WORD METEOROLOGICAL ORGANISATION
TURKISH STATE METEOROLOGICAL SERVICE (TSMS)
CALIBRATION CENTER
REGIONAL INSTRUMENT CENTER IN RAVI
WIND SPEED MEASURING INSTRUMENTS (ANEMOMETER)
CALIBRATION LABORATORY

In cooperation with
NATIONAL METROLOGY INSTITUTE OF TURKEY
(TÜBİTAK UME)

FINAL REPORT
On Intercomparison (ILC) in the field of wind speed
TSMS-ILC-WS01-2018

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REPORT
On intercomparison in the field of wind speed (air speed) (anemometer)
TSMS-ILC-WS01-2018

Data analysis coordinator

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Prepared by: Hakan Kaykısızlı

Issued by :National Metrology Institute of TURKEY, Fluid Flow Laboratory (TÜBİTAK EMU)

Date of İntercomparison: The measurements for this intercomparison were carried out in the time period of May 2018 to October 2018 with four participating laboratory from WMO RAVI region. The data analysis coordinator specified above performed measurements before and after the participating laboratories. Also, coordinator for WMO RAVI, Turkish State Meteorological Service (TSMS), performed measurements before and after the participating laboratories. All the data analysis were done by data analysis coordinator.

Copy Holder : TSMS-ILC-WS01-2018
Participants (4 participants)

Prepared by : Hakan Kaykısızlı
Responsible of Fluid Flow Laboratory (coordinator)

TABLE OF CONTENT

1. INTRODUCTION

The subject of this report is evaluation of the interlaboratory comparison in the field of measurement of wind speed. All the analysis were done in accordance with accredited procedures.

Interlaboratory comparison (ILC) serves as a tool for comparison of measurement results carried out by accredited or non-accredited calibration laboratories in the relevant field of measurement. ILC represents very effective means to demonstrate technical competence of the participant and also serves as a technical base for accreditation. Furthermore, it is the most important element for monitoring of quality of measurement results as required by ISO/IEC 17025:2017 standard for laboratories in part 7.7.

This ILC was organized by the Regional Instrument Centre in RAVI (Turkish State Meteorological Service TSMS) and all data were analyzed by National Metrology Institute of Turkey (TÜBİTAK UME). Wind Speed Calibration Laboratory of TSMS has been accredited by Turkish Accreditation Agency (TÜRKAK) since 2010 (AB-0072-K). TÜBİTAK UME has been accredited by Turkish Accreditation Agency (TÜRKAK) (AB-0034-K).

It was recommended that the participants use their standard procedure during the wind speed – anemometer (pitot tube and vane anemometers) calibration and if possible avoid making extra time-consuming measurements. The proficiency test was carried out in accordance with ISO/IEC 17043:2010.

Pitot tube (with digital display) and vane anemometer (with digital display) were used as transfer device in ILC. Participating laboratory separately calibrated transfer devices according to their laboratory capability and measuring values were recorded. The measuring values of two devices were separately analyzed on the ILC final report. The participants used their procedures to take the measuring values at the ILC. Final report was prepared by Fluid Flow Laboratory of National Metrology Institute of Turkey (TÜBİTAK UME).

Technical supervision of this interlaboratory comparison was provided by Hakan Kaykısızlı, as an expert in the field. The reference value was determined by the TÜBİTAK UME National Metrology Institute of Turkey.

The test items were sent via registered mail or hand carried. The ILC was performed in accordance with expected time schedule. Delays occurred only in reporting of the results and shipping problems.

This report was sent to the participating laboratories in electronic form.

2. SPECIFICATION OF THE INTERLABORATORY COMPARISON

The purpose of the proficiency test was to compare the results of the participating laboratories during calibration of wind speed (anemometer). More details are given in the attached PT protocol.

Two different handle type anemometers were calibrated in the ILC as transfer device.

Measuring quantity:	Anemometer 01	Anemometer 2
Measuring instrument:	Pitot tube Digital display	Vane anemometer Digital display
Manufacturer:	Fluke	Testo
Type:	PT12 (12 in) Display 922	Vane prob (Ø 16 mm diameter, 890 mm with telescope) Display 435-4
Serial number:	A52AB (probe) 36300329 (display)	10353041/706 (probe) 01414604/709 (display)
Measuring range:	1 m/s – 80 m/s	0.6 m/s – 40 m/s
Output:	Digital display (m/s)	Digital display (m/s)
Resolution	0,001 m/s	0.1 m/s

The instrument's owner: TSMS

The calibration certificates were prepared separately for each transfer device according to ISO/IEC 17025 standards. Measurement uncertainty was calculated according to EA-4/02 M:2013 document and ILAC-P14:01/2013 policy for uncertainty in calibration. Applied procedure was declared in the certificate. Expanded uncertainty (k=2) was declared for each measuring level in the calibration certificates. The calibration certificate was send to the coordinator by e-mail electronically.

All participants used their own calibration procedure for the calibration of the transfer device. If possible avoid making extra time-consuming measurements, as described in the proficiency testing protocol. Measuring unit was m/s.

Measurements levels:

Target Velocity	UNIT
3.0	m/s
5.0	m/s
7.0	m/s
10.0	m/s
15.0	m/s
20.0	m/s
30.0	m/s

Participating laboratories were expected to take measurements according to their own laboratory capability. Laboratory Reference values were within the ± 5 % of the target velocities. Environmental conditions (temperature, humidity and pressure) of the laboratory shortly before and right after calibration procedure were declared on the calibration certificates and report form.

Prior to the calibration, test measurements were performed in order to assess stability of the instruments and indicate any problems, which could occur as the consequence of the transport. From the measurements it has been concluded that all the instruments were stable enough and their short-term stability didn't influence the final results of intercomparison.

The results were reported electronically.

Two different handle type anemometers are calibrated in the ILC as transfer device.

3. PARTICIPANTS

There were four (4) participants to this proficiency testing. The participants agreed that results of this proficiency testing are anonymous. Each laboratory has received a code, which was generated as random letter between A and Z. The code is sent only to the participating laboratory. In such way, anonymity of the results is guaranteed.

Participating laboratory: Deutscher Wetterdienst (Germany)
Contact person: Mr. Dörschel Holger
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Zip: 22393
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Country: Germany
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Fax: + 496 980 626 699
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Participating laboratory: Deutscher Wetterdienst / German Meteorological Office (Germany)
Contact person: Mr. Richard Seidl
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Zip: 85764
City: Oberschleißheim
Country: Germany
Phone: ++ 496 980 629 109
Fax: ++ 496 980 629 113
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Participating laboratory: Republic Hydrometeorological Service of Serbia RHMSS (Serbia)
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Country: Serbia
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Fax: + 381 11 305 08 47
Email: bojan.turundzivalic@hidmet.gov.rs

Participating laboratory: Turkish State Meteorological Service TSMS (Turkey)
Contact person: Mr. Dr. Zafer Turgay DAĞ
Address: Kütükçüalibey cad. No:4 Keçiören
Zip: 06120
City: Ankara
Country: Turkey
Phone: + 90 312 302 22 09
Fax: + 90 312 361 23 56
Email: ztdag@mgm.gov.tr

Time schedule and deadlines

The intercomparison was organized in one loop. All participating laboratories had four weeks for calibration including transport to the next laboratory. The transport was planned for each of the participating laboratories, so that the subsequent laboratory receives the equipment no later than on Monday in the first week, in which the calibration is planned to be carried out. More details are given in the attached PT protocol.

If a participant anticipated difficulties in keeping the deadlines, the coordinator had to be contacted immediately. In such a case the other participants were contacted as soon as possible and informed about eventual changes.

Deadline for reporting the results were 4 weeks after the equipment had left the laboratory. It was important that the deadline was met since the results were analyzed continuously by the PT provider.

4. RESULTS AND ANALYSING METHOD

4.1 Laboratory uncertainty

The uncertainties are calculated according to the following formulas (see *Guide to Expression of Uncertainty in Measurement* (ISO. Geneva. 1995)).

Type A uncertainty based on statistical methods of analyzing measurement results is calculated using the following equation:

$$u_A^2 = \frac{1}{n(n-1)} \sum_{i=1}^{n} (x_i - \bar{x})^2 \tag{1}$$

Type B uncertainty is determined on the basis of non-statistical methods. It consists the root-sum-of squares of the relevant sources of uncertainty from the mathematical model:

$$u_B = \frac{1}{V_{Em}} \cdot \sqrt{\sum_{i=1}^{k} \left(\frac{\partial V_{Em}}{\partial x_i} \right)^2 . u^2(x_i)} \tag{2}$$

Combined uncertainty is calculated according to the following formula:

$$u_c = \sqrt{u_A^2 + u_B^2} \tag{3}$$

The expanded uncertainty *U* is obtained by multiplying the combined standard uncertainty u_c by coverage factor according to the formula:

$$U = k \cdot u_c \tag{4}$$

where the coverage factor *k*=2 is usually used in the flow community.

4.2 Description of the method

The reference value was determined in each flow speed separately. The method of determination of reference value in each flow speed corresponds to the procedure A presented by M.G.Cox.

There reference value *y* was calculated as weighted mean error (WME):

$$y = \frac{\frac{x_1}{u_{x1}^2} + \frac{x_2}{u_{x2}^2} + ...\frac{x_n}{u_{xn}^2}}{\frac{1}{u_{x1}^2} + \frac{1}{u_{x2}^2} + ...\frac{1}{u_{xn}^2}} \quad , \qquad [4]$$

where $x_1, x_2, ... x_n$ are errors of the meter in one flow speed in different laboratories *1,2, ...n*

$u_{x1}, u_{x2}, ...u_{xn}$ are standard uncertainties (not expanded) of the error in different laboratories *1,2, ...n*

The standard uncertainty of the reference value u_y is given by

$$\frac{1}{u_y^2} = \frac{1}{u_1^2} + \frac{1}{u_2^2} + ...\frac{1}{u_n^2} \qquad [5]$$

The expanded uncertainty of the reference value *U(y)* is

$$U(y) = 2.u_y \qquad [6]$$

The chi-squared test for consistency check was performed using values of errors of the anemometer in each flow speed. At first the chi-squared value χ_{obs}^2 was calculated by

$$\chi_{obs}^2 = \frac{(x_1 - y)^2}{u_{x1}^2} + \frac{(x_2 - y)^2}{u_{x2}^2} + ...\frac{(x_n - y)^2}{u_{xn}^2} \qquad [7]$$

The degrees of freedom ν were assigned

$$\nu = n - 1 \qquad [8]$$

where *n* is number of evaluated laboratories.

The consistency check was failing if

$$Pr\{\chi_\nu^2 > \chi_{obs}^2\} < 0{,}05 \qquad [9]$$

(The function *CHIINV(0,05;n)* in MS Excel was used. The consistency check was failing if *CHIINV(0,05;n)*< χ_{obs}^2)

If the consistency check did not fail then *y* was accepted as the key reference value x_{ref} and *U(y)* was accepted as the expanded uncertainty of the key reference value $U(x_{ref})$.

If the consistency check failed then the laboratory with the highest value of $\frac{(x_i - y)^2}{u_{xi}^2}$ was excluded for the next round of evaluation and the new reference value *y* (WME), the new standard uncertainty of the reference value u_y and the chi-squared value χ^2_{obs} were calculated again without the values of excluded laboratory. The consistency check was calculated again, too. This procedure was repeated till the consistency check passed.

When the consistency check passed then the values *di* were calculated for each laboratory by

$$di = x_i - x_{ref} \qquad [10]$$

Then *U(di)* was calculated. As it is mentioned in the other final report of comparison for the laboratories that contributed to the key reference value, the uncertainty *U(di)* is

$$U(di) = 2.\sqrt{u_{xi}^2 - u_{xref}^2} \qquad [11]$$

while for the other participants that were excluded by chi-squared consistency check

$$U(di) = 2.\sqrt{u_{xi}^2 + u_{xref}^2} \qquad [12]$$

At the end the coefficient *Ei* was calculated. This coefficient *Ei* is degree of equivalence in this comparison.

$$Ei = \frac{di}{U(di)} \qquad [13]$$

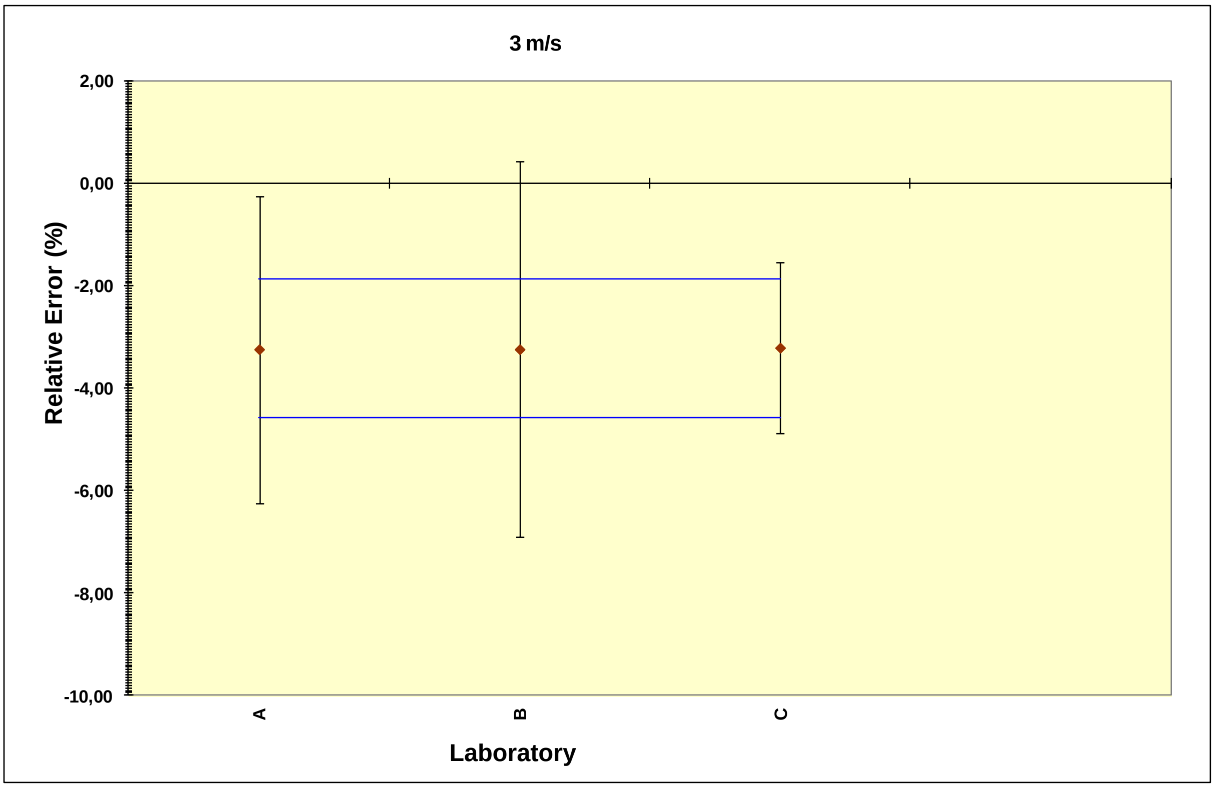
The normalized error is a measure for the equivalence of the results of any laboratory, respectively:

- the results of a laboratory were *equivalent (**passed**)* if $E_i \leq 1.0$
- the laboratory were determined as *not equivalent (**failed**)* if $E_i > 1.2$
- for values of E_i in the range $1 < Ei_n \leq 1.2$ the "**warning level**" was defined. In this case some actions to check are recommended for the laboratory.

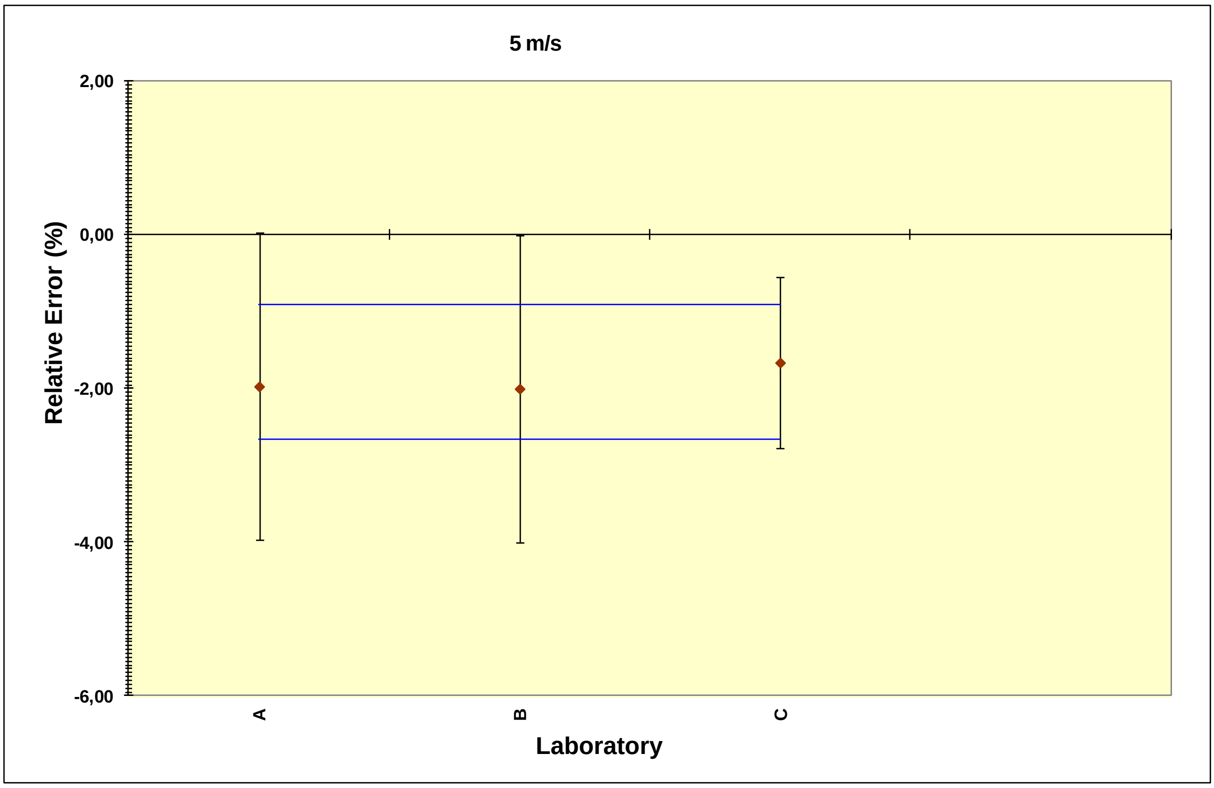
5. PITOTE TUBE ANEMOMETER RESULTS

Three laboratories participated in pitot tube comparison and their results are indicated by using codes that are given to the coordinators of participants.

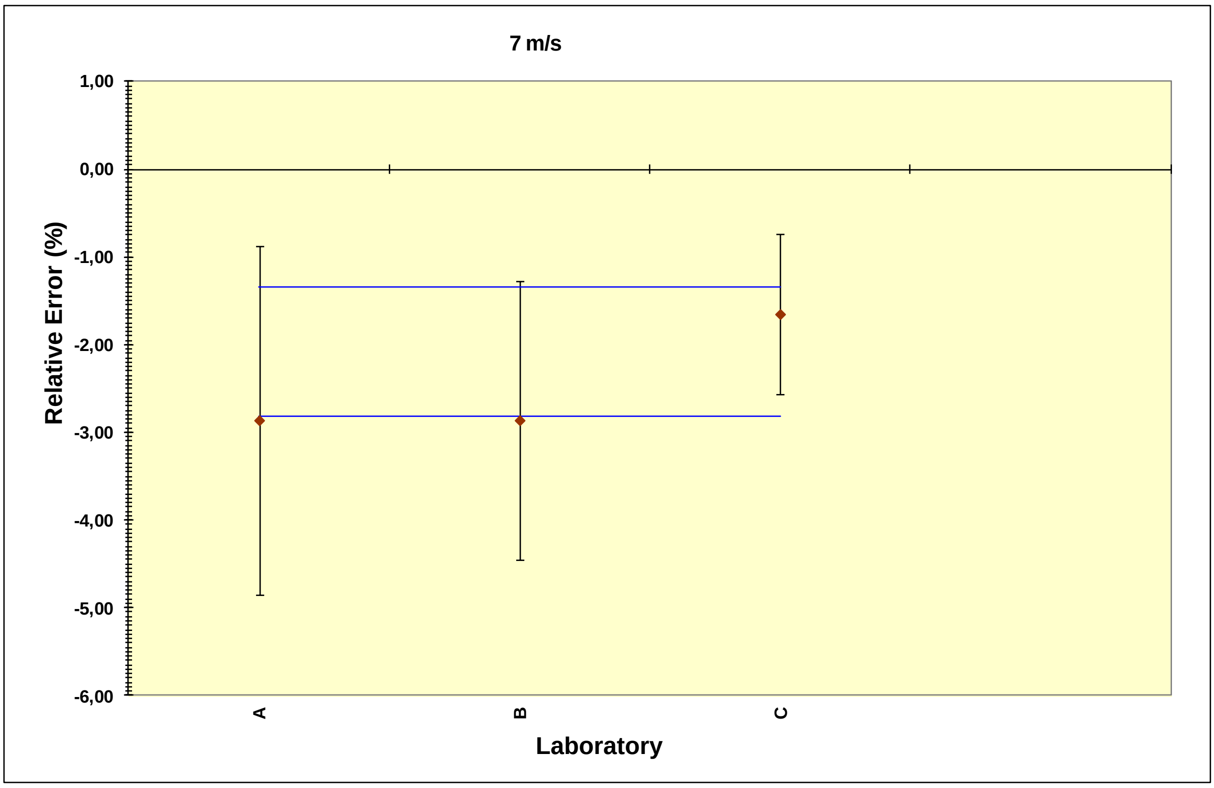
The relative error of a measurement and uncertainty belongs to that value is graphed for each air speed and laboratory.



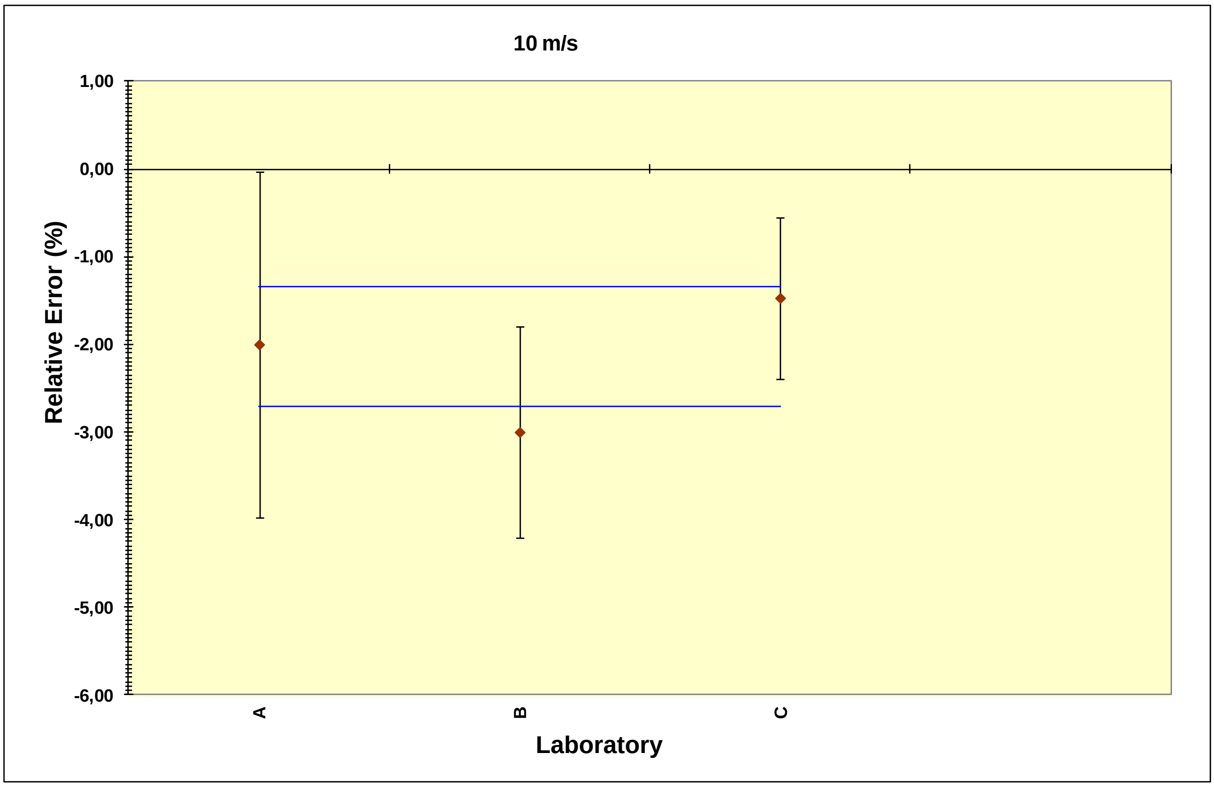
Graph1. Error bands for 3 m/s



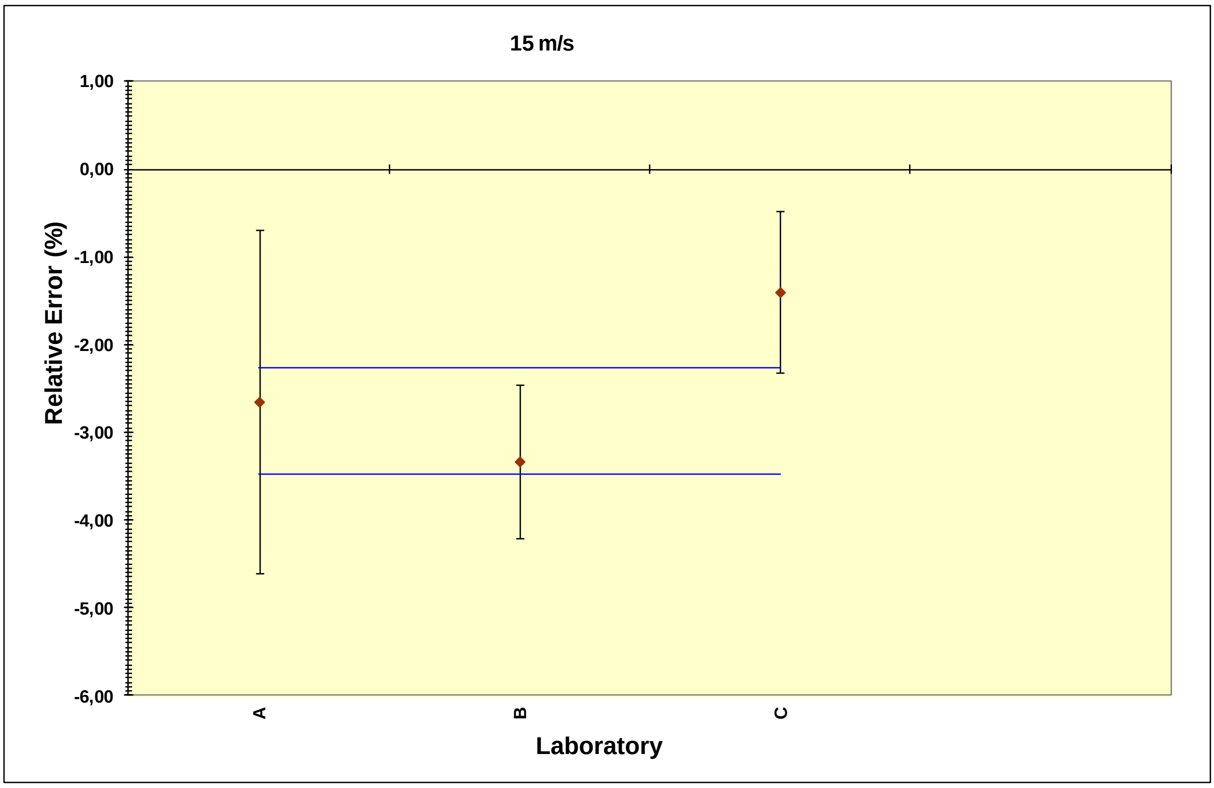
Graph2. Error bands for 5 m/s



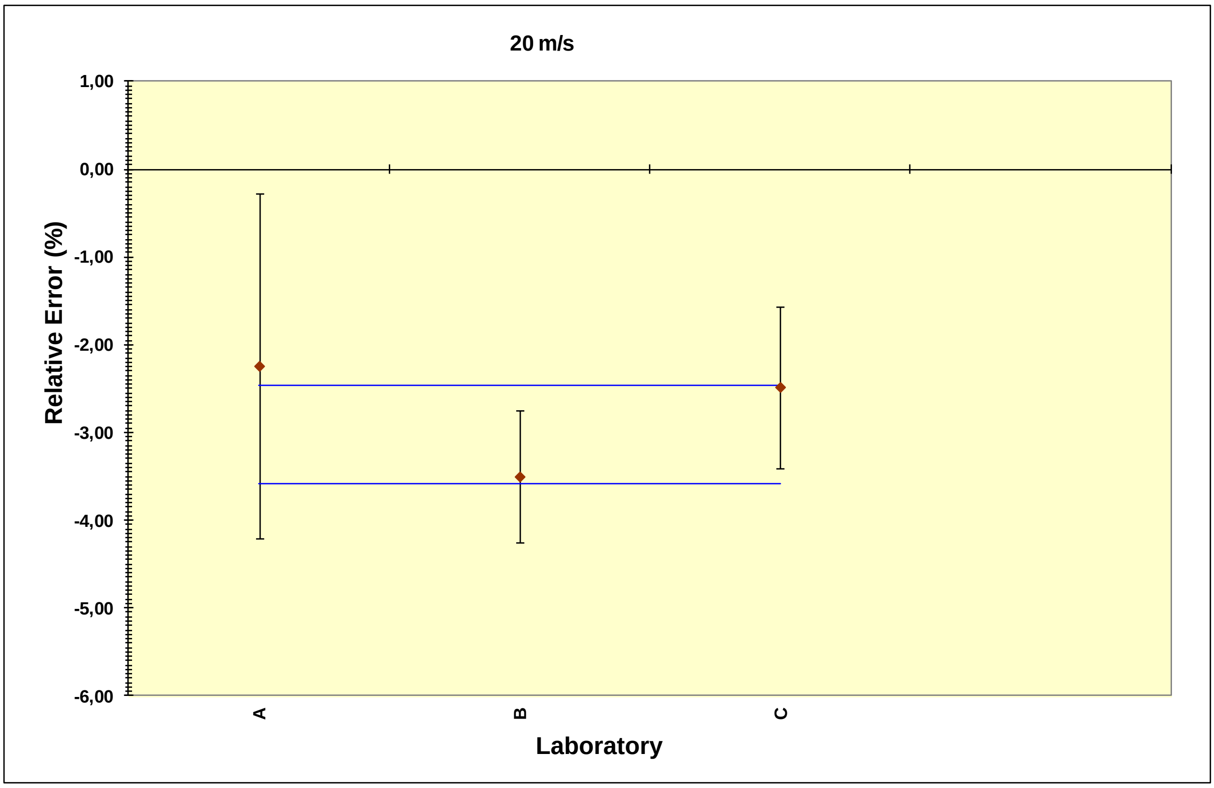
Graph3. Error bands for 7 m/s



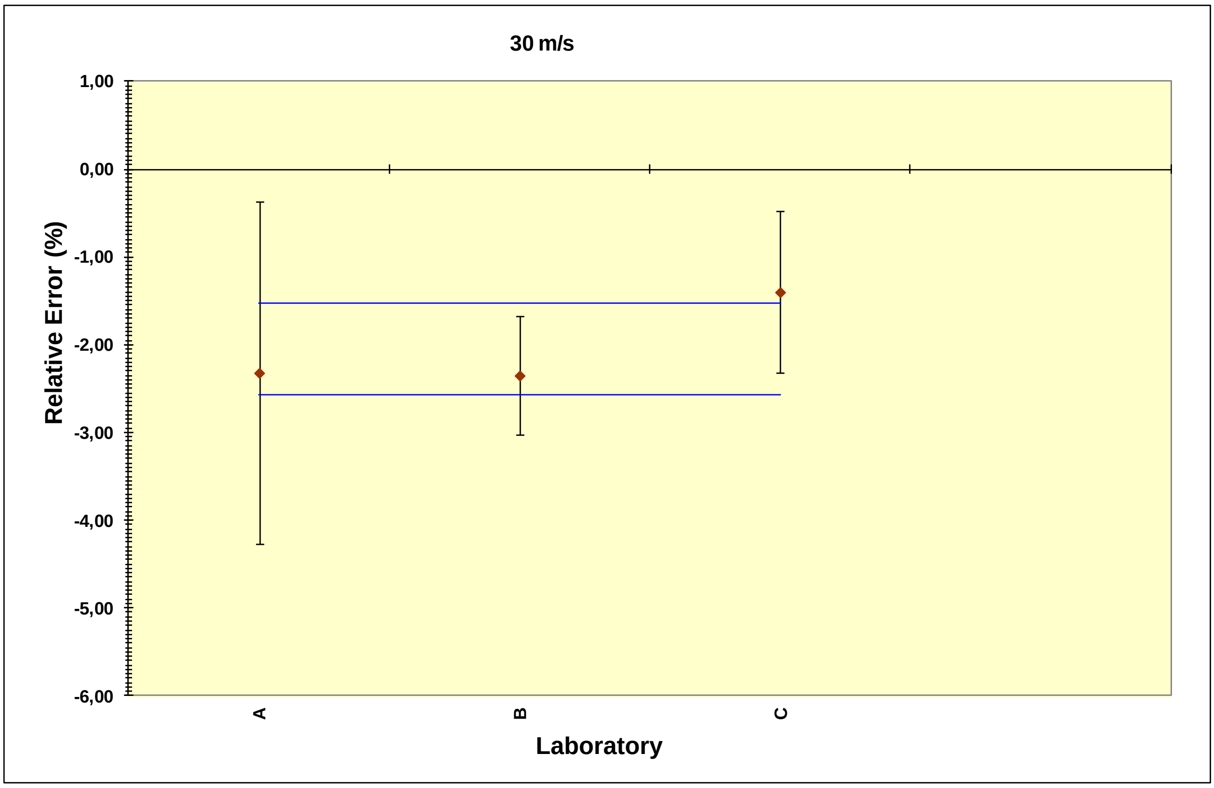
Graph4. Error bands for 10 m/s



Graph5. Error bands for 15 m/s



Graph6. Error bands for 20 m/s

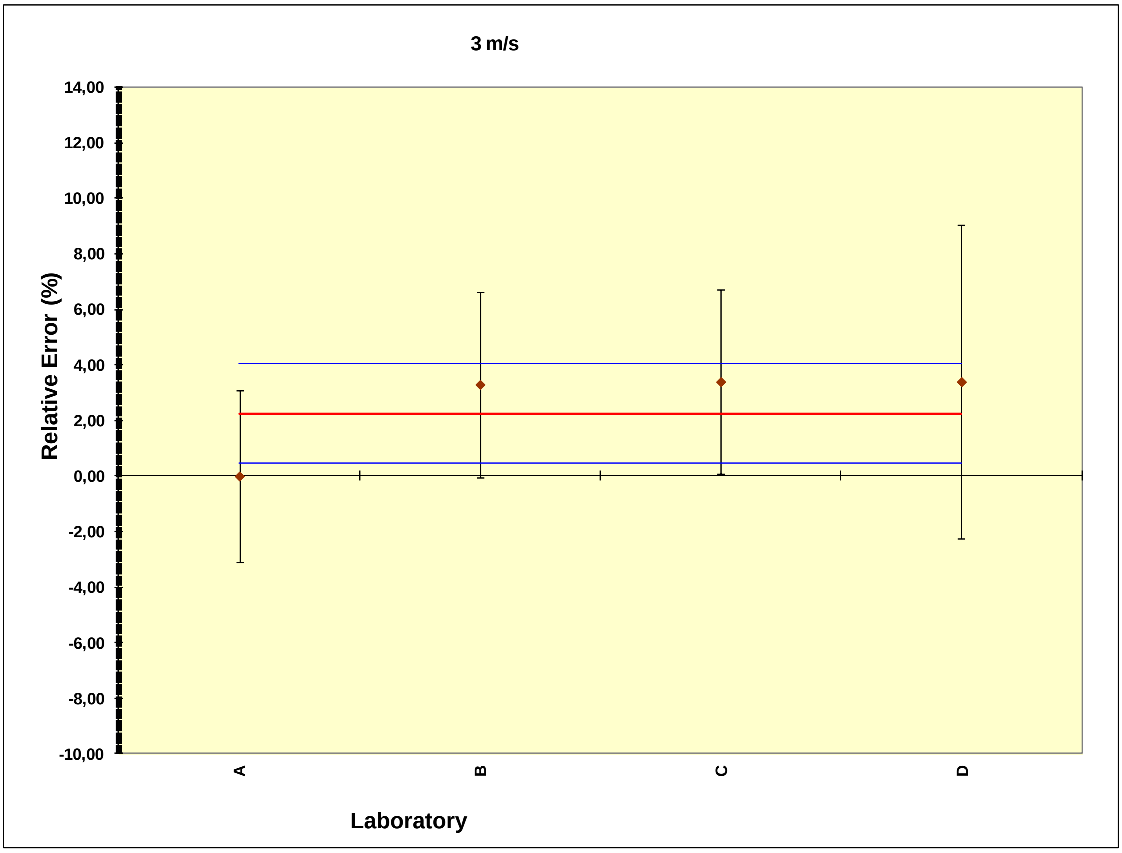


Graph7. Error bands for 30 m/s

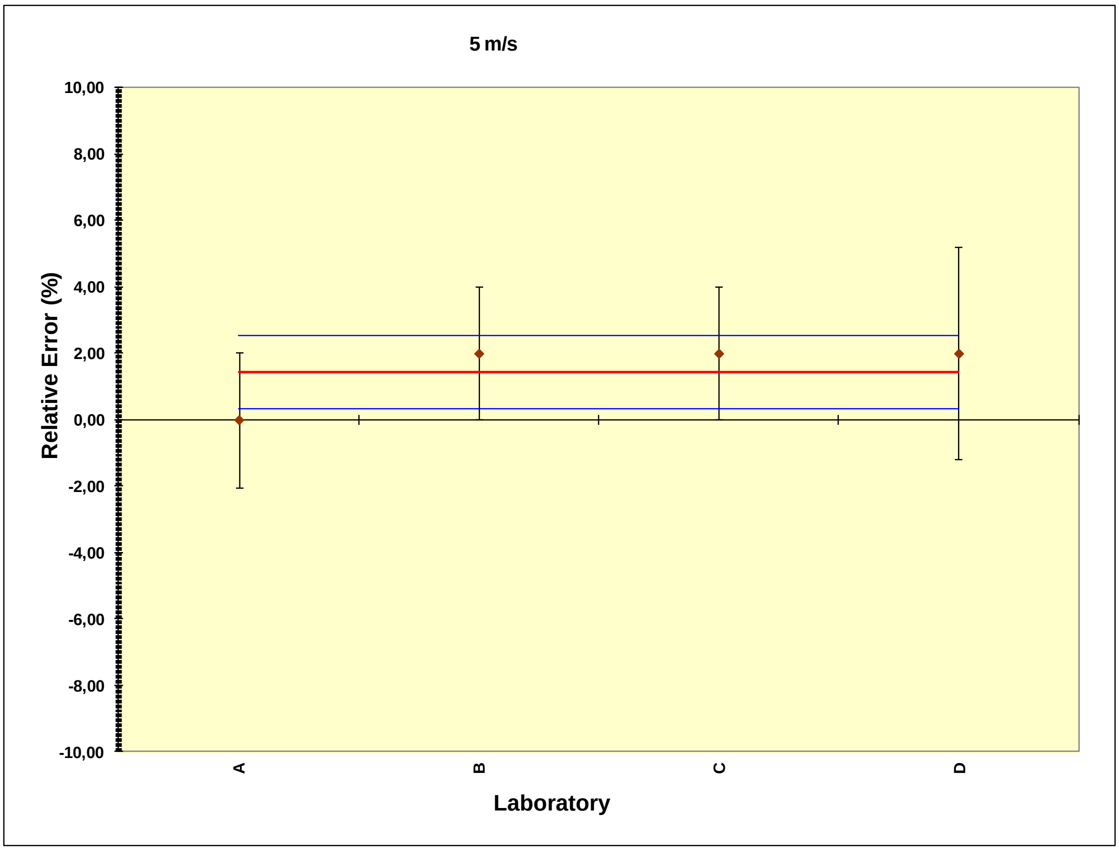
6. VANE ANEMOMETER RESULTS

Four laboratories participated in vane anemometer comparison and their results are indicated by using letter codes that are given to coordinators of participants.

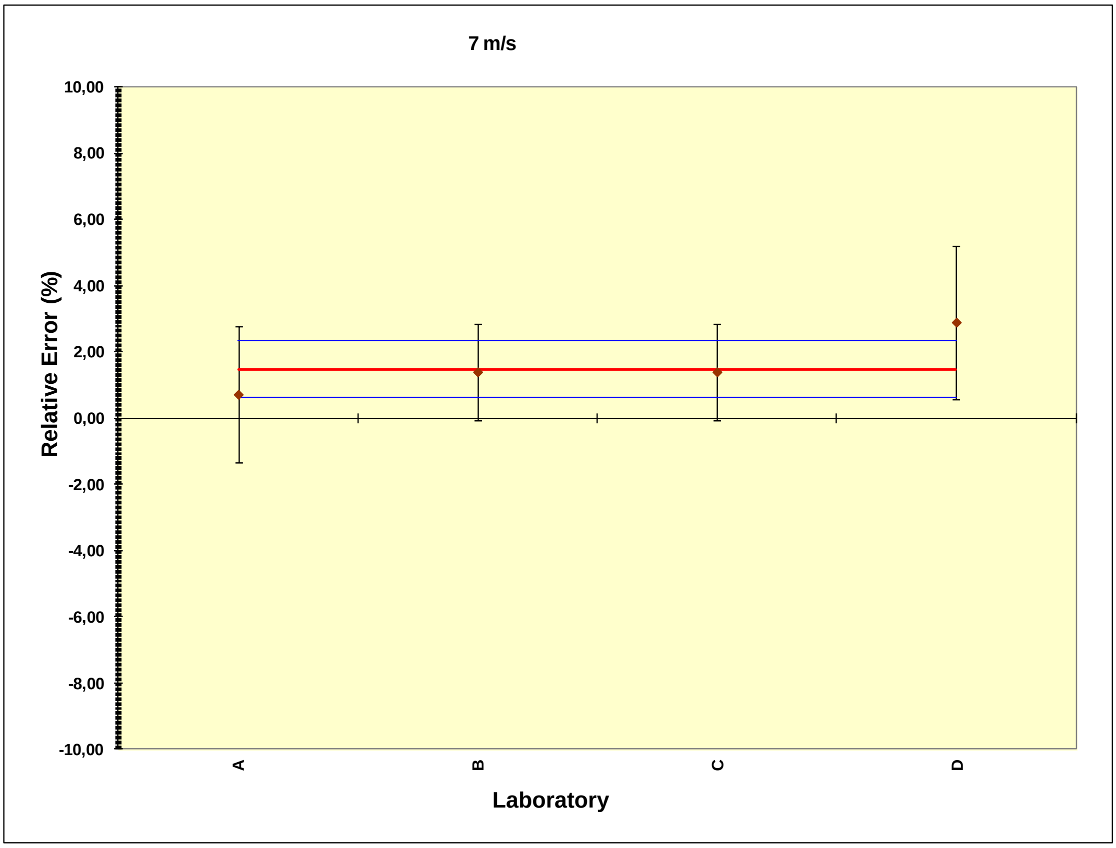
The relative error of a measurement and uncertainty belongs to that value is graphed for each air speed and laboratory.



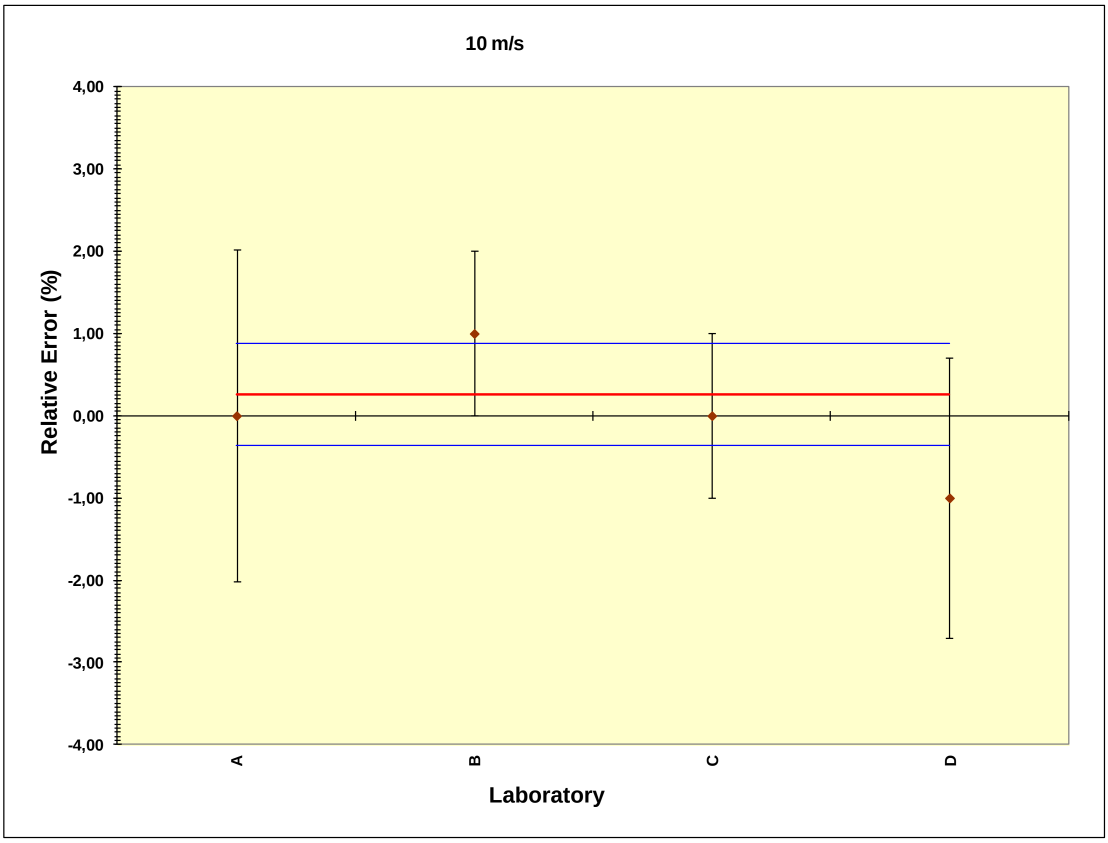
Graph8. Error bands for 3 m/s



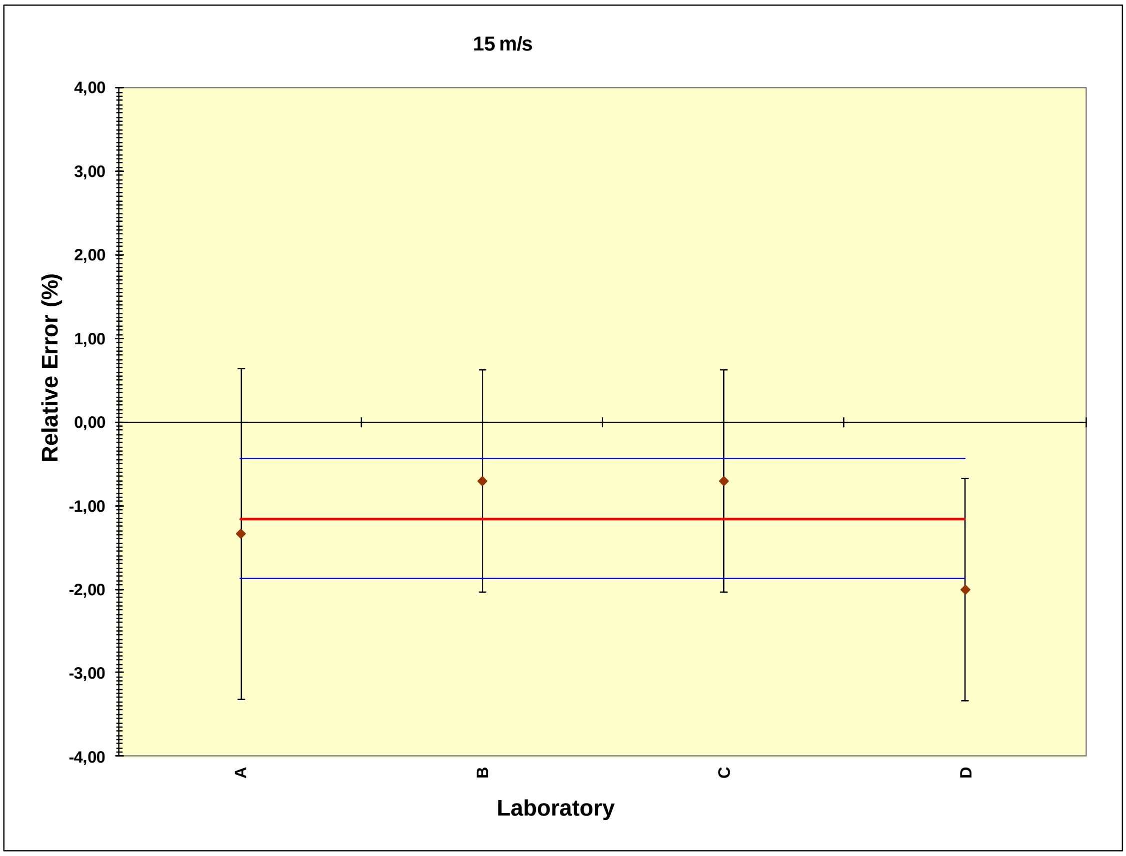
Graph9. Error bands for 5 m/s



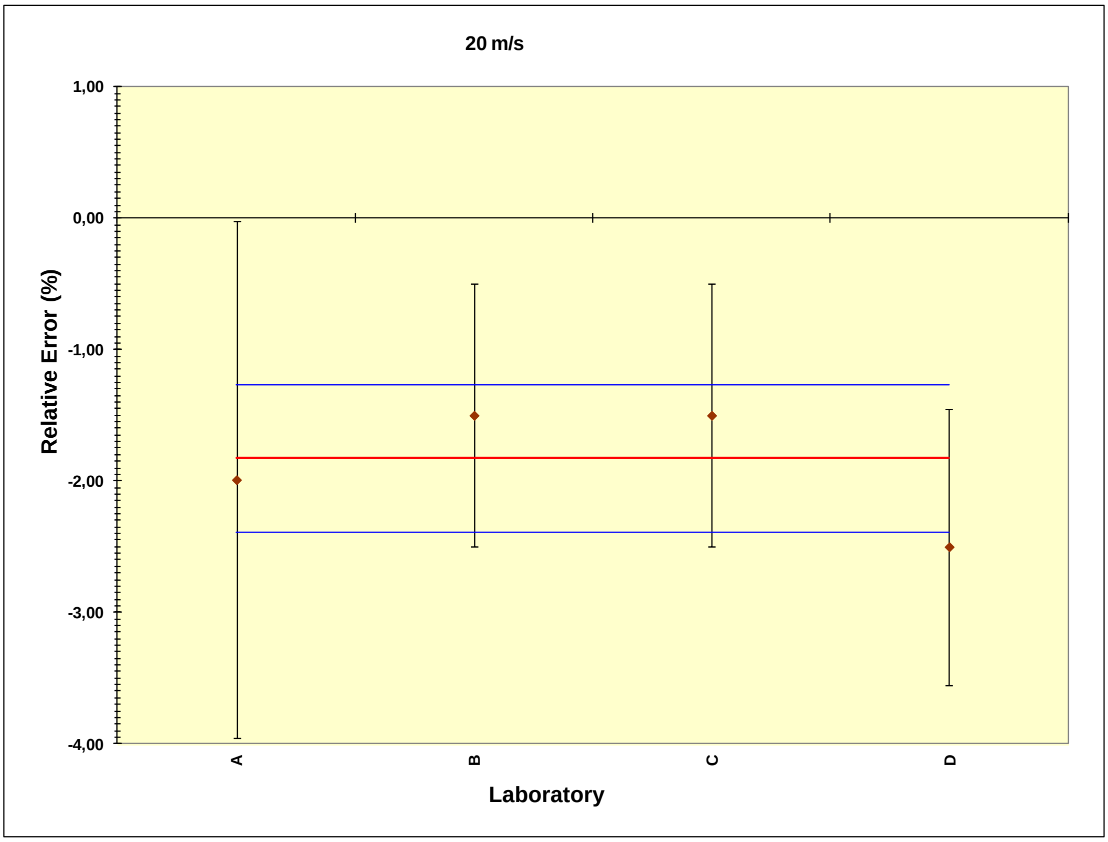
Graph10. Error bands for 7 m/s



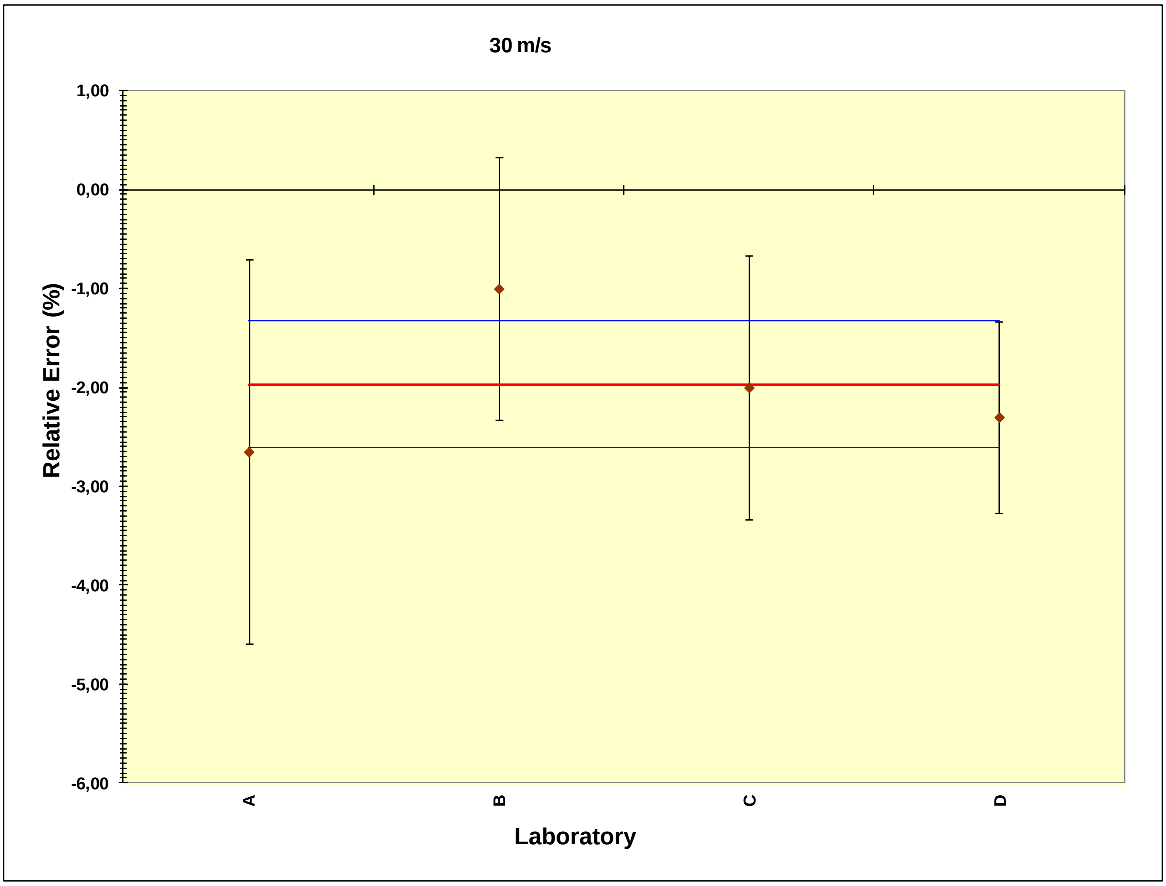
Graph11. Error bands for 10 m/s



Graph12. Error bands for 15 m/s

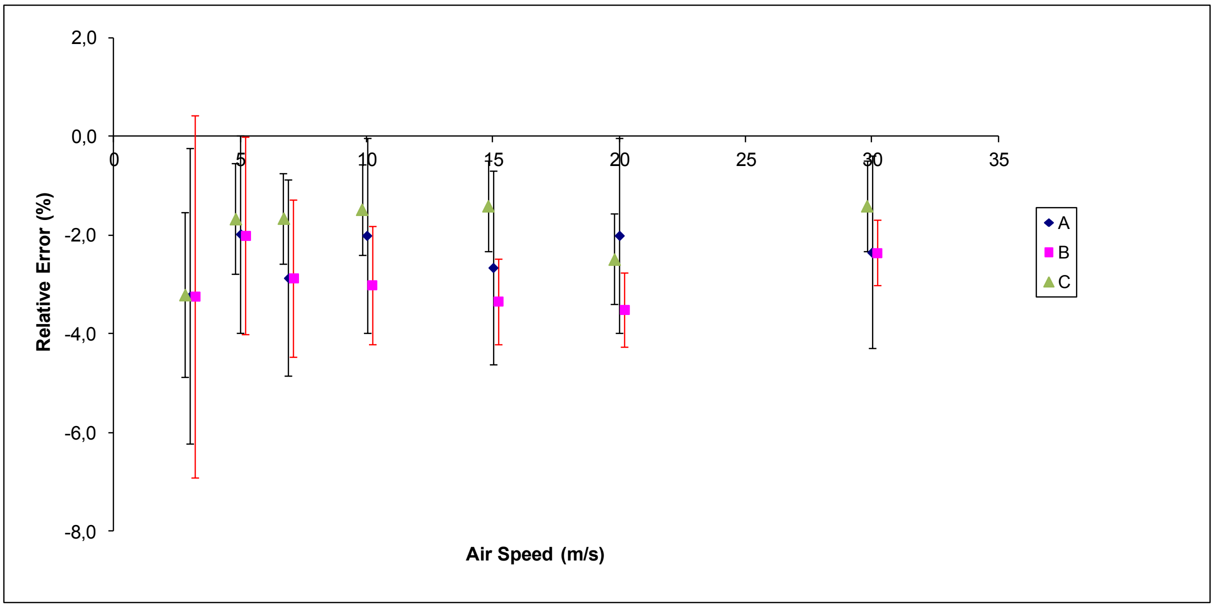


Graph13. Error bands for 20 m/s

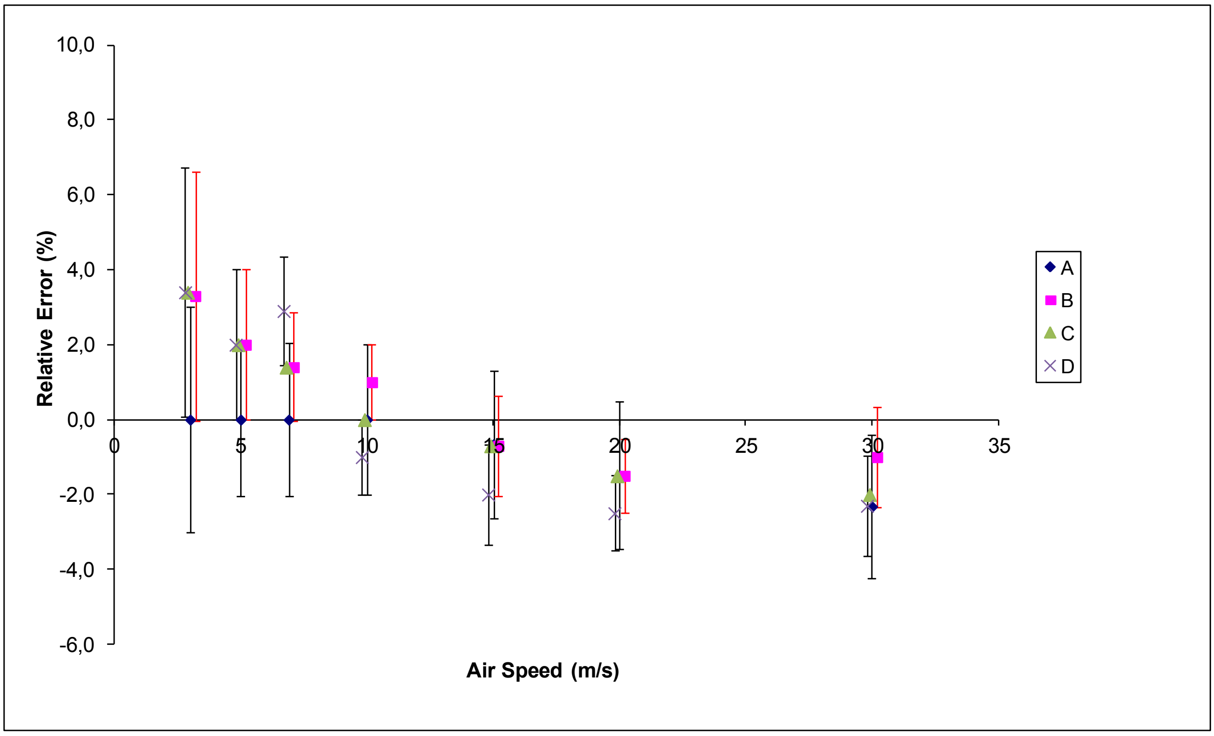


Graph14. Error bands for 30 m/s

7. EVALUATION



Graph15. Error presentation for pitot tube intercomparison



Graph16. Error presentation for vane anemometer intercomparison

The evaluation criteria for the intercomparison are;

- the results of a laboratory were *equivalent (**passed**)* if $E_i \leq 1.0$
- the laboratory were determined as *not equivalent (**failed**)* if $E_i > 1.2$
- for values of E_i in the range $1 < E_i \leq 1.2$ the "**warning level**" was defined. In this case some actions to check are recommended for the laboratory.

The Ei values calculated for pitot tube intercomparison are given in Table 1.

Table 1. Pitot Tube Comparison Evaluation

Air Speed	**Ei Values**		
v (m/s)	**A**	**B**	**C**
3,0	0,01	0,01	0,01
5,0	0,10	0,12	0,18
7,0	0,42	0,56	0,78
10,0	0,02	0,98	0,91
15,0	0,12	0,73	0,67
20,0	0,42	0,95	0,74
30,0	0,15	0,73	0,85

The Ei values calculated for vane anemometer intercomparison are given in Table 2

Table2. Vane Anemometer Intercomparison Evaluation

Air Speed	Ei Values			
v (m/s)	A	B	C	D
3,0	0,89	0,37	0,41	0,21
5,0	0,83	0,34	0,34	0,19
7,0	0,41	0,07	0,07	0,61
10,0	0,13	0,95	0,32	0,79
15,0	0,09	0,41	0,41	0,75
20,0	0,09	0,39	0,39	0,76
30,0	0,37	0,83	0,03	0,45

8. COMMENTS AND CONCLUSIONS

The intercomparison was performed with two anemometers; one was the pitot tube and the other was the vane anemometer.

Pitot tube measurements were done by TSMS and Serbia. TUBITAK UME results were included in the calculation of average reference value and the uncertainty related with that average value. Ei evaluation results for pitot tube intercomparison are given in Table 1. Ei values are all below 1 so it is concluded that each three participated laboratory has satisfactory results.

Vane anemometer measurements were done by TSMS, Germany/Hamburg, Germany/Oberschleißheim and Serbia. TUBITAK UME results were not needed in this comparison because more than two laboratories participated the intercomparison. The calculation of average reference value and the uncertainty related with that average value is done by the measurements of four laboratories. Ei evaluation results for vane anemometer intercomparison are given in Table 2. Ei values are all below 1 so it is concluded that each four participated laboratory has satisfactory results.

9. ORGANIZATION

The organization and evaluation of the ILC was made in accordance with the following documents:

1. Cox M.G., The Evaluation of Key Comparison Data, Metrologia 39, 589-595, 2002
2. Cox M.G., The Evaluation of Key Comparison Data: Determining The Largest Consistent Subset, Metrologia 44, 187-200, 2007

10. ANNEX A PROFICIENCY TESTING PROTOCOL

WORD METEOROLOGICAL ORGANISATION

TURKISH STATE METEOROLOGICAL SERVICE (TSMS)
CALIBRATION CENTER
REGIONAL INSTRUMENT CENTER IN RAVI

WIND SPEED MEASURING INSTRUMENTS (ANEMOMETER)
CALIBRATION LABORATORY

NATIONAL METROLOGY INSTITUTE OF TURKEY
(TÜBİTAK UME)

FINAL ILC PROTOCOL

INSTRUCTION FOR THE PARTICIPANTS OF THE INTERLABORATORY COMPARISON

Intercomparison on The Wind Speed (Anemometer) Calibration

TSMS-ILC-WS01-2018

JUNE.2018 - TURKEY

TABLE OF CONTENT

11. INTRODUCTION

All laboratories especially accredited ones should participate in the ILCs periodically according to ISO/IEC 17025:2017 standard. Participation in ILC is very important in terms of the reliability of the laboratory's ability to measure, weather it is accredited or not. Therefore, laboratories participate in the ILC according to their scope of calibration.

Turkish State Meteorological Service (TSMS) organizes the InterLaboratory Comparison (ILC) on “Wind Speed Calibration”. Wind Speed Calibration Laboratory of TSMS has been accredited by Turkish Accreditation Agency (TÜRKAK) since 2010. It should be noticed that the organization of the ILC will ensure the terms of ISO/IEC 17043:2010 standard.

Pitot tube (whit digital display) and vane anemometer (with digital display) will be used as transfer device in ILC. Participating laboratory should separately calibrate transfer devices according to their laboratory capability and measuring values should be recorded. So that, the measuring values of two devices are separately analyzed on the ILC final report. The participants will use their procedures to take the measuring values at the ILC. Final report will be prepared by Fluid Flow Laboratory of National Metrology Institute of Turkey.

11.1. Coordinator Laboratory for wind speed ILC

TSMS wind speed calibration laboratory is the coordinator for the ILC and responsible of the data evaluation.

Coordinator:
Mr. Dr. Zafer Turgay DAĞ
Quality Manager TSMS Calibration Center
Kütükçüalibey cad. No:4 Zip:06120 Keçiören / ANKARA / TURKEY
Phone : + 90 312 302 2209 Fax : + 90 312 361 2356
E-mail : ztdag@mgm.gov.tr

11.2. Data analysis

ILC values are analyzed by National Metrology Institute (UME) of TURKEY.

Mr. Hakan KAYKISIZLI
National Metrology Institute of Turkey
Fluid Flow Laboratory
TÜBİTAK Gebze yerleşkesi
Barış mah. PK54 41470 Gebze / Kocaeli / TURKEY

Phone : + 90 262 679 50 00 Fax : + 90 262 679 50 01
E-mail : Hakan.kaykisizli@tubitak.gov.tr

11.3. Participants

The participants in this intercomparison are as follows. The details of the contact infomations are listed as alphabetically order:

Participating laboratory: Deutscher Wetterdienst (Germany)
Contact person: Mr. Dörschel Holger
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City: Hamburg
Country: Germany
Phone: + 496 980 626 688
Fax: + 496 980 626 699
Email: holder.doeschel@dwd.de

Participating laboratory: Deutscher Wetterdienst / German Meteorological Office (Germany)
Contact person: Mr. Richard Seidl
Address: Referat TI35
August – Schmauss – St. 1
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Country: Germany
Phone: ++ 496 980 629 109
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Participating laboratory: Republic Hydrometeorogical Service of Serbia RHMSS (Serbia)
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Participating laboratory: Turkish State Meteorological Service TSMS (Turkey)
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Zip: 06120
City: Ankara
Country: Turkey
Phone: + 90 312 302 22 09
Fax: + 90 312 361 23 56
Email: ztdag@mgm.gov.tr

11.4. Time Schedule and deadlines

All participants have got 4 weeks for calibration including transport to the next laboratory.

If a participant anticipates difficulties in keeping the deadlines, the coordinator must be contacted immediately. In such a case the other participants will be contacted as soon as possible and be informed about eventual changes.

All participants have got 4 weeks for reporting the results after the equipment has left the laboratory. It is important that the deadline is met since the results are being analyzed continuously by the reference laboratory. If there are any problems or doubt regarding the results of the participant laboratory, the laboratory will be contacted immediately. In any case of suspicion regarding the equipment being defected or drifted, participant laboratory is expected to contact with the coordinator to determine next step to prosecute.

The measuring values of transfer equipment will be calibrated by the National Metrology Instute of Turkey, TUBITAK UME at the begining and ending of the ILC.

Time Schedule

ILC TIME SCHEDULE OF 2018

PARTICIPANT LABORATORY	WEEKS																					
	MAY					JUNE				JULY				AUGUST					SEPTEMBER			
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
NMI of TURKEY	X	X	X																			
TSMS				X	X																	
Deutscher Wetterdienst						X	X	X	X													
Deutscher Wetterdienst / German Meteorological Office										X	X	X	X									
Republic Hydrometrological Service of Serbia RHMSS														X	X	X	X					
TSMS																		X	X			
NMI of TURKEY																				X	X	X

11.5. Transportation of the equipment

Participants should be aware that all shipping costs (to the next laboratory) including insurance of the shipment will be covered by the participating laboratories. The participating laboratory is expected to cover expenses of shipment of the equipment with an insurance.

The coordinator will be informed by participant when the equipment are arrived (by e-mail). The inspection is carried out to the equipment which is unpacking. If there is any damage due to transportation, it should immediately be reported to the coordinator before the calibration.

Equipment will be accompanied with ATA CARNET forms for non-EU **countries.** Please, don’t forget to fill them when crossing border. In case that your country is not signatory of ATA CARNET convention, please perform temporary import/export procedure.

The equipment can be sent via registered mail (UPS or FedEx) or hand carried (personal transport) to the next laboratory (preferably hand carried).

12. DESCRIPTION OF THE EQUİPMENT

Two different handle type anemometers are calibrated in the ILC as transfer device.

12.1. General

Measuring quantity:	Anemometer 01	Anemometer 2
Measuring instrument:	Pitot tube Digital display	Vane anemometer Digital display
Manufacturer:	Fluke	Testo
Type:	PT12 (12 in) Display 922	Vane prob (Ø 16 mm diameter, 890 mm with telescope) Display 435-4
Serial number:	A52AB (probe) 36300329 (display)	10353041/706 (probe) 01414604/709 (display)
Measuring range:	1 m/s – 80 m/s	0.6 m/s – 40 m/s
Output:	Digital display (m/s)	Digital display (m/s)
Resolution	0,001 m/s	0.1 m/s

The instrument’s owner: TSMS
The measuring instruments will be placed in a protective case for transportation purposes.

It is required to report to coordinator of the ILC immediately, when it is observed by any participant that there are any missing or damaged parts of the transfer devices.

12.2. Environmental Conditions

Participant will calibrate the transfer devices according to their procedures. The starting and ending ambient conditions of the calibration (temperature, humidity and pressure) shall be reported in the calibration certificate and report form (Appendix.A1/2).

12.3. Handling

Delivery Form (Appendix.E) should be filled and sent to the ILC Coordinator right after equipment are received.

12.3.1. Packing and unpacking

Procedure for unpacking:

a. Inspect the transportation boxes for damage. If the boxes are damaged, the coordinator shall be contacted before continuation.

b. Unpack the equipment and check that all equipment mentioned in the section “Description of equipment” is present.
c. If any equipment is missing, the coordinator shall be contacted.
d. Inspect the equipment. If any of the equipment indicates visible signs of damage, the coordinator shall be contacted.

The packing procedure is as follows:

a. Check that all equipment mentioned in the section “Description of equipment” is packed before the equipment is transported to the reference laboratory
b. Be sure that the calibration certificate, manual, guide of equipment and filled delivery form (Appendix.E) and report form (Appendix.A1/2) are inserted into the transportation box.

12.3.2. Mounting

The wind direction of the tunnel should be considered during the installation of the anemometer. Wind tunnel direction is required to be the same as anemometer direction label indicated. Anemometer should be installed according to participant’s calibration procedure.

13. CALIBRATION/TEST METHOD

All participants are expected to use their own calibration procedure for the calibration of the transfer device. Extra time-consuming actions should be avoided throughout the calibration procedure. Measuring unit must be m/s.

13.1. Start-up and initial inspection

This section will be performed according to participant’s own laboratory procedure.

13.2. Measurement Levels

Target Velocity	UNIT
3.0	m/s
5.0	m/s
7.0	m/s
10.0	m/s
15.0	m/s
20.0	m/s
30.0	m/s

Participating laboratories are expected to take measurements according to their own laboratory capability. Laboratory Reference values should be within the ± 5 % of the target velocities. Environmental conditions (temperature, humidity and pressure) of the laboratory shortly before and right after calibration procedure should be declared on the calibration certificates and report form.

13.3. Reporting of results

The results will be reported electronically in the forwarded Report Form (Appendix A1/2). If both of the devices are calibrated, report form should be separately prepared. The report form should be sent to the coordinator by e-mail electronically.

The calibration certificates should be prepared separately for each transfer device according to ISO/IEC 17025 standards. Measurement uncertainty should be calculated according to EA-4/02 M:2013 document and ILAC-P14:01/2013 policy for uncertainty in calibration. Applied procedure has to be declared in the certificate. Expanded uncertainty (k=2) should be declared for each measuring level in the calibration certificates. The calibration certificate should be sent to the coordinator by e-mail electronically.

Every participant will be named with a code designated by the coordinator. Coding system will be kept as classified for the third parties. Both of the transfer devices will separately be evaluated on the final ILC reports. Summary of the measurements, assigned values and uncertainties of assigned values and evaluation of the performance will be conveyed to the participants. Final report will be prepared by National Metrology Institute (NMI) (UME) as absolutely independent evaluator for the data. The evaluation of measurement results will be made on the basis of E_n number:

$$E_n = \frac{X_{lab} - X_{ref}}{\sqrt{U_{lab}^2 + U_{ref}^2}}$$

X_{lab} : Participant’s result of transfer device
X_{ref} : Reference values result of transfer device
U_{lab} : expanded (k=2) uncertainty of a participant’s result
U_{ref} : expanded (k=2) uncertainty of the reference values result

References and E_n values will be evaluated according to Data Treatments Methods defined by Cox.

Criteria for performance evaluation will be based on statistical determination for E_n number:

$|E_n| \leq 1$: satisfactory
$1 < |E_n| \leq 1.2$: warning
$|E_n| > 1.2$: unsatisfactory

Participants may file a complaint or appeal to the coordinator in 60 days after receiving the final ILC report.

13.4. Measurements Uncertainty

The measurement results should be stated with their associated uncertainties. The evaluation of uncertainties should be calculated according to the EA-4/02 M:2013 document and ILAC-P14:01/2013 policy for uncertainty in calibration. The ILC should be made according to best laboratory measurement practices of participant.

14. Appendixes

Appendix.A1: Report Form (pitot-tube)

Name of Laboratory (participant):	
Equipment received (Date) :	
Equipment Calibrated (Date) :	
Shipping date to next laboratory:	

Calibration of Pitot-Tube Air Flow Meter

Target Velocity (m/s) [1]	**Laboratory Reference Value (m/s)** [2]	**Test value (m/s)** [3]	**Error (m/s)** [4]	**Relative Error (%)** [5]	**Expanded Uncertainty (k=2)** [6]
3.0 m/s					
5.0 m/s					
7.0 m/s					
10.0 m/s					
15.0 m/s					
20.0 m/s					
30.0 m/s					

Ambient conditions	**Before Calibration**	**After Calibration**	**Laboratory criteria (range) for ambient conditions**
Temperature (C°)			
Humidity (% RH)			
Pressure (mbar)			

1. Target Velocity.
2. Laboratory reference values measured by the participant (It should be within the ± 5 % of target velocities.)
3. Test value, read on the display of the transfer device
4. Error = Test value – Reference value
5. Relative Error = (100 * Error) / Reference value
6. Expanded (k=2) Uncertainty of the calibration at the measuring point

Note: The resolution should be taken as 0.1 at each measuring level (1 decimal)

Appendix.A2: Report Form (vane anemometer)

Name of Laboratory (participant):	
Equipment received (Date) :	
Equipment Calibrated (Date) :	
Shipping date to next laboratory:	

Calibration of Vane Anemometer

Target Velocity (m/s) [1]	**Laboratory Reference Value (m/s)** [2]	**Test value (m/s)** [3]	**Error (m/s)** [4]	**Relative Error (%)** [5]	**Expanded Uncertainty (k=2)** [6]
3.0 m/s					
5.0 m/s					
7.0 m/s					
10.0 m/s					
15.0 m/s					
20.0 m/s					
30.0 m/s					

Ambient conditions	**Before Calibration**	**After Calibration**	**Laboratory criteria (range) for ambient conditions**
Temperature (C°)			
Humidity (% RH)			
Pressure (mbar)			

1. Target Velocity.
2. Laboratory reference values measured by the participant (It should be within the ± 5 % of the target velocities.)
3. Test value, read on the display of the transfer device
4. Error = Test value – Reference value
5. Relative Error = (100 * Error) / Reference value
6. Expanded (k=2) Uncertainty of the calibration at the measuring point

Note: The resolution should be taken as 0.1 at each measuring level (1 decimal)

Appendix.B: Participant Form

Calibration Center	TURKISH STATE METEOROLOGICAL SERVICE CALIBRATION CENTER INTERLABORATORY COMPARISON PARTICIPANT FORM	DOC. NO	KM.FR.64
		PUBLICATION DATE	10.01.2018
		REV.NO/DATE	00/10.02.2018
		PAGE NO/TOTAL PAGE	36 / 39

PARTICIPANT LABORATORY INFORMATION

Demand Date		**Demand Number ***	
Name			
Address			
Zip		**City/Country**	

CONTACT PERSON INFORMATION

Name			
Surname		**His/Her Title**	
Phone Number		**Fax Number**	
E-mail			
Notes / Explanation			

INTERLABORATORY COMPARISON INFORMATION

NO	ILC CODE	INTERLABORATORY COMPARISON TITLE	MEASURING DATE	MEASURING RANGE
1	TSMS-ILC-WS01-2018	Wind Speed	(Sample) 23., 24., 25., 26. Weeks of June 2018	3 m/s to 30 m/s

DELIVERY INFORMATION (All Shipping costs are the responsibility of the Participant.)

	Post	By Hand	E-mail	Remarks (If you want your shipment to a different address)
Standard / Devıce	☒	☒	☐	
Certificate / Report	☐	☐	☒	

NOTES : This form is only used for ILC participant demands.
In case of insufficiency of the ILC participant form, this form may be duplicated.
You can sent the form by fax (+90 312 361 23 56) or by e-mail (kalibrasyon@mgm.gov.tr).
You can specify 4 week to take measurements.
(*) Demand number will be filled by TSMS.

Appendix.C: ILC Participant Privacy Statement Form

ILC Participant Privacy Statement

The information of all laboratories and measurements are kept secret by the organizer, and the information is not shared with third parties. all participants agree that they will not share their measurement values, their results and any information about the interlaboratory comparison with the other participants. The laboratory management is responsible for the problems that may arise as a result of sharing this information.

Responcible of the Laboratory

Name & Surname:

Date:

Signature:

Appendix.D: Delivery Form

Recipient :	
Sender :	

The transfer equipment of ILC that is coded as TSMS-ILC-WS01-2018 were received by ………..……………………….(lab name) on …………………..(date).

Inspection:

Check the transportation boxes before unpacking. Please check appropriate box and write down your notes if necessary.

☐ There is no any visible damage on the packing.
☐ There is visible damage on the packing.

NOTES:…………………………………………………………………………………
…… ……………………………………………………………………………………….

Check the content of the transportation boxes. Please check appropriate box and write down your notes if necessary.

☐ There is no any missing part.
☐ There are missing parts.

NOTES:…………………………………………………………………………………
…… ……………………………………………………………………………………….

Check the transfer equipment. Is there any damage on the devices that might affect the measurements?

☐ There is no any damage that might affect measurements.
☐ There is visible damage that might affect measurements.

NOTES:…………………………………………………………………………………
…… ……………………………………………………………………………………….

Content of transportation boxes:

Fluke 922 display	User’s guide of Testo 435
Fluke pitot-tube	User’s guide of Fluke 922
Two pitot-tube hose	Transportation box of Fluke
Testo 435-4 display	Transportation box of Testo
Testo vane probe	ATA CARNET

Appendix.E: User's Guide For Fluke 922

You can find the User's Guide of Fluke 922 into the transportation box.

Appendix.F: User's Guide For Testo 435

You can find the User's Guide of Testo 435 into the transportation box.

5 References

16 Cox M.G., The Evaluation of Key Comparison Data, Metrologia 39, 589-595, 2002

17 Cox M.G., The Evaluation of Key Comparison Data: Determining The Largest Consistent Subset, Metrologia 44, 187-200, 2007