WNIOSEK
O WSZCZĘCIE POSTĘPOWANIA HABILITACYJNEGO

Załącznik 2b

AUTOREFERAT W JĘZYKU ANGIELSKIM

dr inż. Agnieszka Lechowska

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Annex 2b

PhD Agnieszka Lechowska
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SELF-PRESENTATION

Table of contents:

1. Name and surname

Agnieszka Lechowska

2. Diplomas

30.06.1995 Master's degree in environmental engineering, T. Kościuszko Cracow University of Technology, Department of Environmental Engineering, master's thesis *The universal solution of equations of the laminar boundary layer during forced convection*, Supervisor: PhD Piotr Gryglaszewski

15.11.2000 Doctoral degree, doctor of technical sciences in the field of environmental engineering, T. Kościuszko Cracow University of Technology, Department of Environmental Engineering, doctoral thesis *Determination of average heat transfer coefficients using the unified Wilson method*, supervisor: prof. dr hab. Eng. Teresa Styrylska, reviewers: prof. zw. dr hab. Eng. Zygmunt Kolenda, dr hab. Eng. Marian Hopkowicz, prof. PK

3. Information on previous employment in scientific units

1.02.2001 - 31.01.2002 Scientific and didactic assistant in the Faculty of Heating, Thermal Systems and Waste Utilization of the Institute of Thermal Engineering and Air Protection, Department of Environmental Engineering, T. Kościuszko Cracow University of Technology

1.02.2002 - 31.01.2014 Scientific and didactic adjunct in the Faculty of Heating, Thermal Systems and Waste Utilization of the Institute of Thermal Engineering and Air Protection, Department of Environmental Engineering, T. Kościuszko Cracow University of Technology

1.02.2014 - up till now Scientific and didactic adjunct in the Chair of Heating, Ventilation, Air Conditioning and Refrigeration of the Institute of Thermal Engineering and Air Protection, Department of Environmental Engineering, T. Kościuszko Cracow University of Technology

8.01.2011 - 30.11.2013 Head of postgraduate studies in Energy Consulting in Civil Engineering, Department of Environmental Engineering, T. Kościuszko Cracow University of Technology

1.09.2013 - up till now Deputy Director of Science, Institute of Thermal Engineering and Air Protection, Department of Environmental Engineering, T. Kościuszko Cracow University of Technology

19.04.2016 - up till now Technical Manager of the Laboratory of Thermal Engineering in the Chair of Heating, Ventilation, Air Conditioning and Refrigeration of the Institute of Thermal Engineering and Air Protection, Department of Environmental Engineering, T. Kościuszko Cracow University of Technology

4. Indication of the scientific achievement resulting from the art. 16 par. 2 act of 14 March 2003 on academic degrees and academic title, and on degrees and title in the field of art (Official Journal of 2003 No 65, pos. 595 with changes)

4.1. Title of scientific achievement

Transient thermal models of building components

4.2. Authors, titles of publications, publication date, name of the publishing house, publishing reviewers

Monograph:
Lechowska Agnieszka, *Transient thermal models of building components*, Monographs of Cracow University of Technology, Environmental Engineering Series, Kraków 2017, publishing reviewers: prof. zw. dr hab. Eng. Bogusław Zakrzewski, dr. hab. Eng. Jan Radoń, prof. UR

Article:
Lechowska Agnieszka, Guzik Artur, *Model of unsteady heat exchange for intermittent heating taking into account hot water radiator capacity*, Elsevier, Energy and Buildings, Vol. 76, pp. 176-184, 2014

4.3. Discussing the scientific goal of the work and the results achieved, and discussing their possible use

My scientific work after defending my doctoral thesis and employment at the Institute of Thermal Engineering and Air Protection of the Cracow University of Technology were mainly related to the application in the environmental engineering of the issues of heat exchange, heating and building physics. An important issue in the scientific work was the possibility of saving energy during the heating season by heating the rooms with switch-off modes or with lower set-point temperature. It is a method in which, in selected periods of time, a controlled radiator heating system either stops or reduces the flow of heating medium in the radiators causing a decrease in the internal temperature in rooms to a given level, enabling energy savings for heating purposes. Lowering the indoor temperature in residential buildings is possible either during the day when the room occupants are absent or at night when the users are asleep and the lower temperature does not affect the feeling of reduced thermal comfort. In non-residential buildings, in turn, it is possible to carry out during periods of the day, when users do not stay indoors.

As part of cooperation with dr hab. Eng. Marian Hopkowicz, prof. PK, I undertook the issue of mathematical modeling of unsteady heat exchange in heated rooms with switch-off modes. The subject of energy-saving heating in this time (year 2006 and subsequent) was an important trend of scientific development, which was reflected in the codification work of the European Commission, but also at scientific conferences. As a result, in 2007 I developed a mathematical model of transient heat exchange in a heated room with switch-off modes. In this model I used transient heat transfer through building partitions surrounding the room. The numerical control volume method has been applied, in which the area under examination (eg. a wall, ceiling) is discretized into geometrical elements and enthalpy balances are prepared for each element. Room partitions were divided into parallel elements 1D. The absence of internal energy sources was assumed. It has been also assumed that each element is represented by a node lying in the center of its mass, while the whole element has a temperature equal to the temperature of the node. Between the adjacent nodes, there is a linear temperature distribution, in the nodes located inside the body, the entire thermal capacity of the elements is concentrated, while the nodes located on the body surface have no capacity. Heat entering the considered node from neighboring nodes or from the surface of the body causes the increase of the element enthalpy with the assumption of isobaric heat transfer. An additional equation closing the system of equations was the equation describing the exchange of heat in the room between air and surfaces of partitions surrounding the room, and the radiator, heat transfer through the window and infiltrating from the outside into the room. This model allows to determine both temperatures inside the partitions (in all nodes), as well as air temperature in the room. The model I have developed differs from previously developed models because it is based on the control volume method method instead of the simpler finite difference method. What's more, it uses the original method of calculating the components in the equation of thermal balance of air in the room. In addition, the developed model uses full transient processes, in which I replaced the derivative of temperature over time with a differential backward implicit scheme.

After developing a model of transient heat exchange in the room, I undertook laboratory measurements aimed at the experimental verification of the prepared model by measuring the air temperature and the surface of the partitions in the actual heated room with cut-off modes. For research I chose an office room on the campus of the Cracow University of Technology. I obtained satisfactory convergence between the measurement and simulation results. The maximum discrepancies reached 10%, despite the fact that at this stage I adopted a number of simplifying assumptions, eg. concerning the description of solar radiation on external barriers.

Thanks to the developed model, I was able to determine the temperature in the layers of the building envelope surrounding the room. Knowledge of their values allowed me to determine what part of the external and internal walls from the room side is involved in the heat exchange in the room.

The calculations showed that the first dozen centimeters in the external walls from the room side take on significant temperature changes when the heating is turned off and when the room is cooling down. This is the same layer taking part in heat exchange with air in the room.

The remaining part of the partitions only slightly changes its temperature with significant changes in the internal temperature. It should be added that, of course, lightweight partitions with a small thermal capacity react more quickly to changes than heavy partitions. I analyzed several types of external walls, from heavy solid bricks through a brick wall, layered reinforced concrete up to a light wall filled with mineral wool. I analyzed these partitions in two types of rooms: in smaller and larger cubature. I found that the room with smaller cubature slower diminishes its temperature. The reason is the thermal capacity of the air in the room, which is much smaller than the capacity of the partitions. A smaller room has more partitions that store heat than a larger room.

In the course of my further work, I analyzed the possibilities of improving and developing the model of transient heat exchange in rooms that I prepared. I have found that the element that can affect the obtained final results of temperatures in the partitions and air in the room is the heat capacity of the radiator, especially in rooms with light partitions, which are increasingly common in office buildings. I decided to take it into account in the model I was developing. Therefore, I took into account the thermal capacity of the water filling the radiator and the material of the radiator, which was an additional new element not present in previous works. In the equation of the energy balance of the cooling radiator, I assumed that due to the high thermal conductivity of the steel and the low convective resistance on the inner side of the radiator (from water to the inside walls of the radiator), only heat transfer resistance from the outside walls of the radiator to the room can be considered between water and room air. The energy balance of the cooling heater allowed the determination of the water temperature in the radiator. However, due to the fact that both air temperature in the room as well as temperature of the water in the radiator change at every time step, this balance had to be also solved at every time step.

I verified the improved model of transient heat exchange in the room with measurements. I carried out the measurements in another room heated with cut-off modes. This time for research I chose a room that is an office room with partitions of low thermal capacity and large glazing. In this type of rooms, the heat capacity of the radiator is much more important than in rooms with heavy partitions. I have extended the measurement method so that the measurements concerned not only the surface of the partitions and air temperatures, but also the temperature of the water in the radiator and other air parameters affecting thermal comfort such as the average radiative temperature, relative humidity and air velocity in the room. Based on the measurement results of the mentioned parameters, I carried out calculations of thermal comfort indices in the analyzed room. I also made simulation calculations as a supplement to these results using the mathematical model I developed. Mathematical model was additionally extended by an element that takes into account the time distribution of internal heat gains. What's more, I introduced the so-called sol-air temperature, i.e. I indirectly took into account solar radiation by converting the measured outside air temperature into a slightly higher temperature taking into account the total solar radiation falling on the room's outer walls. It is a method of avoiding non-linear balance equations that is often used in modeling, allowing for taking into account heat gains from solar radiation, which even in winter are of considerable importance. The convergence of the air temperatures determined in the model and the measured temperatures in the cooling room and the temperature of the water in the radiator was very good, which allowed me to prepare a publication entitled *Model of unsteady heat exchange for intermittent heating taking into account hot water radiator capacity*, which due to the advanced nature of the modeling and laboratory measurements was published in the leading global magazine Energy and Buildings in 2014 (Annex 3, point A.2.2). In the publication, I also put emphasis on the statistical processing of measurement results and model simulation results. An important conclusion of the work was that in order to achieve an occupant-acceptable level of thermal comfort in the room, it is necessary to switch on the heating system about 4 hours before users return to the building, if the installation was turned off, for example, for 10 hours or more.

The next stage of my work on the mathematical model of transient heat exchange in a heated room with cut-offs was to add a module that takes into account mechanical ventilation in the building if it occurs. The last version of the model I developed was described and verified by measurements in my monograph entitled *Transient thermal models of building components* published in 2017 (Annex 3, point A.2.1) constituting the quintessence of the postdoctoral achievement.

During my scientific work in order to expand the developed models of transient heat exchange in elements of heating installations and building structures, I extended the scientific workshop on CFD (Computational Fluid Dynamics) with help of the advanced computer program Ansys Fluent using the finite element method. I have successfully implemented the CFD method for the calculation of heat exchange and mass flow in the range enabling the incorporation of modern CFD method into developed models of transient heat exchange in building elements. Although the mathematical model of transient work of the cooling radiator that I developed was already verified by means of measurements, in order to improve the modeling results, I additionally developed a geometrical model of the actual radiator using the Ansys Fluent program. The radiator was installed in the room during measurements. I verified the CFD model of the radiator using the results of previously performed measurements. In the transient third type of boundary conditions, I assumed the results of the air temperature measurements surrounding the radiator in the cooling room. I received a very good convergence of calculation results in the program and the results of measurements of the water temperature in the radiator. I published the results of this stage of my work in the aforementioned monograph entitled *Transient thermal models of building components* (Annex 3, point A.2.1). Summing up this stage of my work, I can say that the preparation of the correct geometrical model of the actual radiator and numerical mesh is very time-consuming, but it allows to obtain calculation results convergent with the measurement results. An additional barrier to the implementation of such extended models is the need to access advanced computers with high computing power.

Performing transient calculations by a computer with normal computing power, with a grid consisting of 4 million elements for 12 hours of cooling a radiator at a time step of 2 minutes, lasted 3 weeks. In order to shorten the computing time, I used super computers available in the plgrid network as a part of the computational grant received at the Academic Computer Center CYFRONET AGH. The Zeus super computer was used in the calculations.

It is a computing cluster with the Scientific Linux 6 operating system, an Intel Xeon processor with 23 TB of computing power 169 TFlops. The use of super computers makes it possible to significantly reduce the calculation time.

In the further stage of my work, I undertook another very important issue omitted in the current literature on the dynamics of heat transfer processes through transparent building structures. It is usually assumed that when the outside and inside air temperatures change, the window thermal transmittance does not change. To decide whether such a simplification is justified, I carried out an analysis allowing the assessment of this simplification. As a technical manager of the Laboratory of Thermal Engineering, which, in the calorimetric chamber of the Institute of Thermal Engineering and Air Protection PK, carries out standard measurements of the thermal transmittance of samples in the steady state conditions, I carried out a measurement of the external vertical window sample. Then I made a numerical model of the cross section of this window in the Ansys Fluent program and determined the thermal transmittance for the entire window. The measured value differed with the numerically calculated value by less than 7%. Therefore, I assumed that the thermal transmittance of the window can be numerically determined in a correct way. Thus, only the last stage remained, i.e. changing the boundary conditions and checking how it affects the final result of the thermal transmittance of the window. My calculations showed that the window thermal transmittance changes by less than 10% with extremely different temperature conditions at the boundaries. However, the change in window thermal transmittance did not cause significant changes in the results of the internal temperature calculation in my model of transient heat exchange in the rooms (maximum 1.5%). I described the results of these analyzes in my monograph (Annex 3, point A.2.1). Therefore, it can be considered reasonable to introduce a simplification based on the adoption of a constant value of window heat transfer coefficient in calculations of transient heat exchange in rooms. This is an important application that can be used in further scientific work.

The last stage of my work as part of numerical modeling was developing a numerical 3D model in the Ansys Fluent program and then coupling the calculation results of partition surface temperatures obtained in the model of transient heat exchange in rooms and introducing them as input data in first type boundary conditions of the 3D CFD model of the whole room. As a final result from the 3D model I received the values of heat transfer coefficients between the room air and the partition surfaces forming the room. The obtained values allowed for the improvement of the input data values to my model of transient heat exchange in the room, because heat transfer coefficients were introduced there as known a priori adopted values. This coupling of two methods and two models allowed me to improve the convergence of the model of transient heat exchange in the room. I presented the results of these analyzes in my monograph (Annex 3, point A.2.1).

Summing up, it can be concluded that having a computational mathematical model developed by itself, the duration of data entry and simulation calculations is incomparably shorter than in the CFD calculations. This is the undoubted advantage of simple computational models. Yes, they have a lot of simplifications (my model assumed a one-dimensional heat flow and ideal air mixing in the room - no air temperature gradient), however, very accurate calculation models are not always needed. There are situations, for example with integrated design, that in the decision-making process as to the selection of structure materials or their thickness, information is needed on how office space will react to the night heating cut-offs. Such a simplified model can give a quick response without the need for time-consuming, real and accurate 3D models of building. It can also give an answer of the necessary heating time prior to the occupants working hours, so that the users of rooms will be provided with thermal comfort after returning to them. Thanks to the developed model, you can also easily calculate the energy losses of the room, and therefore energy savings obtained during periods of cut-offs or weaknesses in the power of the heating installation. What's more, you can predict the parameters of thermal comfort in the room, which is in turn useful from the point of view of employee efficiency.

5. The course of scientific work and discussion of other scientific and research achievements

5.1. The course of scientific work before obtaining the doctoral degree

I started my master's studies in 1989 at the Department of Sanitary and Water Engineering (currently the Department of Environmental Engineering) of the Cracow University of Technology in the field of environmental engineering. During my studies I chose the specialty of thermal, health and air protection devices. I have prepared my master's thesis under the supervision of PhD Piotr Gryglaszewski. The title of my work was: *The universal solution of equations of the laminar boundary layer during forced convection*. The work concerned methods of solving the equations of the laminar boundary layer created at the flow of bodies of any shape. In my work, I proposed the method of "universalization" of Saljnikow's equations used to describe a laminar thermal boundary layer. "Universalization" consisted in the appropriate transformation of these equations so that they are independent of the velocity distribution, i.e. the shape of the body flowed around. I defended my master's thesis with a very good result in June 1995, receiving a master's degree in engineering.

In the same year, immediately after completing my Master's studies, I started doctoral studies at the Department of Environmental Engineering at the Cracow University of Technology. The promoter of my doctoral thesis was Mrs. dr hab. Eng. Teresa Styrylska, who formulated the scientific task related to the Wilson method and the compensatory approach. The Wilson method consists in separating the total resistance of heat transfer through the wall in the heat exchanger to the sum of convective resistances and conduction resistance and the use of linear regression to determine the average heat transfer coefficients. In this method, the heat exchanger is balanced on the basis of properly carried out series of temperature measurements and flow rates of the medium, and then the equation describing the resistance of heat transfer through the wall is reduced to an equation with a number of unknown parameters numerically calculated. These constants are coefficients in the criterion equations for Nusselt numbers. A compensatory approach can be used to balance the exchanger and the results of the measurement series. It relates to the appropriate statistical elaboration of measurement series results. Physical equations describing the heat transfer between fluids in a heat exchanger can be linearized by developing into the Taylor series. When there are many measurement results, a system of linear equations is obtained in which there are corrections to unknowns, corrections to measured quantities and residues. The system of equations is solved numerically.

In the initial work on the doctorate I cooperated with Phd Adam Nowarski, with whom I developed a publication related to the subject of my dissertation, published by the Cracow University of Technology Publishing House in 1998 (Annex 3, point B.5.1). It concerned the so-called "modified" and "generalized" Wilson's methods. The generalization involving the use of directly non-linear equations of conditions and their linearization around the measured quantities and approximate unknowns using the Taylor formula, was suggested earlier by my Promoter, prof. dr hab. Eng. Teresa Styrylska. Then, further analyzing the Wilson method and its modifications, I developed an article under the direction of Mrs. Professor on the "extended" Wilson method, which I presented in papers at two international conferences. One of the conferences was held in Gdańsk in 1999 - Third Baltic Heat Transfer Conference, at which I gave a lecture related to the publication (Annex 3, point B.12.1). The second conference - Annual Scientific Conference was organized by GAMM (Gesellschaft für Angewandte Mathematik und Mechanik) in 2000 in Göttingen (Germany). I also gave a lecture on it (Annex 3, point B.12.2). The previously mentioned various modifications of the Wilson method can be called in the compensatory approach by direct measurement cases with unknowns or the general case of the least squares method in which unknown quantities are determined by solving the system of equations with corrections to measured values, separately corrections to uncertainties and non-compliances of conditional equations.

In addition to the PhD thesis, I also took part in a research project, awarded by the Committee for Scientific Research, on modeling thermoelasticity issues. I was one of the contractors and my task was to develop the results of measurements and calculation results (Annex 3, point B.10.1).

In further work on the PhD thesis, together with my Promoter, we developed the unified Wilson method, which is the subject of my doctoral thesis. Wilson's unified method consisted of further modification, in which I used the unified method of least squares in order to increase the stability of the solution. In the compensatory approach, the formulated problem can be called direct conditioned measures, in which in the extended vector of corrections to the determined values there are the corrections to the measured values and to the unknowns together. In the unified Wilson method, the magnitudes of unknowns are treated as measured quantities. This approach ensures a better estimation of the calculated values and improves the stability of the method while reducing the uncertainty of the determined values. The unified Wilson method proposed by me was used to determine unknowns in the criterion models for Nusselt numbers, and thus for dimensionless heat transfer coefficients when fluids flow in heat exchangers.

In 1999, under the supervision of Mrs. dr hab. Eng. Teresa Styrylska, I submitted a request to the Scientific Research Committee for a supervisor's grant, which was approved positively (Annex 3, point B.10.2). Thanks to this funding, I was able to complete my doctoral dissertation and take part in the 8th International Symposium on Heat Exchange and Renewable Energy Sources, Łeba 2000 before I defended my doctoral thesis. I gave a lecture there and prepared a publication (Annex 3, point B.12.3). After this conference, I received the prize for the best prepared papers (Annex 4, point C.1).

In November 2000, I defended my doctoral thesis with a positive result.

5.2. The course of scientific work after obtaining the doctoral degree

After obtaining the doctoral degree, I was employed in February 2001 at the Institute of Thermal Engineering and Air Protection at the Department of Environmental Engineering as a research and teaching assistant. Immediately after the doctoral thesis I was still involved in the Wilson method. This topic was published in two publications still related to the subject of my dissertation. One publication appeared in the Technical Transactions of the Cracow University of Technology Publishing House (Annex 3, point B.5.2), the other in The American Society of Mechanical Engineers (ASME) Journal of Heat Transfer (Annex 3, point B.1.1). This publication was quoted 11 times according to the Web of Science database.

In the next period, my main research activity was related to the problem of unsteady-state heating (with cut-offs) as one of the types of energy-saving heating (Annex 3, point B.5.3, B.12.4-B.12.6, B.12.8, B.12.10). The second direction of my activity are, generally speaking, issues related to building physics, on the one hand due to my scientific interests in this field and on the other hand due to the subject I teach: building physics.

In 2006, I started cooperation with the Architecture Department of the Cracow University of Technology. I conducted teaching classes there for many years and developed scientific cooperation. Initially, I dealt with issues of thermal comfort. Two publications were created in this subject. One related to the heat exchange by radiation in the rooms and the determination of the configuration coefficients on the room partition surfaces in order to accurately calculate the average radiative temperature in the rooms. The nomograms developed in this cooperation, presented in the publication, make it much easier to determine the configuration coefficients for particular surfaces in rooms. I gave a lecture on this publication at the XVI National Scientific-Technical Conference Ventilation, Air Conditioning, Heating, Health, Zakopane-Kościelisko in 2007 (Annex 3, point B.12.7). The second publication related to thermal comfort in rooms concerned the determination of zones of local discomfort in rooms with large glazing areas. As part of the research, it was shown that in the case of large glazing in rooms and lack of radiators (for example in air heating) there are zones of local discomfort in the space of the room near the glazing. A presentation on this publication was given by me at XII International Conference on Air Conditioning, Air Protection and District Heating, Wrocław-Szklarska Poręba in 2008 (Annex 3, point B.12.9). The further part of my cooperation with the Architecture Department of the Cracow University of Technology was still related to the building physics, namely the analysis of thermo-modernization in historic buildings, where there is no possibility to insulate external walls on the external air side. On the other hand, insulation of external walls on the inside carries the risk of inter-layer moisture condensation in the external wall. The analysis showed that the insulation of a thick brick wall made of polystyrene on the inside does not create a risk of inter-layer condensation. In addition, the insulation on the inside made of mineral wool also does not cause inter-layer condensation, but only under the condition of placing a vapor barrier on the room side. The results of the analyzes have been published and presented by me in the paper at the XIII International Conference on Air & Heat - Water & Energy, Wrocław-Kudowa Zdrój in 2011 (Annex 3, point B.12.11). The second issue directly related to the subject of thermo-modernization of historic buildings is the occurrence of thermal bridges in the buildings after thermo-modernization. A catalog of thermal bridges occurring in historic buildings subjected to thermo-modernization was developed. A publication prepared on this subject was published in 2014 in the magazine Ciepłownictwo Ogrzewnictwo Wentylacja which is on the B list of the Ministry of Science and Higher Education (Annex 3, point B.5.9). Cooperation with the Architecture Department of the Cracow University of Technology continues. Mastering the Design Builder tool with the EnergyPlus module used to simulate energy consumption in buildings throughout the year, allowed me to perform calculations analyzing different variants of the location of radiators in an energy-saving building with natural ventilation and a window vent. Analyzes have shown that in a building with a low heat transfer coefficient of windows and external walls, the placement of the radiator is not as arbitrary as one would expect. The location of the radiator on the inner wall opposite the window is slightly better than on the wall perpendicular to the window, nevertheless placing the radiator in a different location than under the window significantly disturbs convective movements of the air in the room. The publication prepared on this subject with the results of the CFD simulation was published in 2018 in the magazine Ciepłownictwo Ogrzewnictwo Wentylacja (Annex 3, point B.5.11).

From 2013, I was a member of the scientific team in the project of the Małopolska Regional Operational Program "Małopolskie Laboratorium Budownictwa Energooszczędnego". The project concerned the design and construction of two buildings: "Małopolskie Laboratorium Budownictwa Energooszczędnego" on the campus of the Cracow University of Technology and "Poligon Energooszczędności" in the Construction Schools Complex in Tarnów. The aim of the project was to create a scientific and research base (laboratory) for research, evaluation and implementation of modern technological solutions, material-construction and installation solutions for energy-efficient buildings. My activity in the project was related to the "Małopolskie Laboratorium Budownictwa Energooszczędnego" (MLBE). I participated in creating design assumptions of the building before its creation and in creating the concept of laboratories and research equipment. When the building project was being prepared, I was in the advisory group on the building physics problems (choice of insulation thickness, partitions with air gaps, etc.). The building is a "living laboratory" equipped with a system of acquisition and storage of data from a large number of temperature, humidity and air temperature sensors as well as temperature and medium flow sensors for heating and cooling. In the design phase, I participated in consultations with designers regarding the measurement of the building. I participated in creating the concept of sensor placement in the structure of the building (walls, ceilings, floor on the ground, cornices, etc.) and in the ground as well as in the air heat exchanger under and beside the building in the ground, which task is to preheat in winter and cooling in the summer of ventilation air directed to the building. The MLBE building as a laboratory facility has many sources of energy (heat and refrigeration) that can work independently or cooperate with each other (eg. a district heating supply unit, a glycol-water heat pump, an air-to-water heat pump, a gas condensing heater). I participated in creating the concept of heating the building, i.e. equipping it with the above mentioned heat sources, as well as in developing the concept of placing various types of heat receivers in the rooms (radiator, floor, wall and ceiling heating). When the building design was approved, a tender for the construction of the MLBE building was announced, followed by tenders for equipping the building with research equipment. I participated in the works of the tender committee in the tender for the construction of the building (the value of the tender about PLN 8 million) and in almost all tenders for the purchase of laboratory equipment (the total value of the research equipment purchased is about PLN 2 million). In addition, I was a co-author of the research program carried out in the laboratory (Annex 3, point B.10.3).

In the next period, under the guidance of prof. dr hab. Eng. Jacek Schnotale, I was the main contractor and organizer of the Laboratory of Thermal Engineering, in which one of the basic elements of equipment is a calorimetric chamber. It is a set of two independent chambers simulating rooms (warm and cool) separated by a foamed polystyrene wall (masking frame), in the hole which the test sample is mounted. In both rooms, controlled and stable temperature conditions are generated. Thanks to the temperature difference created between the rooms, heat is transmitted through the mask with the tested sample. Indirect measurements of thermal transmittance of samples such as homogeneous partitions (single-layer, multi-layer masonry samples, glazing, etc.) and inhomogeneous (windows, doors, window frames, door frames, shutters or partitions with thermal bridges) are made in the chamber. At this stand, it is possible to perform heat flow tests in steady-state conditions, but also in transient conditions. In my scientific work I developed a concept for indirect measurements of the tested samples thermal transmittance. I have developed a methodology for processing measurement results in order to obtain the final results of calculations as well as a methodology for determining measurement uncertainties. I carried out measurements of various samples mentioned above in the calorimetric chamber and I worked out the results of calculations based on measurements. This scope of my activity was, among others, carried out in the Facility of Heating, Ventilation, Air Conditioning and Refrigeration as part of its statutory activity (Annex 3, points B.6.10, B.6.13, B.6.17, B.6.20).

At the same time, under the direction of Prof. dr hab. Eng. Jacek Schnotale, I developed the numerical calculations workshop using the finite volume method performed in the Ansys Fluent program. The first publications on the topics related to research in the calorimetric chamber and CFD simulations were developed as a result of the cooperation with the industry in the development of a prototype multi-pane glazing consisting of several ultrathin internal windows to determine the heat transfer coefficient of the sample. The two publications were published in the Technical Journal of the Cracow University of Technology Publishing House in 2014 after the 12th International Scientific and Technical Conference "Energodom 2014", on which I had two presentations on these publications (Annex 3, points B.5.9 and B.5.10). Another publication related to multi-pane glazing was prepared for the conference 14th International Conference of the International Building Performance Simulation Association, in December 2015 in India, at which I gave a lecture (Annex 3, point B.12.14).

Further cooperation with the industry led to the establishment of a consortium between Cracow University of Technology, Rzeszów University of Technology and DAGlass company. The consortium prepared a joint application for co-financing a research project in the PBS3 competition announced by the National Center for Research and Development. The application was considered positively. The budget for the project was about PLN 2.4 million. I was the main contractor of the project on behalf of PK. The aim of the project was to design and manufacture such glazing so that its thermal transmittance was not greater than 0.3 W/(m^2K) while meeting the maximum thickness condition of 0.2 m. As part of the project I took part in the following works: determining the amount of gas space in glazing and space width between glazed panes, building a numerical model for performing CFD calculations, numerical calculations of heat flow through glazing, calculating thermal transmittance of the glazing, measuring thermal transmittance of the glass prototype in the calorimetric chamber and developing calculation results and developing a final report. In the analyzes I made, I received a very good convergence of the numerical simulation results with the results of measurements in the calorimetric chamber, which confirms both my ability to perform calculations using the finite element method, as well as the ability to process measurement results performed in the calorimetric chamber (Annex 3, point B .10.4).

The experience acquired during the glazing tests within the grant as well as the observation of the numerical results of simulations of gas convection movements in gaps in the glazing allowed me to develop a way to improve the temperature distribution in the lower part of the glazing. In natural conditions in glazing, for example double glazed, the interior pane from the room side has a lower temperature in the lower part of the glazing than in the central part. In low-quality glazing, i.e. with low values of thermal transmittance, there is the possibility of moisture condensation on the glazing surface. The performed analyzes and experimental studies allowed for the formulation of an innovative modification of the glazing by introducing an additional window glass pane in the bottom of the glazing. Its presence improves the temperature distribution in the lower part of the glazing. This modification makes it possible to increase the temperature at the bottom of the inner pane by approximately 2 K, which may prevent condensation of moisture on the glazing surface. This solution was submitted as a patent application to the Patent Office of the Republic of Poland and obtained legal protection, and in 2017 a patent was granted for an invention (Annex 3, point B.3). After obtaining legal protection, the proposed solution was published in a global journal registered by the Web of Science base, Journal of Building Engineering (Annex 3, point B.1.2).

My further scientific work on the glazing allowed me to observe that the thermal transmittance of glazing changes with the angle of glazing, which in the current literature was only considered in a very simplified, imperfect way. Thermal transmittance is different for vertical glazing, different for horizontal glazing, as for example in roof glazing, and yet another for glazing of the so-called glazing. "Inverted", ie when the heat side (room) is higher than the surroundings. Such glazing is more and more often found in modern buildings (eg. a room with a façade deviated from the vertical by an angle of 45° or even glazing in the floor above the surroundings). I noticed that there are not many publications related to this subject in the literature, and there is no information about the glazing with the downward heat flow in the standards for calculating the thermal transmittance of glazing. So I built a research stand in the calorimetric chamber, where it was possible to set the glazing at any angle. The heat flux meter and temperature sensors performed measurements after obtaining stable conditions between the hot and cold side of the glazing. After the measurements, I carried out an analysis that allowed me to develop a publication in the Energy and Buildings magazine on a global scale, registered in the Web of Science database. In the publication, I proposed amendments to existing standards taking into account the “inverted” glazing (Annex 3, point B.1.3).

To increase the rank and reliability of the conducted measurements for scientific papers and work performed for the industry and concerning the thermal transmittance tests in the calorimetric chamber, work was undertaken to obtain the accreditation of the Polish Center for Accreditation (PCA) by the Laboratory of Thermal Engineering. I was appointed as the technical manager and I was responsible for the development of all research procedures and forms related to the technical system, technical preparation of technical staff, preparation of the schedule and conducting the calibration process of the measurement equipment. The aim of the research was to determine the thermal transmittance of the samples. Since the tests in the Laboratory of Thermal Engineering in its scope cover both the measurement and calculation methods using the finite element method, it was necessary to validate the test methods as well as interlaboratory comparisons for measurements and numerical calculations. I carried out comparative measurements with another laboratory, which resulted in a positive assessment of comparisons. I also carried out numerical calculations of window sections for interlaboratory comparisons, which also resulted positively.

The sample thermal transmittance by the measurement method in the calorimetric chamber is determined in accordance with the developed algorithms based on the results of measurements obtained from several dozen thermocouples. Each of them performs measurement with some uncertainty. Therefore, I carried out a full analysis of the uncertainty of the received value of the thermal transmittance, which I made using the error propagation rule. In 2016, the Laboratory of Thermal Engineering received the accreditation of the Polish Center for Accreditation No. AB 1632. Our research team performs both normative measurements of samples aimed at providing the manufacturer with the final result of the thermal transmittance (Annex 4, points L.6, L.9, L. 10, L.11, L.14), as well as more specialized measurements, implementation works in which, in addition to carrying out only the prototype sample measurement, the producer expected expert advice in the field of production development towards products optimized in terms of thermal properties (Annex 3, points B.6.12, B.6.14, B.6.15, B.6.18, B.6.21, B.6.22, B.6.25 - B.6.28).

In the course of research work due to incoming inquiries from industry, I built a research stand for measuring the flow (leakage) of air through samples such as dampers, ventilation ducts or windows in order to investigate their air tightness class. Standard measurements (Annex 4, points L.7, L.8, L.12) and advisory, development and implementation works were also performed at this stand (Annex 3, points B.6.19, B.6.23, B.6.24).

Another research stand, which I co-created was a stand for mechanical tests of casings of ventilation and air-handling units. The measured properties are: air tightness of the unit walls, tightness of filter fastening, thermal transmittance of the unit walls and the factor of performance of thermal bridges as well as sound protection of the unit walls (Annex 4, point L.12).

Currently, in the Laboratory of Thermal Engineering, we create another stand, this time to test the efficiency of heat recovery in recuperators. The stand is ready for calibration.

My further scientific work was also related to research in a calorimetric chamber. In 2015, Mrs. PhD. Annette Harte, together with her PhD. student at the National University of Ireland, asked the Institute of Thermal Engineering and Air Protection to conduct tests on the thermal transmittance of lightweight layered walls with various thermal bridges. I was appointed as the manager of this project. I have established cooperation with the aforementioned university leading to the signing of a cooperation agreement between the Cracow University of Technology and the National University of Ireland Galway. I was indicated as a person responsible for scientific and research matters carried out within this agreement. In the research work as part of this cooperation, I managed the progress of MSc. Małgorzata O'Grady doctorate, who carried out the measuring part for her doctoral thesis in our laboratory at the Cracow University of Technology. After completing a short-term internship at the National University of Ireland Galway, I was appointed by the university there as an auxiliary promoter in the doctoral thesis of MSc. M. O'Grady (Annex 4, point J.1). The defense of the dissertation is expected in the middle of 2018.

As part of this work, normative measurements of thermal transmittance of a dozen samples with different thermal bridges in a calorimetric chamber were carried out, on the other hand, samples mounted in a calorimetric chamber were subjected to infrared camera measurements of temperature fields on both the hot and cold side of the samples. PhD student M. O'Grady developed with my help the analysis of thermograms, which allowed us to propose a method for determining in situ thermal transmittances of linear thermal bridges based on thermal images analysis made at appropriate internal and external conditions in existing buildings. This method is the subject of a doctoral dissertation MSc. M. O'Grady. The effects of this project were reflected in joint publications in Energy and Buildings (two publications) and Applied Energy (one publication) magazines registered in the Web of Science database (Annex 3, points B.1.4, B.1.6 and B.1.8). The fourth article on this topic was sent, accepted and presented by me at the Cold Climate Conference 2018 in Kiruna, Sweden in March 2018 (Annex 3, point B.12.15).

In 2015 at the International Building Performance Simulation Association conference in India together with Prof. dr hab. Eng. Jacek Schnotale we have made contact with with PhD. Giorgio Baldinelli from the Università Degli Studi di Perugia in Italy. On the basis of one of the research works for the industry, a concept was developed to reduce the thermal transmittance of window frames made of PVC without changing the geometry, structure or material of window frames. This reduction can be achieved by injecting an insulating material (e.g., polyurethane foam) into the air spaces in the window frame. Our research has shown that after placing the insulation in the air spaces in the frame, the thermal transmittance of the frame can reduce the value up to 20%. Measurements of thermal transmittances were performed in the manner of modified window frames as described above, and numerical simulations of CFD were carried out in the Ansys Fluent program. Part of the work was carried out in cooperation with PhD. Giorgio Baldinelli in order to check in a simulation to what extent it is possible to reduce the heat transfer coefficient of window frames, if instead of filling the insulation with air gaps in the PVC frame, the PVC surfaces in contact with air will be covered with the low-E coating. Our simulations showed a similar effect as filling the gaps with insulation. The thermal transmittance of the analyzed frame also decreased by about 20%. The results of these analyzes were published in 2017 in the journal Energy and Buildings registered on the Web of Science list (Annex 3, point B.1.5).

Cooperation with the University of Perugia was further developed by research begun in a laboratory in Perugia, where a calorimetric chamber with similar parameters to that which we have at the Laboratory of Thermal Engineering at PK is installed. However, the LIC chamber has larger dimensions, which made it possible to carry out measurements impossible to make in Perugia. In the calorimetric chamber, in addition to thermal measurements in steady state conditions, measurements can also be carried out in conditions of dynamically changing air temperatures. Such measurements were carried out as part of further joint research with the University of Perugia. In the designed studies, the layered sample was subjected to sudden increases of temperature and then to the initial air temperature in the hot chamber. These dynamic changes in air temperature caused the sample to react also by increasing and then decreasing its temperature, but with a time delay and with a lower amplitude than the air temperature. The method of calculating the dynamic properties of samples is described in the PN-EN ISO 13786 standard - Thermal performance of building components - Dynamic thermal characteristics - Calculation methods. However, it is a calculation method that is tedious and time-consuming and does not take into account the actual thermal properties of the materials in the analyzed specimen, but only the assumed normative properties. On the basis of dynamic measurements carried out both in the calorimetric chamber in Perugia and in Krakow, in the article prepared by us, we proposed a new, simpler method for determining the dynamic thermal properties of homogeneous building partitions based on measurements. The prepared publication was published in the journal Energy and Buildings registered in the Web of Science database in 2018 (Annex 3, point B.1.7).

My current scientific activity remains related to thermal and flow measurements and CFD simulations.

5.3. Summary of scientific achievements

Before obtaining the doctoral degree, I was the co-author of **1** article published in a journal, **2** chapters in monographs, **2** publications in conference materials and **1** abstract in the book of abstracts. I presented the results of my research at **3** international conferences. I was a contractor in **2** research projects.

After obtaining the doctoral degree, my scientific achievements were presented in **30** publications, of which **9** are articles published in journals registered in the Journal Citation Reports Web of Science database (JCR) and **8** are on the A list of the Ministry of Science and Higher Education, **1** monograph, **1** book, **3** chapters in a book, **6** chapters in monographs, **10** publications in magazines that are not registered in the JCR database, but are on the B list of the Ministry of Science and Higher Education, **1** publication in a journal of international scope not registered on the list of Ministry of Science and Higher Education.

I was the author of one patent for an invention.

I presented my articles at **6** international and **2** national conferences. I took part in **2** research projects as the main contractor. I participated in **11** projects of a statutory activity and **2** in the nature of own research. I was the manager of **21** expert opinions, mostly technical and implementation, commissioned by industrial units and a contractor in **8** expert opinions.

My average percentage share in published works is **61.2%**.

The total Impact Factor (IF) of my publications according to the year of publication is **31,821**. The total number of points for all publications according to the Ministry of Science and Higher Education in accordance with the year of publication is **321**, while publications from the A list of the Ministry of Science and Higher Education are **285**.

I combined my scientific achievements in tables 1 ÷ 5.

Table 1. Quantitative list of scientific achievements

No.	Type of publication	Before the doctorate	After the doctorate	Sum
1.	Publications in journals from the A list of the Ministry of Science and Higher Education indexed in the JCR database	-	9	9
2.	Monographs	-	1	1
3.	Chapters in monographs	2	6	8
4.	Publications in journals from the B list of the Ministry of Science and Higher Education not indexed in the JCR database	1	10	11
5.	Publications in conference proceedings	3	5	8
6.	Patents	-	1	1
7.	Unpublished research studies, including: - research carried out as part of research projects - expert opinions for business entities - research carried out as part of statutory activities - research carried out as part of own research	 2 - - -	 2 29 11 2	 4 29 11 2

Table 2. List of journals and publishing houses in which original scientific papers have been published - after doctorate

No.	Type of journal or publishing house	Number of published works	Publication language
Journals from the A list of Ministry of Science and Higher Education indexed in the JCR database			
1.	ASME Journal of Heat Transfer	1	English
2.	Applied Energy	1	English
3.	Energy and Buildings	6	English
Journals from the B list of Ministry of Science and Higher Education not indexed in the JCR database			
4.	Czasopismo Techniczne (Technical Transactions)	4	English
5.	Ciepłownictwo, Ogrzewnictwo, Wentylacja	5	Polish
6.	Gaz, Woda i Technika Sanitarna	1	Polish
Monograph			
7.	Cracow University of Technology Publishing House	1	English
Chapters in monographs			
8.	International Building Performance Simulation Association	1	English
9.	Polskie Zrzeszenie Techników i Inżynierów Sanitarnych	4	Polish
10.	Instytut Klimatyzacji i Ogrzewnictwa, Wydział Inżynierii Środowiska, Politechnika Wrocławska	2	Polish
Book			
11.	Cracow University of Technology Publishing House	1	Polish
Chapters in a book			
12.	Centrum Szkolenia i Organizacji Systemów Jakości PK	3	Polish

Table 3. List of presentations at scientific conferences - after doctoral thesis

International conferences	National conferences
6	2

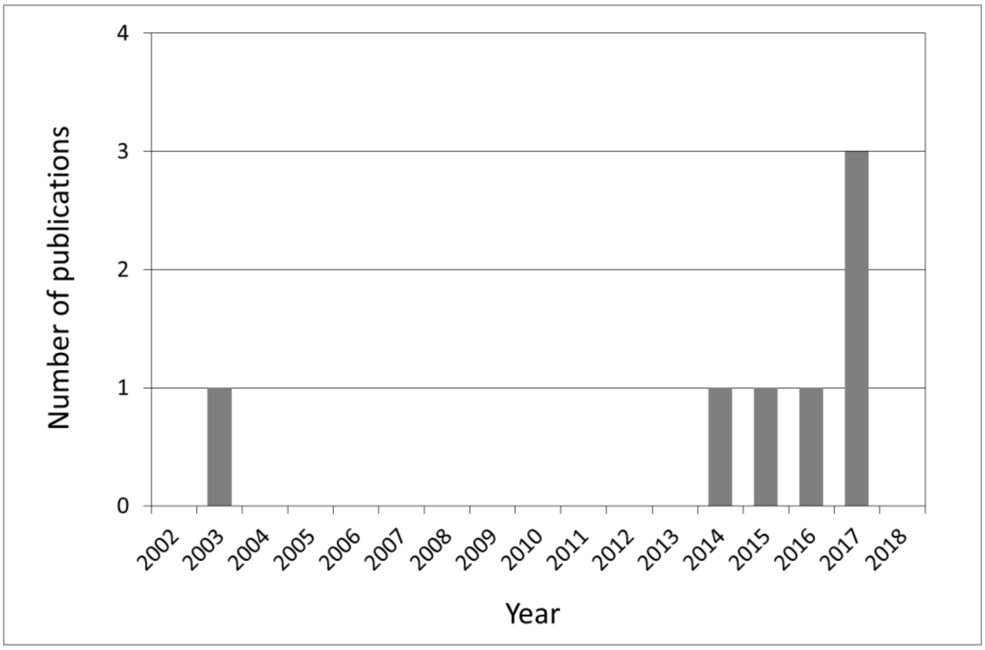
Table 4. Indicators of scientific achievements

	Web of Science	Scopus	Google Scholar
Total amount of citations	24	28	51
Amount of citations without auto-citations	20	-	-
Number of articles registered in the base	7	10	38
Hirsh Index	3	-	3

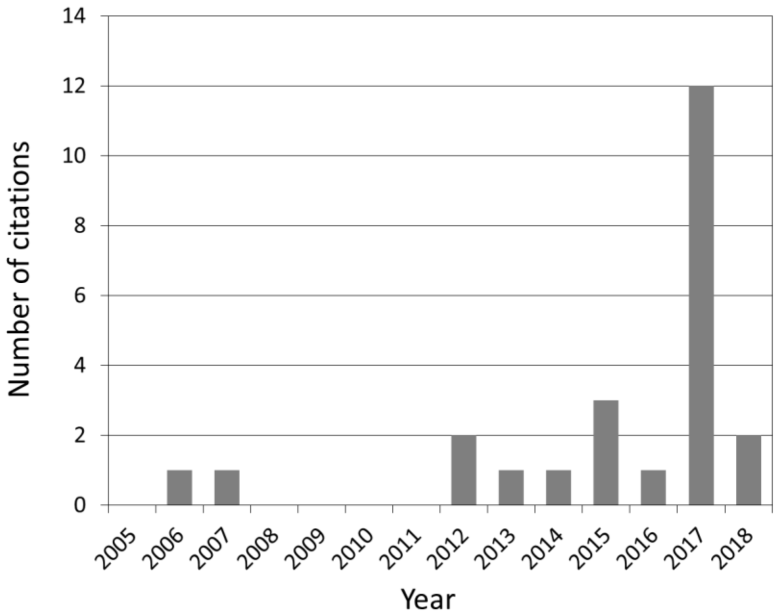
Table 5. Indicators of scientific achievements - cont.

No.	Journal name with the year of publication	Impact Factor from the year of publication	Impact Factor actual	MNiSW points
1.	ASME Journal of Heat Transfer 2003	1,420	1,866	-
2.	Applied Energy 2017	7,182	7,182	45
3.	Energy and Buildings 2014	2,884	4,067	40
4.	Energy and Buildings 2016	4,067	4,067	40
5.	Energy and Buildings 2017	4,067	4,067	40
6.	Energy and Buildings 2017	4,067	4,067	40
7.	Energy and Buildings 2018	4,067	4,067	40
8.	Energy and Buildings 2018	4,067	4,067	40
	Sum:	31,821	33,004	285

In graphs 1 and 2, I gave the number of publications and the number of quotations compiled in individual years according to the database Web of Science.



Graph 1. Quantitative specification of indexed publications in individual years according to Web of Science database



Wykres 2. Ilościowe zestawienie cytowań publikacji w poszczególnych latach wg Web of Science

6. Summary of work and professional achievements

6.1. Didactic and popularizing activities

I have been teaching since the beginning of employment at PK, that is since 2001. I have taught at the Department of Environmental Engineering of PK in the following subjects: thermodynamics, thermal engineering, heating, heat exchange and aeromechanics, heat exchange and heat exchangers, building physics, heat engineering, central heating installations, construction installations, alternative energy sources and advanced thermal and flow calculations. Among these classes were lectures, exercises, projects, laboratories and computer laboratories. I run classes for both full-time and weekend students.

For a number of years, I also lectured at the Department of Architecture of PK a two-semester subject, building installations.

In 2010, I was nominated for the Best Didactic of the Depatment of Environmental Engineering award and I received this award. It should be noted that this is an award granted by the students themselves (Annex 4, point C.3).

I have developed a program of the subject "Building physics" for engineering studies and a program of the subject with the same name for supplementary masters' weekend studies. I also developed the author's program of the subject "Advanced thermal and flow calculations" for students of the last year of master's studies. In all the above-mentioned subjects, I run the whole course: lecture, exercises and a computer lab. Another program I have developed concerns the subject of "Water, sewage and heating system design" for master's students.

I am also the author of the program of the new subject "Energy efficient buildings and their elements", which is intended to be conducted by me in English for foreign students.

As part of my international cooperation, I completed a scientific internship at the University of Galway Ireland, where I conducted a seminar for PhD students and employees (Annex 4, point H.10).

I am the co-author of the textbook entitled *Examples of tasks from the basics of thermodynamics: a textbook for university students* (Annex 4, point H.9), for which I received the Rector's team award for didactic achievements in 2014 (Annex 4, point C.4). I am also the author of the chapter in the textbook entitled *Energy audit for the needs of thermo-modernization and energy assessment of buildings: collective work. Vol. 2, Building physics, energy audit, renovation audit, energy performance certificates* and two chapters in the textbook entitled *Energy audit for the needs of thermo-modernization and energy assessment of buildings: collective work. No. 4, Thermal protection of buildings, gasification technology, energy sources - rationalization of consumption, central heating installation, hot water supply system* (Annex 4, point H.6 - H.8). For the preparation of these textbooks I also received the Rector's team award for didactic achievements in 2010 (Annex 4, point C.2).

I was the promoter of 67 engineering works and 72 master's theses, including 4 awarded engineering works and 9 honorable master's theses.

In 2001, I received a distinction for the best-prepared papers at the 8th International Symposium on "Heat Exchange and Renewable Energy Sources", at which the symposium I gave a lecture in English (Annex 4, point C.1).

As part of the knowledge-promoting activity, I have taught courses in various subjects at post-graduate studies. At the Institute of Thermal Engineering and Air Protection of the PK there were postgraduate studies: *Air conditioning and heating* (I took part in two editions of these studies) as well as *Energy consulting in construction* (I took part in six editions of these studies) (Annex 4, point H.11, H.12). I was also the promoter of 60 final theses at postgraduate studies at the Department of Environmental Engineering of the PK.

In addition to postgraduate studies at the Department of Environmental Engineering, I also conducted classes at three editions of postgraduate studies *Energy audit of the building for the needs of thermo-modernization and energy assessment of buildings* organized by the Training Center and Organization of Quality Systems PK (Annex 4, point H.13).

Apart from the Cracow University of Technology, I lectured at the postgraduate studies in *Contemporary wooden construction* organized by the Department of Mining and Geoengineering at the Academy of Mining and Metallurgy in Krakow (Annex 4, point H.14).

In addition, I conducted three editions of training for people applying for the right to prepare a certificate of energy performance of the building organized by the National Association of Real Estate Managers "Nasz Dom" in Krakow and two trainings on the same subject organized by the Office of Technical Inspection in Krakow (Annex 4, point H.15, H.16).

6.2. Organizational activity

My the most important achievements in the field of organizational activity include the process of obtaining the accreditation of the Polish Center for Accreditation for the Laboratory of Thermal Engineering from the very beginning. I was the author of all the procedures of the technical area. I organized the necessary calibrations for each measuring path in the calorimetric chamber, which is equipped with several dozen temperature sensors. I carried out the necessary validation of research methods and organized and carried out interlaboratory comparisons both in the measurement method and the numerical calculation method. In December 2016, the Polish Center for Accreditation after the visit of auditors and very detailed control granted accreditation No. AB 1632 for the Laboratory of Thermal Engineering, including in its scope measurements of thermal transmittance of windows, roof windows, skylights, doors, blinds, window frames, curtain walls, etc. as well as numerical calculations in the Ansys Fluent of thermal transmittance of the aforementioned samples. It should be emphasized that this is probably the first case of PCA accreditation given for calculations using the Ansys Fluent program.

My next organizational achievement was the preparation of two test stands for measurements of air tightness of samples and sound protection of samples. Preparation of measurement stands was linked with the development of new research procedures, organization of calibration of all research equipment, validation of calculation procedures, determination of measurement errors and conducting interlaboratory comparisons. I established cooperation with the certifying institute TÜV Reinland Polska, as a result of which the Laboratory of Thermal Engineering received the TÜV Reinland Polska recognition in 2017, thanks to which the laboratory can carry out mechanical tests of air handling unit enclosures including: air tightness of the enclosure, tightness of filters mounting, heat transfer coefficient and the thermal bridging factor as well as the acoustic integrity of the housing.

For the organization of the accredited laboratory, members of the Laboratory of Thermal Engineering team received in 2017 the team award of the Rector of PK for organizational achievements (Annex 4, point C.6).

In connection with the preparation of a new stand for measurements of air tightness of the samples, the Laboratory of Thermal Engineering submitted an application to the Polish Center for Accreditation for extending the scope of accreditation for air tightness tests of samples such as windows, doors, dampers, ventilation ducts. In December 2017, the visit of the PCA auditors took place, which ended positively and the Laboratory of Thermal Engineering received an extension of the accreditation for an additional scope.

Another important organizational achievement was the work in the project MRPO.05.01.00-12-089 / 12-00 - Małopolskie Laboratorium Budownictwa Energooszczędnego (MLBE) (Annex 3, point B.10.3). My role in this project was mainly substantive and advisory, but nevertheless I also did a lot of organizational work in it. I can include the participation in the works of the tender committee regarding the tender for the construction of the MLBE building as well as works for the equipment of this laboratory: market recognition, preparation of specifications for ordered testing equipment, participation in tender committees. In addition, during the construction of the MLBE building, I took part in the majority of weekly working meetings between designers, contractors and the technical department of PK. For the work in the MLBE project I received a team Rector's award for organizational achievements (Annex 4, point C.5).

From September 2013, I am the deputy director of the Institute of Thermal Engineering and Air Protection for science (Annex 4, point O.3). I am responsible for supervising the research activities at the Institute, in particular for research carried out as part of statutory activities and by young researchers (preparation of applications and reports, control of financial matters, verification of documentation and factual reports). I am also responsible for supervising the current organizational issues of the institute.

Since 2013, I have been a member of three department committees: for statutory activities, statutory activities of young science employees and for awards (Annex 4, point O.6). From 2017, I am also a member of the department commission to develop or change a doctoral studies program (Annex 4, point O.7).

In the years 2011-2013 I was the substantive manager of the postgraduate studies in Energy Consulting in Construction (Annex 4, point A.1). My task was to organize these studies.

Since 2008, I have been a member of the choice of the Council of the Department of Environmental Engineering as a representative of auxiliary academic staff (Annex 4, point O.8).

Agnieszka Lechowska