

# Instrument calibration sheet

|                |                 |               |            |
|----------------|-----------------|---------------|------------|
| Certificate N° | 000161          | Date of issue | 09/12/2019 |
| Client         | ENEL Produzione | Work order    | 8000000591 |

## Instrument specification

|             |                         |               |                |                 |     |
|-------------|-------------------------|---------------|----------------|-----------------|-----|
| Type        | Turbidity meter         | Manufacturer  | Endress-Hauser | Max capacity    | 80  |
| Model       | Liquiline CM442         | Serial number | E3087305G00    | Readability     | 0,1 |
| Description | C1 Itar Turbidity meter |               |                | Unit of measure | FNU |

## Test ambient conditions

|             |                |          |     |              |                  |
|-------------|----------------|----------|-----|--------------|------------------|
| Location    | ENEL - C1 Itar |          |     | Date of test | 09/12/2019 10:30 |
| Temperature | 23° C          | Humidity | 75% | Pressure     | 1021hPa          |

## Standard certificates used

| Name      | Number | Issuer | Date of issue |
|-----------|--------|--------|---------------|
| Turbidity | 852    | DPG    | 24/05/2019    |

## Calibration summary

| Test                 | Certificate name | Uncertainty | Temperature | Humidity    | Pressure |
|----------------------|------------------|-------------|-------------|-------------|----------|
| Repeatability        | Turbidity        | 0,894893FNU | 23° C       | 75%         | 1021hPa  |
| Linearity            | Turbidity        | 0,132288FNU | 23° C       | 75%         | 1021hPa  |
| Expanded uncertainty |                  |             |             | 0,264575FNU |          |

## Notes

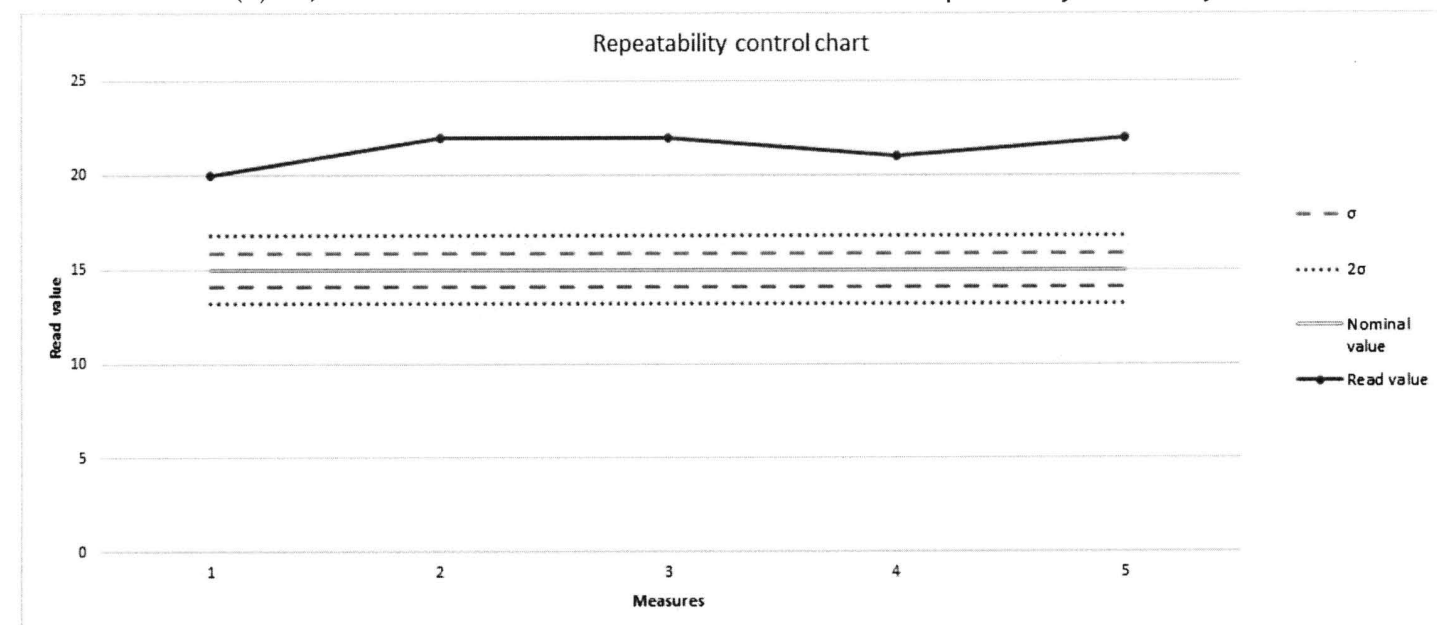
Technician  
Noto Fulvio

### Repeatability

| Measure |               |                    |            |           | Standard reference |             |      |
|---------|---------------|--------------------|------------|-----------|--------------------|-------------|------|
|         | Nominal value | Conventional value | Read value | Deviation | Serial             | Uncertainty | OIML |
| 1       | 15            | 14,95              | 20         | 5,05      | F0043051           | 0,1         |      |
| 2       | 15            | 14,95              | 22         | 7,05      | F0043051           | 0,1         |      |
| 3       | 15            | 14,95              | 22         | 7,05      | F0043051           | 0,1         |      |
| 4       | 15            | 14,95              | 21         | 6,05      | F0043051           | 0,1         |      |
| 5       | 15            | 14,95              | 22         | 7,05      | F0043051           | 0,1         |      |

Min value 20      Max value 22      Average value 21,4

Standard deviation ( $\sigma$ ) 0,894427      Repeatability uncertainty 0,894893



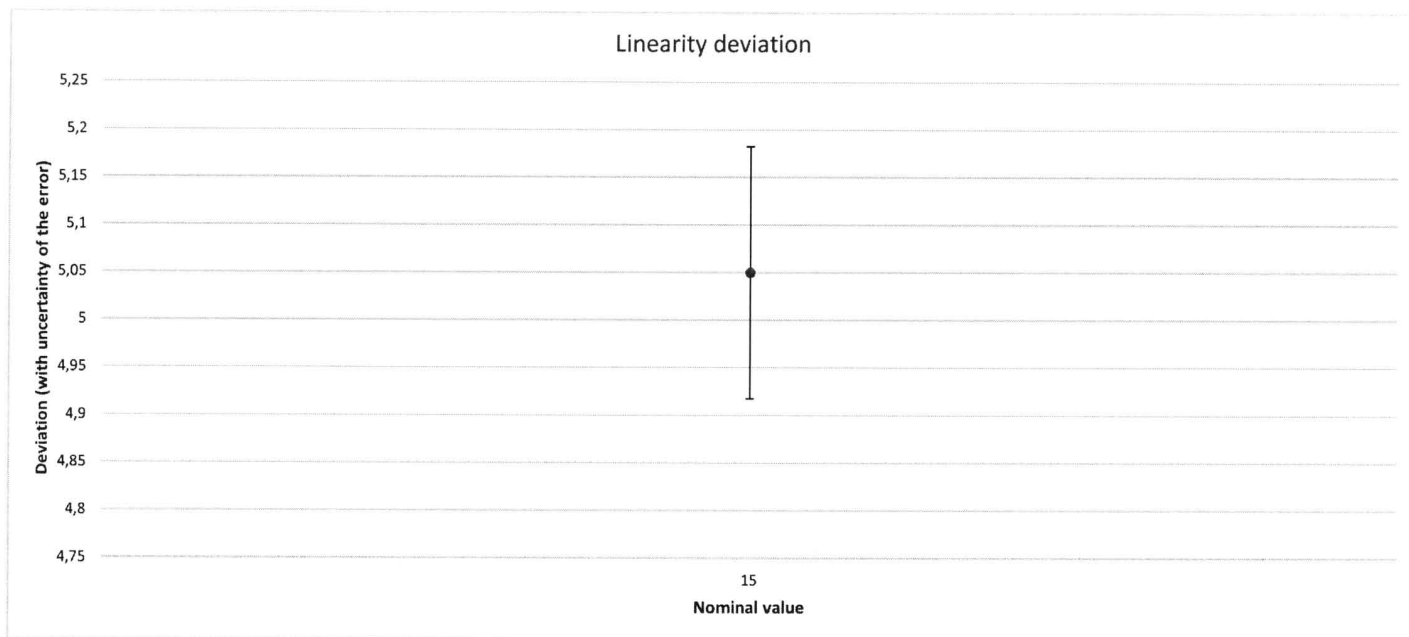
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### Linearity

| Measure | Nominal value | Conventional value | Read value | Error | Uncertainty of error | Standard reference |      |
|---------|---------------|--------------------|------------|-------|----------------------|--------------------|------|
|         |               |                    |            |       |                      | Uncertainty        | OIML |
| 1       | 15            | 14,95              | 20         | 5,05  | 0,132288             | 0,1                |      |

Min value 20      Max value 20      Average value 20

Standard deviation 5,05      k-Factor: 2 (95,45%)      Expanded uncertainty 0,264575



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## Formulas

### Repeatability

The test consists in the repeated measure of the same reference value, under identical conditions of handling the reference and the instrument, and under constant test conditions, both as far as possible

Standard deviation is computed to allow an appraisal of the instrument's performance.

$$s(I) = \sqrt{\frac{1}{n-1} \sum_{i=1}^n (I_i - \bar{I})^2} \quad \bar{I} = \frac{1}{n} \sum_{i=1}^n I_i$$

Repeatability standard uncertainty has been computed with the following formula, taking into account instrument's scale interval (d)

$$u_{rep} = \sqrt{s(I)^2 + \left(\frac{d_I}{12}\right)^2}$$

### Linearity

This test is performed with different test values distributed fairly evenly over the normal measuring range. The purpose of this test is an appraisal of the performance of the instrument over the whole measuring range.

The uncertainty of the error is computed with the following formula and takes into account repeatability and eccentricity uncertainty when applicable:

$$u(E) = \sqrt{u^2(I_{digo}) + u^2(I_{digi}) + u^2(I_{rep}) + u^2(I_{ecc}) + u^2(I_{mc}) + u^2(I_{mb}) + u^2(I_{md}) + u^2(I_{mconv})}$$

The terms relative to air buoyancy (mb) and convection effects (mconv) are considered negligible due to enough acclimatisation allowed to the instrument.

Expanded uncertainty has been computed with the following formula:

$$U = u(E)_{max} k$$

For this report a coverage factor of 2 as been considered giving an overall confidence level of 95,45%