Measuring-Network of Wind Energy Institutes

20ld01

# Mechanical Loads Proficiency Test

IECRE Public Report

Issue date November 2024

**Technical coordinator: Martin Falk, windtest grevenbroich gmbh**

**Participants identities managed by MEASNET Secretariat**

# Contents

# Preface

IEC Conformity Assessment Systems are globally recognized as giving consumers and industry more widely the confidence that a device or system meets or exceeds international standards.

IECRE is the global system for renewable energy conformity assessment and was established in 2014. Stakeholders in the system, those delivering conformity assessment activities, have to meet exacting criteria before being approved to operate.

In IECRE we have a global network of testing laboratories —known as RETLs— who meet the criteria in ISO/IEC 17025 for best management and measurement practice. An essential element of 17025 compliance is the demonstration of competence through inter laboratory or proficiency testing. Specifically for an international system with mutual acceptance of test results and certifications, proficiency testing is an integral element fostering the mutual trust which enable acceptance. All participants within the IECRE know and have proof that the system evaluates qualification to harmonized and aligned criteria.

IECRE has been working closely with MEASNET, who is the provider of proficiency testing in the renewables sector.

IECRE and MEASNET are delighted to publish the final report for the most recent round of Loads proficiency testing and to make this available to all stakeholders and interested parties.

This report is the most comprehensive overview of Loads evaluation ever undertaken by almost every testing organization active in the renewables sector and it is hoped demonstrates that all laboratories in IECRE have proved their competence through a thorough and independent process.

We encourage the reports use in the renewables sector and welcome any comments or feedback.

Wolfram Zeitz
IECRE Executive Secretary

Alistair Mackinnon
IECRE Chair

Alejandro Martínez
MEASNET Vice Chairman

# 1. Introduction & Methodology

Within the framework of the MEASNET network internal quality evaluation program, the collaboration with the IECRE organization and the consideration of proficiency testing as a service offered to its customers, a Mechanical Loads proficiency test exercise was organized and performed.

This internal report is issued according to the contents described in the IECRE O.D. 551-17 [2]

## 1.1. Standards in Scope.

The participants performed the tasks according to the standard IEC 61400-13:2015 [1].

## 1.2. Methodology.

According to the IECRE O.D. 551-17 [2], the proficiency test was performed in two rounds.

Round 1 is conceived as a preparation phase intended to find the sources of the differences among the participants, and is restricted to type A participants.

Round 2 is open to type A and type B participants. The Pass and Fail criteria proposed below shall be used by IECRE to determine the proficiency of the laboratories belonging to the system.

## 1.3. Preliminary Line Choice.

The line choice is a set of instructions handled to the participants explaining which options, among those valid and present in the standard, have to be taken in order to improve the intercomparability of the results.

For this Mechanical Loads Proficiency Test one line choice has been defined.

Round 1 identifies a misunderstanding in creating load statistics of the tower bending moment because of the aliment and signal direction was mistakable.

The Round 1 team agreed to update the instructions with a position sketch for the tower strain gauges / signals (see picture 6.1) and to repeat the load statistic step for Round 1, in order to make sure that this misunderstanding source is solved.

# 2. Topics covered by the PT

## 2.1. Chunk data definition.

The input data for the PT follows the chunk data idea. The data were provided in form of text files (tabulator separated) and FAMOS files.

Database for step by step calculations:

1. Capture Matrix (task001)
    - Times series with scaled wind speed
    - Evaluated of mean value and turbulence intensity
2. Load Statistics (task002)
    - Times series with scaled load signal
    - Evaluation of mean, min, max and standard deviation
3. Yaw misalignment (task003)
    - Times series of scaled wind direction and nacelle position
    - Evaluation of misalignment, calculation the mean, min, max and standard deviation
4. Frequency calculations (task004)
    - Time series with several frequencies
    - Evaluation of the frequencies

Database after Rain-flow count and uncertainty calculations:

5. Load Spectra (task005)
    - Mean-Span-Rain-flow matrix
    - Evaluation of the load spectra and cumulative load spectra
6. Damage Equivalent Loads (task006)
    - Load spectra
    - Calculation of the DEL
7. Total Uncertainty (task007)
    - Table with:
        i. No. of DS
        ii. Wind speed [m/s]
        iii. Load average [kNm]
        iv. Load standard deviation [kNm]

v. Wind speed uncertainty [m/s]
vi. Calibration uncertainty [kNm]
vii. Signal uncertainty [kNm]

- Calculating of:
  i. Total uncertainty
  ii. Uncertainty of the BIN scatter
  iii. Uncertainty of the x-axis quantity

## 2.2. Databases

For this Mechanical Loads Proficiency Test two databases were used. One was intended to be used for the mandatory step by step evaluation (compare to chapter 2.1 bullet points 1…4); the second one (compare to chapter 2.1 bullet points 5…7) contained the results of the rain-flow counting and the data for the uncertainty analysis.

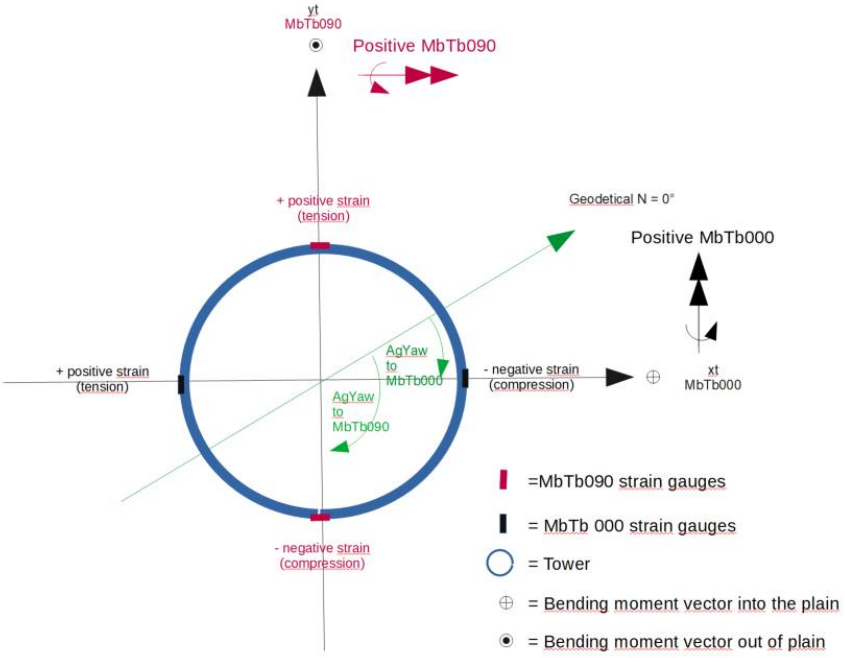
## 2.3. Calibration factors

Table 2-1 Load channels

| No. | Channel name | Offset | Slope |
|---|---|---|---|
| | MbTb000V (x-axis) | 6,000 kNm | 23,000 kNm/(mV/V) |
| | MbTb090V (y-axis) | 11,000 kNm | 24,000 kNm/(mV/V) |
| | MbBlFlatV | 1,012 kNm | 4,300 kNm/(mV/V) |

Table 2-2 Strain gauge positions to geodetical north

| No. | Description | Value | Unit |
|---|---|---|---|
| | MbTb000V (x-axis) | 40 | ° |
| | MbTb090V (y-axis) | 130 | ° |




Picture 2-1: Assigning strain gauge signal/positions of tower base and north orientation referring to the IEC61400-13 Figure A.4

Table 2-3 Meteorological channels

| No. | Channel name | Offset | Slope |
|---|---|---|---|
| | DirWndU | 202.4 ° | 2.3 °/V |
| | VWndU | 0.22 m/s | 0.25 (m/s)/Hz |
| | VWndAlphaU | 0 | 1 |

Table 2-4 Wind turbine channels

| No. | Channel name | Offset | Slope |
|---|---|---|---|
| | PElU | 1,200 kW | 190 kW/V |
| | StWtModU | - | - |
| | AgYawU | -40 ° | 220 °/V |
| | NRotU | 0 rpm | 2.9 rpm/V |

Table 2-5 Output values status wind turbine mode

| Status channel | Signal | Status |
|---|---|---|
| StWTModU | 5 +- 0.5 | grid connection |
| StWTModU | 3.5 +- 2 | system Ok |

Table 2-6 Output values status signals

| Status channel | Signal | Status |
|---|---|---|
| StGrid | 0 | no grid connection |
| StGrid | 1 | grid connection |
| StSysOk | 0 | system not ok |
| StSysOk | 1 | system ok |

## 2.4. Data filtering

Filtering according to:

1. Sector of evaluation (exclude 0° to 182°)
2. Status grid connection
3. Status system ok
4. Pitch Type

## 2.5. Rain-flow parameters

For information only. The results of the rain-flow count for further analysis can be found in the above mentioned Excel sheet.

Table 2-7 Rain-flow parameters

| Channel name | Resolution [kNm] | Range [kNm] |
|---|---|---|
| MbBlFlat | 150 | -2,000..4,000 kNm |

Rainflow counting with full circles and residuals.

## 2.6. Material exponent

Table 2-8 Material exponent

| Channel name | Material exponent |
|---|---|
| MbBlFlat | 10 |

# 3. Pass / Fail Criteria

The RETLs belonging to IECRE must fulfil the following pass and fail criteria in order to be part of the IECRE system. These criteria are not mandatory for other participants.

The following aspects of the loads testing shall be covered by the proficiency test and the results from multiple items will be compared. Below there is a summary of the aspects and the pass/fail criteria to be applied:

Database for step by step calculations:

1. Capture Matrix (task001)
    - Any deviation is considered as a fail result.
2. Load Statistics (task002)
    - Maximum allowed difference is 0.5% from median value.
3. Yaw misalignment (task003)
    - Maximum allowed difference is 0.5% from median value.
4. Frequency calculations (task004)
    - Maximum allowed difference is 0.5% from median value.

For a successful participation of the PT it is mandatory to fulfil the criteria of the above mentioned tasks 1 to 4.

Database after Rain-flow count for DEL and uncertainty calculations as an informative evaluation with chunk data (compare to chapter 2.1):

- Load Spectra (task005)
    - Any deviation is considered as a fail result.
- Damage Equivalent Loads ($R_i$ is the average value of the $i^{th}$ range bin of the fatigue load spectrum) (task006)
    - Maximum allowed difference is 0.5% from median value.
- Total Uncertainty (task007).
    - Maximum allowed difference is 0.5% from median value.
- Uncertainty of the BIN scatter (task007).
    - Maximum allowed difference is 0.5% from median value.
- Uncertainty of the x-axis quantity (task007).
    - Maximum allowed difference is 0.5% from median value.
- Uncertainty of BIN averaged mean values (task007).
    - Maximum allowed difference is 0.5% from median value.

Deviation greater than 0.5% from median will be shaded in orange.

# 4. Participant List

The participants enlisted for Round 1 & Round 2 (type A participants) are, in alphabetical order:

| TESTING LABORATORY |
|---|
| Anonymous laboratory 1[1] |
| Aresse Engineering S.L. |
| Barlovento Recursos Naturales S.L. |
| Beijing CGC Certification Center Co., Ltd. |
| Center for Renewable Energy Sources and Saving - CRES |
| China Classification Society Certification Co., Ltd. - CCSC |
| China Electric Power Research Institute - CEPRI |
| Deutsche WindGuard Consulting GmbH |
| DNV Energy Systems Germany GmbH |
| DNV Maritime and Energy, S.L.U. |
| DTU Wind Energy |
| Fraunhofer-Institut für Windenergiesysteme - IWES |
| Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek - TNO |
| Shanghai SERCAL New Energy Technology Co., Ltd. |
| UL International GmbH |
| Wind-consult GmbH |
| windtest grevenbroich gmbh |

Participants registered for Round 2 only (type B participants), in alphabetical order:

| TESTING LABORATORY |
|---|
| Anonymous laboratory 2[1] |
| Goldwind Science & Technology Co., Ltd. |
| Korea Institute of Energy Research |

[1] Anonymous laboratories 1 and 2 have not granted MEASNET permission to display their names on this list.

# 5. Proficiency Test Calendar

The following calendar describes the process of the Proficiency Test:

Preparation:

| | |
|---|---|
| Application period deadline for Round 1 | 14.01.2022 |
| Election of coordinator & participation appeals | 14.01.2022 to 04.02.2022 |
| Fees payment deadline for Round 1 participants | 04.03.2022 |

Round 1:

| | |
|---|---|
| Round 1 Instructions delivery | 13.05.2022 |
| Round 1 results submission deadline | 17.06.2022 |
| Round 1 data analysis from conductor | 20.06.2022 to 24.06.2022 |
| Round 1 results discussion | 27.06.2022 to 08.07.2022 |

Second Round 1 – Load Statistics (task002)[2]

| | |
|---|---|
| Round 1 Instructions delivery | 07.10.2022 |
| Round 1 results submission deadline | 21.10.2022 |
| Round 1 data analysis from conductor | 24.10.2022 – 28.10.2022 |
| Round 1 results discussion | 03.11.2022 |

[2] Some issues were found and discussed about the load statistics task, so the group decided further investigate these issues on a voluntary participation basis.

Round 2:

| | |
|---|---|
| Application period deadline for Round 2 | 07.10.2022 |
| Fees payment deadline for Round 2 participants | 30.11.2022 |
| Round 2 Kick-off meeting | 17.11.2022 |
| Round 2 Instructions delivery | 18.11.2022 |
| Q&A period | 21 to 25.11.2022 |
| Round 2 results submission deadline* | 12.12.2022 to 09.01.2023 |
| Round 2 data analysis from conductor | 10 to 17.01.2023 |
| Round 2 results communication & room for non-technical corrections | 30.01 to 10.02.2023 |
| Round 2 final report creation | 13 to 24.02.2023 |

* This period was defined to conceal claims of several participants.

# 6. Results provided by participants

## 6.1. Data base: Capture Matrix (Task001).

Determination of capture matrix, see also task001, chapter 2 'Topics covered by the PT'.

Result: No deviations found for this task.

**Table 6-1: Capture matrix, data set count, wind speeds**

| | Data set count |
|---|---|
| Institute 0309 | 1 |
| Institute 2707 | 1 |
| Institute 3600 | 1 |
| Institute 3605 | 1 |
| Institute 3926 | 1 |
| Institute 4253 | 1 |
| Institute 4333 | 1 |
| Institute 4652 | 1 |
| Institute 4928 | 1 |
| Institute 4956 | 1 |
| Institute 4998 | 1 |
| Institute 5144 | 1 |
| Institute 5599 | 1 |
| Institute 7646 | 1 |
| Institute 7722 | 1 |
| Institute 8418 | 1 |
| Institute 8946 | 1 |
| Institute 9328 | 1 |
| Institute 9962 | 1 |

| | Wind speeds [m/s] |
|---|---|
| Institute 0309 | 10,22 |
| Institute 2707 | 10,22 |
| Institute 3600 | 10,22 |
| Institute 3605 | 10,22 |
| Institute 3926 | 10,22 |
| Institute 4253 | 10,22 |
| Institute 4333 | 10,22 |
| Institute 4652 | 10,22 |
| Institute 4928 | 10,22 |
| Institute 4956 | 10,22 |
| Institute 4998 | 10,22 |
| Institute 5144 | 10,22 |
| Institute 5599 | 10,22 |
| Institute 7646 | 10,22 |
| Institute 7722 | 10,22 |
| Institute 8418 | 10,22 |
| Institute 8946 | 10,20 |
| Institute 9328 | 10,22 |
| Institute 9962 | 10,22 |

## Table 6-2: Capture matrix, results

| | Normal power production | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Time series length | 10 minutes | | | | | | | | | | | | | | | | | | |
| WS (> to <=) [m/s] TI (> to <=) [%] | Institute 0309 | Institute 2707 | Institute 3600 | Institute 3605 | Institute 3926 | Institute 4253 | Institute 4333 | Institute 4652 | Institute 4928 | Institute 4956 | Institute 4998 | Institute 5144 | Institute 5599 | Institute 7646 | Institute 7722 | Institute 8418 | Institute 8946 | Institute 9328 | Institute 9962 |
| <5 | | | | | | | | | | | | | | | | | | | |
| 5..7 | | | | | | | | | | | | | | | | | | | |
| 7..9 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 9..11 | | | | | | | | | | | | | | | | | | | |
| 11..13 | | | | | | | | | | | | | | | | | | | |
| 13..15 | | | | | | | | | | | | | | | | | | | |
| 15..17 | | | | | | | | | | | | | | | | | | | |
| 17..19 | | | | | | | | | | | | | | | | | | | |
| 19..21 | | | | | | | | | | | | | | | | | | | |
| 21..23 | | | | | | | | | | | | | | | | | | | |
| 23..25 | | | | | | | | | | | | | | | | | | | |
| 25..27 | | | | | | | | | | | | | | | | | | | |
| 27..29 | | | | | | | | | | | | | | | | | | | |
| >29 | | | | | | | | | | | | | | | | | | | |
| Number of turbulence BINs>= 3 data sets | | | | | | | | | | | | | | | | | | | |
| Summary recorded data sets | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

## 6.2. Data base: Load Statistics (Task002).

Determination of load statistics of tower bending nominal moments, see also task002, chapter 2 'Topics covered by the PT'.

The results have been compared relatively to the average and median of all participants' load statistics.

A limit value for deviation has been defined as +- 0.5 % of median.

Result: Participant 4253 and participant 4333 have greater deviations than 0.5% from median.

**Table 6-3: Load statistics, data set count, wind speeds**

| | Data set count |
|---|---|
| Institute 0309 | 1 |
| Institute 2707 | 1 |
| Institute 3600 | 1 |
| Institute 3605 | 1 |
| Institute 3926 | 1 |
| Institute 4253 | 1 |
| Institute 4333 | 1 |
| Institute 4652 | 1 |
| Institute 4928 | 1 |
| Institute 4956 | 1 |
| Institute 4998 | 1 |
| Institute 5144 | 1 |
| Institute 5599 | 1 |
| Institute 7646 | 1 |
| Institute 7722 | 1 |
| Institute 8418 | 1 |
| Institute 8946 | 1 |
| Institute 9328 | 1 |
| Institute 9962 | 1 |

| | Wind speeds [m/s] |
|---|---|
| Institute 0309 | 10,22 |
| Institute 2707 | 10,22 |
| Institute 3600 | 10,22 |
| Institute 3605 | 10,22 |
| Institute 3926 | 10,22 |
| Institute 4253 | 10,22 |
| Institute 4333 | 10,22 |
| Institute 4652 | 10,22 |
| Institute 4928 | 10,22 |
| Institute 4956 | 10,22 |
| Institute 4998 | 10,22 |
| Institute 5144 | 10,22 |
| Institute 5599 | 10,22 |
| Institute 7646 | 10,22 |
| Institute 7722 | 10,22 |
| Institute 8418 | 10,22 |
| Institute 8946 | 10,22 |
| Institute 9328 | 10,22 |
| Institute 9962 | 10,22 |

**Table 6-4: Load statistics, results**

| | Wind speed 10,22 m/s | | | |
|---|---|---|---|---|
| MbTbNormal | MbTbNormal maximum [kNm] | MbTbNormal average [kNm] | MbTbNormal minimum [kNm] | MbTbNormal standard deviation [kNm] |
| Institute 0309 | 12463,025 | 11576,263 | 10690,946 | 388,216 |
| Institute 2707 | 12463,025 | 11576,263 | 10690,946 | 388,216 |
| Institute 3600 | 12463,025 | 11576,263 | 10690,946 | 388,216 |
| Institute 3605 | 12463,025 | 11576,263 | 10690,946 | 388,216 |
| Institute 3926 | 12463,025 | 11576,263 | 10690,946 | 388,216 |
| Institute 4253 | -316,223 | -890,718 | -1562,476 | 272,005 |
| Institute 4333 | 12334,580 | 11495,639 | 10678,434 | 364,680 |
| Institute 4652 | 12463,025 | 11576,263 | 10690,946 | 388,216 |
| Institute 4928 | 12463,025 | 11576,263 | 10690,946 | 388,216 |
| Institute 4956 | 12463,025 | 11576,263 | 10690,946 | 388,216 |
| Institute 4998 | 12463,025 | 11576,263 | 10690,946 | 388,216 |
| Institute 5144 | 12463,025 | 11576,263 | 10690,946 | 388,216 |
| Institute 5599 | 12463,025 | 11576,263 | 10690,945 | 388,216 |
| Institute 7646 | 12463,025 | 11576,263 | 10690,946 | 388,216 |
| Institute 7722 | 12463,030 | 11576,260 | 10690,950 | 388,210 |
| Institute 8418 | 12463,025 | 11576,263 | 10690,945 | 388,216 |
| Institute 8946 | 12463,025 | 11576,263 | 10690,946 | 388,216 |
| Institute 9328 | 12463,026 | 11576,263 | 10690,946 | 388,216 |
| Institute 9962 | 12463,025 | 11576,263 | 10690,946 | 388,216 |
| **Average** | **12455,890** | **11571,784** | **10690,251** | **386,908** |
| **Median** | **12463,025** | **11576,263** | **10690,946** | **388,216** |

Statistical outliers or insufficient information that are not considered for calculation of the average values.

**Table 6-5: Load statistics, relative deviation to average**

| | Wind speed 10,22 m/s | | | |
|---|---|---|---|---|
| MbTbNormal | MbTbNormal maximum [%] | MbTbNormal average [%] | MbTbNormal minimum [%] | MbTbNormal standard deviation [%] |
| Institute 0309 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 2707 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 3600 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 3605 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 3926 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 4253 | -102,54 | -107,70 | -114,62 | -29,70 |
| Institute 4333 | -0,97 | -0,66 | -0,11 | -5,75 |
| Institute 4652 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 4928 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 4956 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 4998 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 5144 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 5599 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 7646 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 7722 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 8418 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 8946 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 9328 | 0,06 | 0,04 | 0,01 | 0,34 |
| Institute 9962 | 0,06 | 0,04 | 0,01 | 0,34 |

Deviation greater than limit, see also task002, chapter 3 Pass / Fail Criteria.

**Table 6-6: Load statistics, relative deviation to median**

| | Wind speed 10,22 m/s | | | |
|---|---|---|---|---|
| MbTbNormal | MbTbNormal maximum [%] | MbTbNormal average [%] | MbTbNormal minimum [%] | MbTbNormal standard deviation [%] |
| Institute 0309 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 2707 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3600 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3605 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3926 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4253 | -102,54 | -107,69 | -114,61 | -29,93 |
| Institute 4333 | -1,03 | -0,70 | -0,12 | -6,06 |
| Institute 4652 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4928 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4956 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4998 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5144 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5599 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7646 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7722 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8418 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8946 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9328 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9962 | 0,00 | 0,00 | 0,00 | 0,00 |

Deviation greater than limit, see also task002, chapter 3 Pass / Fail Criteria.

## 6.3. Data base: Yaw Misalignment (Task003).

Determination of yaw misalignment, see also task003, chapter 2 'Topics covered by the PT'.

The results have been compared relatively to the average and median of all participants' yaw misalignments.

A limit value for deviations has been defined as +- 0.5 % of median.

Result: No deviations found for this task.

**Table 6-7: Yaw misalignment, data set count, wind speeds**

| | Data set count |
|---|---|
| Institute 0309 | 1 |
| Institute 2707 | 1 |
| Institute 3600 | 1 |
| Institute 3605 | 1 |
| Institute 3926 | 1 |
| Institute 4253 | 1 |
| Institute 4333 | 1 |
| Institute 4652 | 1 |
| Institute 4928 | 1 |
| Institute 4956 | 1 |
| Institute 4998 | 1 |
| Institute 5144 | 1 |
| Institute 5599 | 1 |
| Institute 7646 | 1 |
| Institute 7722 | 1 |
| Institute 8418 | 1 |
| Institute 8946 | 1 |
| Institute 9328 | 1 |
| Institute 9962 | 1 |

| | Wind speeds [m/s] |
|---|---|
| Institute 0309 | 10,22 |
| Institute 2707 | 10,22 |
| Institute 3600 | 10,22 |
| Institute 3605 | 10,22 |
| Institute 3926 | 10,22 |
| Institute 4253 | 10,22 |
| Institute 4333 | 10,22 |
| Institute 4652 | 10,22 |
| Institute 4928 | 10,22 |
| Institute 4956 | 10,22 |
| Institute 4998 | 10,22 |
| Institute 5144 | 10,22 |
| Institute 5599 | 10,22 |
| Institute 7646 | 10,22 |
| Institute 7722 | 10,22 |
| Institute 8418 | 10,22 |
| Institute 8946 | 10,22 |
| Institute 9328 | 10,22 |
| Institute 9962 | 10,22 |

**Table 6-8: Yaw misalignment, results**

| Yaw misalignment | Yaw misalignment maximum [°] | Yaw misalignment average [°] | Yaw misalignment minimum [°] | Yaw misalignment standard deviation [°] |
|---|---|---|---|---|
| Institute 0309 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 2707 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 3600 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 3605 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 3926 | 9,988 | 9,586 | 9,183 | 0,231 |
| Institute 4253 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 4333 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 4652 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 4928 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 4956 | 9,988 | 9,586 | 9,183 | 0,231 |
| Institute 4998 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 5144 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 5599 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 7646 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 7722 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 8418 | 9,988 | 9,585 | 9,183 | 0,231 |
| Institute 8946 | 9,987 | 9,585 | 9,182 | 0,231 |
| Institute 9328 | 9,988 | 9,586 | 9,183 | 0,231 |
| Institute 9962 | 9,987 | 9,585 | 9,182 | 0,231 |
| **Average** | **9,987** | **9,585** | **9,182** | **0,231** |
| **Median** | **9,987** | **9,585** | **9,182** | **0,231** |

**Table 6-9: Yaw misalignment, relative deviation to average**

| Yaw misalignment | Yaw misalignment maximum [%] | Yaw misalignment average [%] | Yaw misalignment minimum [%] | Yaw misalignment standard deviation [%] |
|---|---|---|---|---|
| Institute 0309 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 2707 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3600 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3605 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3926 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4253 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4333 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4652 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4928 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4956 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4998 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5144 | 0,00 | 0,00 | 0,00 | -0,04 |
| Institute 5599 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7646 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7722 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8418 | 0,01 | 0,00 | -0,01 | -0,04 |
| Institute 8946 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9328 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9962 | 0,00 | 0,00 | 0,00 | 0,00 |

**Table 6-10: Yaw misalignment, relative deviation to median**

| Yaw misalignment | Yaw misalignment maximum [%] | Yaw misalignment average [%] | Yaw misalignment minimum [%] | Yaw misalignment standard deviation [%] |
|---|---|---|---|---|
| Institute 0309 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 2707 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3600 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3605 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3926 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4253 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4333 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4652 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4928 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4956 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4998 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5144 | 0,00 | 0,00 | 0,00 | -0,04 |
| Institute 5599 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7646 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7722 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8418 | 0,01 | 0,00 | -0,01 | -0,04 |
| Institute 8946 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9328 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9962 | 0,00 | 0,00 | 0,00 | 0,00 |

## 6.4. Data base: Frequency (Task004).

Determination of frequency of tower bending normal moments, see also task004, chapter 2 'Topics covered by the PT'.

The results have been compared relatively to the average and median of all participant's frequencies.

A limit value for deviations has been defined as +- 0.5 % of median.

Result: Participant 4333 has greater deviations than 0.5% from median.

**Table 6-11: frequency, results**

| MbTb000 | Frequency 1 [Hz] | Frequency 2 [Hz] | Frequency 3 [Hz] | Frequency 4 [Hz] | Frequency 5 [Hz] |
|---|---|---|---|---|---|
| Institute 0309 | 0,29910 | 0,50050 | 1,00100 | 1,99890 | 0,00000 |
| Institute 2707 | 0,29907 | 0,50049 | 1,00098 | 1,99890 | 0,00000 |
| Institute 3600 | 0,29910 | 0,50049 | 1,00098 | 1,99890 | 0,00000 |
| Institute 3605 | 0,30000 | 0,50000 | 1,00000 | 2,00000 | 0,00000 |
| Institute 3926 | 0,30000 | 0,50000 | 1,00000 | 2,00000 | 0,00000 |
| Institute 4253 | 0,30059 | 0,50048 | 0,99945 | 2,00042 | 0,00000 |
| Institute 4333 | 0,29300 | 0,50700 | 0,98700 | 2,00100 | 0,00000 |
| Institute 4652 | 0,30000 | 0,50000 | 1,00000 | 2,00000 | 0,00000 |
| Institute 4928 | 0,30000 | 0,50000 | 1,00000 | 2,00000 | 0,00000 |
| Institute 4956 | 0,30000 | 0,50000 | 1,00000 | 2,00000 | 0,00000 |
| Institute 4998 | 0,29903 | 0,50037 | 1,00098 | 2,00195 | 0,00000 |
| Institute 5144 | 0,29910 | 0,50050 | 1,00100 | 1,99900 | 0,00000 |
| Institute 5599 | 0,29907 | 0,50049 | 1,00098 | 1,99890 | 0,00000 |
| Institute 7646 | 0,30000 | 0,50000 | 1,00000 | 2,00000 | 0,00000 |
| Institute 7722 | 0,30000 | 0,50000 | 1,00000 | 2,00000 | 0,00000 |
| Institute 8418 | 0,29907 | 0,50049 | 1,00098 | 2,00195 | 0,00000 |
| Institute 8946 | 0,30000 | 0,50000 | 1,00000 | 2,00000 | 0,00000 |
| Institute 9328 | 0,30000 | 0,50000 | 1,00000 | 2,00000 | 0,00000 |
| Institute 9962 | 0,30000 | 0,50000 | 1,00000 | 2,00000 | 0,00000 |
| **Average** | **0,29924331** | **0,50056468** | **0,99971576** | **1,99994146** | **0,00000000** |
| **Median** | **0,30000000** | **0,50037040** | **1,00000000** | **2,00000000** | **0,00000000** |

**Table 6-12: frequency, relative deviation to average**

| MbTb000 | Frequency 1 [Hz] | Frequency 2 [Hz] | Frequency 3 [Hz] | Frequency 4 [Hz] |
|---|---|---|---|---|
| Institute 0309 | -0,04788943 | -0,01292064 | 0,12846008 | -0,05207453 |
| Institute 2707 | -0,05715760 | -0,01526175 | 0,12611566 | -0,05200617 |
| Institute 3600 | -0,04788943 | -0,01491838 | 0,12615942 | -0,05207453 |
| Institute 3605 | 0,25286918 | -0,11280783 | 0,02843164 | 0,00292708 |
| Institute 3926 | 0,25286918 | -0,11280783 | 0,02843164 | 0,00292708 |
| Institute 4253 | 0,45003315 | -0,01691613 | -0,02658399 | 0,02392770 |
| Institute 4333 | -2,08636444 | 1,28561286 | -1,27193797 | 0,05292855 |
| Institute 4652 | 0,25286918 | -0,11280783 | 0,02843164 | 0,00292708 |
| Institute 4928 | 0,25286918 | -0,11280783 | 0,02843164 | 0,00292708 |
| Institute 4956 | 0,25286918 | -0,11280783 | 0,02843164 | 0,00292708 |
| Institute 4998 | -0,07148227 | -0,03881140 | 0,12665956 | 0,10052994 |
| Institute 5144 | -0,04788943 | -0,01292064 | 0,12846008 | -0,04707438 |
| Institute 5599 | -0,05715781 | -0,01526180 | 0,12611566 | -0,05200617 |
| Institute 7646 | 0,25286918 | -0,11280783 | 0,02843164 | 0,00292708 |
| Institute 7722 | 0,25286918 | -0,11280783 | 0,02843164 | 0,00292708 |
| Institute 8418 | -0,05715614 | -0,01526200 | 0,12611941 | 0,10058494 |
| Institute 8946 | 0,25286918 | -0,11280783 | 0,02843164 | 0,00292708 |
| Institute 9328 | 0,25286918 | -0,11280783 | 0,02843164 | 0,00292708 |
| Institute 9962 | 0,25286918 | -0,11280783 | 0,02843164 | 0,00292708 |

Deviation greater than limit, see also task003, chapter 3 Pass / Fail Criteria

**Table 6-13: frequency, relative deviation to median**

| MbTb000 | Frequency 1 [Hz] | Frequency 2 [Hz] | Frequency 3 [Hz] | Frequency 4 [Hz] |
|---|---|---|---|---|
| Institute 0309 | -0,30000000 | 0,02590081 | 0,10000000 | -0,05500000 |
| Institute 2707 | -0,30924479 | 0,02355880 | 0,09765625 | -0,05493164 |
| Institute 3600 | -0,30000000 | 0,02390229 | 0,09770000 | -0,05500000 |
| Institute 3605 | 0,00000000 | -0,07402516 | 0,00000000 | 0,00000000 |
| Institute 3926 | 0,00000000 | -0,07402516 | 0,00000000 | 0,00000000 |
| Institute 4253 | 0,19666667 | 0,02190377 | -0,05500000 | 0,02100000 |
| Institute 4333 | -2,33333333 | 1,32493849 | -1,30000000 | 0,05000000 |
| Institute 4652 | 0,00000000 | -0,07402516 | 0,00000000 | 0,00000000 |
| Institute 4928 | 0,00000000 | -0,07402516 | 0,00000000 | 0,00000000 |
| Institute 4956 | 0,00000000 | -0,07402516 | 0,00000000 | 0,00000000 |
| Institute 4998 | -0,32353333 | 0,00000000 | 0,09820000 | 0,09760000 |
| Institute 5144 | -0,30000000 | 0,02590081 | 0,10000000 | -0,05000000 |
| Institute 5599 | -0,30924500 | 0,02355875 | 0,09765625 | -0,05493164 |
| Institute 7646 | 0,00000000 | -0,07402516 | 0,00000000 | 0,00000000 |
| Institute 7722 | 0,00000000 | -0,07402516 | 0,00000000 | 0,00000000 |
| Institute 8418 | -0,30924333 | 0,02355855 | 0,09766000 | 0,09765500 |
| Institute 8946 | 0,00000000 | -0,07402516 | 0,00000000 | 0,00000000 |
| Institute 9328 | 0,00000000 | -0,07402516 | 0,00000000 | 0,00000000 |
| Institute 9962 | 0,00000000 | -0,07402516 | 0,00000000 | 0,00000000 |

Deviation greater than limit, see also task003, chapter 3 'Pass / Fail Criteria'.

## 6.5. Data base: Load Spectra (Task005).

Determination of load spectra of blade flat bending moment of a given rain-flow count, see also task005, chapter 2 'Topics covered by the PT'.

Any deviation is considered as a fail result.

Result:

- Count result: Participant 9328 has a deviation compared to the majority.
- Cumulative count: Participant 4333, participant 7646 and participant 9328 have a deviation compared to the majority.

**Table 6-14: Load spectra, data set count, wind speeds**

| | Data set count |
|---|---|
| Institute 0309 | 1 |
| Institute 2707 | 1 |
| Institute 3600 | 1 |
| Institute 3605 | 1 |
| Institute 3926 | 1 |
| Institute 4253 | 1 |
| Institute 4333 | 1 |
| Institute 4652 | 1 |
| Institute 4928 | 1 |
| Institute 4956 | 1 |
| Institute 4998 | 1 |
| Institute 5144 | 1 |
| Institute 5599 | 1 |
| Institute 7646 | 1 |
| Institute 7722 | 1 |
| Institute 8418 | 1 |
| Institute 8946 | 1 |
| Institute 9328 | 1 |
| Institute 9962 | 1 |

| | Wind speeds [m/s] |
|---|---|
| Institute 0309 | 10,22 |
| Institute 2707 | 10,22 |
| Institute 3600 | 10,22 |
| Institute 3605 | 10,22 |
| Institute 3926 | 10,22 |
| Institute 4253 | 10,22 |
| Institute 4333 | 10,22 |
| Institute 4652 | 10,22 |
| Institute 4928 | 10,22 |
| Institute 4956 | 10,22 |
| Institute 4998 | 10,22 |
| Institute 5144 | 10,22 |
| Institute 5599 | 10,22 |
| Institute 7646 | 10,22 |
| Institute 7722 | 10,22 |
| Institute 8418 | 10,22 |
| Institute 8946 | 10,20 |
| Institute 9328 | 10,22 |
| Institute 9962 | 10,22 |

## Table 6-15: load spectra count, results

| | Count | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Span [kNm] (>= to <) | Institute 0309 | Institute 2707 | Institute 3600 | Institute 3605 | Institute 3926 | Institute 4253 | Institute 4333 | Institute 4652 | Institute 4928 | Institute 4956 | Institute 4998 | Institute 5144 | Institute 5599 | Institute 7646 | Institute 7722 | Institute 8418 | Institute 8946 | Institute 9328 | Institute 9962 |
| 0 to 150 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 12000,0 | 0,0 |
| 150 to 300 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 2000,0 | 1999,5 |
| 300 to 450 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 450 to 600 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 600 to 750 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 750 to 900 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 900 to 1050 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 1050 to 1200 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 1200 to 1350 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 1350 to 1500 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 1500 to 1650 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 1650 to 1800 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 1800 to 1950 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 1950 to 2100 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 2100 to 2250 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 2250 to 2400 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 2400 to 2550 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 2550 to 2700 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 2700 to 2850 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 2850 to 3000 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 3000 to 3150 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 3150 to 3300 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 3300 to 3450 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 3450 to 3600 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 3600 to 3750 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 3750 to 3900 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 3900 to 4050 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 4050 to 4200 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 4200 to 4350 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 4350 to 4500 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 4500 to 4650 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 4650 to 4800 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 4800 to 4950 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 4950 to 5100 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 5100 to 5250 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 5250 to 5400 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 5400 to 5550 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 5550 to 5700 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 5700 to 5850 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 5850 to 6000 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |

Deviation to majority, see also task005, chapter 3 ‘Pass / Fail Criteria’.

## Table 6-16: load spectra cumulative count, results

| | | Cumulative Count | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Span [kNm] (>=) | Institute 0309 | Institute 2707 | Institute 3600 | Institute 3605 | Institute 3926 | Institute 4253 | Institute 4333 | Institute 4652 | Institute 4928 | Institute 4956 | Institute 4998 | Institute 5144 | Institute 5599 | Institute 7646 | Institute 7722 | Institute 8418 | Institute 8946 | Institute 9328 | Institute 9962 |
| 0 | 0,00 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 0,0 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 0,0 | 1999,5 | 1999,5 | 1999,5 | 12000,0 | 1999,5 |
| 1 | 0,25 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 1999,5 | 2000,0 | 1999,5 |
| 2 | 0,50 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 3 | 0,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 4 | 1,00 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 5 | 1,25 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 6 | 1,50 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 7 | 1,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 8 | 2,00 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 9 | 2,25 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 10 | 2,50 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 11 | 2,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 12 | 3,00 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 13 | 3,25 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 14 | 3,50 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 15 | 3,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 16 | 4,00 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 17 | 4,25 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 18 | 4,50 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 19 | 4,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 20 | 5,00 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 21 | 5,25 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 22 | 5,50 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 23 | 5,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 24 | 6,00 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 25 | 6,25 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 26 | 6,50 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 27 | 6,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 28 | 7,00 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 29 | 7,25 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 30 | 7,50 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 31 | 7,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 32 | 8,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 33 | 9,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 34 | 10,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 35 | 11,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 36 | 12,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 37 | 13,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 38 | 14,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |
| 39 | 15,75 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1999,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 |

Deviation to majority, see also task005, chapter 3 ‘Pass / Fail Criteria’.

## 6.6. Data base: Damage equivalent loads (Task006).

Determination of damage equivalent loads (DEL) of blade flat bending moments (m=10) of a given rain-flow count, see also task006, chapter 2 'Topics covered by the PT'.

The results have been compared relatively to the average and median of all participants' DEL.

A limit value for deviations has been defined as +- 0.5 % of median.

Result: Participant 4333 and participant 9962 have greater deviations than 0.5% from median.

**Table 6-17: DEL, data set count, wind speeds**

| | Data set count |
|---|---|
| Institute 0309 | 1 |
| Institute 2707 | 1 |
| Institute 3600 | 1 |
| Institute 3605 | 1 |
| Institute 3926 | 1 |
| Institute 4253 | 1 |
| Institute 4333 | 1 |
| Institute 4652 | 1 |
| Institute 4928 | 1 |
| Institute 4956 | 1 |
| Institute 4998 | 1 |
| Institute 5144 | 1 |
| Institute 5599 | 1 |
| Institute 7646 | 1 |
| Institute 7722 | 1 |
| Institute 8418 | 1 |
| Institute 8946 | 1 |
| Institute 9328 | 1 |
| Institute 9962 | 1 |

| | Wind speeds [m/s] |
|---|---|
| Institute 0309 | 10,22 |
| Institute 2707 | 10,22 |
| Institute 3600 | 10,22 |
| Institute 3605 | 10,22 |
| Institute 3926 | 10,22 |
| Institute 4253 | 10,22 |
| Institute 4333 | 10,22 |
| Institute 4652 | 10,22 |
| Institute 4928 | 10,22 |
| Institute 4956 | 10,22 |
| Institute 4998 | 10,22 |
| Institute 5144 | 10,22 |
| Institute 5599 | 10,22 |
| Institute 7646 | 10,22 |
| Institute 7722 | 10,22 |
| Institute 8418 | 10,22 |
| Institute 8946 | 10,22 |
| Institute 9328 | 10,22 |
| Institute 9962 | 10,22 |

**Table 6-18: DEL, results**

| | Wind speed [m/s] |
|---|---|
| **DEL MbBlFlat [kNm]** | **10,22** |
| Institute 0309 | 253,781 |
| Institute 2707 | 253,781 |
| Institute 3600 | 253,781 |
| Institute 3605 | 253,781 |
| Institute 3926 | 253,781 |
| Institute 4253 | 253,781 |
| Institute 4333 | 237,652 |
| Institute 4652 | 253,781 |
| Institute 4928 | 253,781 |
| Institute 4956 | 253,781 |
| Institute 4998 | 253,781 |
| Institute 5144 | 253,781 |
| Institute 5599 | 253,781 |
| Institute 7646 | 253,781 |
| Institute 7722 | 253,781 |
| Institute 8418 | 253,780 |
| Institute 8946 | 253,781 |
| Institute 9328 | 253,790 |
| Institute 9962 | 257,198 |
| **Average** | **253,782** |
| **Median** | **253,781** |

Statistical outliers or insufficient info that are not considered for calculation of the average values.

**Table 6-19: DEL, deviation to average**

| | Wind speed [m/s] |
|---|---|
| **DEL MbBlFlat [%]** | **10,22** |
| Institute 0309 | 0,00 |
| Institute 2707 | 0,00 |
| Institute 3600 | 0,00 |
| Institute 3605 | 0,00 |
| Institute 3926 | 0,00 |
| Institute 4253 | 0,00 |
| Institute 4333 | -6,36 |
| Institute 4652 | 0,00 |
| Institute 4928 | 0,00 |
| Institute 4956 | 0,00 |
| Institute 4998 | 0,00 |
| Institute 5144 | 0,00 |
| Institute 5599 | 0,00 |
| Institute 7646 | 0,00 |
| Institute 7722 | 0,00 |
| Institute 8418 | 0,00 |
| Institute 8946 | 0,00 |
| Institute 9328 | 0,00 |
| Institute 9962 | 1,35 |

Deviation greater than limit, see also task007, chapter 3 'Pass / Fail Criteria'.

**Table 6-20: DEL, deviation to median**

| | Wind speed [m/s] |
|---|---|
| **DEL MbBlFlat [%]** | **10,22** |
| Institute 0309 | 0,00 |
| Institute 2707 | 0,00 |
| Institute 3600 | 0,00 |
| Institute 3605 | 0,00 |
| Institute 3926 | 0,00 |
| Institute 4253 | 0,00 |
| Institute 4333 | -6,36 |
| Institute 4652 | 0,00 |
| Institute 4928 | 0,00 |
| Institute 4956 | 0,00 |
| Institute 4998 | 0,00 |
| Institute 5144 | 0,00 |
| Institute 5599 | 0,00 |
| Institute 7646 | 0,00 |
| Institute 7722 | 0,00 |
| Institute 8418 | 0,00 |
| Institute 8946 | 0,00 |
| Institute 9328 | 0,00 |
| Institute 9962 | 1,35 |

Deviation greater than limit, see also task007, chapter 3 'Pass / Fail Criteria'.

## 6.7. Data base: Uncertainty (Task007).

Determination of uncertainties. Informative only, see also task007, chapter 2 'Topics covered by the PT'.

A limit value for deviations has been defined as +- 0.5 % of median.

Result:

- BIN8: Participant 9328 has greater deviations than 0.5% from median.
- BIN9: No deviations found for this task.
- BIN10: Participant 3926, participant 4956, participant 8418 and participant 8946 have greater deviations than 0.5% from median.

**Table 6-21: Uncertainty, BIN 8 results**

| | BIN No. 8 | | | |
|---|---|---|---|---|
| **Uncertainties** | **Total Uncertainty [kNm]** | **BIN scatter Uncertainty [kNm]** | **X-axis quantity Uncertainty [kNm]** | **BIN averaged mean values Uncertainty [kNm]** |
| Institute 0309 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 2707 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 3600 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 3605 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 3926 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 4253 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 4333 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 4652 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 4928 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 4956 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 4998 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 5144 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 5599 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 7646 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 7722 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 8418 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 8946 | 60,356 | 35,381 | 31,540 | 76,742 |
| Institute 9328 | 60,356 | 35,381 | - | - |
| Institute 9962 | 60,356 | 35,381 | 31,540 | 76,742 |
| **Average** | **60,356** | **35,381** | **31,540** | **76,742** |
| **Median** | **60,356** | **35,381** | **31,540** | **76,742** |

**Table 6-22: Uncertainty, BIN 8 relative deviation to average**

| | BIN No. 8 | | | |
|---|---|---|---|---|
| Uncertainties | Total uncertainty [kNm] | BIN scatter Uncertainty [kNm] | X-axis quantity Uncertainty [kNm] | BIN averaged mean values Uncertainty [kNm] |
| Institute 0309 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 2707 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3600 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3605 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3926 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4253 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4333 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4652 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4928 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4956 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4998 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5144 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5599 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7646 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7722 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8418 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8946 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9328 | 0,00 | 0,00 | na | na |
| Institute 9962 | 0,00 | 0,00 | 0,00 | 0,00 |

Deviation greater than limit, see also task007, chapter 3 ‘Pass / Fail Criteria’.

**Table 6-23: Uncertainty, BIN 8 relative deviation to median**

| | BIN No. 8 | | | |
|---|---|---|---|---|
| Uncertainties | Total uncertainty [kNm] | BIN scatter Uncertainty [kNm] | X-axis quantity Uncertainty [kNm] | BIN averaged mean values Uncertainty [kNm] |
| Institute 0309 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 2707 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3600 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3605 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3926 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4253 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4333 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4652 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4928 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4956 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4998 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5144 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5599 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7646 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7722 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8418 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8946 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9328 | 0,00 | 0,00 | na | na |
| Institute 9962 | 0,00 | 0,00 | 0,00 | 0,00 |

Deviation greater than limit, see also task007, chapter 3 ‘Pass / Fail Criteria’.

**Table 6-24: Uncertainty, BIN 9 results**

| | BIN No. 9 | | | |
|---|---|---|---|---|
| Uncertainties | Total Uncertainty [kNm] | BIN scatter Uncertainty [kNm] | X-axis quantity Uncertainty [kNm] | BIN averaged mean values Uncertainty [kNm] |
| Institute 0309 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 2707 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 3600 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 3605 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 3926 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 4253 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 4333 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 4652 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 4928 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 4956 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 4998 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 5144 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 5599 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 7646 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 7722 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 8418 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 8946 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 9328 | 60,356 | 56,161 | 31,540 | 88,270 |
| Institute 9962 | 60,356 | 56,161 | 31,540 | 88,270 |
| **Average** | **60,356** | **56,161** | **31,540** | **88,270** |
| **Median** | **60,356** | **56,161** | **31,540** | **88,270** |

**Table 6-25: Uncertainty, BIN 9 relative deviation to average**

| | BIN No. 9 | | | |
|---|---|---|---|---|
| Uncertainties | Total uncertainty [kNm] | BIN scatter Uncertainty [kNm] | X-axis quantity Uncertainty [kNm] | BIN averaged mean values Uncertainty [kNm] |
| Institute 0309 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 2707 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3600 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3605 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3926 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4253 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4333 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4652 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4928 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4956 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4998 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5144 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5599 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7646 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7722 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8418 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8946 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9328 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9962 | 0,00 | 0,00 | 0,00 | 0,00 |

**Table 6-26: Uncertainty, BIN 9 relative deviation to median**

| | BIN No. 9 | | | |
|---|---|---|---|---|
| Uncertainties | Total uncertainty [kNm] | BIN scatter Uncertainty [kNm] | X-axis quantity Uncertainty [kNm] | BIN averaged mean values Uncertainty [kNm] |
| Institute 0309 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 2707 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3600 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3605 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3926 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4253 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4333 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4652 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4928 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4956 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4998 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5144 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5599 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7646 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7722 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8418 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8946 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9328 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9962 | 0,00 | 0,00 | 0,00 | 0,00 |

**Table 6-27: Uncertainty, BIN 10 results**

| | BIN No. 10 | | | |
|---|---|---|---|---|
| Uncertainties | Total Uncertainty [kNm] | BIN scatter Uncertainty [kNm] | X-axis quantity Uncertainty [kNm] | BIN averaged mean values Uncertainty [kNm] |
| Institute 0309 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 2707 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 3600 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 3605 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 3926 | 60,356 | 45,334 | 108,901 | 132,504 |
| Institute 4253 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 4333 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 4652 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 4928 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 4956 | 60,356 | 45,334 | 108,901 | 132,504 |
| Institute 4998 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 5144 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 5599 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 7646 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 7722 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 8418 | 60,356 | 45,334 | 108,901 | 132,504 |
| Institute 8946 | 60,356 | 45,334 | 108,901 | 132,504 |
| Institute 9328 | 60,356 | 45,334 | -108,901 | 132,504 |
| Institute 9962 | 60,356 | 45,334 | -108,901 | 132,504 |
| **Average** | **60,356** | **45,334** | **-108,901** | **132,504** |
| **Median** | **60,356** | **45,334** | **-108,901** | **132,504** |

Applying the equation stated in the standard, the values are negative in this case. Outliers where due to the “absolute function” of some participants where the result will be always positive. Due to the characteristics of uncertainty a positive value is correct as well.

**Table 6-28: Uncertainty, BIN 10 relative deviation to average**

| | BIN No. 10 | | | |
|---|---|---|---|---|
| Uncertainties | Total uncertainty [kNm] | BIN scatter Uncertainty [kNm] | X-axis quantity Uncertainty [kNm] | BIN averaged mean values Uncertainty [kNm] |
| Institute 0309 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 2707 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3600 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3605 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3926 | 0,00 | 0,00 | 200,00 | 0,00 |
| Institute 4253 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4333 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4652 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4928 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4956 | 0,00 | 0,00 | 200,00 | 0,00 |
| Institute 4998 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5144 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5599 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7646 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7722 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8418 | 0,00 | 0,00 | 200,00 | 0,00 |
| Institute 8946 | 0,00 | 0,00 | 200,00 | 0,00 |
| Institute 9328 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9962 | 0,00 | 0,00 | 0,00 | 0,00 |

Deviation greater than limit, see also task007, chapter 3 ‘Pass / Fail Criteria’.

Note: Table 6-29: Uncertainty value is correct by the amount but positive instead of negative.

**Table 6-29: Uncertainty, BIN 10 relative deviation to median**

| | BIN No. 10 | | | |
|---|---|---|---|---|
| Uncertainties | Total uncertainty [kNm] | BIN scatter Uncertainty [kNm] | X-axis quantity Uncertainty [kNm] | BIN averaged mean values Uncertainty [kNm] |
| Institute 0309 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 2707 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3600 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3605 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 3926 | 0,00 | 0,00 | 200,00 | 0,00 |
| Institute 4253 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4333 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4652 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4928 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 4956 | 0,00 | 0,00 | 200,00 | 0,00 |
| Institute 4998 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5144 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 5599 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7646 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 7722 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 8418 | 0,00 | 0,00 | 200,00 | 0,00 |
| Institute 8946 | 0,00 | 0,00 | 200,00 | 0,00 |
| Institute 9328 | 0,00 | 0,00 | 0,00 | 0,00 |
| Institute 9962 | 0,00 | 0,00 | 0,00 | 0,00 |

Deviation greater than limit, see also task007, chapter 3 ‘Pass / Fail Criteria’.

Note: Table 6-29: Uncertainty value is correct by the amount but positive instead of negative.

## 6.8. Proficiency Test overall summary

14 out of 19 participants have passed all tasks, including the informative.

**Table 6-30: Overview all tasks**

| | Institute 0309 | Institute 2707 | Institute 3600 | Institute 3605 | Institute 3926 | Institute 4253 | Institute 4333 | Institute 4652 | Institute 4928 | Institute 4956 | Institute 4998 | Institute 5144 | Institute 5599 | Institute 7646 | Institute 7722 | Institute 8418 | Institute 8946 | Institute 9328 | Institute 9962 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capture Matrix | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed |
| Load Statistics | passed | passed | passed | passed | passed | failed | failed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed |
| Yaw Misalignment | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed |
| FFT | passed | passed | passed | passed | passed | passed | failed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed |
| **Informative only / has to be discussed** | | | | | | | | | | | | | | | | | | | |
| Load Spectra | passed | passed | passed | passed | passed | passed | failed | passed | passed | passed | passed | passed | passed | failed | passed | passed | passed | failed | passed |
| DEL | passed | passed | passed | passed | passed | passed | failed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | failed |
| Uncertainties | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | failed | passed |
| | | | | | | | | | | | | | | | | | | | |
| **Sum (excl. informative)** | passed | passed | passed | passed | passed | failed | failed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed |
| **Sum (incl. informative )** | passed | passed | passed | passed | passed | failed | failed | passed | passed | passed | passed | passed | passed | failed | passed | passed | passed | failed | failed |

"passed" = Applying the equation stated in the standard the values are negative in this case. Outliers where due to the "absolute function" of some participants where the result will be always positive. Due to the characteristics of uncertainty a positive value is correct as well.

"failed" = Task is failed
"passed" = Task is passed

## 6.9. Proficiency Test informative tasks summary

15 out of 19 participants have passed the informative tasks.

**Table 6-31: Overview informative tasks**

| | Institute 0309 | Institute 2707 | Institute 3600 | Institute 3605 | Institute 3926 | Institute 4253 | Institute 4333 | Institute 4652 | Institute 4928 | Institute 4956 | Institute 4998 | Institute 5144 | Institute 5599 | Institute 7646 | Institute 7722 | Institute 8418 | Institute 8946 | Institute 9328 | Institute 9962 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Load Spectra | passed | passed | passed | passed | passed | passed | failed | passed | passed | passed | passed | passed | passed | failed | passed | passed | passed | failed | passed |
| DEL | passed | passed | passed | passed | passed | passed | failed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | failed |
| Uncertainties | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | failed | passed |
| | | | | | | | | | | | | | | | | | | | |
| **Sum (only informative)** | passed | passed | passed | passed | passed | passed | failed | passed | passed | passed | passed | passed | passed | failed | passed | passed | passed | failed | failed |

"passed" = Applying the equation stated in the standard the values are negative in this case. Outliers where due to the "absolute function" of some participants where the result will be always positive. Due to the characteristics of uncertainty a positive value is correct as well.
"failed" = Task is failed
"passed" = Task is passed

## 6.10. Proficiency Test mandatory tasks summary

17 out of 19 participants have passed the mandatory tasks.

**Table 6-32: Overview mandatory tasks**

| | Institute 0309 | Institute 2707 | Institute 3600 | Institute 3605 | Institute 3926 | Institute 4253 | Institute 4333 | Institute 4652 | Institute 4928 | Institute 4956 | Institute 4998 | Institute 5144 | Institute 5599 | Institute 7646 | Institute 7722 | Institute 8418 | Institute 8946 | Institute 9328 | Institute 9962 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Capture Matrix | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed |
| Load Statistics | passed | passed | passed | passed | passed | failed | failed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed |
| Yaw Misalignment | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed |
| FFT | passed | passed | passed | passed | passed | passed | failed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed |
| | | | | | | | | | | | | | | | | | | | |
| **Sum (excl. informative)** | passed | passed | passed | passed | passed | failed | failed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed | passed |

"failed" = Task is **failed**
"passed" = Task is passed

# 7. IECRE Participants that passed the Proficiency Test

The following participants (in alphabetical order) are either IECRE RETLs or RETL candidates and have passed the Proficiency Test:

| TESTING LABORATORY |
|---|
| Aresse Engineering S.L. |
| Barlovento Recursos Naturales S.L. |
| Beijing CGC Certification Center Co., Ltd. |
| China Classification Society Certification Co., Ltd. - CCSC |
| China Electric Power Research Institute - CEPRI |
| Deutsche WindGuard Consulting GmbH |
| DNV Energy Systems Germany GmbH |
| DNV Maritime and Energy, S.L.U. |
| DTU Wind Energy |
| Fraunhofer-Institut für Windenergiesysteme - IWES |
| Korea Institute of Energy Research |
| Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek - TNO |
| Shanghai SERCAL New Energy Technology Co., Ltd. |
| UL International GmbH |
| Wind-consult GmbH |
| windtest grevenbroich gmbh |

**Note:** This list **only contains the IECRE members (or in process of becoming so)** that have **passed** the Proficiency Test. Additional participants have passed it too, but they are not related to the IECRE system, and therefore not listed here.

The list reflects both the laboratories that have passed the second round of the Proficiency Test and those that have successfully completed the Correction Plan Phase. In order to improve the result analysis, tables in section 6 show the results of Round 2 **before** the correction plan phase. Thus, the number of successful participants does not match between section 6 and the current one.

# 8. Conclussions an recommendations after Round 1

See chapter Preliminary Line Choice.

# 9. Conclussions an recommendations after Round 2

In the informative annex B of the standard IEC61400-13, formula B.9 is the result not indicated as an absolute value. Within this Loads Proficiency Test there was the situation that some participant derived the correct value as negative (as per formula B.9) and some participant derived the exact same result but stated as positive (as absolute value of formula B.9).

An interpretation is that the uncertainty as a physical magnitude is always a positive value and as such, the absolute of the result might be presented when reporting the results. Although this has no effect to the following calculation sequence, this could be optimized to uniform these results according to the standard.

# 10. References

[1] IEC 61400-13:2015, Measurement of mechanical loads.

[2] IECRE OD-551-17, Edition 1.0, IECRE, 2020-08-17.