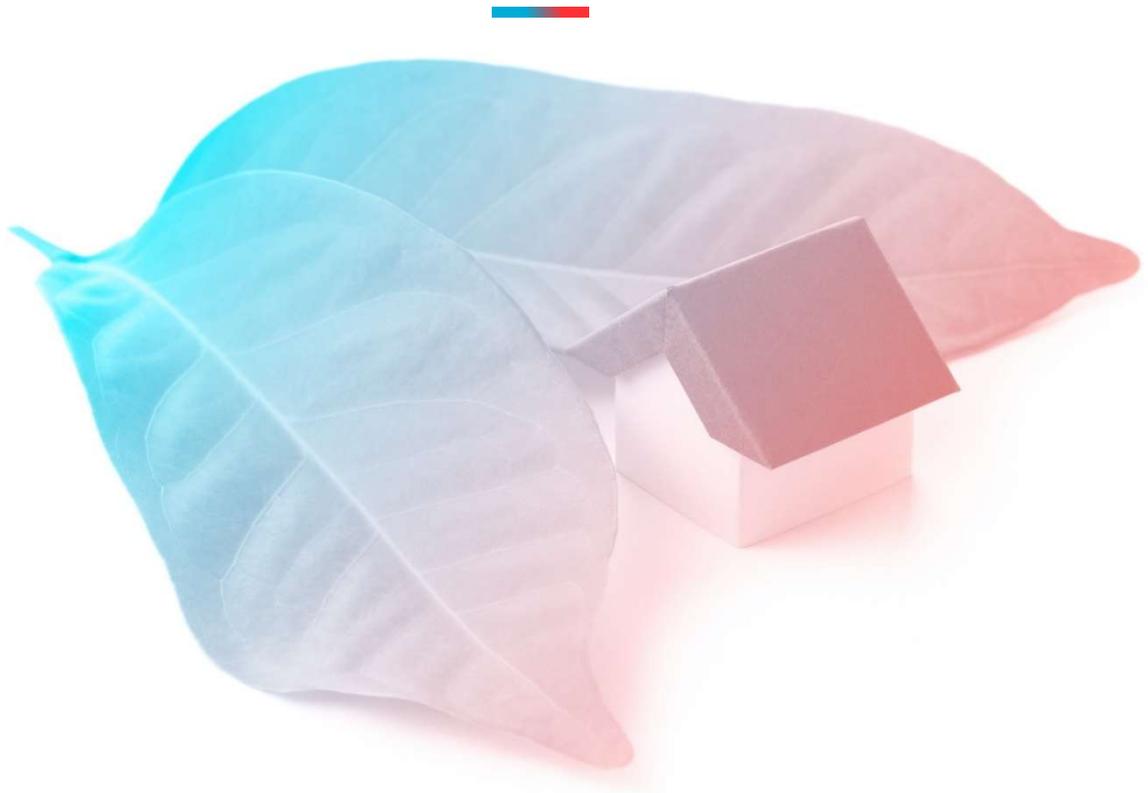




D8.5 Definitive version of MiniStor promotional activities towards standardization and other relevant bodies



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Summary			
<p>The objective of this Deliverable 8.5 "Definitive version of MiniStor promotional activities towards standardization and other relevant bodies" is to be the final report on results of activities done to promote the project according to task objectives, overall recommendations, and work for further research.</p> <p>This deliverable presents the activities performed during the second half of the project to promote the project to standardization and other relevant bodies. In this second part, tangible results were made available, such as manufactured prototypes that were certified by notified bodies in both France and Greece, and experiences were gained from their use in the demonstration site. This includes the performance testing, which was verified by SGS and formed the basis for a validated opinion.</p> <p>Promotional activities included presenting the project to the Technical Committee on Air Conditioning (CTN-100) of the Spanish Association for Standardization (UNE), and contacts held with international bodies such as CEN. It also included providing structured insights (policy briefs) based on the experiences from partners in formulating, designing and operating the system. Other activities included participation in relevant fora where stakeholders attended and could be presented with project results.</p> <p>Finally, a validated opinion was provided by SGS that provides quality assurances that performance has been measured in a verifiable and repeatable manner by partner EMI as done for Task 6.2</p>			
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1. Introduction

This Deliverable corresponds to the activity T8.3 Networking with standardization & professional bodies to address common challenges with respect to standardization, certification and safety. This report is the definitive version of the MiniStor promotional activities towards standardization and other relevant bodies.

The activities developed in this deliverable consist of: Process to contact relevant international and national standardization bodies in order to navigate and achieve the correct approach to influence standards in a way that is meaningful and relevant to the standardization bodies. Promotion of project results (achieved in the second half of the project) in relevant events to relevant stakeholders from academia, industry and standardization. Perform a validation opinion on the performance testing procedure, as substitute of the Product Audit Program (PAP) due to its discontinuation as a product offered by SGS, as explained in Section 4.1 but with the same validity. The validation opinion (as substitute of the PAP) is done with the objective of providing quality assurances that performance has been measured in a verifiable and repeatable manner. This will help a future commercialization stage of the project outcomes. At the same time, Policy Briefs formulated in the second part of the project reflect on the regulatory considerations and offer insights into the advantages of MiniStor technologies and how they could be improved.

The D2.3 was analysed, looking at the regulations applicable to MiniStor project and discussing the structure of the PAP. The type of preliminary test to carry out were also established, and the difficulties encountered in carrying out all these activities.

Finally, we established the steps to follow to continue with the standardisation of the product, making an analysis of the standardisation bodies at European and international level, and the different possibilities we could find.

Deliverable 8.5 covers all activities carried out for the standardisation of the Ministor results, as well as all activities related to the elaboration of the "Validation Opinion"

This Deliverable has connection with the following others:

- D2.1 "Definition of stakeholder requirements, market demands and application challenges"
- D2.3 "Analysis of relevant legislation and standards for system operation"
- D8.1 "First version of the communication and dissemination plan"

2. Standardization activities covered in this report

As part of the development of task 8.3, and with the aim of achieving maximum standardisation of MiniStor results, a plan was established to be followed by the partners involved. This plan had the aim to present the results of the project, as it had achieved the manufacture and installation of the first prototypes, which had been certified by notified bodies.

Standards are elaborated through a process of sharing knowledge and building consensus among technical experts from interested parties and other stakeholders - including big and small businesses, consumers, researchers, societal and environmental groups, and authorities.

The stakeholders join a technical body which can be permanent (Technical Committee) or temporary (CEN-CENELEC Workshop). These technical bodies are integrated in the structure of the recognized Standardization Organizations at three coordinated levels: national, European and international. These organizations provide the sustainable framework, the recognition and the common playing rules for the elaboration of reliable standards in all sectors.

The members of the European and International standardization organizations are **the National Standardization Bodies and Technical Committees**, present in every country. They will help you to find the right path to standards, engage in standardization processes and integrate all of this in your R&I projects and proposals.

The steps in the process are as follows:

2.1. Screening of existing standards

By screening existing standards on national, European, and international level, partners were able to access leading knowledge and resources on the topic we were working on. This included European Directives and their harmonized standards across various industries.

One of the most relevant standards for the development of MiniStor in terms of design, emplacement and safety has been the European Standard EN 378-3 *Refrigerating systems and heat pumps - Safety and environmental requirements - Part 3: Installation site and personal protection*.

2.2. Contribution to new standards

The MiniStor project has developed a novel thermal storage system where specific application challenges were found and solved using existing standards, but which might not be applicable in the future commercialization effort due to the nature of the application (e.g. residential use). Therefore, it was necessary to study the possibility of the creation of new standards such as for example specific standards related to the use of ammonia on residential environment taking advantage of the technical advances reached by the demonstration activity.

Standards are common playing rules for industry, societal actors, public administrations etc. Integrate results of your R&I activities in new standards is the way to enhance their impact beyond your consortium, gain visibility and increase their chances of successful exploitation. There are several levels to perform this objective¹.

There are **three possible options** for the development of the standardisation activities, with the scope described in each of the following subsections (What is it? What is it good for? When should it be used? How can it be done?):

- Standardization planning
- Influence ongoing standardization

¹ CEN-CENELEC: Increase the Impact of your R&I Project by Integrating Standardization

- Proposal and elaboration of new standards

2.2.1. Standardization planning:

What is it?	Identify, analyse, discuss and elaborate a structured plan for future standardization development in a sector or topic.
What is it good for?	Raise awareness about standardization needs and opportunities discovered in your project. Building up networks of your project with interested stakeholders in different environments (research, industry, users, administrations, etc.). Link with other projects and approaches
When should it be used?	When there are no previous standardization activities in an innovative topic, or they are heavily scattered. A need or opportunity has been identified.
How can it be done?	Organize events for meeting stakeholders, discussing needs, checking willingness and obtaining conclusions, involving standardization organizations to get more relevance. For a deeper level of development at a medium term, lead a CEN-CENELEC STAIR Platform, involving interested stakeholders. As a result, elaborate a standardization roadmap, showing relevant Technical Committees and groups, further stakeholders and their participation as well as upcoming standardization projects, future fields of activities and concrete recommendations, priorities, etc. To be relevant, it should be elaborated in collaboration with the standardization organizations

2.2.2. Influence ongoing standardization

What is it?	Take the opportunity of ongoing standardization works relevant for your project, to integrate some of its results in them. Ongoing works can be for new standards or for the modification of existing one
What is it good for?	Gain visibility, applicability and long-term impact of your project results. Use the momentum of existing works instead of starting new ones. Opportunity to network with all participating experts. Get first-hand information on standards development. Overcome or clarify any potential technical barrier or gap.

When should it be used?	When an existing Technical Committee is developing new standardization works related to project results. In a time frame that can be compatible with your project and post-project interests
How can it be done?	<p>Contact the Technical Committee and provide some informed suggestions, recommendations or proposals. It is a simple process, but real influence is not guaranteed.</p> <p>Join the Technical Committee works by participating as an expert through the National Standardization Body. You will represent your organization (not directly the project), and you will have full voting rights.</p> <p>Ask for a Project Liaison, your project will be then represented as an entity, giving it more visibility, and can fully contribute but without voting rights. Collaboration with the standardization organizations.</p>

2.2.3. Proposal and elaboration of new standards:

What is it?	Directly engage standardization organizations to lead the elaboration of new standards which support your project results. Standardization depends on the consensus with stakeholders external to the project, so you must be conscious of the need to agree and the possibility of having different results than expected, or even no results.
What is it good for?	<p>Increase long-term impact of the project.</p> <p>Set basis for future innovation.</p> <p>Use the fastest-track options available in the standardization system.</p>
When should it be used?	When no ongoing standardization works exist. When extended impact is required, especially where different sectors and stakeholders can benefit from it.
How can it be done?	<p>Propose the creation of a CEN-CENELEC Workshop to develop a CWA (CEN-CENELEC Workshop Agreement). This is the fastest kind of standard as it is elaborated in an ad hoc group, especially well-suited for results of R&I, that can be the first step for a future EN or ISO standard.</p> <p>Propose in a Technical Committee the elaboration of a Technical Specification. This is a kind of standard similar to CWA, providing specifications in experimental circumstances and/or evolving technologies, but elaborated in a Technical Committee, and can take slightly more of time as it depends on the rhythm of work of the Committee.</p>

	Another option in a Technical Committee is a Technical Report, informative standard summarizing the status quo and recording available knowledge, without stating requirements.
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Developing a new standard involves creating a CEN-CENELEC Workshop Agreement (CWA), which is a specific document designed for R&I projects and that forms the basis for new standards. Drafting time is about 6-12 months, after which the CWA could be further developed into a European standard or integrated into an existing one.

2.2.3.1. Regulatory considerations and standardisation of ammonia use

As part of the ongoing effort to contribute to new standards and enhance the long-term impact of MiniStor's results, specific insights have been gathered by partners using project experiences, and stated in the form of **Policy Brief A**, entitled "*Use of ammonia as refrigerant in compact thermochemical heat/cold storage units for residential buildings*", attached as Annex III.

The document highlights the considerable advantages of using **ammonia (R-717)** as the working fluid in the MiniStor thermochemical storage unit, particularly for residential applications:

- Ammonia enables **compact, highly efficient thermal energy storage**, achieving a **coefficient of performance (COP) of 1.8**, which is significantly higher than average values for similar systems.
- The **reversible thermochemical reaction** involving ammonia ensures stable and cyclical heat absorption and release over decades, with no observable degradation of performance even after **20+ years of operation**.
- The **sealed-loop configuration** used in MiniStor minimises the need for maintenance, while advanced **sensor-based automation** reduces the need for manual inspections.
- Ammonia salts and graphite, used as absorbent materials and thermal conductivity enhancers respectively, are **fully recyclable** and highly durable.
- Ammonia is **environmentally friendly**, with **zero ozone depletion potential** and **negligible global warming potential**, aligning with EU climate targets.
- Ammonia benefits from a **well-established global supply chain**, as it is one of the most widely produced industrial chemicals, further facilitating system scalability and commercial deployment.

These findings reinforce the technological relevance and maturity of the MiniStor solution and support the development of **dedicated technical standards** for compact thermochemical storage systems in residential settings.

2.3. Contact with CEN Research Helpdesk

Following the options stated in Section 2.2, and to decide which of them was suitable, CEN and CENELEC members were contacted. To facilitate the national interaction between the research projects and standardization community, a majority of CEN and CENELEC members have appointed a dedicated national contact for Research, Development and Innovation (RDI). Their contact details can be consulted [here.](https://www.standardsplusinnovation.eu/get-started) (<https://www.standardsplusinnovation.eu/get-started>)

After extensive communication, a thorough decision-making process was carried out to determine the most appropriate option among those available. The final decision was made in conjunction with Tyndall-IERC, the project coordinator, in close collaboration with FEUGA and SGS, after several meetings and detailed discussions. During this process, we carefully analysed the advantages and potential challenges associated with each option, ensuring that the choice was in line with the project's objectives and requirements. In addition, we received valuable guidance and expert advice from the Spanish Association for Standardisation (UNE), with whom we held multiple meetings to review and evaluate the different possibilities. Their expertise helped us make an informed decision and outline the next steps to move forward effectively. In this case, it was decided to identify relevant technical committees (TC) within the CEN structure. It must be noted there is no specific committee on thermal energy storage, and forming one is out of the scope of the project.

The identified European standardisation committees were the following:

2.3.1. European standardisation TC identified

The following technical committees that could be of interest to the project were identified:

CEN/CLC/JTC 14 Energy management and energy efficiency in the framework of energy transition

- WG 1 Energy audits

CEN/TC 89 Thermal performance of buildings and buildings components

- WG 8 Thermal test methods

CEN/TC 176 - HEAT METERS

- CEN/TC 176/WG 1 - Editing
- CEN/TC 176/WG 2 - Heat Meters - Requirements, test methods and technical editing
- CEN/TC 176/WG 3 - Detailed specifications
- CEN/TC 176/WG 4 - Heat meters - Data exchange and interfaces
- CEN/TC 176/WG 5 - Installation etc

CEN/TC 228 Heating systems and water-based cooling systems in buildings

- CEN/TC 228/WG 1 General performance requirements of heating systems and sub-systems in buildings
- CEN/TC 228/WG 4 Calculation methods and system performance and evaluation

From this interaction, it was suggested by CEN to identify and interact first with a national working group where the project could be presented as part of their regular meetings. Due to the extensive collaboration that SGS has with UNE, it was decided to present MiniStor to the National Technical Committee (CTN) CTN-100 on Air conditioning, as it deals with HVAC equipment except fans. The committee is well represented at CEN and ISO. It helps with the definition and implementation of locally formulated standards and the homologation of standards produced at the European level.

2.4. Participation on Plenary Committee CTN-100

Before the meeting, FEUGA produced a factsheet summarising all the progress and results of the project to be presented to the Committee. The factsheet is intended for distribution to the committee members and explains in brief how the system works, and how the project has relationship to relevant standards as identified in D2.3.



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Standardisation Technical Factsheet

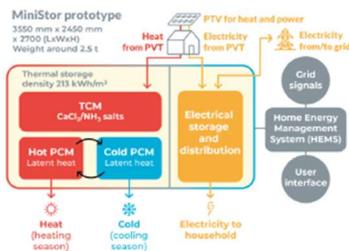
MiniStor

Minimal Size Thermal and Electrical Energy Storage System for In-Situ Residential Installation

MiniStor, a H2020 project, is testing its high-density thermal storage system in multiple climate conditions and home configurations, providing both heating and cooling in an integrated yet flexible unit. Despite being operational, existing standards involving ammonia operation lean mainly towards industrial implementation and there is no specific standard for this residential applications.

Design

Operating year round, MiniStor aims to provide energy security across Europe's residential sector with a thermal storage density well over 10 times that of water, a practical solution for leveraging the variability of renewable energy sources.



The system uses a thermochemical heat storage (TCM) technology based on a $\text{CaCl}_2/\text{NH}_3$ (calcium chloride/ammonia) sorption cycle, utilizing reversible chemical reactions to store and generate heat on a deferred basis to meet the building's thermal needs and ensure long-term operation.

The TCM technology is combined with other key components providing an integrated system, the MiniStor system, capable of sustainable heating, cooling and electricity storage, while utilizing renewable energy sources, specifically solar energy. The heat generated by the TCM is later transferred through additional indirect systems to the dwelling.

It is acknowledged that ammonia can be safely used as a refrigerant provided the system is properly designed, constructed, operated, and maintained. It is important to recognize, however, that ammonia is toxic and careless management can be a hazard to human health.

<https://ministor.eu/>

1



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Standardisation Technical Factsheet

A fusion of technologies

- Multi-day thermal energy storage based on $\text{CaCl}_2/\text{NH}_3$ salts, cooling and heating buildings
- Phase-change material for cooling and heating storage
- Hybrid photovoltaic thermal (PVT) collectors for TCM operation and battery system
- PVT panels feature glazed collectors with a laminate of 265Wp, to be combined with solar thermal flat plate collectors (FPC); and unglazed collectors with 390Wp laminate
- Home Energy Management System (HEMS) smart digital operation tool and IoT platform



Units installed in the Szentendre test environment and the recent Santiago demonstrator. Credits: ÉMI, FEUGA

Relevant Standards

These are the relevant standards upheld by MiniStor for trials and operations:

- Directive 2014/30/EU on Electromagnetic Compatibility (EMC)
- 2014/34/EU on potentially Explosive Atmospheres (ATEX)
- 2014/35/EU on low voltage (LVD)
- 2006/42/CE on machinery
- 2014/68/EU on pressure equipment (PED)
- EN13445-3 2021
- EN13480-5 2017+A1:2019+A2:2021 for metallic industrial piping – inspection and testing.
- 2011/65/EU on hazardous substances in electrical and electronic equipment (ROHS)
- 2014/29/EU on simple pressure vessels (SPVD)
- CE Marking: internal production control, Test environment and Project Audit Programme
- EN 378: ammonia-containing parts in assembly, transport, installation location / occupancies, refrigeration and charge limit requirements; EN 378 Part 2 for leak prevention; EN 378 Part 4 for usage conditions
- EN ISO 12100 safety of machinery

<https://ministor.eu/>

2

Figure 1 Factsheet produced by FEUGA

Presentation of the project was made by the project coordinator to the committee members of the CTN-100 (Air Conditioning) Committee of the Spanish Association for Standardization during its mid-year meeting on 24 October 2024 as an online presentation.

The presentation indicated the main aims of the project, the components of the system, their operating principles for thermochemical heat storage and electrical storage, together with the cities where it is being installed. The presentation detailed the standards that were used for designing, sizing and certifying the system, as well as the certifications achieved to that date. It presented the dates and companies that certified it according to the pressurized vessel directive. Photographs were shown of the actual components, and of the ease of delivery and installation of the prototypes as units ready for connection.



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It was also noted during the presentation that although several standards were used to design the system and for its compliance for operation, there is no single standard that defines thermal energy storage or how to measure its performance.

Meeting participants made questions regarding the actual measure of the thermal energy stored according to the declared value. They also made note that the process to modify standards takes much longer but that the presentation made them aware of the cross-sectionality of different standards to develop new products.



3. Indicative List of MiniStor Relevant events & conferences for contact with standardization and other relevant bodies

With the aim of promoting activities and facilitating knowledge exchange between key stakeholders, partners have attended high-level academic conferences and workshops organised by national, European and international organisations involving and/or representing the energy efficiency topic. MiniStor partners have been participating in local (national), European and international conferences, industry fairs and exhibitions to publicise MiniStor activities and expected results and disseminate relevant developments and results. Partners have focused on promoting the project results at key industrial events attracting a large number of stakeholders in the sectors of interest, aiming to maximise the effect of direct interaction with stakeholders. In addition, attendance at relevant events will also benefit MiniStor by having continuous updates on specific aspects of the project topic.

In addition, all events and activities carried out during the project are collected in the MiniStor Dissemination and Communication Activities Tracker. These are some of the most relevant where partners attended:

Construma 2022: It is a construction industry event focusing on building materials, equipment, and innovations, providing networking opportunities for professionals in the sector.

SEAI Energy Show 2022 is Ireland's leading event on energy efficiency and renewable energy, showcasing the latest technologies and policies to promote sustainable energy solutions. <https://seai.ie/events/energy-show/>

Eurosun 2022 is a conference dedicated to solar energy, focusing on advancements in solar thermal and photovoltaic technologies, bringing together industry experts and researchers.

Sustainable Places 2022 is an event that promotes sustainable building practices, smart cities, and energy-efficient solutions, encouraging collaboration among stakeholders.

EUSEW 2022, the European Sustainable Energy Week, is a major European event that discusses policies, innovations, and projects aimed at accelerating the clean energy transition across Europe. <https://eusew.eu/>

BUILDUP Webinar offers online seminars on energy efficiency, renewable energy, and sustainable building practices, providing knowledge sharing for professionals.

ECCA2023 is the European Conference on Catalysis and Catalytic Processes, focusing on advancements in catalysis research and applications.

ECTP Assembly 2023 is the European Construction, Built Environment, and Energy Efficiency platform's annual meeting, discussing innovations in construction and energy efficiency.

Sustainable Places 2023 continues to promote sustainable building and urban development, fostering collaboration among industry leaders.

Construma 2023 is a construction industry event similar to its 2022 edition, highlighting new building technologies and materials.

Pollack Expo 2023 is an exhibition showcasing innovations in construction, architecture, and urban development.

International Symposium on Applied Science 2023 gathers researchers and professionals to discuss recent advances in applied sciences across various fields.

"III International Seminar on Sustainable Engineering" focuses on sustainable engineering practices, innovations, and research to promote environmentally friendly solutions.

CES 2024, the Consumer Electronics Show, is a global event showcasing the latest in consumer technology and innovation. <https://www.ces.tech/>

PowR Earth Summit is an event dedicated to renewable energy and sustainable development, bringing together industry leaders and policymakers.

Eurosun 2024 will continue to focus on solar thermal and photovoltaic technologies, fostering industry growth and innovation.

ENLIT 2024 is a major energy industry event that covers power generation, smart grids, and energy storage solutions. <https://enlit-europe.com/>

CTN-100 Plenary is a conference or meeting related to the CTN-100 project or initiative, focusing on technological advancements.

ECTP 2024 Conference is the European Construction, Built Environment, and Energy Efficiency platform's upcoming event, emphasizing sustainable construction practices.

AEPIBAL Day. III National Energy Storage Meeting is a national event discussing innovations, policies, and research in energy storage technologies.

ICRES 2025 is an international conference on renewable energy systems, focusing on research and development in the field.

EU Sustainable Energy Week (EUSEW 25): Organized by the European Commission in Brussels, gathers several projects on the topics of sustainability, new technologies and policy

The IEA - Solar Heating and Cooling (SHC) Program, Task 73, PVT Heating and Cooling Systems, is a collaborative effort to advance solar thermal PVT systems, with a final conference to present results.

Congreso CAE is a conference related to the ceramic industry, exploring innovations and opportunities within the sector.

4. Validation Opinion from Performance Tests Procedure

4.1. Introduction

The main objective of this section, carried out by SGS, is to validate the process and ensure that the results obtained by the Ministor system, using the prototype installed at the EMI premises in Budapest meet or exceed the expectations set out in the consortium's grant agreement. To this end, the following sections remind the reader of the energy objectives of the Ministor system, the data and energy information acquisition methods, and the employed calculation procedure. This procedure can provide assurances for future commercialization that performance testing procedures can be replicated elsewhere, increasing its quality offer. Further details of how the procedure was carried out and its results can be consulted in D6.2.

The evaluation considers the following:

- The existence of an own methodology developed by EMI and described at deliverable D6.2 for obtaining energy efficiency values will be verified.
- It will be verified that the data was acquired according to the measurement methods indicated in the aforementioned deliverable D6.2 as well as in the deliverable D6.1 related to design of the monitoring system.
- Verify that the energy efficiency calculation results, obtained by EMI and detailed at deliverable D6.2, reach the Grant Agreement target value.

The validation performed by SGS was initially proposed within an SGS certification scheme called the Product Audit Program (PAP), which, for commercial reasons, is no longer offered as a service by SGS Worldwide.

In any case, SGS, as a world-leading testing, inspection, and certification company, has the capabilities and resources necessary to guarantee that a piece of equipment or plant has been completed to the required quality and meets all contractual specifications. Therefore, although the defunct PAP scheme was replaced, nevertheless the information collected and provided by those responsible for the performance testing and calculation procedures established by the project Consortium was used for the new process. The information provided in the corresponding deliverables allowed SGS to validate the energy efficiency results obtained, issuing the corresponding certificate as an Independent Entity.

From the perspective of the objectives for this specific task, outlined in the Grant Agreement (MiniStor_GA_869821 Ammendment reference AMD-869821-32), both SGS and the other members of the MiniStor Consortium consider this new approach to be technically equivalent, achieving the following objectives:

- Validate that certain product characteristics are met.
- Issue an opinion with the obtained results that will serve to increase its marketability

4.2. Objectives of the MiniStor system

MiniStor is a project funded by the European Union's Horizon 2020 research and innovation programme to offer a sustainable solution to harness the energy efficiency potential of the European building stock.

MiniStor aims at designing and producing a novel compact integrated thermal storage system for achieving sustainable heating, cooling and electricity storage.

The overall objective of the MiniStor project is to design and develop a novel compact, integrated thermal storage system for achieving sustainable heating, cooling and electricity storage that can be adapted to new and existing residential buildings.

The MiniStor concept will be demonstrated and evaluated in an operational environment of real-life conditions in one pre-pilot and five demonstration sites, where a series of performance key-performance indicators (KPIs) will be measured.

4.2.1. Objectives on the Grant Agreement (Efficiency Commitments)

The point Impact#3 of the Grant Agreement [1] between the European Commission and the Ministor Consortium shows the expected impact related to energy savings. According to this point the solution should demonstrate a potential to reduce the net energy consumption of a building by at least 25%. However, the expected reduction considered by the Consortium want to achieve at least 44% of energy savings.

As indicated in the document:

The proposed energy storage solution can contribute to 44% reduction in total energy consumptions when it is compared to a HP-PV based system without energy storage.

Scenario description	Heating consumption Q _h (kWh) ^a	Net PE heating consumption Q _{h,PE} (kWh) ^b	Net PE heat consumption reduction ^c	Net electricity consumption (kWh), P _{el}	Net total PE cons (kWh), Q _{h,PE} + P _{el}	Net PE total consumption reduction ^c
Gas boiler	43	43	93%	10	53	77%
Oil boiler	44	44	93%	10	54	77%
HP (grid driven)	13	26	88%	10	37	66%
HP (grid & PV driven)	13	11	73%	10	22	44%
Ministor	6	3	-	9	12	-

a Q_h= QD/ η_{eff} for gas/oil boilers and Q_h= QD/ COP for the case of Heat Pumps

b The primary energy factor (PEF) for gas and oil is assumed equal to 1 and PEF=2 for electricity

c The net heating/total consumptions reduction: $\Delta Q_h = (1 - Q_{h,PE,i} / Q_{h,PE,5})$, where i: scenarios 1-4 and Q_{h,PE,5} the corresponding value for scenario 5

d Electricity consumptions are P_{el}=0.2*QD. In scenario 5, the total consumptions are reduced by 5% thanks to the beneficial impact of HEMS

Table 1. Average daily PE (primary energy) based heat and energy consumptions for the five examined scenarios (Own elaboration based on data from table 6 of the mentioned Grant Agreement document)

4.3. Monitoring of the system

This section indicates the procedures and characteristics of the measuring equipment necessary for data acquisition in the testing facilities, according to the information in the documents D6.1 and D6.2

4.3.1. Measurement and Data Collection Equipment

The MiniStor system monitors a large number of variables using various internal measurement equipment. The performance testing at EMI facilities attached external measurement equipment to

track different variables. The following table shows the equipment used at EMI facilities, which is used to determine (among other parameters) the system's energy efficiency level:

Manufacturer	Name / Type	Serial number	Measured Value	Uncertainty	Status*
IMI	TA Scope (Dp-Visio)	ÉMI 1388 / SN:14769 (SN:102112209)	3 – 1000kPa	+/- 0,2kPa	Calibrated
Metrix	Multimeter MX 54C	ÉMI 1318 / SN:249804XAX	0 – 250V 0 – 16A	+/- 0,17V +/- 0.025A	Calibrated
SIEMENS	Ultrasonic Heat meter WSM515 (T230)	ÉMI 1384 / SN:70283877	0 – 1000l/h 0 – 95°C	+/- 0,87% +/- 0,1°C	Calibrated
SIEMENS	Ultrasonic Heat meter WSM515 (T230)	ÉMI 1385 / SN:70283842	0 – 1000l/h 0 – 95°C	+/- 0,63% +/- 0,1°C	Calibrated
PLOUMETER	Ultrasonic Heat meter RC20130M	SN:42307628	0 – 1000l/h 0 – 95°C	class 2 class 2	Used only for control check
DACTON	Power meter PORM5300 33	SN:188002/23.11	0 – 250VAC	+/- 0,2%	Set up
VORTEX	Flow meter SV5050	PA6T/6I (1)	0 – 32l/min	+/- 0,2%	Set up
VORTEX	Flow meter SV5050	PA6T/6I (2)	0 – 32l/min	+/- 0,2%	Set up
VORTEX	Flow meter SV5050	PA6T/6I (4)	0 – 32l/min	+/- 0,2%	Set up
Danfoss	Pressure transmitter MBS4510	ÉMI 1333 / SN:21257451	0 – 10bar	+/- 0,5%	Calibrated
Guenther	Thermocouple 1xNiCr-Ni/K	Article Nr: ZP01374062022 /164	0 – 100°C	+/- 0,7°C	Calibrated
Guenther	Thermocouple 1xNiCr-Ni/K	Article Nr: ZP01374062022 /139	0 – 100°C	+/- 0,7°C	Calibrated
Guenther	Thermocouple 1xNiCr-Ni/K	Article Nr: ZP01374062022 /039	0 – 100°C	+/- 0,7°C	Calibrated
Guenther	Thermocouple 1xNiCr-Ni/K	Article Nr: ZP01374062022 /188	0 – 100°C	+/- 0,7°C	Calibrated
Guenther	Thermocouple 1xNiCr-Ni/K	Article Nr: ZP01374062022 /159	0 – 100°C	+/- 0,7°C	Calibrated
Guenther	Thermocouple 1xNiCr-Ni/K	Article Nr: ZP01374062022 /117	0 – 100°C	+/- 0,7°C	Calibrated

Guenther	Thermocouple 1xNiCr-Ni/K	Article Nr: ZP01374062022 /085	0 – 100°C	+/- 0,7°C	Calibrated
Guenther	Thermocouple 1xNiCr-Ni/K	Article Nr: ZP01374062022 /184	0 – 100°C	+/- 0,7°C	Calibrated
Guenther	Thermocouple 1xNiCr-Ni/K	Article Nr: ZP01374062022 /064	0 – 100°C	+/- 0,7°C	Calibrated
Guenther	Thermocouple 1xNiCr-Ni/K	Article Nr: ZP01374062022 /162	0 – 100°C	+/- 0,7°C	Calibrated
National Instruments	Rack NI9214	SN:195DA78	Thermocouple input	-	Set up
National Instruments	Rack NI9207 with DSUB	SN:2234BFA	4-20mA input	-	Set up
National Instruments	NI cDAQ 9189	SN:2134519	Data Logger	-	Set up

Table 2 Measurement devices (information from table 2 of deliverable D6.2)

As indicated in document D6.2 in relation to the calibration of the equipment indicated in the "Status" column of the table:

The sixth column indicates the status of the instrument. The status can be calibrated or set. The calibrated status devices were used as a reference for the adjustment to the data logger for flow meters and for electricity meters, since the calibrated device is not suitable for connection to the data logger. For the flow meters, we designed the heat meters to be installed on the same wiring as the set flow meters, so that we could perform a spot check during the measurement, [...] To measure the amount of electric energy, we chose a device that measures the amount of energy consumed without any computational relation. [...] setting up this device for the data logger involves disconnecting the electrical wiring. For the setup, this modification has been temporarily made.

4.3.2. Data collection and storage

Two systems were installed for collecting data. One is the local system installed and connected to the EMI calibrated measuring devices described in this report. The second consists of the internal monitoring system of the MiniStor prototype which is used to control the components. The protocol for the internal controllers is the same of the smart meters explained in Deliverable D6.1 *Design of the monitoring system and KPI definition*:

The smart meters were able to supply data via the Modbus system, which makes the connection easier. Other sensors (predominately heat meters, temperature and humidity sensors) were connected via M-Bus via a logging device. The individual data sources were collected by a raspberry Pi microcontroller and subsequently transmitted to the CERTH IoT platform.

The process of recording the monitoring data utilizes a data flow procedure that collects the measurement data onsite, aggregates it locally and then transmits it to cloud storage.

4.4. Calculation of energy efficiency

According to report D6.2 as well as the Excel calculation process on the file provided by EMI, the calculation of energy efficiency is carried out, based on data and measurements, according to the following formula:

$$\frac{DHW\ energy\ (kWh) + Heating\ energy(kWh) + Cooling\ Energy\ (kWh)}{Electricity\ (kWh) + Solar\ energy(kWh)}$$

4.5. SGS Validation

4.5.1. Calibration certificates for Budapest equipment

It has been possible to verify that the following measurement and data collection equipment installed at the Budapest demo site have calibration certificates and CE marking:

Manufacturer	Name / Type:	Serial number:
IMI	TA Scope (Dp-Visio)	ÉMI 1388 / SN:14769 (SN:102112209)
Metrix	Multimeter MX 54C	ÉMI 1318 / SN:249804XAX
SIEMENS	Ultrasonic Heat meter WSM515 (T230)	ÉMI 1384 / SN:70283877
SIEMENS	Ultrasonic Heat meter WSM515 (T230)	ÉMI 1385 / SN:70283842
Danfoss	Pressure transmitter MBS4510	ÉMI 1333 / SN:21257451
Guenther	Thermocouple 1xNiCr-Ni/K	Article Nr: ZP01374062022 /164

Table 3 Calibrated measurement devices (Own elaboration based on data from table 2 of deliverable D6.2)

The original calibration certificates sent by EMI are added as Annex II to the present deliverable:



Figure 2 Preview of the calibration certificates

4.5.2. Data file verification

The generated file (.xlsx) has a total of 7.444 rows and 37 columns, with the maximum number of rows with data being 7.417, which include the following situations contemplated in D6.2:

- Winter mode (Solar temp. 70[°C])
- Winter mode (Solar temp. 80[°C])
- Summer mode (Solar temp. 70[°C])

The existing columns in this file are as follows:

'Winter/Summer mode', 'Charging/Discharging', 'Pumps = ON', 'Time', 'Ambient [Thermocouple 1xNiCr-Ni/K] (°C)', 'Cooling Calculated Energy (kW)', 'Cooling Calculated Energy (kWh)', 'Cooling Flowrate (l/h)', 'Cooling from Building [Thermocouple 1xNiCr-Ni/K] (°C)', 'Cooling to Building [Thermocouple 1xNiCr-Ni/K] (°C)', 'DHW Calculated Energy (kW)', 'DHW Calculated Energy (kWh)', 'DHW Flow Sensor (PA6T/6I_2) Signal (mA)', 'DHW Flowrate (l/h)', 'DHW from Building [Thermocouple 1xNiCr-Ni/K] (°C)', 'DHW to Building [Thermocouple 1xNiCr-Ni/K] (°C)', 'Electric Apparent Power (kW)', 'Electric Apparent Power (kWh)', 'Electric Effective Power (kW)', 'Electric Effective Power (kWh)', 'Electric Power Sensor (PQR5300 33) Apparent Signal (mA)', 'Electric Power Sensor (PQR5300 33) Effective Signal (mA)', 'Heating Calculated Energy (kW)', 'Heating Calculated Energy (kWh)', 'Heating Flow Sensor (PA6T/6I_4) Signal (mA)', 'Heating Flowrate (l/h)', 'Heating from Building [Thermocouple 1xNiCr-Ni/K] (°C)', 'Heating to Building [Thermocouple 1xNiCr-Ni/K] (°C)', 'INPUT ENERGY (kW)', 'OUTPUT ENERGY Summer (kW)', 'OUTPUT ENERGY Winter (kW)', 'Solar Calculated Energy (kW)', 'Solar Calculated Energy (kWh)', 'Solar Flow Sensor (PA6T/6I_1) Signal (mA)', 'Solar Flowrate (l/h)', 'Solar from FCU [Thermocouple 1xNiCr-Ni/K] (°C)', 'Solar from Panels [Thermocouple 1xNiCr-Ni/K] (°C)', 'Solar Pressure (bar)', 'Solar Pressure Sensor (Danfoss MBS4510) Signal (mA)', 'Solar to Panels [Thermocouple 1xNiCr-Ni/K] (°C)',

An additional column called "Total_System_Efficiency" is created according to the calculation in the "Calculator" tab of the data file:

$$\left(\frac{\text{HeatingCalculatedEnergykW} + \text{DHWCalculatedEnergykW}}{\text{SolarCalculatedEnergykW} + \text{ElectricApparentPowerkW}} \right) + \left(\frac{\text{CoolingCalculatedEnergykW}}{\text{SolarCalculatedEnergykW} + \text{ElectricApparentPowerkW}} \right)$$

It is important to understand that the names indicated at previous formula are the name of the columns from EMI's excel file. In this file, the data from each row has been referred to an interval of 3:20:00 minutes. Hence, it should be named kWh as energy unit.

For a more convenient analysis, a new .xlsx file is generated, including only the columns EMI has deemed relevant for verifying system efficiency, sorted chronologically. We also include the "Time" column, the operating mode, and the column related to pumping:

- [Time],
- [Winter/Summer mode],
- [Charging/Discharging],
- [Pumps = ON],
- [Total_System_Efficiency],
- [Heating Calculated Energy (kW)],
- [Cooling Calculated Energy (kW)],
- [DHW Calculated Energy (kW)],
- [Solar Calculated Energy (kW)],
- [Electric Aparent Power (kW)]

The calculation of the overall system efficiency for each situation is validated. As commented, in order to avoid confusion, the column names in the Excel file received have been maintained, with each row representing a power measurement at a specific time. These measurements, over a period of time, refer to a unit of energy (kWh).

	Heating Calculated Energy (kW)	Cooling Calculated Energy (kW)	DHW Calculated Energy (kW)	Solar Calculated Energy (kW)	Electric Apparent Power (kW)	GLOBAL EFFICIENCY (%)
Winter-70	1.491,94	1,49	-6,93	1.351,87	2.043,07	43,79%
Winter-80	2.205,90	57,80	2.742,81	3.096,88	3.446,94	76,51%
Summer-70		1.123,65	1.508,10	2.166,09	2.537,34	55,95%

Table 4 Calculated energy and Global Efficiency

4.5.3. Validation of Global Efficiency results.

As a result from the information received and as well from our visit to the demo site during the period of test, we can conclude that a methodology for data acquisition and for calculation of energy efficiency results exists, as described in the corresponding deliverables.

The overall energy efficiency values obtained (for the different modes tested) range from a minimum of 43.79% (slightly lower than the Efficiency Commitments target of 44%) to a maximum of 76.51%.

	GLOBAL EFFICIENCY (%)
Winter-70	43,79%
Winter-80	76,51%
Summer-70	55,95%

Table 5 Global Efficiency

The validation opinion is attached as Annex I

5. Conclusions

The deliverable has presented the activities that were followed for the promotion of project results towards their standardisation. As mentioned, there is no single standard that covers thermal energy storage, its performance measurement and its commercial validation. Although production of the prototypes and their certification has been done through cross-sectionality of several standards, this opens the possibility to formulate one or several standards on thermal energy storage as part of the project's long-term contributions.

However, the deliverable also provides an overview that this process is a long-term effort that requires building up momentum at the national and international level. It involves contacts with several stakeholders from industry, regulatory and notified bodies, academia and professional associations, among others. The first contacts were made through the relevant committee in one of the Member States, which it is expected to raise awareness as a first stage, and then as knowledge and application of thermal energy storage advances, evidence such as the one provided by MiniStor will contribute towards a level evaluation field through standardization that will help its introduction to the wider European market.



Bibliography

- [1]. Grant Agreement number: 869821 — Minimal Size Thermal and Electrical Energy Storage System for In-Situ Residential Installation (MiniStor)
- [2]. D6.2 Results from functional and quality acceptance tests
- [3]. D6.1 Design of the monitoring system and KPI definition
- [4]. Policy Brief A: “Use of ammonia as refrigerant in compact thermochemical heat/cold storage units for residential buildings “



Annex I: Validation Opinion by SGS



NUMBER N°: MIN-BUD-IE-01

VALIDATION OPINION

SGS Tecnos, S.A., as Independent Inspection Entity

Hereby affirm that related the next Machinery / Equipment:

Property:	MINISTOR CONSORTIUM (*)
Location / Installation Site:	EPITESUGYI MINOSEGELLENORZO INNOVACIO NONPROFIT KFT (EMI) facilities at 2000 Szentendre, Dózsa György út 26. (Budapest, Hungary)
Type of equipment:	Thermal storage system
Brand:	--- (Prototipe)
Model and serial number:	---
Manufacturing year:	2024

(*) MiniStor is a project funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000785

The energy efficiency results obtained by the Ministor system, corresponding to the prototype installed at the Budapest demosite, and collected and provided by EMI has been validate and the results are on a range from a 43,79% of global efficiency as a minor result to a 78,51% as best result.

This certificate is issued for all relevant purposes and to whom it may concern on 28th June 2025.

 digital signed by ANTONIO DOMINGUEZ DOMINGUEZ on 2025.06.27 10:46:21 +0200	73773517M ANTONIO PASCUAL DOMINGUEZ (C.A2E34557 7) digital signed by ANTONIO PASCUAL DOMINGUEZ DOMINGUEZ on 2025.06.27 10:46:21 +0200
--	---

Signature / Date:

The validity of this certificate is conditional on the maintenance of the applicable conditions, existing and verified, during the inspection on which it was issued, as well as the conditions for its CE marking provided by the manufacturer and established in the Implementing directives, in particular the machinery directive.

Annex II: Original calibration certificates by EMI



LABORATORIUM WZORCUJĄCE
Guenther Polska Sp. z o.o.
Ul. Wrocławska 27C 55-095 Długoleka
Tel: 71 352 70 70 Fax: 71 352 70 71

Technologie pomiaru temperatury
Niezawodne . Dokładne . Certyfikowane

2020 08 05

fotec

CALIBRATION CERTIFICATE NO. :PS2208001a

CALIBRATION CERTIFICATE NO.

Release date: 18.08.2022

APPLICANT	Dicontrol Iranyitastechnika Korlatolt Felelossegu Tarsasag 1147 Budapest, 14Ov u. 143. 00-117 Budapest		
PLACE OF CALIBRATION	Guenther Polska Sp. z o.o. ul. Wrocławska 27c 55-095 Długoleka		
EXTERNAL ORDER NO.	Angebot 01.08.2022 Guenther Polska		
INTERNAL ORDER NO.	ZS 4/08/2022/P		
OBJECT OF CALIBRATION	Name: Thermocouple	Type:	1 x NiCr-Ni/K
	Article code: 22062524	Registration No.:	From: PS2208001/1 To: PS2208001/200
	Charge: 0101013202207	Manufacturer/ Model:	Guenther
DATE OF CALIBRATION	17.08.2022		
TYPE OF CALIBRATION	Initial		

CALIBRATION METHOD The calibration has been performed in accordance with procedure QMV9.01.01 Calibration of the thermocouple by the comparison method ver.3.0 from 12.10.2021 (based on the ASTM E220-19).

MEASUREMENT TRACEABILITY The certificate provides traceability of measurement results with of the International System of Units (SI).

MEASUREMENT UNCERTAINTY The measurement uncertainty has been determined in accordance with EA-4/02 M: 2022. Provided uncertainty values are expanded uncertainties with a probability of extension of about 95% and a expansion factor of $k = 2$.

COMMENTS Calibration results apply only calibrated object.
This certificate may be presented or copied as a whole document only.

CALIBRATION CERTIFICATE NO. PS2208001a

REFERENCE PROBES AND MEASURING DEVICES

Cold junction 0°C

WIKA	2022-465-PT-1	L-Z-0002	30-05-2023
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Measuring instrument

Keysight	6394/2021	L-M-0008	30-11-2022
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Temperature source

Fluke	immersion depth = 150 mm	L-H-0008	
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Reference probes

PtRh10-Pt/S	Z2-Z21.4180.61.2022.2153.1	L-T-0025	11-07-2023
-------------	----------------------------	----------	------------

ENVIRONMENTAL CONDITIONS

Ambient temperature (22,5 + 23,0) °C

Humidity (43,6 + 45,0) %

RESULTS OF CALIBRATION

SENSOR TYPE	TEMPERATURE			THERMOVOLTAGE	MEASUREMENT ERROR	MEASUREMENT UNCERTAINTY	COMMENTS
	NOMINAL	REFERENCE	CALCULATED				
	[°C]			[mV]	[°C]	± [°C]	
K	50,0	50,2	50,2	2,029	0,0	0,7	thermocouple roll start
	200,0	200,2	200,4	8,155	0,2	0,7	
	350,0	350,2	350,7	14,321	0,5	0,7	
K	50,0	50,2	50,2	2,030	0,0	0,7	thermocouple roll end
	200,0	200,2	200,6	8,162	0,4	0,7	
	350,0	350,2	350,9	14,333	0,7	0,7	

COMMENTS

- Nominal temperature: set point specified in the order.
- Reference temperature: average value of the measurements read from the reference standard.
- Calculated temperature: calculated temperature value on the basis of the PN-EN 60584-1:2014-04 from the measured thermovoltage of the calibrated object.
- Measurement error = Calculated temperature - Reference temperature
- Average measurement error of calibrated objects.

SENSOR TYPE	NOMINAL TEMPERATURE	AVERAGE MEASUREMENT ERROR
	[°C]	
K	50,0	0,0
	200,0	0,3
	350,0	0,6

Made by:

Kierownik Laboratorium
Head of Laboratory

Signature:

Eliwira Słocka
mgr inż. Eliwira Słocka

Approved:

Inżynier Laboratorium
Laboratory Engineer

Signature:

Tomasz Słocki
mgr inż. Tomasz Słocki

END



ATKIS AUTOMATIKA
Ipari és Kereskedelmi KFT
1161 Bp., Köztársaság útja 9.



5.1 B 1 / 1 oldal

Kalibrálási bizonyítvány
száma: 79025

KALIBRÁLÁSI BIZONYÍTVÁNY

Megrendelő neve, címe: **ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft.**
2000 Szentendre, Dózsa György út 26.

Kalibrálandó mérőeszköz megnevezése: **Számkijelzésű nyomáskülönbség mérő külső érzéklővel**

Gyártó, típus, gyári szám: **IMI Tip.: TA SCOPE Gy.sz.: 14769**

Méréshatár: **3 ... 1000 kPa**

Elfogadási hibahatár: **3 - 10 kPa tartományban: ± 0,2 kPa**
100 - 1000 kPa tartományban: ± 0,1 kPa

Külső érzékelő: **DpS-Visio Gy.sz.: 102112209**

Egyedi azonosító szám: **1388**

Átvételi állapot: **Használt / kalibrálásra alkalmas**

A kalibráláshoz használt etalonok megnevezése, gyári száma, és a visszavezethetőséget igazoló dokumentum:

1 Nyomásetalon: **Budenberg 551A gy.sz.: A7154 BFKH MMFF NYO-0102/2019**

2 Nyomásetalon: **SI 6390-6/X3000 gy.sz.: 8322/X3000 ATKIS 73407**

Egyéb mérőeszköz:

Hőmérő **ATKIS TM6 gy.sz.: -- KALIBRA 59 K/101849**

Kalibrálás eredményei:

Név. érték (kPa)	Leolvasott érték (kPa)		Hiba (kPa)		Elfogadási hibahatár [TL]	Kiterjesztett mérési bizonytalanság (kPa) [U]
	növekvő	csökkenő	növekvő	csökkenő		
3	2,95	2,97	-0,05	-0,03	± 0,2 kPa	0,0058
5	4,90	4,90	-0,10	-0,10		0,0058
10	10,0	10,1	0,0	0,1		0,058
100	99,9	99,9	-0,1	-0,1	± 0,1 kPa	0,059
500	500	500	0	0		0,58
1000	1000	1000	0	0		0,59

Környezeti hőmérséklet: **22,2 °C**

Kalibrálás módja: Közvetlen összehasonlítással KE-1/2018 kalibrálási eljárás alapján.

Visszavezethetőség: Az alkalmazott használati etalonokkal mért értékek az országos etalonokra visszavezethetők.

A közölt mérési eredmények a manométer talált metrológiai jellemzőire vonatkoznak.
A kiterjesztett mérési bizonytalanság a 2-es szorzóval megszorított standard bizonytalanság, azaz $k=2$, amely normális eloszlás esetén közelítőleg 95%-os fedési valószínűségnek felel meg.
Ez a bizonytalanság tartalmazza az etalonokból, a kalibrálás módszerével a környezeti feltételekből és a kalibrált eszköz okozta rövid ideig tartó hatásokból eredő részbizonytalanságokat az EA-4/02 szerint.

Minősítés: ¹ A közölt kalibrálási eredmények alapján a készülék a megrendelő pontossági igényének ($w = 0$ biztonsági sávval) **megfelel.**

A kalibrálás helye és időpontja: **ATKIS AUTOMATIKA Kft. Kalibráló Laboratórium Budapest, 2022.09.21.**

Kiadás dátuma: **2022.09.21**

Kalibrálást végezte:


Meisinger Antal **ATKIS**

ATKIS AUTOMATIKA Kft
Kalibráló Laboratórium
1161 Bp., Köztársaság útja 9.
Tel.: 06-1-329-5453
Tel./Fax: 06-1-451-0961

Ellenőrizte:


Muszka Zoltán

¹ Döntési szabály: **ILAC-G8:09/2019 [4.2.1]**

 Aeroplex of Central Europe Ltd. Légijármű Műszaki Központ AEROPLEX Közép-Európai Kft. Kalibráló Labor 1185 Budapest, Liszt Ferenc Nemzetközi repülőtér Tel: 06-20-9820166	Bizonyítvány száma: K 496 / 2023 Serial No. of certificate: 1 / 5 oldal / page A NAH által NAH-2-0162/2023 számon akkreditált kalibrálólaboratórium.				
KALIBRÁLÁSI BIZONYÍTVÁNY Certificate of Calibration					
A mérőeszköz típusa / Part number : MX 54C					
Megnevezése / Description : Digital multimeter					
Gyári száma / Serial number : 249804XAX					
Eszköz azonosító / Asset number : -					
Gyártó / Manufacturer : Metrix					
A tulajdonos neve / Name of the owner : ÉMI Építésügyi Minőségellenőrző Innovációs NKFT.					
A tulajdonos címe / Address of the owner : H-2000 Szentendre, Dózsa György út 26.					
A megrendelő neve / Name of the customer : ÉMI Építésügyi Minőségellenőrző Innovációs NKFT.					
A megrendelő címe / Address of the customer : H-2000 Szentendre, Dózsa György út 26.					
A megrendelés száma / Number of order : 44503					
Átvételi állapot / Incoming condition : Üzemképes / Serviceable					
A kalibrálás helye / Place of calibration : ACE KL. 8/A szoba					
A kalibrálás körülményei / Environmental conditions					
Hőmérséklet / Temperature : 23,4 °C					
Páratartalom / Humidity : 46,3 %rH					
A kalibrálás dátuma / Date of calibration : 2023.05.19					
A kalibrálás módja / Method of calibration					
Eljárás azonosítója / No. of calibration procedure : KE01/06					
Dokumentáció száma / No. of documentation : M87/14					
A kalibráláshoz használt etalonok, mérőeszközök / The reference, working standards:					
Megnevezés (Description)	Típus (Part number)	Gyári szám (S/N)	Kal.biz.szám (S/N of Cal.Cert.)	Kal.dátuma (Date of Cal.)	Kal. ciklus lejár (Due date)
hő és páratartalom regisztráló	42280	9105029	HE425/23	2023.04.03	2024.04.
ac/dc kalibrátor	9000	27255	HE713/22	2022.07.12	2023.07.
referencia multiméter	8508A	906651995	RE10/22	2022.06.30	2024.06.
ellenállás dekád	RK11M	65523	HE949/22	2022.09.07	2023.09.
Az etalonok révén a mérések eredményei nemzeti és nemzetközi etalonokra vannak visszavezetve. The results of measurements with the standards are traceable to national and international standards.					
A bizonyítvány csak teljes terjedelmében érvényes és másolható. / This certificate is valid and may not be reproduced other than full.					

 <p>A-E Aeroplex of Central Europe Ltd Légjármű Műszaki Központ Kalibráló Labor</p>	<p>Típus / P/N: MX 54C Gyári szám / S/N: 249804XAX</p>	<p>Bizonyítvány száma: K 496 / 2023 Serial No. of certificate: 2 / 5 oldal / page</p>
<p>Mérési eredmények / Measurement results:</p> <p>A készülék részletes mérési eredményeit a következő oldal(ak) tartalmazza(ák). The results of the calibration are give on the next page(s).</p> <hr/> <p>Mérési bizonytalanság / Uncertainty of the measurement:</p> <p>A mérési bizonytalanság kiszámítása az EA-4/02 M dokumentum szerint történt. A kiterjesztett mérési bizonytalanság a kettes kiterjesztési tényezővel megszorított standard bizonytalanság, azaz $k=2$, ami normál eloszlás esetén 95 %-os konfidencia szintnek felel meg. The uncertainty was calculated in accordance with the document EA-4/02 M. The reported expanded uncertainties are based on the standard uncertainties multiplied by a coverage factor $k=2$, providing a level of confidence of approx. 95 %.</p> <p>Bélyegzés / Marking:</p> <p>Az ACE Kalibráló Labor címkéjével ellátva. / The instrument is marked with label of ACE Calibration Laboratory.</p> <p>Megjegyzés / Note:</p> <p>A bizonyítványban közölt adatok a mérőeszköz talált metrológiai jellemzőire vonatkoznak. The certificate reports the results at the time of the calibration.</p> <p>A megrendelő a kalibrálási ciklusidő ajánlását kérte / <input type="checkbox"/> Igen / Yes <input checked="" type="checkbox"/> Nem / No The customer has requested to give a recommended calibration interval</p> <p>A mérőeszköz rendeltetésszerű használata és az előírás szerinti gondos tárolása és szállítása esetén az újra kalibrálás javasolt ciklus ideje: - hónap In case of proper usage and handling of the instrument the proposed interval of the calibration is: - months.</p> <p>Minősítés / Statement of compliance:</p> <p>A megrendelő a minősítést kérte / The customer has requested the evaluation : <input type="checkbox"/> Igen / Yes <input checked="" type="checkbox"/> Nem / No</p> <p>Követelmények / Basis of evaluation : -</p>		
<p>Kiadható / Approved by:</p> <p>A kiadás dátuma / Date of issue: 2023.05.19</p> <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="text-align: center;">  </div> <div style="text-align: right;"> <p>..... Bujtás István Kalibráló Labor vezető / Head of Cal. Lab.</p> </div> </div>		

 Carol - Víz Méréstechnikai Kft.	CAROL-VÍZ Méréstechnikai Kft. 1183 Budapest, Gyömrői út. 210. Tel: 30-332-8781 Telephely: 7100 Szekszárd, Keselyűsi út. 22. Tel: 74/506-557
Bankszámlaszám: Budapest Bank 10104617-43851800-01004006	Adószám: 11295585-2-43

Sorszám: 17/2022

KALIBRÁLÁSI JEGYZŐKÖNYV

A mérés helye: Carol-Víz Méréstechnikai Kft
1183 Budapest Gyömrői út 210.

A mérés ideje: 2022.03.31

Vizsgálati módszer: 6/2-2021

Alkalmazott etalonok:

Megnevezés	Gyártó	Típus	Gyártási szám	Mérési Tartomány	Bizonyítvány száma	Érvényessége
Mérlég	Mettler-Toledo	ID1-2071743	2153354	0-300 kg	BP/2002/00974-2/2021/0002	2022.04.01
Indukciós vízmérő	Krohne	IFC300	A 1100820	0,2-20 m ³ /h	BP/2004/00305-2/1/2022	2023.03.26
Ultrahangos vízmérő	Landis&Gyr	UH50	66446955	0,006-1,2 m ³ /h	BP/2004/00305-2/1/2022	2023.03.26
Hőérzékelő	IAS	PI100	0014/2000	10-70 C	Carol-Víz Méréstechnikai Kft.	2025.03.09

A mérőeszköz:

megnevezése:	Hőfogyasztásmérő átfolyásmérője
gyártója:	Siemens
típusa:	T230
mérési tartománya: [l/h]	0,15-3000 l/h
gyártási száma:	70283877
számláló állása: [m ³]	42,31

Mérési eredmények:

Beállított térfogatáram [liter/óra]	Mért érték [liter]	Helyes érték [liter]	Eltérés [liter]	Hiba [%]	Hibahatár [%]	
1	500	20,30	20,383	-0,083	-0,41	+/- 3
2	1000	50,30	50,742	-0,442	-0,87	+/- 3
3	1500	105,86	107,639	-1,779	-1,65	+/- 3
4	2000	200,13	203,876	-3,746	-1,84	+/- 3
5	2500	250,46	254,668	-4,208	-1,65	+/- 3
6	3000	302,35	306,807	-4,457	-1,45	+/- 3

Minősítés: nem minősített

Megjegyzés: Vízhőmérséklet 40 °C


CAROL-VÍZ Méréstechnikai Kft.
 1183 Budapest Gyömrői út 210.
 Mészinger István



ÉMI ÉPÍTÉSÜGYI
MINŐSGELLENŐRZŐ
INNOVÁCIÓS NKFT.

Bizonyítvány szám: MK-095-2022
Oldal szám: 1/2
Hivatkozási szám: -

2000. Szentendre, Dózsa György út 26, Postacím: 2001. Szentendre, Pf. 180.

A NAH által NAH-2-0331/2017 számon akkreditált kalibrálólaboratórium.

KALIBRÁLÁSI BIZONYÍTVÁNY

A kalibrálás tárgya:	Digitális hőmérő
Gyártó:	Siemens
Típus:	T230-A21C-HU06-P zöld jelű szonda, bal oldali kijelzett érték
Gyártási szám/azonosító:	70283877 / 1 - 1384
Méréstartomány:	0 ... 180 °C
Osztásérték:	0,1 °C
Az eszköz állapota:	Kalibrálható
A vevő neve és címe:	ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft. Központi Anyag- és Szerkezetvizsgáló Laboratórium 2000. Szentendre, Dózsa György út 26
A tulajdonos neve és címe:	ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft. Központi Anyag- és Szerkezetvizsgáló Laboratórium 2000. Szentendre, Dózsa György út 26
A kalibrálás helye, ideje:	ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft. Kalibráló Laboratórium 2000 Szentendre, Dózsa György út 26. 2022.02.28
A kalibrálást végezte:	Kovács Mátyás 

Használati etalonok:

Megnevezés	Digitális hőmérő	Hő és légnedvességmérő
Gyártó	Ahlborn GmbH	Steinberg
Típus	Almemo 2290-3	SBS-DL-123E
Gyári szám	H99041502M	462620210533
Méréstartomány	-40..180 °C (0,01°C)	-40..125°C , 0..100%rH
Kalibrálási bizonyítvány	HŐM-0119/2021	MK-285-2021 , MK-286-2021

A használati etalonok mérési bizonytalanságát a fenti táblázatban megadott számú bizonyítványok tartalmazzák, amelyek értelmében a használati etalonnal végzett mérések eredményei az országos etalonra visszavezethetők.

A kalibrálás módja:

A kalibrálás az ÉMI Nonprofit Kft. Kalibráló laboratóriumának KL-T02/2016 kódszámú eljárási utasítása alapján történt.

Környezeti feltételek:	hőmérséklet	19,9 ... 20,1 °C
	páratartalom	31,8 %rH

A bizonyítvány a kalibráló laboratórium írásbeli engedélye nélkül csak teljes terjedelemben másolható!

Bizonylat azonosító: KBiA-VIII- 12-20210915_ Digitális hőmérő



Bizonyítvány szám: MK-095-2022
Oldal szám: 2/2

Mérési eredmények

Helyes érték (°C)	Mért érték (°C)	Hiba (°C)	Kiterjesztett mérési bizonytalanság (°C)
19,8	19,9	0,1	0,1
39,7	39,6	-0,1	0,1
60,0	60,0	0,0	0,1
79,9	79,9	0,0	0,1
95,0	94,9	-0,1	0,1
-	-	-	-

A közölt kiterjesztett mérési bizonytalanság a standard bizonytalanság $k=2$ -vel szorzott értéke, ami normális eloszlás esetén közelítőleg 95%-os fedési valószínűséggel felel meg. A standard bizonytalanság meghatározása az EA-4/02M (Expression of the Uncertainty of Measurement in Calibration) kiadványnak megfelelően történt.

A minősítést az ILAC-G8:09/2019 4.2.1-2. döntési szabály alapján a vevő:

Kérte Nem kérte
w= 0

A minősítést a vevő kérésére végeztük.

Minősítési paraméter: a helyes értéktől való megengedett legnagyobb eltérés: $\pm 2^\circ\text{C}$.

Megfelelt Nem felelt meg

Ellenőrzést tanúsító jel: **ÉMI KAL**
MK-095-2022

Szentendre, 2022.03.01

A bizonyítvány kiadható:



A bizonyítvány a kalibráló laboratórium írásbeli engedélye nélkül csak teljes terjedelemben másolható!



ÉMI ÉPÍTÉSÜGYI
MINŐSÉGELLENŐRZŐ
INNOVÁCIÓS NKFT.

Bizonyítvány szám: MK-094-2022
Oldal szám: 1/2
Hivatkozási szám: -

2000. Szentendre, Dózsa György út 26, Postacím: 2001. Szentendre, Pf. 180.

A NAH által NAH-2-0331/2017 számon akkreditált kalibrálólaboratórium.

KALIBRÁLÁSI BIZONYÍTVÁNY

A kalibrálás tárgya:	Digitális hőmérő
Gyártó:	Siemens
Típus:	T230-A21C-HU06-P kék jelű sonda, jobb oldali kijelzett érték
Gyártási szám/azonosító:	70283877 / 1 - 1384
Méréstartomány:	0 ... 180 °C
Osztásérték:	0,1 °C
Az eszköz állapota:	Kalibrálható
A vevő neve és címe:	ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft. Központi Anyag- és Szerkezetvizsgáló Laboratórium 2000. Szentendre, Dózsa György út 26
A tulajdonos neve és címe:	ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft. Központi Anyag- és Szerkezetvizsgáló Laboratórium 2000. Szentendre, Dózsa György út 26
A kalibrálás helye, ideje:	ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft. Kalibráló Laboratórium 2000 Szentendre, Dózsa György út 26. 2022.02.28
A kalibrálást végezte:	Kovács Mátyás

Használati etalonok:

Megnevezés	Digitális hőmérő	Hő és légnedvességmérő
Gyártó	Ahlborn GmbH	Steinberg
Típus	Almemo 2290-3	SBS-DL-123E
Gyári szám	H99041502M	462620210533
Méréstartomány	-40..180 °C (0,01°C)	-40..125°C , 0...100%rH
Kalibrálási bizonyítvány	HŐM-0119/2021	MK-285-2021 , MK-286-2021

A használati etalonok mérési bizonytalanságát a fenti táblázatban megadott számú bizonyítványok tartalmazzák, amelyek értelmében a használati etalonnal végzett mérések eredményei az országos etalonra visszavezethetők.

A kalibrálás módja:

A kalibrálás az ÉMI Nonprofit Kft. Kalibráló laboratóriumának KL-T02/2016 kódszámú eljárási utasítása alapján történt.

Környezeti feltételek:	hőmérséklet	19,9 ... 20,1 °C
	páratartalom	31,8 %rH

A bizonyítvány a kalibráló laboratórium írásbeli engedélye nélkül csak teljes terjedelemben másolható!

Bizonylat azonosító: KBiA-VIII- 12-20210915_ Digitális hőmérő



Bizonyítvány szám: MK-094-2022
Oldal szám: 2/2

Mérési eredmények

Helyes érték (°C)	Mért érték (°C)	Hiba (°C)	Kiterjesztett mérési bizonytalanság (°C)
19,8	19,8	0,0	0,1
39,7	39,5	-0,2	0,1
60,0	59,9	-0,1	0,1
79,9	79,9	0,0	0,1
95,0	94,8	-0,2	0,1
-	-	-	-

A közölt kiterjesztett mérési bizonytalanság a standard bizonytalanság $k=2$ -vel szorzott értéke, ami normális eloszlás esetén közelítőleg 95%-os fedési valószínűséggel felel meg. A standard bizonytalanság meghatározása az EA-4/02M (Expression of the Uncertainty of Measurement in Calibration) kiadványnak megfelelően történt.

A minősítést az ILAC-G8:09/2019 4.2.1-2. döntési szabály alapján a vevő:

Kérte Nem kérte

$w = 0$

A minősítést a vevő kérésére végeztük.

Minősítési paraméter: a helyes értéktől való megengedett legnagyobb eltérés: $\pm 2^\circ\text{C}$.

Megfelelt Nem felelt meg

Ellenőrzést tanúsító jel: ÉMI KAL
MK-094-2022

Szentendre, 2022.03.01

A bizonyítvány kiadható:



laboratóriumvezető
Dali Judith Zita

A bizonyítvány a kalibráló laboratórium írásbeli engedélye nélkül csak teljes terjedelemben másolható!

		CAROL-VÍZ Méréstechnikai Kft. 1183 Budapest, Gyömrői út. 210. Tel: 30-332-8781 Telephely: 7100 Szekszárd, Keselyűsi út. 22. Tel: 74/506-557
Bankszámlaszám: Budapest Bank 10104617-43851800-01004006		Adószám: 11295585-2-43

Sorszám: 16/2022

KALIBRÁLÁSI JEGYZŐKÖNYV

A mérés helye: Carol-Víz Méréstechnikai Kft
1183 Budapest Gyömrői út 210.

A mérés ideje: 2022.03.31

Vizsgálati módszer: 6/2-2021

Alkalmazott etalonok:

Megnevezés	Gyártó	Típus	Gyártási szám	Mérési Tartomány	Bizonyítvány száma	Érvényessége
Mérleg	Mettler-Toledo	IDI-2071743	2153354	0-300 kg	BP/2002/00974-2/2021/0002	2022.04.01
Indukciós vízmérő	Krohne	IFC300	A 1100820	0,2-20 m ³ /h	BP/2004/00305-2/1/2022	2023.03.26
Ultraszagos vízmérő	Landis&Gyr	UH50	66446955	0,006-1,2 m ³ /h	BP/2004/00305-2/1/2022	2023.03.26
Hőérzékelő	IAS	Pt100	0014/2000	10-70 C	Carol-Víz Méréstechnikai Kft.	2025.03.09

A mérőeszköz:

megnevezése:	Hőfogyasztásmérő átfolyásmérője
gyártója:	Siemens
típusa:	T230
mérési tartománya: [l/h]	0,15-3000 l/h
gyártási száma:	70283842
számláló állása: [m ³]	33,95

Mérési eredmények:

Beállított térfogatáram [liter/óra]	Mért érték [liter]	Helyes érték [liter]	Eltérés [liter]	Hiba [%]	Hibahatár [%]
1	500	20,29	20,383	-0,093	-0,46
2	1000	50,42	50,742	-0,322	-0,63
3	1500	106,64	107,639	-0,999	-0,93
4	2000	201,60	203,876	-2,276	-1,12
5	2500	252,18	254,668	-2,488	-0,98
6	3000	304,30	306,807	-2,507	-0,82

Minősítés: nem minősített

Megjegyzés: Vízhőmérséklet 40 °C



ÉMI ÉPÍTÉSÜGYI
MINŐSÉGELLENŐRZŐ
INNOVÁCIÓS NKFT.

Bizonyítvány szám: MK-092-2022
Oldal szám: 1/2
Hivatkozási szám: -

2000. Szentendre, Dózsa György út 26, Postacím: 2001. Szentendre, Pf. 180.

A NAH által NAH-2-0331/2017 számon akkreditált kalibrálólaboratórium.

KALIBRÁLÁSI BIZONYÍTVÁNY

A kalibrálás tárgya:	Digitális hőmérő
Gyártó:	Siemens
Típus:	T230-A21C-HU06-P kék jelű szonda, jobb oldali kijelzett érték
Gyártási szám/azonosító:	70283842 / 1 - 1385
Méréstartomány:	0 ... 180 °C
Osztásérték:	0,1 °C
Az eszköz állapota:	Kalibrálható
A vevő neve és címe:	ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft. Központi Anyag- és Szerkezetvizsgáló Laboratórium 2000. Szentendre, Dózsa György út 26
A tulajdonos neve és címe:	ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft. Központi Anyag- és Szerkezetvizsgáló Laboratórium 2000. Szentendre, Dózsa György út 26
A kalibrálás helye, ideje:	ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft. Kalibráló Laboratórium 2000 Szentendre, Dózsa György út 26. 2022.02.28
A kalibrálást végezte:	Kovács Mátyás

Használati etalonok:

Megnevezés	Digitális hőmérő	Hő és légnedvességmérő
Gyártó	Ahlborn GmbH	Steinberg
Típus	Almemo 2290-3	SBS-DL-123E
Gyári szám	H99041502M	462620210533
Méréstartomány	-40..180 °C (0,01°C)	-40..125°C , 0...100%RH
Kalibrálási bizonyítvány	HŐM-0119/2021	MK-285-2021 , MK-286-2021

A használati etalonok mérési bizonytalanságát a fenti táblázatban megadott számú bizonyítványok tartalmazzák, amelyek értelmében a használati etalonnal végzett mérések eredményei az országos etalonra visszavezethetők.

A kalibrálás módja:

A kalibrálás az ÉMI Nonprofit Kft. Kalibráló laboratóriumának KL-T02/2016 kódszámú eljárási utasítása alapján történt.

Környezeti feltételek:	hőmérséklet	19,9 ... 20,1 °C
	páratartalom	31,8 %RH

A bizonyítvány a kalibráló laboratórium írásbeli engedélye nélkül csak teljes terjedelemben másolható!

Bizonylat azonosító: KBI A-VIII- 12-20210915_ Digitális hőmérő

Mérési eredmények

Helyes érték (°C)	Mért érték (°C)	Hiba (°C)	Kiterjesztett mérési bizonytalanság (°C)
19,8	19,8	0,0	0,1
39,7	39,7	0,0	0,1
60,0	60,0	0,0	0,1
79,9	80,0	0,1	0,1
95,0	94,9	-0,1	0,1
-	-	-	-

A közölt kiterjesztett mérési bizonytalanság a standard bizonytalanság $k=2$ -vel szorzott értéke, ami normális eloszlás esetén közelítőleg 95%-os fedési valószínűséggel felel meg. A standard bizonytalanság meghatározása az EA-4/02M (Expression of the Uncertainty of Measurement in Calibration) kiadványnak megfelelően történt.

A minősítést az ILAC-G8:09/2019 4.2.1-2. döntési szabály alapján a vevő:

Kérte Nem kérte
w= 0

A minősítést a vevő kérésére végeztük.

Minősítési paraméter: a helyes értéktől való megengedett legnagyobb eltérés: $\pm 2^\circ\text{C}$.

Megfelelt Nem felelt meg

Ellenőrzést tanúsító jel: **ÉMI KAL**
MK-092-2022

Szentendre, 2022.03.01

A bizonyítvány kiadható:




laboratóriumvezető
Dali Judith Zita

A bizonyítvány a kalibráló laboratórium írásbeli engedélye nélkül csak teljes terjedelemben másolható!



ÉMI ÉPÍTÉSÜGYI
MINŐSÉGELLENŐRZŐ
INNOVÁCIÓS NKFT.

Bizonyítvány szám: MK-093-2022
Oldal szám: 1/2
Hivatkozási szám: -

2000. Szentendre, Dózsa György út 26, Postacím: 2001. Szentendre, Pf. 180.

A NAH által NAH-2-0331/2017 számon akkreditált kalibrálólaboratórium.

KALIBRÁLÁSI BIZONYÍTVÁNY

A kalibrálás tárgya: Digitális hőmérő
Gyártó: Siemens
Típus: T230-A21C-HU06-P zöld jelű szonda, bal oldali kijelzett érték
Gyártási szám/azonosító: 70283842 / 1 - 1385
Méréstartomány: 0 ... 180 °C
Osztásérték: 0,1 °C
Az eszköz állapota: Kalibrálható

A vevő neve és címe: ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft.
Központi Anyag- és Szerkezetvizsgáló Laboratórium
2000. Szentendre, Dózsa György út 26

A tulajdonos neve és címe: ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft.
Központi Anyag- és Szerkezetvizsgáló Laboratórium
2000. Szentendre, Dózsa György út 26

A kalibrálás helye, ideje: ÉMI Építésügyi Minőségellenőrző Innovációs Nonprofit Kft.
Kalibráló Laboratórium
2000 Szentendre, Dózsa György út 26.
2022.02.28

A kalibrálást végezte: Kovács Mátyás

Használati etalonok:

Megnevezés	Digitális hőmérő	Hő és légnedvességmérő
Gyártó	Ahlborn GmbH	Steinberg
Típus	Almemo 2290-3	SBS-DL-123E
Gyári szám	H99041502M	462620210533
Méréstartomány	-40..180 °C (0,01°C)	-40..125°C , 0...100%rH
Kalibrálási bizonyítvány	HŐM-0119/2021	MK-285-2021 , MK-286-2021

A használati etalonok mérési bizonytalanságát a fenti táblázatban megadott számú bizonyítványok tartalmazzák, amelyek értelmében a használati etalonnal végzett mérések eredményei az országos etalonra visszavezethetők.

A kalibrálás módja:

A kalibrálás az ÉMI Nonprofit Kft. Kalibráló laboratóriumának KL-T02/2016 kódszámú eljárási utasítása alapján történt.

Környezeti feltételek: hőmérséklet 19,9 ... 20,1 °C
páratartalom 31,8 %rH

A bizonyítvány a kalibráló laboratórium írásbeli engedélye nélkül csak teljes terjedelemben másolható!

Bizonylat azonosító: KBiA-VIII- 12-20210915_ Digitális hőmérő



Bizonyítvány szám: MK-093-2022
Oldal szám: 2/2

Mérési eredmények

Helyes érték (°C)	Mért érték (°C)	Hiba (°C)	Kiterjesztett mérési bizonytalanság (°C)
19,8	19,8	0,0	0,1
39,7	39,5	-0,2	0,1
60,0	59,9	-0,1	0,1
79,9	79,8	-0,1	0,1
95,0	94,8	-0,2	0,1
-	-	-	-

A közölt kiterjesztett mérési bizonytalanság a standard bizonytalanság $k=2$ -vel szorzott értéke, ami normális eloszlás esetén közelítőleg 95%-os fedési valószínűséggel felel meg. A standard bizonytalanság meghatározása az EA-4/02M (Expression of the Uncertainty of Measurement in Calibration) kiadványnak megfelelően történt.

A minősítést az ILAC-G8:09/2019 4.2.1-2.döntési szabály alapján a vevő:

Kérte Nem kérte

$w=0$

A minősítést a vevő kérésére végeztük.

Minősítési paraméter: a helyes értéktől való megengedett legnagyobb eltérés: $\pm 2^\circ\text{C}$.

Megfelelt Nem felelt meg

Ellenőrzést tanúsító jel: **ÉMI KAL**
MK-093-2022

Szentendre, 2022.03.01

A bizonyítvány kiadható:




laboratóriumvezető
Dali Judith Zita

A bizonyítvány a kalibráló laboratórium írásbeli engedélye nélkül csak teljes terjedelemben másolható!

Data sheet

Pressure transmitter for industrial applications

MBS 4510



The high accuracy flush diaphragm pressure transmitter MBS 4510 is designed for use in non-uniform, high viscous or crystallizing media within industrial applications, and offers a reliable pressure measurement, even under harsh environmental conditions.

The flexible pressure transmitter programme covers a 4 – 20 mA output signal, absolute or gauge (relative) versions, measuring ranges from 0 – 0.25 to 0 – 25 bar zero and span adjustment. A rotatable plug connection and a G1A conic pressure connection with flush mounted diaphragm.

Excellent vibration stability, robust construction, and a high degree of EMC/EMI protection equip the pressure transmitter to meet the most stringent industrial requirements.

Features

- Designed for use in severe industrial environments
- Enclosure and wetted parts of acid-resistant stainless steel (AISI 316L)
- Pressure ranges in relative (gauge) or absolute up to 25 bar
- Output signal: 4 – 20 mA
- Temperature compensated and laser calibrated
- Accuracy 0.5% FS
- Zero and span adjustment
- USDA-H1 approved oil filling
- For use in Zone 2 explosive atmosphere

Data sheet | Pressure transmitter for industrial applications, MBS 4510

Technical data

Performance (EN 60770)

Accuracy (incl. non-linearity, hysteresis and repeatability)		$\leq \pm 0.2\%$ FS (typ.)
		$\leq \pm 0.5\%$ FS (max.)
Non-linearity BFSL (conformity)		$\leq \pm 0.2\%$ FS
Hysteresis and repeatability		$\leq \pm 0.1\%$ FS
Thermal zero point shift	Measuring range:	0 – 250 mbar $\leq \pm 0.4\%$ FS / 10K
		0 – 400 mbar $\leq \pm 0.3\%$ FS / 10K
		≥ 0 – 600 mbar $\leq \pm 0.2\%$ FS / 10K
Thermal sensitivity (span) shift	Measuring range:	0 – 250 mbar $\leq \pm 0.4\%$ FS / 10K
		0 – 400 mbar $\leq \pm 0.35\%$ FS / 10K
		≥ 0 – 600 mbar $\leq \pm 0.2\%$ FS / 10K
Response time		< 4 ms
Durability, P: 10 – 90% FS		$> 10 \times 10^6$ cycles
Zero point adjustment	Measuring range:	0 – 0.25 to 0 – 10 bar -5 – 20% FS
		0 – 16 to 0 – 25 bar -5 – 10% FS
Span adjustment	Measuring range:	0 – 0.25 to 0 – 25 bar -5 – 5% FS

Available measuring ranges

Pressure range [bar]	Max. Overload pressure [bar]	Burst pressure [bar]
-0.25 – 0.50	2	50
0.00 – 0.25	2	50
0.00 – 0.40	2	50
0.00 – 0.60	2	50
0.00 – 1.00	2	50
0.00 – 1.60	8	50
0.00 – 2.50	8	50
0.00 – 4.00	8	50
0.00 – 6.00	20	50
0.00 – 10.00	20	50
0.00 – 16.00	100	100
0.00 – 25.00	100	100

Electrical specifications

Nom. output signal (short-circuit protected)	4 – 20 mA
Supply voltage [U _s] polarity protected	10 – 30 V DC
Supply voltage dependency	$\leq \pm 0.1\%$ FS / 10V
Current limitation (linear output signal up to 1.5 x rated range)	28 mA (typ.)
Load [R _L] (load connected to 0V)	$R_L \leq (U_s - 10V) / 0.02$ A [Ω]

Data sheet | Pressure transmitter for Industrial applications, MBS 4510

Technical data
(continued)

Environmental conditions

Sensor temperature range	Normal	-40 – 85 °C
	ATEX Zone 2	-10 – 85 °C
Media temperature	115 - (0.35 x ambient temperature)	
Ambient temperature range	-10 – 85 °C	
Compensated temperature range	0 – 80 °C	
Transport / Storage temperature range	-25 – 85 °C	
EMC – Emission	EN 61000-6-3	
EMC – Immunity	EN 61000-6-2	
Insulation resistance	> 100 MΩ at 100 V	
Mains frequency test	Based on SEN 361503	
Vibration stability	Sinusoidal	15.9 mm-pp, 5 Hz – 25 Hz 20 g, 25 Hz – 2 kHz
	Random	7.5 g _{rms} , 5 Hz – 1 kHz
Shock resistance	Shock	500 g / 1 ms
	Free fall	1 m
Enclosure (depending on electrical connection)	IP65	

Explosive atmospheres

Zone 2 applications		EN60079-0; EN60079-15
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When used in ATEX Zone 2 areas at temperatures <10 °C the cable and plug must be protected against impact

Mechanical characteristics

Materials	Wetted parts	EN 10088-1; 1.4404 (AISI 316 L)
	Enclosure	EN 10088-1; 1.4404 (AISI 316 L)
	Electrical connections	Glass filled polyamid PA 6.6
Gasket (above thread)	DIN 3869-33-NBR	
Net weight (depending on pressure connection and electrical connection)	0,4 kg	

Data sheet | Pressure transmitter for Industrial applications, MBS 4510

Ordering standard

MBS 4510	1	-	A1	C	B	1	2
Measuring range							
0.25 – 0.5 bar	A	4					
0 – 0.25 bar	0	4					
0 – 0.4 bar	0	6					
0 – 0.6 bar	0	8					
0 – 1.0 bar	1	0					
0 – 1.6 bar	1	2					
0 – 2.5 bar	1	4					
0 – 4.0 bar	1	6					
0 – 6.0 bar	1	8					
0 – 10 bar	2	0					
0 – 16 bar	2	2					
0 – 25 bar	2	4					
Pressure reference							
Gauge (relative)	1						
Absolute	2						

Pressure connection
G1A, ISO 228-1, Flush male

Electrical connection
Plug Pg 9 (EN 175301-803-A)

Output signal
1 4 – 20 mA

Preferred version

Electrical connections

Electrical connection	4 – 20 mA output (2 wire)
<p>EN 175301-803-A, Pg 9</p>	<p>Pin 1: + supply Pin 2: - supply Pin 3: Not used</p> <p> Earth: Connected to MBS enclosure</p>

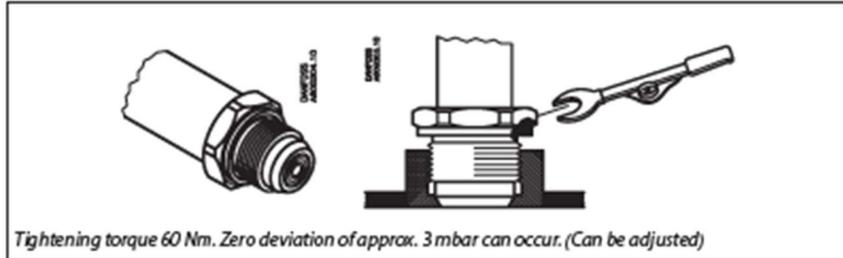
Dimensions

Threaded hole (Sealing above thread)

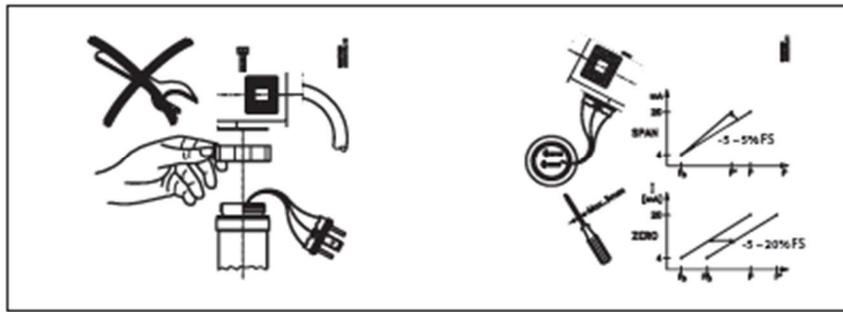
$\phi 33.5^{+0.2}$
 G1A
 27
 DANFOSS MBS4510.10



Installation



Adjustment



Accessories

<p>Welding nipple for conic metal/metal seal Code no.: 060G2501</p>	<p>DIN 11851 (dairy connection), DN40 Code no.: 060G2505</p>
<p>DIN 11851 (dairy connection), DN50 Code no.: 060G2506</p>	<p>Clamp, ISO 2852, 1 1/2 in. Code no.: 060G2502</p>
<p>Clamp, ISO 2852, 2 in. Code no.: 060G2510</p>	<p>SMS 1145 connection, 1 1/2 in. Code no.: 060G2503</p>

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Annex III: Policy Brief A:



Introduction

In the MiniStor technology, ammonia is used as working fluid and chemical energy carrier that interacts with the TCM material. Ammonia's inherent toxicity has forced restrictive standards for its use in HVAC systems since the very earliest refrigeration systems. Systems using ammonia are generally placed outdoors. The final placement of the system, either indoors or outdoors, potentially restricts the market sector for which it is directed. With the proposed enclosures and systems which are being used in commercial applications for mobile refrigeration systems, new standards can be set for ammonia containers, valves and tubing that are safer and more reliable. Ammonia regulations are based on the European Standard regulating the load limits in refrigeration systems: EN 378: 2016. This standard specifies that if the refrigeration system (the absorption loop in the case of the MiniStor system) has a double indirect system configuration, there is no load limit, since the ammonia will be stored in a different room, and not directly connected to any inhabited space. However, the room where the TCM is placed must comply with requirements of EN 378: 2016 - Part 3. It is

very likely that most of EU Member States have legislated certain load limits based on the EN 378:2016. Regional or even local regulations may impose more restrictive requirements that in some cases could bring some interdictions to installing the TCM in certain places. These potential interdictions could be a barrier for the placement of TCM at the time to commercialize the MiniStor product in certain locations. The existing regulations for ammonia at European level cover emissions limits, workplace safety, transportation, environmental protection, and industrial risk management. Companies handling ammonia must strictly comply with these regulations to operate legally and sustainably. Legislation in France and at the European level aims to guarantee worker safety, environmental protection, and public health, considering the industrial needs. The operators of systems using ammonia are required to adhere to strict standards, take necessary measures to prevent accidents and minimize the operational risks. Authorities monitor and update such regulations to ensure the safe use of ammonia.

- Ammonia is a toxic gas that is used as refrigerant interacting with the TCM in the MiniStor unit.
- Ammonia regulations are based on the European Standard EN 378: 2016, which regulates the load limits in refrigeration systems.
- Regional or even local regulations may bring some interdictions to installing the TCM in certain places, such as indoor environments.
- Potential interdictions could be a barrier for the placement of TCM at the time to commercialize the MiniStor product in certain locations.



Use of ammonia as energy carrier in compact thermochemical heat/cold storage units for residential buildings

Benefits of using ammonia

- Ammonia is an environmentally friendly substance which (unlike other refrigerants) does not contribute to the depletion of the Earth's ozone layer and has a negligible global warming potential, whose synthesis and decomposition chemical reactions involve significant enthalpy changes (~30 MJ/kg), enabling compact energy storage in buildings, where minimizing storage volume is crucial.
- Ammonia's decomposition and synthesis through a reversible endothermic/exothermic reaction enables cyclical absorption and release of heat without significant degradation over many cycles, typically ammonia-based thermochemical energy storage systems show no loss of performances in 20+ years.
- Maintenance of ammonia-based thermochemical energy storage systems is manageable because ammonia is contained in sealed closed loop circuits, minimising the need of interventions, e.g. for ammonia refills. Furthermore, sensors and automated controls reduce the need for manual inspection.
- Ammonia salts used in thermochemical energy storage are recyclable as they absorb and release ammonia over many cycles without being consumed. Graphite used in thermochemical energy storage systems as thermal conductivity enhancer and/or structural/porous matrix for salt impregnation is also highly recyclable as it does not react with ammonia or salts, and it may be used for decades.
- Thermochemical heat storage systems using ammonia like the Ministor system are technically performant and are likely to become a commercial products as they have a COP well higher than the average, produce no noise during operation, and are based on a mature and reliable technology.
- Ammonia is one of the most widely produced chemicals, that is used primarily for fertilizers. Therefore, ammonia has a well-established global supply chain. However, the use of ammonia salts in thermochemical energy storage is still an emerging application which is not fully developed at scale yet.

Risks of using ammonia

Risks of using ammonia (NH₃) in the TCM unit to meet the operational requirements of the MiniStor system must be carefully assessed. The aim of such risk assessment is to provide a comprehensive analysis of the potential health, environmental and explosion risks that may result from the use of NH₃. Adequate measures must be implemented to reduce health risk such as discomfort and eye irritation, or more severe respiratory and eye symptoms, e.g., implementing ventilation and gas detection systems to safeguard the well-being of people who could come in contact with ammonia. Other risks that must be assessed include environmental risks, flammability and explosive risk, risk of materials corrosion. Effective safety measures to mitigate the risks associated with the use of ammonia include integrated monitoring systems, risk detection and mitigation technologies, emergency response plans, strict access control, comprehensive training and compliance with regulatory standards.



Use of ammonia as energy carrier in compact thermochemical heat/cold storage units for residential buildings

Conclusion

Barriers, opportunities and recommendations

Policy barriers and opportunities for TCM system application

- 🏠 Safety concerns and regulations may limit the diffusion of the Ministor system to some specific applications and use cases^{1,2,3}.
- 🏠 Ammonia is listed in Annex I of the Seveso-III Directive (2012/18/EU), a European Union regulation aimed at preventing and controlling accidents involving hazardous substances⁴, as it poses an actual risk when it is used in high-volume industrial uses. However, Seveso-III compliance is disproportionate for low-risk applications such as thermochemical energy storage in residential buildings.
 - The Seveso-III directive defines application-specific quantitative limits (thresholds) for ammonia, which differentiate the safety requirements for a specific site depending on whether the site handles or holds amounts of equal to or above these thresholds, without considering whether the application of ammonia is low-risk (e.g. use of ammonia in small, sealed and monitored parts of a thermochemical energy storage system) or high-risk (e.g. tons of ammonia stored in an open tank of a fertiliser plant).
- 🏠 Transport and installation permits for ammonia-based systems are unnecessarily complicated, especially for small and low-risk systems, which could benefit of simplified and accelerated applications for permits without compromising the safety and regulatory compliance.

Policy recommendations

- 🏠 Incentivise the use of highly efficient and environmentally friendly refrigerants such as ammonia (R-717) by means of subsidies or tax breaks.
- 🏠 Incentivise the installation of thermochemical heat storage systems using ammonia which use a photovoltaic thermal (PVT) system and enable to increase RES-generated heat of the PVT, achieving a COP greater than one (the Ministor system achieves a COP of 1.8).
- 🏠 Develop a new technical standard for ammonia-based system design and containment specific for the residential sector, which lacks the infrastructure available in industry to handle risks due to ammonia's toxicity and mild flammability. Key requirements for the design of safe systems in residential buildings are: 1. Place the compressor and ammonia-containing parts in a separate sealed shed outside the main building, while a secondary refrigerant (such as water or glycol) is circulated into the living space. 2. Install leakages detection and ventilation systems.



Use of ammonia as energy carrier in compact thermochemical heat/cold storage units for residential buildings

- 🏠 **Develop** guidelines for the design of ammonia detection systems comprising installation of gas sensors in plant rooms and their connection to emergency ventilation fans, automatic shut-off valves and alarm systems.
- 🏠 **Develop** a comprehensive training programme for technicians of refrigeration and energy storage systems containing ammonia, tailored to residential applications. Such programme should cover aspects related to safety and risk management, system installation and commissioning, ordinary maintenance, diagnosing of common faults and repairs, compliance with technical standards and regulations, system decommissioning with ammonia recovery and disposal.
- 🏠 **Update** the Seveso-III directive introducing an exemption from the application of the directive for low risk applications, such as thermochemical energy storage in residential buildings.
- 🏠 **Allow** pre-certification of ammonia-based system designs using modular components (such as thermochemical energy storage systems for residential buildings), aimed at a faster transport and installation permit approval, especially for low complexity systems containing low amounts of ammonia.



Use of ammonia as energy carrier in compact thermochemical heat/cold storage units for residential buildings

References

- 1 Ministor D2.3: Analysis of relevant legislation and standards for system operation (Identification of barriers and opportunities for system application through examination of standards and regulations.)
- 2 Ministor D2.5 : Safety and maintenance report (Specification of safety requirements for system operation.)
- 3 Ministor D4.6 : Safety assessment for NH₃ handling in the system (detailing of a safe operation plan for handling ammonia in the system)
- 4 Directive 2012/18/EU of the European Parliament and of the Council of 4 July 2012 on the control of major-accident hazards involving dangerous substances. <https://eur-lex.europa.eu/eli/dir/2012/18/oj/eng>

About this Policy Brief

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