cr    | Ni   | Mo     | Ti     | Al    | Cu    | W     | V     | N     | As     | Pb      | Sn     | Sb     |
| Mass fraction, %   | 0.0101 | 0.090 | 0.015 | 0.0030 | 0.0061 | 16.88 | 9.89 | 0.014  | 0.017  | 0.176 | 0.268 | 0.074 | 0.006 | 0.043 | 0.020  | 0.0012  | 0.023  | 0.019  |
| Uncertainty C(95%) | 0.0017 | 0.004 | -     | 0.0006 | 0.0005 | 0.09  | 0.05 | 0.003  | 0.002  | 0.011 | 0.012 | 0.005 | 0.002 | 0.002 | 0.004  | 0.0004  | 0.003  | 0.003  |

Uncertainty C(95%) estimated as the half-width confidence interval of Student's t-distribution, when n is the number of laboratory means (see next page)

$$C(95\%) = \frac{t \cdot s(M)}{\sqrt{n}}$$

*Italic - indicative values*

**SPECIFICATION** The reference materials are made of forged stainless steel melted in a vacuum induction furnace. The samples are cylinders with a diameter of 38 mm (C014-1), 39 mm (C014-2) and a height of 20 mm

**HOMOGENEITY** The homogeneity was evaluated according to ISO Guide 35:2017. The OES method was used to assess homogeneity and the homogeneity was found to be acceptable

**TRACEABILITY** The characterization of RMs was achieved through inter-laboratory experiment. Standardized methods were used in the analysis

**RM VALIDITY** The shelf life of RMs is not limited. The working surface of these samples should be purified before use. The reference materials will remain stable provided they are not subjected to excessive heat (e.g. during preparation of the working surface)

**DATE OF ISSUE** December 2024

**DELIVERY** RMs packed into a box and certificate

**SAFETY** A Safety Data Sheet (SDS) is not required for these reference materials. Material and packing does not contain hazardous chemical, explosives and radioactive substances and substances which might influence health and the environment

## LABORATORY MEANS

|               | n           | C             | Si            | P             | S             | Cr           | Ni          | Mo            | Ti            | Al            | Cu            | W             | V             | N             | As            | Pb             | Sn             | Sb             |
|---------------|-------------|---------------|---------------|---------------|---------------|--------------|-------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|----------------|----------------|----------------|
| <b>C014-1</b> | 1           | 0.0048        | 0.0453        | 0.0016        | 0.0020        | 16.87        | 9.05        | 0.0016        | 0.0010        | 0.0582        | 0.0300        | 0.0045        | 0.0025        | 0.0190        | 0.0015        | 0.00029        | 0.00112        | 0.00170        |
|               | 2           | 0.0050        | 0.0476        | 0.0019        | 0.0025        | 17.01        | 9.10        | 0.0018        | 0.0019        | 0.0648        | 0.0365        | 0.0050        | 0.0047        | 0.0221        | 0.0020        | 0.00030        | 0.00120        | 0.00183        |
|               | 3           | 0.0050        | 0.0500        | 0.0020        | 0.0040        | 17.02        | 9.11        | 0.0019        | 0.0020        | 0.0670        | 0.0367        | 0.0070        | 0.0056        | 0.0223        | 0.0020        | 0.00035        | 0.00120        | 0.00200        |
|               | 4           | 0.0052        | 0.0517        | 0.0020        | 0.0040        | 17.09        | 9.13        | 0.0024        | 0.0020        | 0.0690        | 0.0370        | 0.0077        | 0.0062        |               | 0.0022        | 0.00042        | 0.00140        | 0.00210        |
|               | 5           | 0.0070        | 0.0522        | 0.0024        | 0.0041        | 17.11        | 9.13        | 0.0030        | 0.0020        | 0.0700        | 0.0378        | 0.0088        | 0.0074        |               | 0.0024        |                | 0.00164        |                |
|               | 6           |               | 0.0540        | 0.0026        | 0.0044        | 17.19        | 9.16        |               | 0.0023        | 0.0700        | 0.0390        | 0.0088        | 0.0079        |               | 0.0024        |                |                |                |
|               | 7           |               | 0.0555        | 0.0028        | 0.0048        | 17.19        | 9.19        |               | <0.0010       | 0.0705        | 0.0397        |               |               |               |               |                |                |                |
|               | 8           |               | 0.0600        |               | 0.0050        | 17.20        | 9.25        |               |               | 0.0738        | 0.0424        |               |               |               |               |                |                |                |
|               | 9           |               |               |               |               | 17.23        | 9.31        |               |               | 0.0840        |               |               |               |               |               |                |                |                |
|               | <b>M(M)</b> | <b>0.0054</b> | <b>0.0520</b> | <b>0.0022</b> | <b>0.0039</b> | <b>17.10</b> | <b>9.16</b> | <b>0.0021</b> | <b>0.0019</b> | <b>0.0697</b> | <b>0.0374</b> | <b>0.0070</b> | <b>0.0057</b> | <b>0.0211</b> | <b>0.0021</b> | <b>0.00034</b> | <b>0.00131</b> | <b>0.00191</b> |
|               | <b>s(M)</b> | <b>0.0009</b> | <b>0.0046</b> | <b>0.0004</b> | <b>0.0011</b> | <b>0.12</b>  | <b>0.08</b> | <b>0.0006</b> | <b>0.0004</b> | <b>0.0069</b> | <b>0.004</b>  | <b>0.002</b>  | <b>0.002</b>  | <b>0.0019</b> | <b>0.0003</b> | <b>0.00006</b> | <b>0.00021</b> | <b>0.00018</b> |
| <b>C014-2</b> | n           | C             | Si            | P             | S             | Cr           | Ni          | Mo            | Ti            | Al            | Cu            | W             | V             | N             | As            | Pb             | Sn             | Sb             |
|               | 1           | 0.0082        | 0.0822        | 0.0020        | 0.0050        | 16.73        | 9.76        | 0.0091        | 0.0149        | 0.1532        | 0.2511        | 0.0590        | 0.0023        | 0.0420        | 0.0100        | 0.0008         | 0.0190         | 0.0144         |
|               | 2           | 0.0095        | 0.0851        | 0.0028        | 0.0058        | 16.74        | 9.84        | 0.0100        | 0.0150        | 0.1660        | 0.2585        | 0.0700        | 0.0049        | 0.0420        | 0.0150        | 0.0010         | 0.0198         | 0.0150         |
|               | 3           | 0.0097        | 0.0880        | 0.0029        | 0.0058        | 16.80        | 9.85        | 0.0110        | 0.0160        | 0.1670        | 0.2590        | 0.0732        | 0.0058        | 0.0440        | 0.0156        | 0.0010         | 0.0199         | 0.0170         |
|               | 4           | 0.0110        | 0.0900        | 0.0031        | 0.0060        | 16.87        | 9.89        | 0.0149        | 0.0162        | 0.1670        | 0.2590        | 0.0738        | 0.0068        |               | 0.0158        | 0.0011         | 0.0230         | 0.0200         |
|               | 5           | 0.0120        | 0.0914        | 0.0032        | 0.0063        | 16.87        | 9.89        | 0.0150        | 0.0170        | 0.1760        | 0.2600        | 0.0750        | 0.0070        |               | 0.0189        | 0.0017         | 0.0230         | 0.0208         |
|               | 6           |               | 0.0925        | 0.0040        | 0.0063        | 16.90        | 9.89        | 0.0152        | 0.0170        | 0.1800        | 0.2640        | 0.0764        | 0.0082        |               | 0.0190        | 0.0018         | 0.0240         | 0.0220         |
|               | 7           |               | 0.0930        | <0.0010       | 0.0064        | 16.92        | 9.93        | 0.0152        | 0.0173        | 0.1800        | 0.2750        | 0.0776        |               |               | 0.0210        |                | 0.0245         | 0.0230         |
|               | 8           |               | 0.1000        |               | 0.0070        | 17.02        | 9.95        | 0.0192        | 0.0179        | 0.1910        | 0.2800        | 0.0799        |               |               | 0.0210        |                | 0.0306         |                |
|               | 9           |               |               |               |               | 17.06        | 10.00       |               | 0.0198        | 0.2010        | 0.3040        | 0.0800        |               |               | 0.0288        |                |                |                |
|               | <b>M(M)</b> | <b>0.0101</b> | <b>0.0903</b> | <b>0.0030</b> | <b>0.0061</b> | <b>16.88</b> | <b>9.89</b> | <b>0.0137</b> | <b>0.0174</b> | <b>0.1757</b> | <b>0.2678</b> | <b>0.0739</b> | <b>0.0058</b> | <b>0.0427</b> | <b>0.0196</b> | <b>0.0012</b>  | <b>0.0230</b>  | <b>0.0189</b>  |
|               | <b>s(M)</b> | <b>0.0015</b> | <b>0.0054</b> | <b>0.0006</b> | <b>0.0006</b> | <b>0.11</b>  | <b>0.07</b> | <b>0.0034</b> | <b>0.0023</b> | <b>0.0144</b> | <b>0.0162</b> | <b>0.0064</b> | <b>0.0021</b> | <b>0.0012</b> | <b>0.0062</b> | <b>0.0004</b>  | <b>0.0037</b>  | <b>0.0034</b>  |

M(M) - Mean of intralaboratory means, mass fraction in %

s(M) - Standard deviation of the mean values of laboratories

## PARTICIPATING LABORATORIES

ArcelorMittal Kriviy Rig PJSC, Ukraine

Dnepropress Steel LLC, Ukraine

Dneprospetsstal (DSS) PJSC, Ukraine

Kremenchuk Steel Works, Ukraine

Luvak Inc., USA

Oy NAREMA, Finland

Zaporizhstal PJSC, Ukraine

Zaporozhye Steel Works LLC, Ukraine

## METHODS USED

C, S - Coulometric, Infrared absorption

Si - Photometric, OES, ICP-OES

Ni - Gravimetric, OES, ICP-OES

Cr - Titrimetric, OES, ICP-OES

Mn, Ti, P, Cu, Co, Mo, Nb, Al, V, W - OES, ICP-OES

As, Pb, Sn, Sb - ICP-OES, ICP-MS, FAAS, GFAAS

N - Inert gas fusion with thermal conductivity

## CONTACTS

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