

# Instrument calibration sheet

Certificate N°	000018/2021	Date of issue	28.09.21
Client	ENEL Produzione	Work order	8000000591

## Instrument specification

Type	Turbidity meter	Manufacturer	Endress-Hauser	Serial number	E3087305G00
Min capacity	0	Max capacity	80	Model	Liquiline CM442
Readability At 0	0,1	Readability	0,1	Unit of measure	FNU
Description	C1 Itar Turbidity meter			Next Calibration	28.12.21

## Test ambient conditions

Location	ENEL - C1 Itar			Date of test	28.09.21	00:00
Temperature	24.5	Humidity	84	Pressure	1020hPa	

## Standard certificates used

Name	Number	Issuer	Date of issue
Turbidity	852	DPG	24.05.19

## Calibration summary

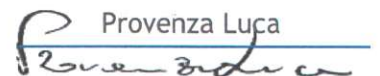
Test	Certificate name	Uncertainty	Temperature	Humidity	Pressure
Repeatability	Turbidity	0,707696FNU	24.5	84	1020hPa
Linearity	Turbidity	0,719954FNU	24.5	84	1020hPa

**Expanded uncertainty** **1,439907FNU**

## Notes

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## Repeatability

Measure	Nominal value	Conventional value	Read value	Deviation	Standard reference		
					Serial	Uncertainty	OIML
1	15	14,95	15	0,05	HI9873-20	0,1	
2	15	14,95	15	0,05	HI9873-20	0,1	
3	15	14,95	14	-0,95	HI9873-20	0,1	
4	15	14,95	15	0,05	HI9873-20	0,1	
5	15	14,95	16	1,05	HI9873-20	0,1	

Min value

14

Max value

16

Average value

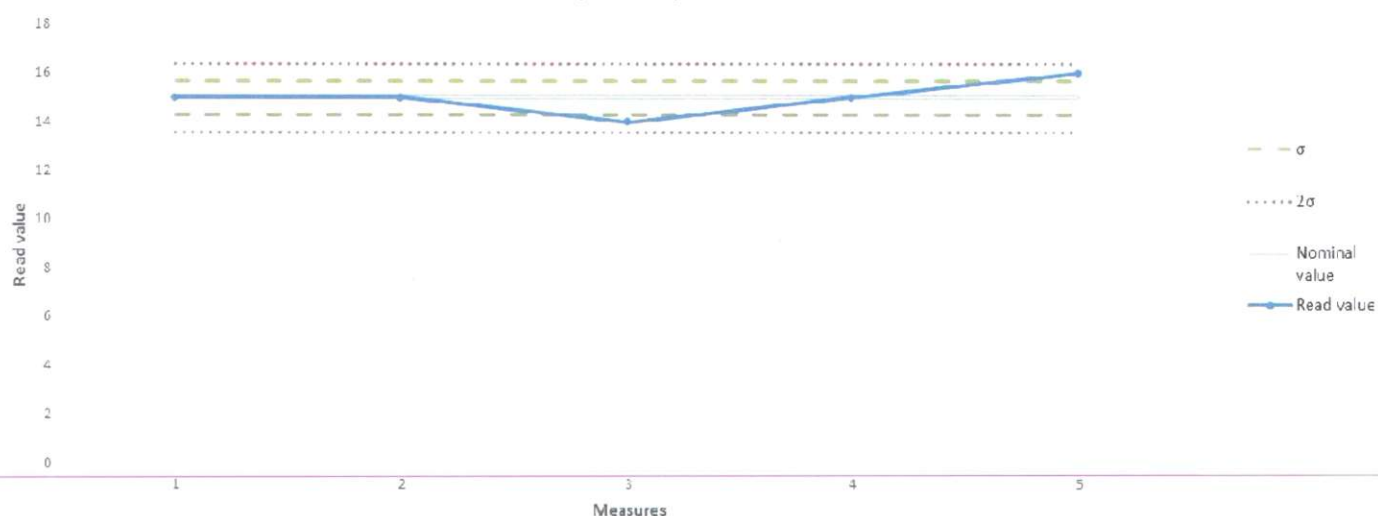
15

Standard deviation ( $\sigma$ ) 0,707107

Repeatability uncertainty

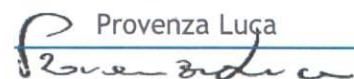
0,707696

Repeatability control chart



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## Linearity

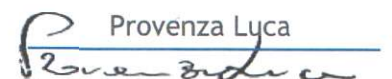
Measure	Nominal value	Conventional value	Read value	Error	Uncertainty of error	Standard reference	
						Uncertainty	OIML
1	15	14,95	14	-0,95	0,719954	0,1	
Min value	14		Max value	14		Average value	14
Standard deviation	0,95		k-Factor:	2 (95,45%)		Expanded uncertainty	1,439907

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)

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

### 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:

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

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%