# REPORT No 11417

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***Status: FINAL REPORT***

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# ASTM E415

# ANALYSIS OF CARBON STEEL BY SPARK ATOMIC EMISSION SPECTROMETRY

# Program: SQO-M6 Round 18

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## 1. FOREWORD

This report summarizes the results of the **SQO-M6 (Round 18)** proficiency testing program on the determination of composition of carbon steels. This program is carried out under a simultaneous participation format, according to the A.3.1 classification of the ISO 17043 standard ("Model 2 - Figure A.1").

**South Quality** conducted the testing program in September/October 2025. The aim of the program was to assess laboratory ability to competently perform the nominated tests.

## 2. ORGANIZATION

| | |
|---|---|
| Program Coordinator: | Eng. Erika Brest |
| Assistant Technician: | Mateo Giovanni |
| Statistic: | Lic. Manuel Tozaki |
| Supervision: | Eng. Emiliano Medina |

## 3. OBJECTIVE

The objective of this proficiency testing program is to determine the composition of carbon steel samples.

These parameters are verified using the following standard:

| Standard |
|---|
| ASTM E415 - 2021 |

Batches of steels samples have been selected.

Participants in this program have not been previously informed of the values or range of values expected from the samples they receive.

## 4. PARTICIPANTS

In the present round, 19 laboratories have participated with the following details:

| CODE | Country | ISO 17025 Accredited | Results delivered |
|---|---|---|---|
| 01 | Spain | No | Yes |
| 02 | Hong Kong | Yes | No |
| 03 | Germany | Yes | Yes |
| 04 | Türkiye | No | Yes |
| 05 | Canada | Yes | Yes |
| 06 | Mexico | Yes | Yes |
| 07 | England | Yes | Yes |
| 08 | Portugal | Yes | Yes |
| 09 | Mexico | Yes | Yes |
| 10 | Italy | No | Yes |
| 11 | Brazil | Yes | Yes |
| 12 | South Africa | Yes | Yes |
| 13 | Spain | Yes | No |
| 14 | Spain | Yes | Yes |
| 15 | Malaysia | No | Yes |
| 16 | France | Yes | Yes |
| 17 | Germany | Yes | Yes |
| 18 | Chile | Yes | No |
| 19 | Argentina | No | No |

## 5. HOMOGENEITY

Several batches were prepared identically by South Quality staff.

Subsequently, a homogeneity study was conducted with an ISO 17025 accredited laboratory.

The control process followed ISO 33405: 2024, clauses 7.4.1.1 / 7.4.1.2. Stratified random sampling was employed, and samples were chosen using random number generation software.

The results of these tests are presented below:

Size of each batch: **50 samples** Tested samples from each batch: **10 samples**

| DETERMINATION | SAE 1045 - HOMOGENEITY OF RESULTS IN THE ANALYZED SAMPLES | | |
|---|---|---|---|
| | BATCH: LM3244 | BATCH: LM3245 | BATCH: LM3246 |
| Element composition | YES | YES | YES |

| DETERMINATION | SAE 1010 - HOMOGENEITY OF RESULTS IN THE ANALYZED SAMPLES | | |
|---|---|---|---|
| | BATCH: LM3426 | BATCH: LM3427 | BATCH: LM3428 |
| Element composition | NO | YES | YES |

Samples for this program are taken from selected batches identified as **LM3245** and **LM3428**.

Analysis of this testing data indicated that samples were sufficiently homogeneous for the program and, therefore, any participant results identified as outliers cannot be attributed to sample variability.

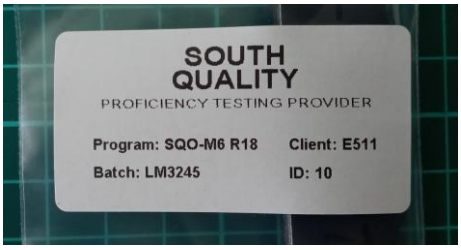
## 6. SAMPLE INFORMATION

The following samples were sent for testing (Participant **Code 10**):

| | |
|---|---|
| Batch: | LM3245 |
| Sample ID: | 10 |
| Observation: | Carbon steel (SAE 1045) - Ø20 x 20 mm |

| | |
|---|---|
| Batch: | LM3428 |
| Sample ID: | 10 |
| Observation: | Carbon steel (SAE 1010) - 20 x 10 x 80 mm |

## 7. IMAGES

| SAMPLES |
|---|
|  |

## 8. ASSIGNED VALUES

The assigned values are obtained from the results reported by all participants (**Consensus values**).

## 9. PARTICIPANTS' RESULTS

| ELEMENT | MASS FRACTION, % - BATCH: LM3245 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB 01 | LAB 03 | LAB 04 | LAB 05 | LAB 06 | LAB 07 | LAB 08 | LAB 09 | LAB 10 | LAB 11 | LAB 12 | LAB 14 | LAB 15 | LAB 16 | LAB 17 | ASSIGNED VALUE | |
| | | | | | | | | | | | | | | | | AVG | SD |
| ALUMINUM | 0.021 | 0.0215 | 0.0325 | NV | 0.0238 | 0.0205 | 0.0211 | 0.0201 | 0.0245 | 0.02207 | 0.022 | 0.0209 | 0.0212 | 0.0235 | 0.0232 | **0.0220** | **0.00138** |
| ANTIMONY | NV | 0.0043 | 0.0038 | NV | 0.0036 | 0.003 | 0.0033 | 0.0057 | NV | 0.0037 | NV | 0.0033 | 0.004 | NV | 0.0033 | **0.0038** | **0.00077** |
| ARSENIC | NV | 0.004 | 0.0035 | NV | 0.0032 | 0.0037 | 0.0036 | 0.004 | NV | 0.00409 | NV | 0.0034 | 0.0039 | NV | 0.004 | **0.0037** | **0.00030** |
| BORON | < LOQ | < LOQ | NV | < LOQ | < LOQ | < LOQ | NV | < LOQ | < LOQ | < LOQ | < LOQ | < LOQ | < LOQ | NV | < LOQ | **< LOQ** | **-** |
| CALCIUM | NV | 0.0017 | 0.0022 | 0.0022 | 0.0016 | 0.0022 | 0.0021 | 0.0014 | NV | 0.00207 | NV | 0.0021 | 0.0023 | 0.002 | 0.0016 | **0.0020** | **0.00030** |
| CARBON | 0.42 | 0.3985 | 0.4278 | 0.4128 | 0.4414 | 0.4361 | 0.392 | 0.4295 | 0.44 | 0.40075 | 0.43 | 0.4132 | 0.4335 | 0.4453 | 0.4146 | **0.4224** | **0.01659** |
| CHROMIUM | 0.062 | 0.065 | 0.0584 | 0.0655 | 0.0668 | 0.0699 | 0.0688 | 0.0995 | 0.065 | 0.06339 | 0.059 | 0.062 | 0.0699 | 0.0677 | 0.0819 | **0.0661** | **0.00583** |
| COBALT | NV | 0.0047 | 0.0056 | 0.0055 | 0.005 | 0.0058 | 0.0047 | 0.0048 | NV | 0.00466 | NV | 0.0045 | 0.0058 | 0.0054 | 0.0051 | **0.0051** | **0.00047** |
| COPPER | 0.135 | 0.1262 | 0.1335 | 0.1417 | 0.1401 | 0.1346 | 0.1356 | 0.1352 | 0.139 | 0.13371 | NV | 0.1321 | 0.1456 | 0.1335 | 0.1271 | **0.1352** | **0.00522** |
| LEAD | NV | 0.002 | 0.0022 | NV | 0.0013 | 0.0019 | 0.0021 | 0.0028 | 0.0014 | < 0.001 | NV | 0.0019 | 0.0018 | 0.0022 | 0.0018 | **0.0019** | **0.00041** |
| MANGANESE | 0.715 | 0.6482 | 0.7297 | 0.643 | 0.7139 | 0.7577 | 0.6999 | 0.6512 | 0.721 | 0.71221 | NV | 0.7117 | 0.7356 | 0.6988 | 0.7148 | **0.7038** | **0.03392** |
| MOLYBDENUM | NV | 0.0099 | 0.0081 | 0.0077 | 0.009 | 0.0066 | 0.0075 | 0.0088 | NV | 0.00932 | 0.0071 | 0.0086 | 0.0095 | 0.0062 | 0.00902 | **0.0083** | **0.00116** |
| NICKEL | 0.055 | 0.0535 | 0.0603 | 0.0531 | 0.0555 | 0.0537 | 0.0621 | 0.0626 | 0.058 | 0.05646 | 0.054 | 0.0567 | 0.0603 | 0.0597 | 0.062 | **0.0575** | **0.00340** |
| NIOBIUM | 0.0006 | 0.0006 | 0.0006 | NV | 0.0005 | 0.0005 | NV | 0.0005 | 0.0006 | < 0.001 | NV | 0.0005 | 0.0007 | NV | 0.0006 | **0.0006** | **0.00007** |
| NITROGEN | 0.0076 | 0.0092 | 0.0094 | NV | 0.012 | 0.0086 | 0.0091 | 0.0089 | 0.0089 | NV | 0.0071 | 0.0086 | 0.0078 | 0.0095 | 0.0063 | **0.0087** | **0.00138** |
| PHOSPHOROUS | 0.0145 | 0.0168 | 0.0145 | 0.0152 | 0.0162 | 0.0147 | 0.0158 | 0.0153 | 0.0153 | 0.01402 | NV | 0.0156 | 0.0148 | 0.015 | 0.0159 | **0.0153** | **0.00075** |
| SILICON | 0.248 | 0.2324 | 0.2198 | 0.2299 | 0.2166 | 0.2358 | 0.229 | 0.255 | 0.259 | 0.23861 | 0.243 | 0.2294 | 0.2489 | 0.2377 | 0.2286 | **0.2368** | **0.01221** |
| SULFUR | 0.011 | 0.0112 | 0.0108 | 0.016 | 0.0112 | 0.015 | 0.0123 | 0.0111 | 0.014 | 0.01006 | 0.012 | 0.0119 | 0.0106 | 0.0107 | 0.0115 | **0.0120** | **0.00172** |
| TIN | NV | 0.0172 | 0.016 | NV | 0.0157 | 0.0159 | 0.0158 | 0.0138 | NV | 0.01648 | 0.018 | 0.0173 | 0.0176 | 0.018 | 0.0173 | **0.0166** | **0.00122** |
| TITANIUM | NV | 0.0012 | 0.0013 | NV | 0.0011 | 0.0013 | 0.0013 | 0.0011 | NV | 0.00109 | NV | 0.0013 | 0.0011 | NV | 0.0011 | **0.0012** | **0.00010** |
| VANADIUM | < LOQ | < LOQ | < LOQ | NV | < LOQ | < LOQ | < LOQ | < LOQ | < LOQ | 0.00112 | NV | < LOQ | < LOQ | < LOQ | < LOQ | **< LOQ** | **-** |
| ZIRCONIUM | NV | NV | NV | NV | NV | NV | NV | NV | NV | 0.001 | NV | NV | NV | NV | NV | **-** | **-** |

| ELEMENT | MASS FRACTION, % - BATCH: LM3428 | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB 01 | LAB 03 | LAB 04 | LAB 05 | LAB 06 | LAB 07 | LAB 08 | LAB 09 | LAB 10 | LAB 11 | LAB 12 | LAB 14 | LAB 15 | LAB 16 | LAB 17 | ASSIGNED VALUE | |
| | | | | | | | | | | | | | | | | AVG | SD |
| ALUMINUM | < LOQ | < LOQ | < LOQ | NV | < LOQ | < LOQ | < LOQ | < LOQ | < LOQ | < LOQ | < LOQ | < LOQ | < LOQ | < LOQ | < LOQ | **< LOQ** | **-** |
| ANTIMONY | NV | 0.00225 | 0.00213 | 0.00232 | 0.00215 | 0.00236 | 0.00245 | 0.00209 | NV | 0.00219 | NV | 0.00212 | 0.0022 | NV | 0.0023 | **0.0022** | **0.00011** |
| ARSENIC | NV | 0.00408 | 0.00392 | 0.00385 | 0.00412 | 0.00409 | 0.00381 | 0.0048 | NV | 0.00396 | NV | 0.00403 | 0.00369 | NV | 0.0034 | **0.0040** | **0.00036** |
| BORON | < LOQ | < LOQ | NV | < LOQ | < LOQ | < LOQ | - | < LOQ | < LOQ | 0.00026 | < LOQ | < LOQ | < LOQ | NV | < LOQ | **< LOQ** | **-** |
| CALCIUM | NV | 0.00037 | 0.0004 | 0.00037 | 0.00039 | 0.0004 | 0.00038 | 0.00036 | NV | 0.00038 | NV | 0.0004 | 0.00041 | 0.00037 | 0.00036 | **0.0004** | **0.00002** |
| CARBON | 0.1785 | 0.1606 | 0.155 | 0.1784 | 0.158 | 0.1821 | 0.1685 | 0.1611 | 0.177 | 0.1676 | 0.161 | 0.1558 | 0.167 | 0.1853 | 0.1716 | **0.1685** | **0.00992** |
| CHROMIUM | 0.0507 | 0.0449 | 0.049 | 0.0476 | 0.0389 | 0.0442 | 0.0487 | 0.0447 | 0.047 | 0.04559 | 0.04 | 0.0437 | 0.0489 | 0.049 | 0.043 | **0.0457** | **0.00344** |
| COBALT | NV | 0.00204 | 0.00235 | 0.00224 | 0.00183 | 0.00204 | 0.00182 | 0.00188 | NV | 0.00207 | NV | 0.00192 | 0.00192 | 0.00203 | 0.00221 | **0.0020** | **0.00017** |
| COPPER | 0.0928 | 0.0843 | 0.0939 | 0.0846 | 0.0868 | 0.0826 | 0.0869 | 0.085 | 0.079 | 0.078 | NV | 0.0792 | 0.066 | 0.0924 | 0.0915 | **0.0845** | **0.00748** |
| LEAD | NV | 0.0012 | 0.0011 | NV | 0.0013 | 0.0013 | 0.0012 | 0.0011 | 0.0013 | < 0.001 | NV | 0.0013 | 0.0012 | 0.0012 | 0.0012 | **0.0012** | **0.00008** |
| MANGANESE | 0.7413 | 0.6786 | 0.785 | 0.7761 | 0.6853 | 0.7515 | 0.7656 | 0.7508 | 0.714 | 0.71808 | NV | 0.6672 | 0.7119 | 0.7251 | 0.7475 | **0.7299** | **0.03625** |
| MOLYBDENUM | NV | 0.0032 | 0.0034 | 0.0044 | 0.0046 | 0.004 | 0.0037 | 0.0041 | NV | 0.00382 | 0.004 | 0.0039 | 0.0046 | 0.0042 | 0.0042 | **0.0040** | **0.00042** |
| NICKEL | 0.0232 | 0.0206 | 0.0207 | 0.0259 | 0.021 | 0.0197 | 0.0206 | 0.0229 | 0.026 | 0.02512 | 0.0216 | 0.0246 | 0.0223 | 0.0246 | 0.0244 | **0.0229** | **0.00212** |
| NIOBIUM | 0.0004 | 0.0005 | 0.0006 | NV | 0.0006 | 0.0004 | NV | 0.0004 | 0.0005 | < 0.001 | NV | 0.0005 | 0.0005 | NV | 0.0004 | **0.0005** | **0.00008** |
| NITROGEN | 0.0086 | 0.009 | 0.0082 | NV | 0.0091 | 0.007 | 0.0069 | 0.0078 | 0.0089 | NV | 0.0071 | 0.0079 | 0.0077 | 0.0088 | 0.0091 | **0.0082** | **0.00082** |
| PHOSPHOROUS | 0.0133 | 0.0143 | 0.0175 | 0.0173 | 0.0127 | 0.0176 | 0.0142 | 0.0097 | 0.0135 | 0.0136 | NV | 0.0155 | 0.0145 | 0.0166 | 0.0153 | **0.0147** | **0.00218** |
| SILICON | 0.1532 | 0.2061 | 0.2146 | 0.1567 | 0.151 | 0.1623 | 0.206 | 0.1566 | 0.182 | 0.17568 | 0.179 | 0.183 | 0.1619 | 0.1997 | 0.1769 | **0.1776** | **0.02103** |
| SULFUR | 0.0161 | 0.0149 | 0.0123 | 0.0173 | 0.0158 | 0.0127 | 0.0122 | 0.0118 | 0.015 | 0.01542 | 0.0128 | 0.017 | 0.0146 | 0.012 | 0.013 | **0.0142** | **0.00189** |
| TIN | NV | 0.0053 | 0.0052 | NV | 0.006 | 0.0043 | 0.0055 | 0.0051 | NV | 0.00555 | 0.004 | 0.0042 | 0.004 | 0.005 | 0.0043 | **0.0049** | **0.00068** |
| TITANIUM | NV | 0.0004 | 0.0003 | NV | 0.0003 | 0.0002 | 0.0003 | 0.0003 | NV | 0.00034 | NV | 0.0004 | 0.0002 | NV | 0.0002 | **0.0003** | **0.00008** |
| VANADIUM | < LOQ | < LOQ | < LOQ | NV | 0.0004 | < LOQ | < LOQ | < LOQ | < LOQ | < LOQ | NV | < LOQ | < LOQ | < LOQ | < LOQ | **< LOQ** | **-** |
| ZIRCONIUM | NV | NV | NV | NV | NV | NV | NV | NV | NV | < LOQ | NV | NV | NV | NV | NV | **-** | **-** |

**NV: NOT VERIFIED**
**LOQ: LIMIT OF QUANTIFICATION**

## 10. STATISTICS

The results must be treated as qualitative as quantitative.

According B.3.1.3 of ISO 17043 the appropriate technique is to compare participant results with the assigned values.

a) For **quantitative** results the comparison will be made through ***z score*** (B3 - ISO 17043).

$$z = \frac{x - X}{\hat{\sigma}}$$

$x$ is the participant's result

$X$ is the assigned value

$\hat{\sigma}$ is the standard deviation

The performance evaluation of each sample is carried out with the following criteria:

**$|z| \leq 2.0$ indicates "satisfactory" performance and generates no signal;**

**$2.0 < |z| < 3.0$ indicates "questionable" performance and generates a warning signal;**

**$|z| \geq 3.0$ indicates "unsatisfactory" performance and generates an action signal;**

b) For the qualitative comparison, several situations may occur, as follows:

i) When more than 70% of the laboratories report a value <LOQ, this indication is adopted as the assigned value for the element in question.
ii) When <LOQ is adopted as the assigned value for an element, any numerical results reported by the remaining laboratories, as well as the <LOQ indications, will not be evaluated (**NE**).
iii) When a numerical value is assigned to an element and a <LOQ value *above* that numerical value is reported, it will be considered qualitatively satisfactory (**S**).
iv) When a numerical value is assigned to an element and a <LOQ value *below* that numerical value is reported, it will be considered qualitatively unsatisfactory (**NS**).
v) In cases where the minimum number of results required to calculate the assigned value and the standard deviation is not reached, the numerical results reported by one or more participants will not be evaluated (**NE**).

## 11. EVALUATION OF PERFORMANCE

| ELEMENT | EVALUATION (QUANTITATIVE/QUALITATIVE) - BATCH: LM3245 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB 01 | LAB 03 | LAB 04 | LAB 05 | LAB 06 | LAB 07 | LAB 08 | LAB 09 | LAB 10 | LAB 11 | LAB 12 | LAB 14 | LAB 15 | LAB 16 | LAB 17 |
| ALUMINUM | -0.72 | -0.36 | 7.61 | - | 1.30 | -1.09 | -0.65 | -1.38 | 1.81 | 0.05 | 0 | -0.80 | -0.58 | 1.09 | 0.87 |
| ANTIMONY | - | 0.65 | 0 | - | -0.26 | -1.04 | -0.65 | 2.47 | - | -0.13 | - | -0.65 | 0.26 | - | -0.65 |
| ARSENIC | - | 1.00 | -0.67 | - | -1.67 | 0 | -0.33 | 1.00 | - | 1.30 | - | -1.00 | 0.67 | - | 1.00 |
| BORON | NE | NE | - | NE | NE | NE | - | NE | NE | NE | NE | NE | NE | - | NE |
| CALCIUM | - | -1.00 | 0.67 | 0.67 | -1.33 | 0.67 | 0.33 | -2.00 | - | 0.23 | - | 0.33 | 1.00 | 0 | -1.33 |
| CARBON | -0.14 | -1.44 | 0.33 | -0.58 | 1.15 | 0.83 | -1.83 | 0.43 | 1.06 | -1.31 | 0.46 | -0.55 | 0.67 | 1.38 | -0.47 |
| CHROMIUM | -0.7 | -0.19 | -1.32 | -0.1 | 0.12 | 0.65 | 0.46 | 5.73 | -0.19 | -0.46 | -1.22 | -0.70 | 0.65 | 0.27 | 2.71 |
| COBALT | - | -0.85 | 1.06 | 0.85 | -0.21 | 1.49 | -0.85 | -0.64 | - | -0.94 | - | -1.28 | 1.49 | 0.64 | 0 |
| COPPER | -0.04 | -1.72 | -0.33 | 1.25 | 0.94 | -0.11 | 0.08 | 0 | 0.73 | -0.29 | - | -0.59 | 1.99 | -0.33 | -1.55 |
| LEAD | - | 0.24 | 0.73 | - | -1.46 | 0 | 0.49 | 2.20 | -1.22 | NS | - | 0 | -0.24 | 0.73 | -0.24 |
| MANGANESE | 0.33 | -1.64 | 0.76 | -1.79 | 0.30 | 1.59 | -0.11 | -1.55 | 0.51 | 0.25 | - | 0.23 | 0.94 | -0.15 | 0.32 |
| MOLYBDENUM | - | 1.38 | -0.17 | -0.52 | 0.60 | -1.47 | -0.69 | 0.43 | - | 0.88 | -1.03 | 0.26 | 1.03 | -1.81 | 0.62 |
| NICKEL | -0.74 | -1.18 | 0.82 | -1.29 | -0.59 | -1.12 | 1.35 | 1.50 | 0.15 | -0.31 | -1.03 | -0.24 | 0.82 | 0.65 | 1.32 |
| NIOBIUM | 0 | 0 | 0 | - | -1.43 | -1.43 | - | -1.43 | 0 | S | - | -1.43 | 1.43 | - | 0 |
| NITROGEN | -0.8 | 0.36 | 0.51 | - | 2.39 | -0.07 | 0.29 | 0.14 | 0.14 | - | -1.16 | -0.07 | -0.65 | 0.58 | -1.74 |
| PHOSPHOROUS | -1.07 | 2.00 | -1.07 | -0.13 | 1.20 | -0.80 | 0.67 | 0.00 | 0.00 | -1.71 | - | 0.40 | -0.67 | -0.40 | 0.80 |
| SILICON | 0.92 | -0.36 | -1.39 | -0.57 | -1.65 | -0.08 | -0.64 | 1.49 | 1.82 | 0.15 | 0.51 | -0.61 | 0.99 | 0.07 | -0.67 |
| SULFUR | -0.58 | -0.47 | -0.70 | 2.33 | -0.47 | 1.74 | 0.17 | -0.52 | 1.16 | -1.13 | 0 | -0.06 | -0.81 | -0.76 | -0.29 |
| TIN | - | 0.49 | -0.49 | - | -0.74 | -0.57 | -0.66 | -2.30 | - | -0.10 | 1.15 | 0.57 | 0.82 | 1.15 | 0.57 |
| TITANIUM | - | 0 | 1.00 | - | -1.00 | 1.00 | 1.00 | -1.00 | - | -1.10 | - | 1.00 | -1.00 | - | -1.00 |
| VANADIUM | NE | NE | NE | - | NE | NE | NE | NE | NE | NE | - | NE | NE | NE | NE |
| ZIRCONIUM | - | - | - | - | - | - | - | - | - | NE | - | - | - | - | - |

| ELEMENT | EVALUATION (QUANTITATIVE/QUALITATIVE) - BATCH: LM3428 | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LAB 01 | LAB 03 | LAB 04 | LAB 05 | LAB 06 | LAB 07 | LAB 08 | LAB 09 | LAB 10 | LAB 11 | LAB 12 | LAB 14 | LAB 15 | LAB 16 | LAB 17 |
| ALUMINUM | NE | NE | NE | - | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE | NE |
| ANTIMONY | - | 0.45 | -0.64 | 1.09 | -0.45 | 1.45 | 2.27 | -1.00 | - | -0.09 | - | -0.73 | 0 | - | 0.91 |
| ARSENIC | - | 0.22 | -0.22 | -0.42 | 0.33 | 0.25 | -0.53 | 2.22 | - | 0.11 | - | 0.08 | -0.86 | - | -1.94 |
| BORON | NE | NE | - | NE | NE | NE | - | NE | NE | NE | NE | NE | NE | - | NE |
| CALCIUM | - | -1.50 | 0 | -1.50 | -0.50 | 0 | -1.00 | -2.00 | - | -1.00 | - | 0 | 0.50 | -1.50 | -2.00 |
| CARBON | 1.01 | -0.80 | -1.36 | 1.00 | -1.06 | 1.37 | 0 | -0.75 | 0.86 | -0.09 | -0.76 | -1.28 | -0.15 | 1.69 | 0.31 |
| CHROMIUM | 1.45 | -0.23 | 0.96 | 0.55 | -1.98 | -0.44 | 0.87 | -0.29 | 0.38 | -0.03 | -1.66 | -0.58 | 0.93 | 0.96 | -0.78 |
| COBALT | - | 0.24 | 2.06 | 1.41 | -1.00 | 0.24 | -1.06 | -0.71 | - | 0.41 | - | -0.47 | -0.47 | 0.18 | 1.24 |
| COPPER | 1.11 | -0.03 | 1.26 | 0.01 | 0.31 | -0.25 | 0.32 | 0.07 | -0.74 | -0.87 | - | -0.71 | -2.47 | 1.06 | 0.94 |
| LEAD | - | 0 | -1.25 | - | 1.25 | 1.25 | 0 | -1.25 | 1.25 | NS | - | 1.25 | 0 | 0 | 0 |
| MANGANESE | 0.31 | -1.42 | 1.52 | 1.27 | -1.23 | 0.60 | 0.98 | 0.58 | -0.44 | -0.33 | - | -1.73 | -0.50 | -0.13 | 0.49 |
| MOLYBDENUM | - | -1.90 | -1.43 | 0.95 | 1.43 | 0 | -0.71 | 0.24 | - | -0.43 | 0 | -0.24 | 1.43 | 0.48 | 0.48 |
| NICKEL | 0.14 | -1.08 | -1.04 | 1.42 | -0.90 | -1.51 | -1.08 | 0 | 1.46 | 1.05 | -0.61 | 0.80 | -0.28 | 0.80 | 0.71 |
| NIOBIUM | -1.25 | 0 | 1.25 | - | 1.25 | -1.25 | - | -1.25 | 0 | S | - | 0 | 0 | - | -1.25 |
| NITROGEN | 0.49 | 0.98 | 0 | - | 1.10 | -1.46 | -1.59 | -0.49 | 0.85 | - | -1.34 | -0.37 | -0.61 | 0.73 | 1.10 |
| PHOSPHOROUS | -0.64 | -0.18 | 1.28 | 1.19 | -0.92 | 1.33 | -0.23 | -2.29 | -0.55 | -0.50 | - | 0.37 | -0.09 | 0.87 | 0.28 |
| SILICON | -1.16 | 1.36 | 1.76 | -0.99 | -1.26 | -0.73 | 1.35 | -1.00 | 0.21 | -0.09 | 0.07 | 0.26 | -0.75 | 1.05 | -0.03 |
| SULFUR | 1.01 | 0.37 | -1.01 | 1.64 | 0.85 | -0.79 | -1.06 | -1.27 | 0.42 | 0.65 | -0.74 | 1.48 | 0.21 | -1.16 | -0.63 |
| TIN | - | 0.59 | 0.44 | - | 1.62 | -0.88 | 0.88 | 0.29 | - | 0.96 | -1.32 | -1.03 | -1.32 | 0.15 | -0.88 |
| TITANIUM | - | 1.25 | 0 | - | 0 | -1.25 | 0 | 0 | - | 0.50 | - | 1.25 | -1.25 | - | -1.25 |
| VANADIUM | NE | NE | NE | - | NE | NE | NE | NE | NE | NE | - | NE | NE | NE | NE |
| ZIRCONIUM | - | - | - | - | - | - | - | - | - | NE | - | - | - | - | - |

Laboratory **Code 01**: The laboratory obtained **SATISFACTORY** results for the assigned-value elements it analyzed.

Laboratory **Code 02**: The laboratory has not sent the results before the deadline.

Laboratory **Code 03**: The laboratory obtained **SATISFACTORY** results for the assigned-value elements it analyzed.

Laboratory **Code 04**: The laboratory obtained an **UNSATISFACTORY** result for *aluminum* (LM3245) and a **QUESTIONABLE** result for *cobalt* (LM3428). All other assigned-value elements it analyzed showed **SATISFACTORY** performance.

Laboratory **Code 05**: The laboratory obtained a **QUESTIONABLE** result for *sulfur* (LM3245), while all other assigned-value elements it analyzed showed **SATISFACTORY** performance.

Laboratory **Code 06**: The laboratory obtained a **QUESTIONABLE** result for *nitrogen* (LM3245), while all other assigned-value elements it analyzed showed **SATISFACTORY** performance.

Laboratory **Code 07**: The laboratory obtained **SATISFACTORY** results for the assigned-value elements it analyzed.

Laboratory **Code 08**: The laboratory obtained a **QUESTIONABLE** result for *antimony* (LM3428), while all other assigned-value elements it analyzed showed **SATISFACTORY** performance.

Laboratory **Code 09**: The laboratory obtained an **UNSATISFACTORY** result for chromium (LM3245) and **QUESTIONABLE** results for *antimony, lead, tin* (LM3245) and *arsenic, phosphorus* (LM3428). All other assigned-value elements it analyzed showed **SATISFACTORY** performance

Laboratory **Code 10**: The laboratory obtained **SATISFACTORY** results for the assigned-value elements it analyzed.

Laboratory **Code 11**: The laboratory obtained **UNSATISFACTORY** results for *lead* in both samples, as it reported an LOQ value lower than the assigned value. All other assigned-value elements analyzed showed **SATISFACTORY** performance.

Laboratory **Code 12**: The laboratory obtained **SATISFACTORY** results for the assigned-value elements it analyzed.

Laboratory **Code 13**: The laboratory has not sent the results before the deadline.

Laboratory **Code 14**: The laboratory obtained **SATISFACTORY** results for the assigned-value elements it analyzed.

Laboratory **Code 15**: The laboratory obtained a **QUESTIONABLE** result for *copper* (LM3245), while all other assigned-value elements it analyzed showed **SATISFACTORY** performance.

Laboratory **Code 16**: The laboratory obtained **SATISFACTORY** results for the assigned-value elements it analyzed.

Laboratory **Code 17**: The laboratory obtained a **QUESTIONABLE** result for *chromium* (LM3245), while all other assigned-value elements it analyzed showed **SATISFACTORY** performance.

Laboratory **Code 18**: The laboratory has not sent the results before the deadline.

Laboratory **Code 19**: The laboratory has not sent the results before the deadline.

## 12. CONCLUSIONS

The overall performance in this **SQO-M6 (Round 18)** program by the participating laboratories, based on the expected results, is as follows:

- Laboratories Codes **01, 03, 07, 10, 12, 14** and **16** have obtained a **SUFFICIENT** performance according to the expected results and should not take action;

- Laboratories Codes **05, 06, 08, 15** and **17** have obtained an **ALMOST SUFFICIENT** performance according to the expected results and must evaluate if it is necessary to take action in the tests where they have obtained a different result than expected;

- Laboratories Codes **04, 09,** and **11** have obtained an **INSUFFICIENT** performance in accordance with the expected results and must take action in the tests where they have obtained a different result than expected (See **Appendix B**).

The criteria used for the evaluation of the overall performance is the following:

- **SUFFICIENT** performance: No unsatisfactory/questionable results were obtained.

- **ALMOST SUFFICIENT** performance: No unsatisfactory results were obtained, but one questionable result was found.

- **INSUFFICIENT** performance: An unsatisfactory result or two questionable results were obtained.

# APPENDIX A

## A1 - PARTICIPANT DATA

| | |
|---|---|
| Company: | **AFV BELTRAME** |
| Laboratory: | **AFV Beltrame Lab** |
| Country: | Italy |
| Client ID: | E511 |
| Contact person: | Eng. Riccardo Rossato ( Quality Assurance Coordinator ) |
| | r.rosatto@beltrame-group.com |

## A2 - PARTICIPANT RESULTS

SOUTH QUALITY
PROFICIENCY TESTING PROVIDER

**INSTRUCTIONS**
**&**
**RESULTS FORM**

| | |
|---|---|
| **PROGRAM:** | Analysis of carbon steel by spark atomic emission spectrometry |
| **CODE:** | SQO-M6 |
| **ROUND:** | 18 |
| **STANDARD:** | ASTM E415 |
| **COORDINATOR:** | Eng. Erika Brest ( ebrest@ptsouthquality.com ) |

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1 - **General**

This document is intended to be filled with the results of the **SQO-M6 (Round 18)** program.

Results must be typed, not handwritten.

2 - **Standard**

**ASTM E415: 2021**

3 - **Participant**

| | |
|---|---|
| **AFV BELTRAME**<br>AFV Beltrame Lab | **CODE 10** |

4 - **Tests involved**

| TEST |
|---|
| Determination of composition of carbon steel |

5 - **Samples**

| CODE | SAMPLE | QUANTITY |
|---|---|---|
| LM3245-10 | Steel - D20 x 20 mm | 1 |
| LM3428-10 | Steel - 20 x 10 x 80 mm | 1 |

6 - **Notes**

**a)** The deadline for the delivery of results is **October 3, 2024**.
**b)** The tables in this document may be modified by the participant, if desired, to include data or observations.
**c)** For specimens from batch LM3245, measurements may be performed on both sides.
**d)** For specimens from batch LM3428, measurements must be conducted on the side opposite the identification mark.
**e)** The samples are to be handled as routine lab samples, with all testing, documentation, and reporting adhering to ASTM E415.
**f)** The samples must be kept until the end of the program, which closes with the submission of the final report.
**g)** To review the results, the submission of images of the tests is appreciated. These images can be attached at the end of this document or sent via email.
**h)** Upon completion of this document, please convert it to a PDF file and send it to the program coordinator.

## 7 - Test conditions

| | |
|---|---|
| Procedure: | According to standard |
| Final grinding: | 80 |

## 8 - Test results

| ELEMENT | MASS FRACTION, % | |
|---|---|---|
| | LM3245-10 | LM3428-10 |
| ALUMINUM | 0.0245 | ≤0.0018 |
| ANTIMONY | N.D. | N.D. |
| ARSENIC | N.D. | N.D. |
| BORON | ≤0.0015 | ≤0.0015 |
| CALCIUM | N.D. | N.D. |
| CARBON | 0.440 | 0.177 |
| CHROMIUM | 0.065 | 0.047 |
| COBALT | N.D. | N.D. |
| COPPER | 0.139 | 0.079 |
| LEAD | 0.0014 | 0.0013 |
| MANGANESE | 0.721 | 0.714 |
| MOLYBDENUM | N.D. | N.D. |
| NICKEL | 0.058 | 0.026 |
| NIOBIUM | 0.0006 | 0.0005 |
| NITROGEN | 0.0089 | 0.0089 |
| PHOSPHOROUS | 0.0153 | 0.0135 |
| SILICON | 0.259 | 0.182 |
| SULFUR | 0.014 | 0.015 |
| TIN | N.D. | N.D. |
| TITANIUM | N.D. | N.D. |
| VANADIUM | ≤0.022 | ≤0.022 |
| ZIRCONIUM | N.D. | N.D. |

| OBSERVATIONS |
| --- |
| 1. Where the chemical element reported with the symbol "≤" means that this is the minimum value that can be considered according to the laboratory's CRM.<br>2. where the symbol n.d. is shown it means that that element is not analyzed by our laboratory. |

| PHOTOGRAPHS |
| --- |
| 1. Sample arrived in AFV Laboratory and the chemical analysis was performed on 17/09/2025 |

# APPENDIX B

VOID

# ----- END OF REPORT -----