

# Instrument calibration sheet

Certificate N°	000151	Date of issue	17/10/2019
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	10/09/2019	10:00
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	0,101801FNU	23°C	75%	1021hPa
Linearity	Turbidity	1,263077FNU	23°C	75%	1021hPa
Expanded uncertainty				<b>2,526154FNU</b>	

## Notes

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## Repeatability

Measure	Nominal value	Conventional value	Read value	Deviation	Standard reference		
					Serial	Uncertainty	OIML
1	15	14,95	14,7	-0,25	F0043051	0,1	
2	15	14,95	14,85	-0,1	F0043051	0,1	
3	15	14,95	14,91	-0,04	F0043051	0,1	
4	15	14,95	14,85	-0,1	F0043051	0,1	
5	15	14,95	14,96	0,01	F0043051	0,1	

Min value

14,7

Max value

14,96

Average value

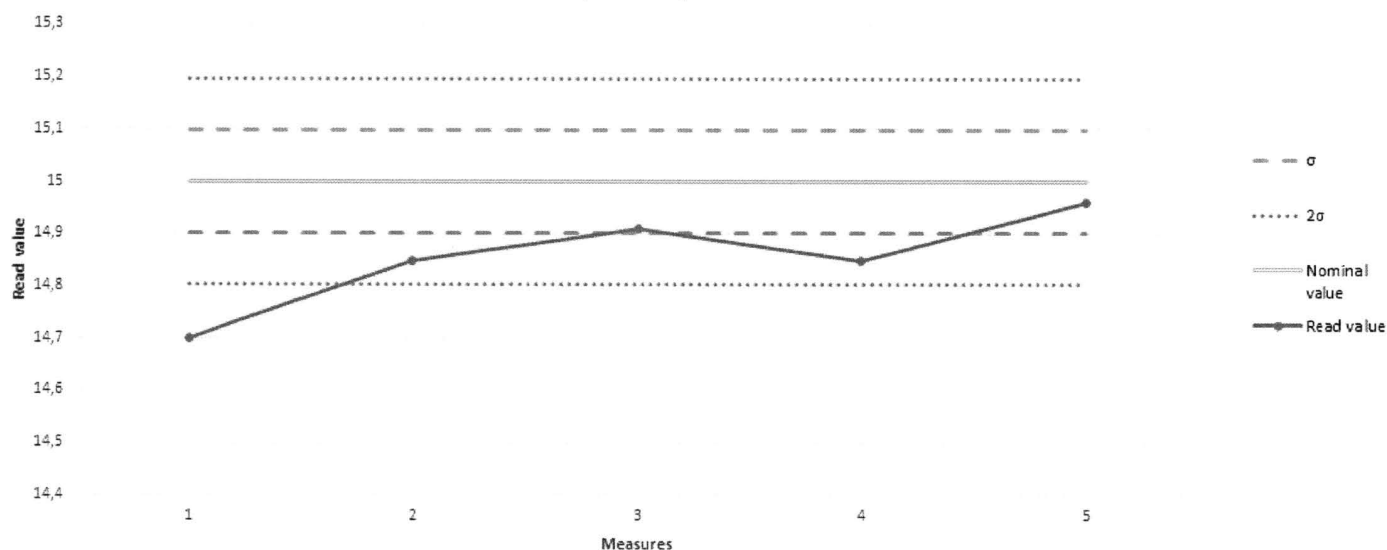
14,854

Standard deviation ( $\sigma$ ) 0,097622

Repeatability uncertainty

0,101801

Repeatability control chart



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### Linearity

Measure	Nominal value	Conventional value	Read value	Error	Uncertainty of error	Standard reference	
						Uncertainty	OIML
1	0,1	0,094	0,11	0,016	0,110401	0,01	
2	15	14,95	14,96	0,01	0,166923	0,1	
3	100	99,87	100,03	0,159999	0,274524	0,2	
4	750	749,4	751,1	1,699976	1,263077	1	

Min value 0,11

Max value 751,1

Average value

216,55

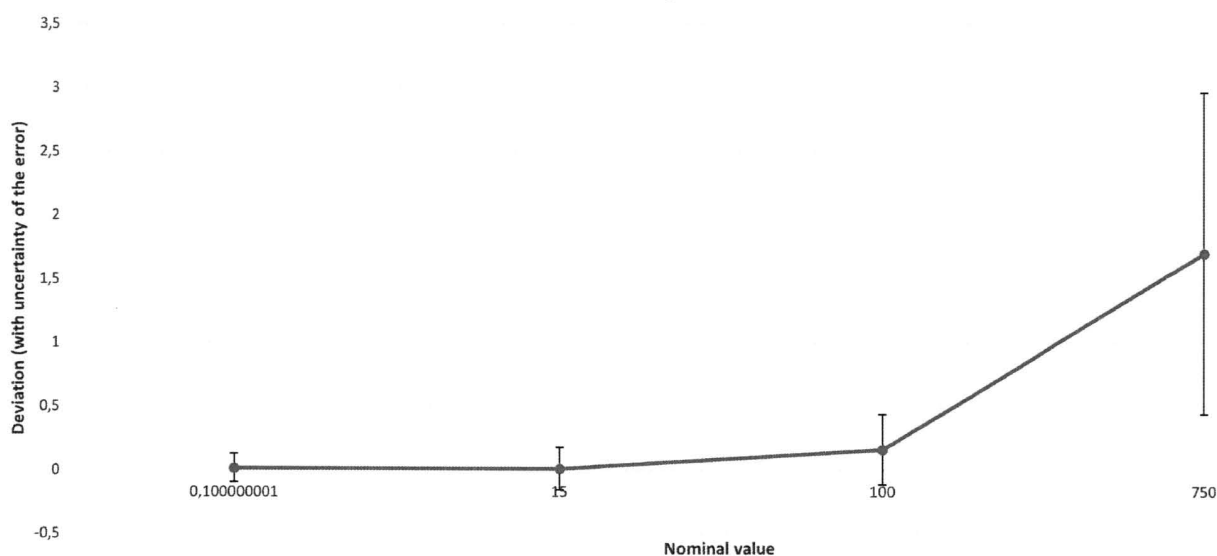
Standard deviation 1,699976

k-Factor: 2 (95,45%)

Expanded uncertainty

2,526154

### Linearity deviation



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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)

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

### 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:

$$u(E) = \sqrt{u^2(I_{dig0}) + u^2(I_{dig1}) + u^2(I_{rep}) + u^2(I_{ecc}) + u^2(I_{mc}) + u^2(I_{mb}) + u^2(I_{md}) + u^2(I_{mconv})}$$

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%