

# CERTIFICATE OF ANALYSIS

**13X 14775 (batch R)**

## Certified Reference Material Information

Type: MARTENSITIC STAINLESS STEEL (CAST)  
Form and Size: Disc 40mm Diameter x 15mm Thickness  
Supplied by: MBH Analytical Limited  
Produced by: Willan Metals Limited

## Certified Analysis

### Percentage element by weight

| Element | C    | Si   | S     | P     | Mn   | Ni   |
|---------|------|------|-------|-------|------|------|
| %       | 0.05 | 0.63 | 0.054 | 0.053 | 1.37 | 1.75 |

| Element | Cr   | Mo   | Cu   | Co   | Nb   |
|---------|------|------|------|------|------|
| %       | 17.7 | 0.47 | 0.21 | 0.15 | 0.75 |

## Usage

Intended use: With optical emission and X-ray fluorescence spectrometers.

Recommended method of use: Steels are generally prepared by finishing, milling, turning or polishing, avoiding contamination with abrasives or lubricants. However, users are recommended to follow the calibration and sample preparation procedures specified by the relevant instrument manufacturer.

Preparation should be the same for reference materials and the samples for test.

When using OE, a minimum of three consistent replicate analyses is recommended to optimise precision and accuracy. Users are advised to check against possible bias between reference materials and production samples due to differences in metallurgical history, and be aware of possible inter-element effects.

## Certified by:

MBH ANALYTICAL LIMITED \_\_\_\_\_

on 1 May 1997



## Method of Preparation

This reference material was produced from pure metals, ferro alloys and master alloys. The discs are the product of one melt poured into a single mould with a feeding system designed to ensure sound discs. Metal has been removed from the cast faces of the discs to minimise surface effects.

## Sampling

Samples for chemical analysis, and discs for homogeneity checks, were each taken from the top and bottom of the mould.

## Chemical Analysis Data

### Percentage element by weight

| Element  | C     | Si    | S      | P      | Mn    | Ni    |
|----------|-------|-------|--------|--------|-------|-------|
| Sample 1 | 0.049 | 0.63  | 0.054  | 0.054  | 1.38  | 1.74  |
| Sample 2 | 0.053 | 0.64  | 0.055  | 0.052  | 1.35  | 1.77  |
| Sample 3 | 0.054 | 0.62  | 0.054  | -      | 1.39  | 1.75  |
| Sample 4 | -     | -     | -      | -      | -     | 1.75  |
| Mean     | 0.052 | 0.630 | 0.0543 | 0.0530 | 1.373 | 1.753 |
| Std Dev  | 0.003 | 0.010 | 0.0006 | 0.0014 | 0.021 | 0.013 |

| Element  | Cr     | Mo    | Cu    | Co    | Nb    |
|----------|--------|-------|-------|-------|-------|
| Sample 1 | 17.74  | 0.48  | 0.206 | 0.162 | 0.76  |
| Sample 2 | 17.66  | 0.48  | 0.20  | 0.14  | 0.79  |
| Sample 3 | 17.78  | 0.46  | 0.20  | 0.15  | 0.72  |
| Sample 4 | 17.63  | 0.46  | 0.22  | 0.14  | 0.72  |
| Mean     | 17.703 | 0.470 | 0.207 | 0.148 | 0.748 |
| Std Dev  | 0.069  | 0.012 | 0.009 | 0.010 | 0.034 |

## Confidence Limits

These are the upper and lower values between which the actual measurements will fall, with the stated probabilities, assuming a Gaussian distribution.

68.3% of the results will fall within  $\pm 1$  x Standard Deviation of the mean.

95.4% of the results will fall within  $\pm 2$  x Standard Deviation of the mean.

99.7% of the results will fall within  $\pm 3$  x Standard Deviation of the mean.

## Homogeneity

Discs from the top and bottom of the mould were checked on the face and back using an optical emission spectrometer.

Multiple measurements were taken from each surface, and averaged.

The mean value of the material was then calculated from these averages.

For each of the four surfaces checked, the differences between the averaged result for each surface and the overall mean value are tabulated below. Results are in % concentration for each element:

### Disc from top of mould

|               | <b>C</b> | <b>Si</b> | <b>S</b> | <b>P</b> | <b>Mn</b> | <b>Ni</b> | <b>Cr</b> | <b>Mo</b> | <b>Cu</b> | <b>Co</b> | <b>Nb</b> |
|---------------|----------|-----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>Face 1</b> | -0.02    | 0.00      | +0.001   | -0.01    | 0.00      | +0.01     | +0.02     | 0.00      | 0.00      | 0.00      | 0.00      |
| <b>Face 2</b> | +0.02    | +0.01     | -0.001   | +0.01    | 0.00      | -0.01     | 0.00      | 0.00      | 0.00      | 0.00      | 0-.01     |
| <b>Ave</b>    | 0.000    | +0.01     | 0.000    | 0.00     | 0.00      | 0.00      | +0.01     | 0.00      | 0.00      | 0.00      | -0.01     |

### Disc from bottom of mould

|               | <b>C</b> | <b>Si</b> | <b>S</b> | <b>P</b> | <b>Mn</b> | <b>Ni</b> | <b>Cr</b> | <b>Mo</b> | <b>Cu</b> | <b>Co</b> | <b>Nb</b> |
|---------------|----------|-----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| <b>Face 1</b> | 0.00     | 0.00      | -0.001   | +0.01    | 0.00      | 0.00      | -0.03     | 0.00      | 0.00      | 0.00      | +0.01     |
| <b>Face 2</b> | 0.00     | -0.01     | +0.001   | -0.01    | 0.00      | 0.00      | +0.02     | 0.00      | 0.00      | 0.00      | 0.00      |
| <b>Ave</b>    | 0.00     | 0-.01     | 0.000    | 0.00     | 0.00      | 0.00      | -0.01     | 0.00      | 0.00      | 0.00      | +0.01     |

## **Participating Laboratories**

|  |                    |                     |
|--|--------------------|---------------------|
| Willan Metals Ltd                            | Rotherham, England | NAMAS Approval 0014 |
| Metals Technology (Testing) Ltd              | Sheffield, England | NAMAS Approval 0963 |
| JB Elds Ltd                                  | Stoke, England     | NAMAS Approval 1173 |
| London and Scandinavian<br>Metallurgical Ltd | Rotherham, England | NAMAS Approval 1091 |

## **Analytical Methods Used**

|             |                   |     |             |
|-------------|-------------------|-----|-------------|
| Carbon:     | Combustion (IRD)  |     |             |
| Silicon:    | Atomic absorption | XRF |             |
| Sulphur:    | Combustion (IRD)  |     |             |
| Phosphorus: | Atomic absorption | XRF | Colorimetry |
| Manganese:  | Atomic absorption | XRF |             |
| Nickel:     | Atomic absorption | XRF |             |
| Chromium:   | Atomic absorption | XRF | Volumetric  |
| Molybdenum: | Atomic absorption | XRF |             |
| Copper:     | Atomic absorption | XRF |             |
| Cobalt:     | Atomic absorption | XRF |             |
| Niobium:    | Atomic absorption | XRF |             |

## **Notes**

Some cast materials may exhibit shrinkage cavities on the rear (engraved) surface of the disc. The above certification is applicable to the front face of the disc and to the first 10mm of depth.

This certificate of analysis is prepared in accordance with the guidelines given in ISO Guide 31-1981.

The material to which this certificate of analysis refers is supplied subject to our general conditions of sale.