DOI: 10.2507/34th.daaam.proceedings.xxx

METHODOLOGY FOR TESTING: LABORATORY COMPARISON OF CLIMATE CHAMBERS IN THE AUTOMOTIVE INDUSTRY

Nikola Skřivanová, Martin Melichar & Kateřina Kašová

This Publication has to be referred as: Skřivanová, N[ikola]; Melichar, M[artin] & Kašová, K[ateřina] (2023). Methodology for Testing: Laboratory Comparison of Climate Chambers in the Automotive Industry, Proceedings of the 34th DAAAM International Symposium, pp.xxxx-xxxx, B. Katalinic (Ed.), Published by DAAAM International, ISBN 978-3-902734-xx-x, ISSN 1726-9679, Vienna, Austria
DOI: 10.2507/34th.daaam.proceedings.xxx

Abstract

This paper describes the design of an experimental methodology for a laboratory comparison of two climate chambers in the context of performing a test with the attributes "Test: Humidity heat, cyclic 12+12 hours" according to DIN EN 60068-2-30: 2006-06. The objective was to verify the consistency of operation of these chambers for identical test setups in the environment of two accredited laboratories focusing on testing electronic components in the Automotive industry. The results of this research are a key element in ensuring consistency and reliability of test results for electronic components for the automotive industry. Further, this testing methodology and the comparison itself enhances the credibility of both laboratories. These results provide important insights for further development and optimization of climate chamber operations. This paper offers valuable information for automotive professionals involved in the process of testing and verifying electronic components under extreme climatic conditions.

Keywords: climate chamber; methodology; laboratory comparison; automotive industry.

1. Introduction

Electronic components in the automotive industry face many challenges that require thorough testing and verification of their durability in different climatic conditions. DIN EN 60068-2-30: 2006-06 provides a framework of testing and comparison conditions, but several key issues remain open for practical deployment. While the standard defines the ambient conditions, it does not provide a specific methodology for performing individual comparison tests. [1]; [2]; [3].

It is in this context that this research was undertaken to design and validate a laboratory comparison methodology for the test "Test Db: Damp Heat, Cyclic 12+12 hours" in accordance with the standard. In addition, it was necessary to ensure that this methodology was reproducible, which is a key element for reliable test results. The objective of this study was to examine the testing process and develop a methodology for laboratory comparison of two identical climate chambers in two accredited testing laboratories. This inter-laboratory comparison would then provide evidence and verification that the two laboratories were operating identically and increase the credibility of the results. [1]; [7].

This study not only provides new insights into the testing of automotive electronic components, but also highlights the importance of a properly set-up laboratory benchmarking methodology to achieve results and its execution. In component testing, this laboratory comparison strengthens the credibility of the result, as the agreement of the results in both laboratories indicates the consistency of the test environment. [4]; [5].

With these key factors in mind, this paper seeks to shed light on the importance of reproducibility of laboratory comparison tests and provide a comprehensive view of the development of a methodology for laboratory comparison of the performance of two climate chambers within two different laboratories in accordance with DIN EN 60068-2-30: 2006-06. [1].

2. Description of the proposed methodology

As mentioned above both accredited laboratories were asked to propose a methodology for laboratory comparison of two identical climate chambers that would reflect the requirements of this standard DIN EN 60068-2-30: 2006-06. The laboratory comparison was designed so that the stresses performed were identical and the procedure was reproducible. This laboratory comparison will be used to verify the reproducibility of the test "Test Db: Moisture heat, cyclic 12+12 hours" according to DIN EN 60068-2-30. The proposed test methodology for the laboratory comparison of two climate chambers will now be presented. [1]; [6]; [8].

<table>
<tr><th></th><th>Number of pieces</th><th>Marking</th><th>Date of receipt</th><th>Producer</th></tr>
<tr><td rowspan="6">Test object</td><td>5 pcs</td><td>Stainless steel balls</td><td>10.1.2023</td><td>External supplier</td></tr>
<tr><td>5 pcs</td><td>Funnel</td><td>10.1.2023</td><td>External supplier</td></tr>
<tr><td>5 pcs</td><td>Measuring cylinder</td><td>10.1.2023</td><td>External supplier</td></tr>
<tr><td>5 pcs</td><td>Stainless steel balls</td><td>24.1.2023</td><td>External supplier</td></tr>
<tr><td>5 pcs</td><td>Funnel</td><td>24.1.2023</td><td>External supplier</td></tr>
<tr><td>5 pcs</td><td>Measuring cylinder</td><td>24.1.2023</td><td>External supplier</td></tr>
<tr><td colspan="5">The information and test object designation is based on information from the customer.
Unless otherwise stated, all tests were conducted under the following ambient conditions:
Temperature: 23 °C ± 5 °C
Relative humidity: 25 % to 75 %.
Results refer only to test objects tested in an accredited test laboratory.
The uncertainty of measurement is given when the declaration of conformity is used or can be requested for each test method.
The expanded uncertainty of measurement has been determined in accordance with JCGM 100 'Guidance for the quotation of uncertainty of measurement' and is given with a coverage factor of 2.
This means that the measurand lies within the assigned interval of values with a probability of 95 %.</td></tr>
<tr><td>Test specifications</td><td colspan="3">Designation of the standard
DIN EN 60068-2-30</td><td>Date of issue
2006-06</td></tr>
</table>

Table 1. Test specifications

2.2. Providing a test facility

The two accredited test laboratories, laboratories X and Y, had five identical test samples each. Five stainless steel balls weighing 874 g each served as test specimens. Figure 1 shows an example of a test specimen.

Fig. 1. Test sample

2.3. Test assumptions and parameters

Since the two test laboratories involved in the laboratory comparison had identical test samples, homogeneity is guaranteed. In addition, the tests in both laboratories were carried out in two identical and technically identical climatic test chambers. In each of the two chambers there were five test samples with identical test set-ups. Five stainless steel spheres weighing 874 g each were used as test specimens and were placed above the measuring cylinder. A funnel was placed between the spheres and the graduated cylinder. The undersides of the balls were placed at a distance of 50 mm to 100 mm above the entrance to the funnel. These assemblies were positioned in the climatic chamber as shown in Figure 2, and their positions were fixed, with the spheres in positions 1, 2, and 5 symmetrical to position 4. Using these assemblies, the amount of condensate that accumulates in the measuring cylinders during climatic stress was measured. In addition to the graphical evaluation of the stresses, this measured quantity should provide another indication of the reproducibility of the method. The five funnels were weighed with their corresponding graduated cylinders before and after loading and the weight was recorded in grams to determine the amount of condensate removed. The average values of the quantities of condensate removed must not have differed by more than 3 % according to the internal specification. The test was carried out in both test laboratories with the same predefined test parameters.

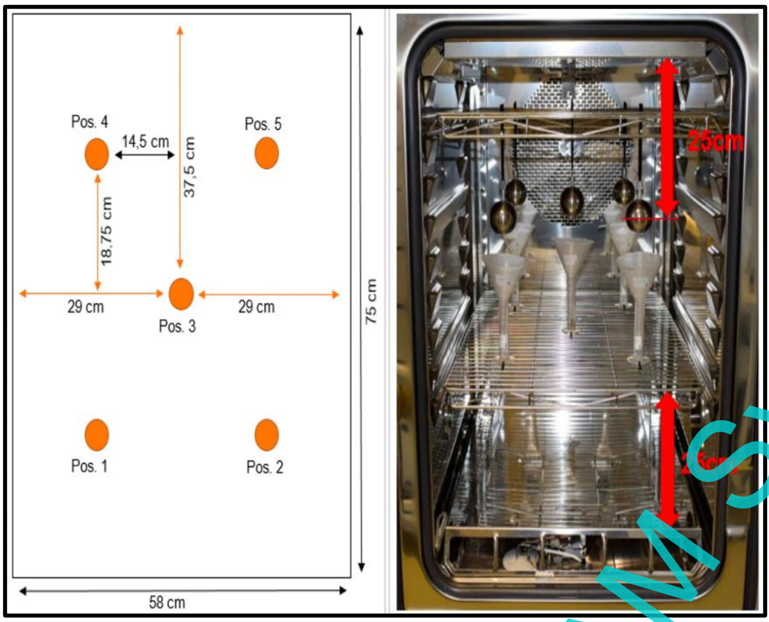

Fig. 2. Location of test assemblies in the climate chamber: top (left) and front (right)

3. Experimental verification

This chapter documents the tests of the two participating Test laboratories X and Y.

3.1. Test Db: Moisture heat, cyclic 12+12 hours - Test laboratory X

The test was carried out according to DIN EN 60068-2-30. The test specimens were placed in the test chamber at standard climatic conditions (Figure 3) and conditioned at 25 °C and 60 % rpm for 75 minutes to achieve thermal equilibrium. The humidity was then increased to 98 % relative humidity within 45 minutes while the temperature in the chamber remained constant. Subsequently, stress testing was performed according to DIN EN 60068-2-30: 2006-06, variant 1. The upper test temperature was 55 °C. A total of two cycles were carried out. After the exposure, a post-treatment was carried out in which the chamber temperature was maintained at 25 °C while the humidity was controlled from 98 % RH to 75 % RH during the first 25 minutes. The test specimens remained in these conditions for a further 95 minutes (Figure 4). [1]; [6]; [8].

Laboratory comparisons were made by: Technician A

Location of laboratory comparison: Test laboratory X

Test facility: ClimeEvent Climate Stress Screening Chamber
Analytical balance

Test parameters: Upper test temperature: 55 °C

Relative humidity: 98 %

Variant: 1

Number of cycles: 2

Test setup:

Fig. 3. Climate chamber – Test laboratory X

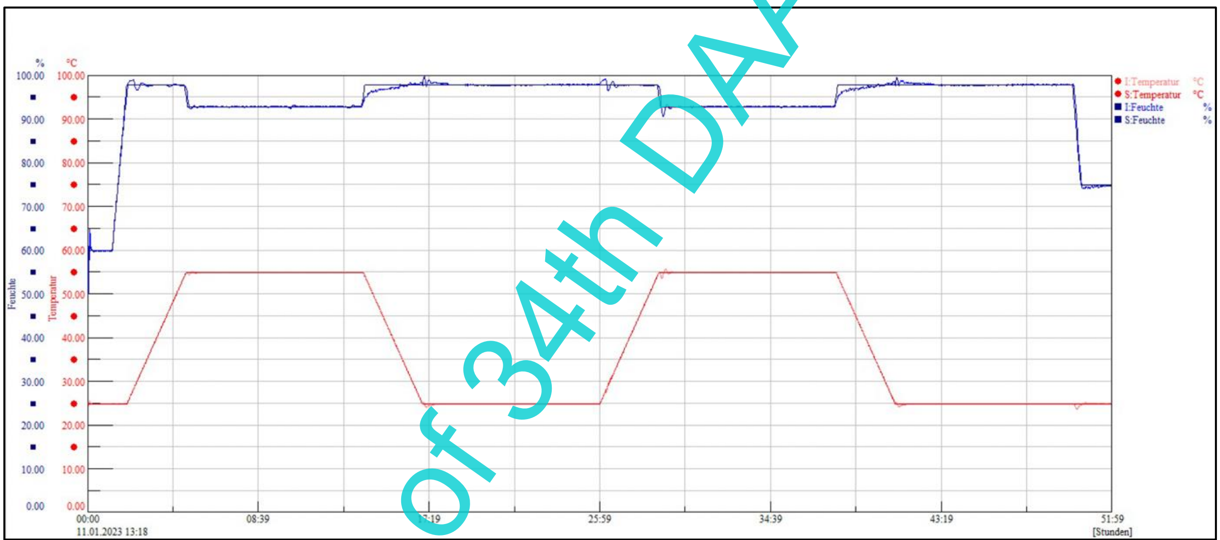

Fig. 4. Climate profile – Test laboratory X

Result: The weights of the graduated cylinder funnels before and after loading are documented in Table 2.

Climate chamber 6 – Test laboratory X			
Position in the chamber	**Weight of graduated cylinder and funnel before test[g]**	**Weight of graduated cylinder and funnel after test [g]**	**Amount of condensate removed [gr]**
Pos. 1	29.20	33.49	4.29
Pos. 2	28.90	32.82	3.92
Pos. 3	29.20	33.33	4.13
Pos. 4	29.40	33.28	3.88
Pos. 5	29.30	32.89	3.59

Table 2. Results – Test laboratory X

3.2. Test Db: Moisture heat, cyclic 12+12 hours - Test laboratory Y

The test was performed as described in section 3.1.

Laboratory comparisons were made by: Technician B

Location of laboratory comparison: Test laboratory Y

Test facility: ClimeEvent Climate Stress Screening Chamber
Santorius AX6202 precision balance
Set of weights

Test parameters: Upper test temperature: 55 °C

Relative humidity: 98 %

Variant: 1

Number of cycles: 2

Test setup:

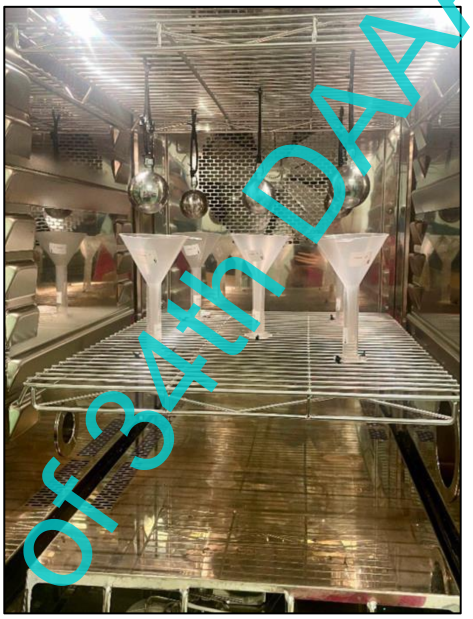

Fig. 5. Climate chamber – Test laboratory Y

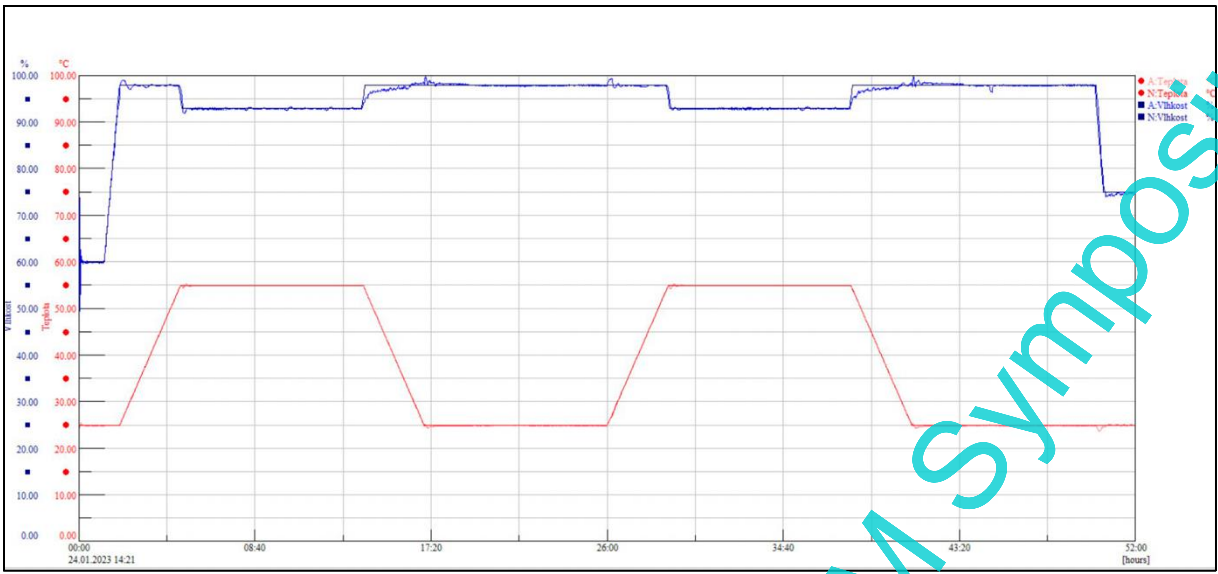

Fig. 6. Climate profile – Test laboratory Y

Result: The weights of the graduated cylinder funnels before and after loading are documented in Table 3.

Climate chamber 1 – Test laboratory Y			
Position in the chamber	**Weight of graduated cylinder and funnel before test[g]**	**Weight of graduated cylinder and funnel after test [g]**	**Amount of condensate removed [gr]**
Pos. 1	29.20	33.42	4.22
Pos. 2	28.90	32.90	4.00
Pos. 3	29.20	33.30	4.10
Pos. 4	29.40	33.24	3.84
Pos. 5	29.30	32.98	3.68

Table 3. Results – Test laboratory Y

4. Conclusion

The results of this study clearly show that both participating test laboratories successfully achieved identical ratings with identical test samples in identical climatic test chambers, while fully complying with the specified parameters. This careful adherence to the specified temperature range and handling of the test samples gives confidence that the measurement results are credible and reliable. The deviation of the average values of the respective sampled condensate quantities, which was within the predetermined range of 3 % (see Table 4), clearly confirms that the procedure used is stable and reproducible.

Comparison of results of the test – Test laboratory X and Test laboratory Y			
Position in the chamber	**Amount of condensate removed [gr] – Test laboratory X**	**Amount of condensate removed [gr] – Test laboratory Y**	**Difference [%]**
Pos. 1	4.29	4.22	-1.66
Pos. 2	3.92	4.00	2.00
Pos. 3	4.13	4.10	-0.73
Pos. 4	3.88	3.84	-1.04
Pos. 5	3.59	3.68	2.45
Average value	3.96	3.97	0.15

Table 4. Comparison of results of the test – Test laboratory X and Test laboratory Y

This research pushes the frontiers of knowledge in the field of testing electronic components for automobiles. An efficient methodology for laboratory comparison has been developed and validated in the context of the test "Db: Damp Heat Test, cyclic 12+12 hours" according to DIN EN 60068-2-30: 2006-06. This methodology represents a key step towards ensuring reliability and consistency in testing electronics under extreme climatic conditions. The next natural step in this research field could be to extend the testing methodology to other types of climate chambers for other ranges and testing parameters. This research provides important insights for industry and the research community and holds promise for future innovation and improved reliability of electronic components in the automotive industry.

5. Acknowledgments

The article contribution has been prepared under project SGS-2022-007 - Research and Development for Innovation in Engineering Technology - Machining Technology IV.

6. References

[1] DIN EN 60068-2-30:2006-06. Environmental Testing - Part 2-30: Tests - Test Db and Guidance: Damp Heat, Cyclic (12 h + 12 h Cycle). German Institute for Standardization, 2006.

[2] Skrivanova, Nikola, Melichar, Martin (2021). Evaluation of Effect of Attributive Measurements in a Clime Compartment on the Value of Dimensional Measurement Uncertainty in an Accreted Test Laboratory, Proceedings of the 32nd DAAAM International Symposium, pp.0289-0293, B. Katalinic (Ed.), Published by DAAAM International, ISBN 978-3-902734-33-4, ISSN 1726-9679, Vienna, Austria, DOI: 10.2507/32nd.daaam.proceedings.041

[3] Bicova Katerina, Bebr Lukas (2018). Analysis and Dependability of Production Processes for the Automotive Industry, Proceedings of the 29th DAAAM International Symposium, pp.0416-0420, B. Katalinic (Ed.), Published by DAAAM International, ISBN 978-3-902734-20-4, ISSN 1726-9679, Vienna, Austria, DOI: 10.2507/29th.daaam.proceedings.061

[4] Dudackova Simona, Bicova, Katerina (2019). Verification of Process and Machine Capability for Precision Automotive Production, Proceedings of the 30th DAAAM International Symposium, pp.0962-0966, B. Katalinic (Ed.), Published by DAAAM International, ISBN 978-3-902734-22-8, ISSN 1726-9679, Vienna, Austria, DOI: 10.2507/30th.daaam.proceedings.133

[5] Skrivanova, Nikola, Melichar Martin (2019). The Comparison of Destructive and Non-Destructive Forms of Measurement in the Automotive Industry, Proceedings of the 30th DAAAM International Symposium, pp.0995-1002, B. Katalinic (Ed.), Published by DAAAM International, ISBN 978-3-90273422-8, ISSN 1726-9679, Vienna, Austria, DOI: 10.2507/30th.daaam.proceedings.138

[6] https://www.testsysteme.cz/nova-generace-teplotnich-klimatickych-komor-climeevent-2, JD Dvořák - Test technique. (nd). JD Dvořák, sro - Test technique, Accessed on: 2023-10-10

[7] ČSN EN ISO/IEC 17025:2018. Zkušební laboratoře a kalibrační laboratoře - Obecné požadavky na kompetenci (ISO/IEC 17025:2017, IDT). Úřad pro technickou normalizaci, metrologii a státní zkušebnictví, 2018.

[8] https://pdf.aeroexpo.online/pdf/weiss-umwelttechnik-gmbh/clime-event/173964-6414.html, (2023). Weiss Umwelttechnik GmbH. (n.d.). Clime Even, Climate test, chamber, Accessed on: 2023-10-10