LITHUANIAN
ENERGY
INSTITUTE

# ANNUAL REPORT '2002

UDK 061.6:620.9(474.5)
Li 233

ISBN 9986 - 492 - 75 - 0


**Contents**

LITHUANIAN ENERGY INSTITUTE is a state scientific research organization, created for carrying out the long-term scientific research works important for the Lithuanian economy, culture and international cooperation. The main activities of the Institute are scientific research and experimental development.

MISSION OF THE INSTITUTE is to act as the highest qualification expert in treating issues of science, engineering, metrology, safety of power industry and economics linked to efficient development of the Lithuanian energy sector.

STRATEGIC OBJECTIVES OF THE INSTITUTE INCLUDE:

1. Carry out fundamental research in the fields of thermal physics, fluid mechanics, metrology, energy installation safety, materials science, hydrology and process control.
2. Prepare conceptual and methodology basis for the formation of state policy in the energy sector, for energy economy planning and control.
3. Prepare the highly qualified professionals for power engineering and scientific investigations related to it.

# LITHUANIAN ENERGY INSTITUTE IN 2002

In 2002 scientific activities in the Institute were carried out according to five main research directions approved and financed by the Government of Lithuania:

***I. Development of energy economy planning methods, investigation of safety and reliability of the power plants, their impact on the environment, efficient energy consumption and the renewable energy sources.***

1. *Creation of conceptual and methodology basis for the formation of state policy in the energy sector and its application for development of the energy sector.*
   - collection and experience generalization of energy demand prognosis and modelling of the energy sector development; formation of methodological and program basis for preparation of the National Energy Strategy;
   - creation and testing of the matrix model for the municipal power sector;
   - draw up of the rational parameters of information supply and implemention for the regional energy planning needs;
   - carried out feasibility assessment of biogas generation and utilization in Lithuania;
   - carried out investigations and presented recommendations on possibilities of efficient energy consumption in buildings and the selected industry branches.
2. *Investigation of the regional ecosystems sustainable development, related to nuclear power and expansion of the Klaipeda port.*
   - developed methods for evaluation of the uncertainly analysis in risk and safety of the technical systems simulation results and evaluated uncertainties of the Ignalina NPP models and other complex systems;
   - performed analysis of the main problems in the final nuclear fuel cycle phase, which arise during the shutdown preparation period of the Ignalina NPP, including the problems related directly to dismounting preparations and nuclear waste handling and storage;
   - strategic evaluation of the effects upon Baltic sea and Curonian Lagoon by expansion of the Klaipeda seaport, including hydro-technical construction, strait deepening, hazardous situations, etc.

***II. Investigations in the fields of thermal physics, fluid mechanics and metrology.***

1. *Experimental and numerical investigations of heat and pulse transfer processes in one-phase and two-phase flows.*
   - mathematical-numerical model of instable wind of middle intensity causing water mixing on the surface was created and temperature stratification conditions of lake water were evaluated;
   - investigated condensation implosion phenomenon, when water vapor contacts cold water directly, experimentally and theoretically;
   - investigated peculiarities of heat transfer in case of mixed convection in conditions of stable density stratification.
2. *Investigation of the weighting method with the aim to achieve international level of the state primary standard of the air (gas) and flow unit and volume and flow characteristics of the standards of the water and oil products in final stage of establishing.*
   - experimentally and theoretically investigated influence of air and liquid temperature as well as pressure variations in the basic bell type device on air volume and flow measurement uncertainties with the aim to reduce them down to ±0.1%;
   - experimentally investigated transfer of air volume and flow values recreated by the weighting method using drum volume meters as intermediate standards;
   - created and investigated high velocity water flow (20 to 100 $m^3/s$) deflector operation and established its optimal regimes, which ensure the least measurement uncertainties;
   - analyzed and implemented the most optimal water density determination method;
   - investigated metrology characteristics of the volume method, intended for recreation of the volume and flow unit values of the oil products having viscosities up to 20 mPa, and created device presented to the Government of Lithuania for approving it as a state primary standard;
   - with the aim to achieve international recognition of the primary standards already created for approaching completion, presented calibration and metering values provided by the primary standards to the EUROMET organization and several international comparisons were carried out.

***III. Simulation of complex systems, development of their control methods and technologies.***

1. *Monitoring of the power and heat systems, creation of the control models and their investigation.*
   - created mathematical models of the power systems and on that basis investigated peculiarities of frequency and regional power regulation by the Baltic United Power System;
   - investigated possibilities of the optimal control and monitoring of strategic objects, taking into account customers' demands and environmental effects.

***IV. Investigation of energy systems' construction elements aging and development of new multifunctioned materials.***

1. *Investigation of influence of corrosion on the structure of austenitic and perlitic steels and of zirconium alloy structure changes as a consequence of thermal blow.*
   - performed investigations of corrosion processes of austenitic (08X18H10) and perlitic (15Ch1M1F) steels with imitation of chemical heat carrier composition effect. Investigated influence on multiple hydride dissolving – formation and temperature blow upon the structure of zirconium alloy (Zr+2.5%Nb).
2. *Manufacture of the electrolyte yttrium stabilized zirconium coatings of electrochemical solid body fuel element using plasma spraying method.*
   - performed investigations of element and phase structure and properties of the yttrium stabilized zirconium coatings obtained by plasma spraying method.

***V. Investigations of combustion and plasma processes in the fields of fuel saving, reduction of environmental pollution and thermal decontamination of materials.***

1. *Experimental investigations of fuel and waste particle gasification and combustion.*
   - investigations of fuel and waste particle gasification and combustion in different reacting flows and temperature regimes were performed.

*COUNCIL OF THE INSTITUTE. In the first row (left to right): Prof. Dr. Habil. L. PRANEVICIUS (Vytautas Magnus University); Dr. R. SLEZAS; Dr. J. KRIAUCIUNIENE; Prof. Dr. Habil. E. USPURAS – Chairman of the Council; Prof. Dr. Habil. J. VILEMAS – Director; Dr. B. TESKEVICIENE (Ministry of Economy); Prof. Dr. Habil. J. GYLYS (Kaunas University of Technology); Prof. Dr. Habil. M. DAUNYS (Kaunas University of Technology).*

*In the second row (left to right): Dr. R. SKEMA – Deputy Director; Dr. G. ZYGMANTAS; Dr. A. GALINIS; Dr. Habil. V. MISKINIS; Dr. Habil. A. PEDISIUS; Prof. Dr. Habil. A. SLANCIAUSKAS; Prof. Dr. Habil. P. POSKAS; Prof. Dr. Habil. A. SKRINSKA (Vilnius Gediminas Technical University); Prof. Dr. Habil. V. KATINAS; Dr. F. BIELINSKIS; Dr. P. VALATKEVICIUS; Dr. F. ZINEVICIUS; Dr. A. BURBA; Doc. Dr. J. AUGUTIS (Vytautas Magnus University); Dr. R. LEVINSKAS – Deputy Director.*

*This photograph does not include two Council members: Prof. Dr. Habil. B. GAILIUSIS; Prof. Dr. Habil. V. JANKAUSKAS (National Control Commission for Prices and Energy).*

2. *Synthesis and property investigations of the catalytic coatings formed using plasma technologies and intended for decontamination of combustion products.*
   - in the plasma flow oxide catalytic coatings were formed and catalyst models were investigated in the gas combustion establishing start of the reaction, its stability and its efficiency.

At the same time the applied science investigations were carried out according to the contracts with power and other economy sector organizations and firms, programs were prepared, standards and other specification documents, regulating activities of the power economy members.

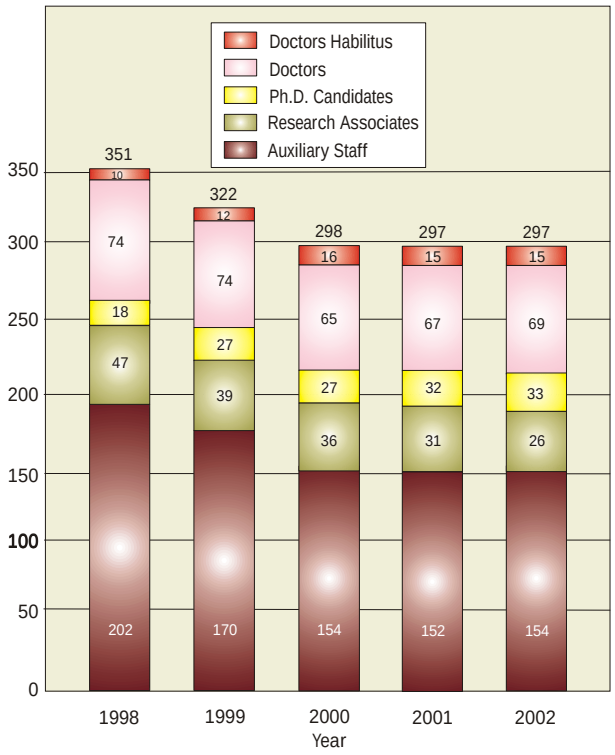
Important place in research activities was occupied by carrying out works of the international programs and investigations according to bilateral and multilateral contracts with the foreign partners.

State funded scientific research programs included 18 scientific research projects, eight of which were finished in 2002 (listed below).

| Title of the finished work | Direction of scientific activity | Leading researcher |
|---|---|---|
| Uncertainty analysis of complex technical systems simulation results | I | Dr. Habil. E. Uspuras |
| Investigation of power engineering problems, analysis of alternative solutions and their generalization | I | Dr. Habil. V. Klevas |
| Feasibility assessment of manufacture and usage possibilities of biofuel in Lithuania | I | Dr. S. Vrubliauskas |
| Investigation of possibilities of enhancing energy utilization efficiency in buildings and industry by implementing the new technologies and preparation of recommendations | I | Dr. R. Skema, Dr. F. Zinevicius |
| Perfection of Lithuanian energy sector principles and methods | I | Dr. Habil. V. Miskinis |
| Experimental and mathematical investigation of condensation implosion event | II | Dr. R. Pabarcius |
| Monitoring, formation of the control models and investigation of electric power and heat systems | III | Dr. R. Andruskevicius |
| Synthesis and investigation of properties of the catalytic coatings, formed using plasma technologies for decontamination of combustion products | V | Dr. P. Valatkevicius |

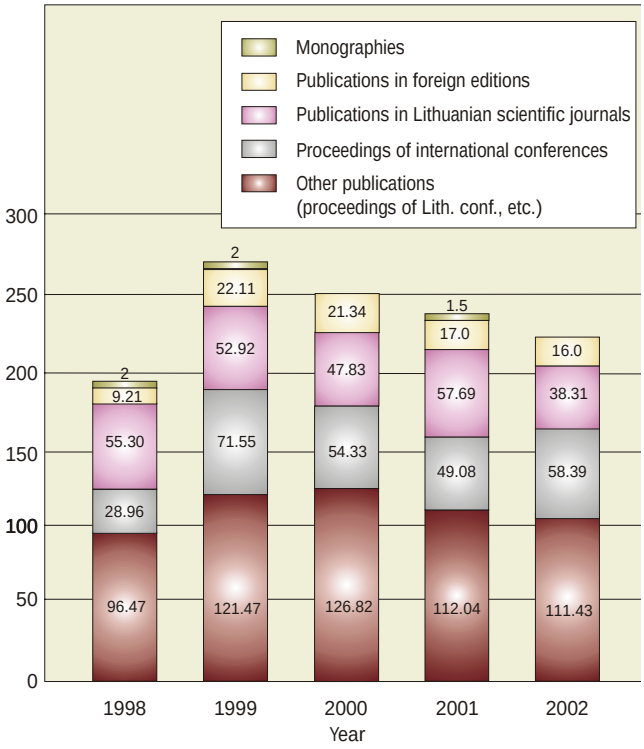
As of December 31, 2002 the number of employees of the Institute was 297 including 15 Doctors Habilitus, 65 Ph.D., 33 Ph.D. Candidates and 26 with M.Sc. and B.Sc.

**Variation of staff number**




In 2002 scientists of the Institute presented nearly 150 papers in various international and national conferences. They published 224 publications (taking into account co-authors) in the international and national scientific journals, conference materials and other publications.

**Variation of publications number**
(Author's contribution evaluated)




In 2002 three researchers of the institute defended Doctor of Science theses and two – Doctor Habilitus of Science theses:

- on April 29, 2002 Doctor of Science degree was conferred by the LEI on Rolandas URBONAS for his work of power and thermal engineering *Coolant flow instability and critical heat flux modelling in parallel heated channels.*
- on June 24, 2002 Doctor of Science degree was conferred by the LEI on Diana SARAUSKIENE for her work of geography *Analysis and modelling of the Druksiai Lake hydrological regime.*
- on December 20, 2002 Doctor of Science degree was conferred by the Vytautas Magnus University on Mindaugas LIAUKONIS for his work of mathematics *Uncertainty evaluation of system reliability mathematical models.*
- on March 14, 2002 Doctor of Science Habilitus degree was conferred by the LEI on Jonas Algirdas KUGELEVICIUS for his work of power and thermal engineering *Models and solutions of management and control for energy supply systems.*
- on April 30, 2002 Doctor of Science Habilitus degree was conferred by the LEI on Benediktas CESNA for his work of work of power and thermal engineering *Development of the fundamentals for the thermalhydraulic calculation of the high temperature heat-generating assemblies.*

In September 23–25, 2002 LEI was one of the organizers of NATO Advanced Research Workshop *Consideration and Options on a New Nuclear Power Plant at Ignalina*, where options of a new nuclear power plant were discussed.

Institute had bilateral cooperation agreements with the Danish, German, Polish Swedish, and USA organizations. The contracts for scientific research and applied scientific activities were concluded with partners in Denmark, France, Holland, Latvia, Moldova, Norway, and other countries.

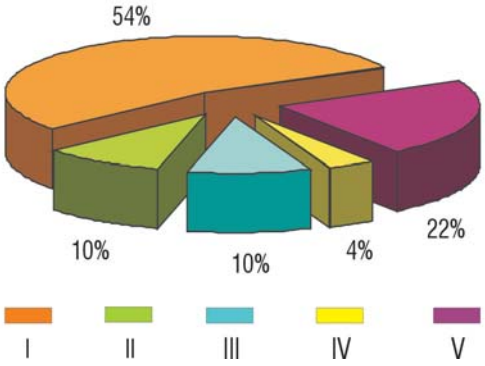
The Institute cooperates closely with many Lithuanian institutes and universities including Kaunas University of Technology, Vilnius Gediminas Technical University, Vytautas Magnus University, Vilnius University, Institute of Geology and Geography, Institute of Ecology and others.

The main directions of cooperation:

- scientific and pedagogical cooperation in conferring scientific degrees and arranging post-graduate studies;
- mutual employment and strengthening of the scientific experiment facilities;
- joint scientific investigations with participation of scientists and students;
- participation in scientific projects and programs and formation of scientific joint groups to solve urgent topical problems;
- participation in the teaching process and educational experimental works;
- preparation and organization of publishing activities, conferences, seminars and other important events;
- analysis of important problems for Lithuania in the fields of hydrology, environmental protection and water economy.

The Government of the Republic of Lithuania in 1998 granted for five years rights to establish doctorate studies and right to confer Doctor of Science and Doctor Habil. of Science degrees for works of power and thermal engineering direction.

**Distribution of researcher according to scientific activities directions**




## ORGANIZATIONAL STRUCTURE AND STATE PROGRAMMES CARRIED OUT

COUNCIL

DIRECTOR

SCIENTIFIC SECRETARY | DEPUTY DIRECTOR | DEPUTY DIRECTOR

**LABORATORIES**

- NUCLEAR ENGINEERING
- NUCLEAR INSTALLATION SAFETY
- ENERGY SYSTEMS RESEARCH
- HYDROLOGY
- REGIONAL ENERGY DEVELOPMENT
- SYSTEMS CONTROL AND AUTOMATION
- COMBUSTION PROCESSES

1. Development of energy economy planning methods, investigation of safety and reliability of the power plants, their impact on the environment, efficient energy consumption and the renewable energy sources
2. Investigations in the fields of thermal physics, fluid mechanics and metrology
3. Simulation of complex energy systems, development of their control methods and technologies
4. Investigation of energy systems' construction elements aging and development of new multifunctioned materials
5. Investigation of combustion and plasma processes in fields of fuel saving, reduction of environmental pollution and thermal decontamination of materials

**LABORATORIES**

- ENERGY EFFICIENCY RESEARCH AND INFORMATION CENTRE
- RENEWABLE ENERGY
- HEAT EQUIPMENT RESEARCH AND TESTING
- MATERIALS RESEARCH AND TESTING
- PLASMA TECHNOLOGIES

AUXILIARY UNITS AND SERVICES

# LABORATORY OF ENERGY SYSTEMS RESEARCH

**Main directions of scientific activities:**

- Scenario analysis of macroeconomic development, modeling and forecasting of energy demand;
- Analysis of medium- and long-term energy supply scenarios using widely approved optimization models;
- Environmental impacts of the energy sector, analysis on pollution reduction technologies and implementation of environment protection policies;
- Research of management and marketing in the energy sector;
- Generalization of energy restructuring and liberalization experience gained in European Union and East and Central European countries and application of the analysis findings for reforms in the Lithuanian energy sector;
- Development of energy information system, collection of statistical data on energy development in Lithuania and foreign countries;
- Development of common power market establishment principles for the Baltic countries.

The major scope of scientific research is a development of methodology foundations and software for the purposes of forecasting of energy demand and optimization of energy sector extension, as well as development of relevant statistical database. In cooperation with International Atomic Energy Agency in 2002, the major efforts have been paid to accomodate the MESSAGE model to Lithuanian economy in order to optimize the energy sector. This model together with other mathematical models used earlier and computer programs constitutes a good basis for creation of the system of models to be used for the energy sector development analysis. The significant outcome of investigations in development of energy systems – the methodology principles for energy planning have been assessed as well as acnowledged forecasting and optimization models used in other countries have been adapted. The effectiveness of various models in solution of particular problems has been analysed, the modelling approaches and solutions with respect to specifics of country's energy sector (excess capacities, CHP, hydropump storage plant, reserves) have been developed, as well as relevant recommendations have been presented which enable the formulation of adequate models of energy objects. With the aim to use graph theory methods and models for energy planning the algorithms and computer programs (CONNECTIVITY, SHIMBEL'S PATH AND COMPLEX PATH) were prepared, which may be used for analysis of electricity transmission contracts, gas transportation prices, etc.

The main result of the applied research carried out in 2002 – preparation of the updated ***National Energy Strategy*** and its scientific, technical and economic approval. In addition Laboratory received very important assignment to carry out additional investigation needed by members of Delegation of EU-Accession Negotations.

The report ***Preparation/Implementation of the National Energy Strategy, integration into the West-European natural gas system and gas supply reliability improvement*** was prepared on the basis of contract with Ministry of Economy. The investigations related to Lithuanian power sector development have been summarized, and the analysis of the development scenarios of the district heat sector were presented. On the grounds of optimizing calculations the trends of power and heat price variation are presented as well as predictions of the $CO_2$ and $NO_x$ emissions. The work also contains major conclusions and recommendations on development of natural gas supply systems and pipeline interconnections with neighbouring countries. In addition, this report presents the new analysis of structural changes in energy supply and consumption, the final energy and electricity demand forecasts, as well as recommendations related to statistical information, which is needed for modelling of sustainable development of energy sectors.

According to the contract with the JSC *Lietuvos Energija* the report was prepared under the title ***Scientific expert examination of the legal basis of the power sector***, in which legal acts, both brought in force and still drafted, have been evaluated, with analysis of concepts used in these acts and with proposals of amendments together with new version of electric power trade regulations.

The Laboratory actively participated in various international projects: ***Indicators of sustainable energy development*** supported by the International Atomic Energy Agency; projects financed by the Danish Energy Agency – ***Economic analysis of the Lithuanian power sector, Environmental requirements for the energy sector, Updating and revision of the National Energy Strategy***. The urgent problems of the power system development and establishment of electricity market in Lithuania and in the Baltic States have been considered in these projects. Implementation strategy of the European Union directives including Directive on the large fuel burning enterprises and Directive on Sulphure was also considered. The methods of energy demand forecasting and energy sector optimization were also discussed.

The year 2002 was significant for Laboratory researchers with respect of their professional growth. Senior research associate J. Kugelevicius summarized up his multi-year scientific investigations in electric power, gas and oil supply systems and maintained his doctor habilitus theses ***Models and solutions of management and control for energy supply systems*** *(technological sciences).* Ph.D. Candidate R. Gatautis worked in Denmark for training period; Dr. I. Konstantinaviciute and Ph.D. Candidate E. Norvaisa took part in training courses organized by the International Atomic Energy Agency in Romania. In cooperation with International Atomic Energy Agency, the experts from Austria, Croatia and Romania visited Laboratory and provided consultations on issues of planning and modelling of the energy sector. Researchers of Laboratory took part in the international conferences presenting their lectures (contributions) in Germany, Czech Republic, Scotland (20 lectures in all) and published 26 articles in Lithuanian and foreign journals, Proceedings of conferences and other publications.

***Dr. Habil. Vaclovas MISKINIS***
*Head of the Laboratory of Energy Systems Research*
*Tel.: +370 37 401959, 453478*
*E-mail: miskinis@isag.lei.lt*

# LABORATORY OF REGIONAL ENERGY DEVELOPMENT

**Strategic Goal of the Laboratory –** create methodology for assessment and revising of the development of local energy sector, with regard to the need to improve state macroeconomic indicators and elaborate software tool to help in formation of development strategy in this sector.

While implementing budget funded project ***Creation and justification of macroeconomic methodology for development of municipal energy sector with regard to the tasks for formation of National Energy Strategy*** data bases were developed for elaborating mathematical model for district heating sector, based on balance sheet of financial flow changes at DH companies, which is integrated into matrix model, established by W. Leontieff.

Project ***Investigation of energy economic issues and generalization of analysis on alternative solutions*** (project manager Dr. Habil. V. Klevas) was completed. The project was devoted to the formulation of the basics of Lithuanian energy economics. It has investigated the methodological background and instruments for the energy economics and performed interaction analysis between energy and economics sectors. Theoretical energy development efficiency criterion was formulated. It should be applied for economic-financial assessment of alternative scenarios for the development of energy sectors. Economic assumptions for reduction of energy supply interruptions risks were discussed. Regional energy development principles were defined and principal methodological assumptions for integration of energy efficiency projects into regional development programs were identified.

While participating in revising of National Energy Strategy the staff of the Laboratory presented the economic background for directions of district heating development.

**Laboratory has participated in three international projects**:

- MUNEE (Municipal Network for Energy Efficiency) network (Network representative in Lithuania dr. V. Kveselis);
- PENELOPE (Promoting Energy Efficiency to Local Organizations through Dissemination Partnerships in Europe) – BACCHUS (Best Actions for Collaborations in Countries for a High Efficient Use of Energy in Structural Funds) project (Project manager in Baltic region, Dr. Habil. V. Klevas);
- SAFIRE-LP (Strategic Assessment Framework for the Implementation of Rational Energy – Local Planning) project (Project manager in Lithuania Prof. Dr. Habil. M. Tamonis).

Trilateral COLLABORATION AGREEMENT was signed on May 23, 2002 between Association of Local Authorities in Lithuania (ALAL), Lithuanian Energy Institute and Lithuanian District Heating Association.

In the framework of Collaboration agreement and using financial support from MUNEE project:

- Software tool was developed at LEI Laboratory of Regional Energy Development for collecting and analysis of information on energy consumption at municipal level;
- Strategic guidelines for development of municipal energy sector were elaborated and adopted by ALAL.

Developed software tool together with adjusted data bases was tested and implemented at Birstonas municipality. This is initial version of Municipal Energy Information System (MEIS) TAUSA, which is further improved and developed. While implementing SAFIRE-LP project, similar information system was started for Birzai municipality.

While implementing BACCHUS project, the gap between activities of regional development experts and energy experts was highlighted, which can become a barrier for the use of Structural Funds for financing of sustainable energy development.

The staff of the Laboratory presented papers at four international conferences.

Laboratory was one of the main organizers and sponsors for the Second International Conference *Decentralization of Energetics: Future of Urban Energetics* (Klaipeda, May 9-11, 2002).

*The meeting of Energy sub-committee of Administration Committee of ALAL*

***Prof. Dr. Habil. Matas TAMONIS***
*Head of the Laboratory of Regional Energy Development*
*Tel.: +370 37 401930*
*Fax: +370 37 401971*
*E-mail: etpl@isag.lei.lt*

# LABORATORY OF NUCLEAR INSTALLATION SAFETY

**Main research areas of the laboratory:**

- Thermal-hydraulic analysis of accidents and operational transients;
- Thermal-hydraulic assessment of Ignalina NPP Accident Localization System and other compartments;
- Simulation of radionuclides and aerosols transport in the compartments;
- Structural analysis of plant components, piping and other parts of Main Circulation Circuit;
- Assessment of RBMK-1500 reactor core modifications and analysis of postulated reactivity accidents;
- Level 1 and Level 2 Probabilistic Safety Assessment of Ignalina NPP;
- Assessment and prognosis of the graphite stack-fuel channel gap closure dynamics;
- Development and validation of coupled neutron kinetics thermal-hydraulic RBMK-1500 model for RELAP5-3D code;
- Single failure analysis and engineering assessment for complex technical systems;
- Investigation of condensation implosion phenomena in water-steam contact;
- Risk and hazard analysis of industrial sites.

For more than 10 years close relations were maintained with Ignalina NPP, therefore most of the projects were directly related to the safety of nuclear power plant, assessment of scheduled or implemented modifications, review of published documents. These technical issues were analyzed and conclusions were assessed using state-of-the-art codes RELAP5, ATHLET, QUABOX/CUBBOX, NEPTUNE, ALGOR, COCOSYS etc. The achieved experience gave possibility to start the deterministic and probabilistic safety and risk assessment not only of Ignalina NPP but for other Lithuanian industrial companies as well.

**Safety Analysis Report of Ignalina NPP Unit 2.** In 2002 the works related to development of Ignalina NPP Unit 2 Safety Analysis Report were finalized. This report is one of the key documents that shall be provided by operating organization in order to receive a license for further operation. In the development of SAR the following works were performed: development of fault schedule for accident analysis, engineering assessment of main circulation circuit and reactor systems, accident analysis, assessment of fuel channels integrity and acceptability demonstration. It should be noted that the accident analysis was performed using best-estimate computer codes according to the methodology applied in western European countries and USA and supplemented with the sensitivity and uncertainty analysis. The compensating measures are recommended in order to enhance NPP safety level to the requirements of modern standards. These measures would allow preventing accidents that still do not have two strong lines of defense.

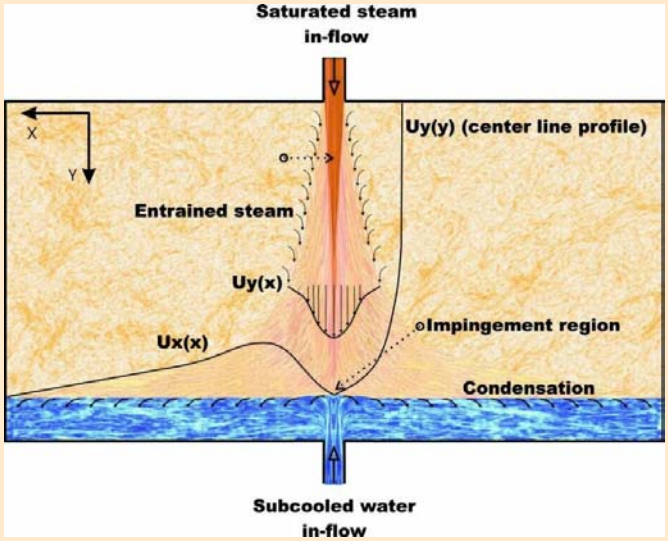
**Variation of gas gap between graphite stack and fuel channel.** In 2002 laboratory was further investigating the variation of gas gap in the individual fuel channels at Ignalina NPP Unit 1 considering the results of measurements performed in 2002. The earlier developed methodology was further enhanced, the mathematical model of graphite diameter variation was improved and probabilities of gas gap closure in 2003–2004 were calculated considering different scenarios of reactor operation. The calculation results showed that the gas gap existence probability until planned preventive maintenance in 2003 for all channels is 0.98.

**Analysis of coolant flowmeters reliability.** The problem about the reliability of the coolant flowmeters system at Ignalina NPP Unit 2 remained in 2002. Analysis of the testing results showed that characteristics and methodology applied for the assessment of flowmeters state are not reliable. Laboratory proposed to use the additional, more reliable flowmeters operation characteristics and developed a new methodology based on the integral assessment of the whole system. This methodology allows to maintain the required system reliability.

**Cooperation with VATESI.** Traditionally close contacts were maintained with State Nuclear Safety Inspectorate (VATESI). In 2002 laboratory performed review of the documents, which were supplied to VATESI for NPP safety improvement according to recommendations presented for licensing of Ignalina NPP Unit 1 and expertise of the documents, which assesses the application of new uranium-erbium fuel at Ignalina NPP.

In 2002 the earlier started projects with Western partners were continued and new contracts were signed with research departments of Denmark and USA:

- **Independent review of Ignalina NPP second shutdown system.** The most important project enhancing the safety level of Ignalina NPP Unit 2 is the implementation of the diverse shutdown system. In 2002 Laboratory together with experts from western countries continued the joint project PHARE LI/TS/15, which objective is to review and check the design documentation, perform independent calculations in order to show that this system complies with the Lithuanian and international safety standards and support VATESI taking decisions on the implementation of this system. This system is foreseen to be implemented in Ignalina NPP Unit 2 in 2004.
- **Pipe whip impact on neighboring structures.** In 2002 the unique international project completed together with Argonne National Laboratory (USA). For the first time in Lithuania deterministic and probabilistic whiping analysis for the group distribution header hypothetic guillotine rupture was performed and the impact of the whip to the neighboring pipe and wall was evaluated. Considering the rupture probability and possible consequences the guillotine rupture of Group Distribution Header was assumed for the analysis with the NEPTUNE code. The uncertainty analysis of input parameters – mechanical characteristics and geometrical data – was performed using ProFES code.
- **Development and validation of coupled neutronic thermal-hydraulic model of RBMK-1500 for RELAP5-3D code.** In 2002 the cooperation with Argonne National Laboratory (USA) was continued on the finalization of the old and starting the new projects on application of RELAP5-3D code for NPP with RBMK reactors. In the first step the coupled neutronic thermal-hydraulic model of RBMK-1500 for RELAP5-3D code was developed and




*Spread of the steam jet within the experimental pulser*

four accident and transient processes were simulated. In the next step the validation of the developed model is performed considering the data measured during real events at Ignalina NPP.

- **Risk-based optimization of the diesel-generators testing interval.** This project was financed by the Denmark Energy Agency and the work was performed together with Risoe National Laboratory of Denmark. The consultancy contract was performed as continuation of *Entrance to EU negotiations and national energy strategy* programme. In the work, which was completed in 2002 the testing intervals of Ignalina NPP diesel-generators (DG) were investigated, the mathematical model of DG reliability management was created, the failure statistics was investigated, the economical effect due to change of the testing intervals was assessed and the acceptable DG reliability barrier was defined.
- **Strength analysis of steam distribution devices and their joints.** A project which objective was – thermal-hydraulic analysis of steam distribution devices in case of maximal design basis accident and the strength evaluation of the steam distribution header and its connection with vertical steam distribution corridors was started in 2001 and continued in 2002. Together with partner – Argonne National Laboratory (USA) – the finite elements models were developed for every type of steam distribution devices and the initial analysis of these devices strength was performed. COCOSYS V2.0v0 code was employed for thermal-hydraulic analysis and NEPTUNE code – for structural analysis.
- **Influence of external events on the Ignalina NPP buildings and structures.** This new project was financed by the US Department of Energy. The project is foreseen for the development of the possibility to perform strength analysis of the buildings, containment and piping under influence of the external hazards. In 2002 the structural analysis of the typical Ignalina NPP building in case of aircraft crash was performed using NEPTUNE code.

Two research projects financed by state budget were completed in 2002:

- **Uncertainty analysis of complex technical systems simulation results.** In 2002 a budgetary work was completed. During this work the multi-stage technique for uncertainty analysis of complex systems simulation was developed. It includes the uncertainty analysis of initial and statistical data models, the quantitative sensitivity analysis of model parameters and uncertainty analysis of deterministic and probabilistic models results. In this work the review of uncertainty assessment methods was performed, the uncertainty sources were discussed, their systemic classification was presented and the software was selected. According to the developed technique the uncertainty analysis of various deterministic and probabilistic models was performed and the conclusions as well as recommendations were stated.
- **Fundamental investigations in thermal physics.** In 2002 the preliminary study to clarify the condensation implosion event phenomena in stratified water – steam system was finished. The experimental investigations and the simulation of this condensation process with RELAP5 and FLUENT codes were performed. Based on these experimental and simulation results, the transition of the condensation process to the condensation implosion event was explained and four condensation modes were described. Further investigations would allow to explore the possibilities to employ this phenomena in the practice.

In 2002 Laboratory personnel participated in different training programmes, cooperated with Lithuanian State Science and Studies Foundation, started close cooperation with Ministry of Education and Science of Lithuania. 35 papers were presented in scientific conferences, the results of work were presented in 49 articles in journals. The qualification of the laboratory personnel could be judged considering the fact that they are invited as lecturers in seminars organised by IAEA, they participate in meetings and technical workshops with other nuclear energy specialists from Europe. Personnel participate in different projects as independent experts and consultants.

***Prof. Dr. Habil. Eugenijus USPURAS***
*Head of the Laboratory of Nuclear Installation Safety*
*Tel.: +370 37 401926*
*E-mail: eugeniju@isag.lei.lt*

# LABORATORY OF NUCLEAR ENGINEERING

**Main areas of scientific activity:**

- Experimental investigation of turbulent mixed convection heat transfer regularities in single-phase flows;
- Numerical modelling of heat transfer and turbulent transport;
- Fire hazard analysis in nuclear power plants;
- Safety assessment of storage facilities for spent nuclear fuel;
- Safety assessment of treatment technology and storage facilities for radioactive waste;
- Long-term safety assessment of repositories for radioactive waste;
- Assessment of different factors related to decommissioning of nuclear power plants;
- Strategy on the management of radioactive waste;
- Creation of the legal and regulatory base for radioactive waste management.

**Experimental and numerical heat transfer and turbulent transport investigation.** The Laboratory has an extensive experience in investigations of heat transfer and flow hydrodynamics to support design of different applications (nuclear reactors, heat exchangers and their elements etc.).

Experimental investigations on turbulent mixed convection heat transfer in inclined flat channel ($10^o$, $20^o$) with one-side heating for opposing airflows have been performed in 2002. Also numerical modelling of local heat transfer, velocity and temperature profiles with FLUENT software have been performed in vertical flat channel with symmetrical heating for aiding flows, both when directions of natural and aiding flows coincide and when they are opposite.

**Fire hazard analysis in nuclear power plants.** In 2001 it was started and in 2002 was completed extensive and complex project on fire hazard analysis at Ignalina Nuclear Power Plant (INPP) Unit 1, which was undertaken by the Laboratory together with Swedish experts. Complex fire hazard analysis of most important rooms with safety related systems elements and adjacent rooms have been performed. Another project was also performed - fire safety analysis of the most important rooms of INPP Unit 2. During fire hazard analysis the consistency of INPP to safe reactor shutdown criteria was evaluated. Modelling of fire propagation in the most important rooms has been also performed.

**Safety assessment of spent nuclear fuel storage facilities.** The dry interim storage facility for spent nuclear fuel at INPP with CASTOR RBMK-1500 and CONSTOR RBMK-1500 type casks was commissioned in 1999.

Laboratory has been and is performing works related with safety assessment of spent nuclear fuel storage. It was determined variation of the nuclide content during 100 years interim storage period, the criticality safety of the casks, dose rate on the surface and at specified distance from the surface of the casks and the temperature fields in the casks. Assessments have been made for the casks with fresh and burned-up nuclear fuel, at the beginning and at the end of interim storage period, in normal operation and accident conditions.

In the year 2002 in cooperation with the Institute of Physics, dosimetric and spectroscopy measurements on the surface of casks and in different distance from them were experimentally performed in spent nuclear fuel storage site. Measurement data were compared with modelling results.

**Safety evaluation of radioactive waste management.** Since 1994 the Laboratory is actively involved in the analysis of the radioactive waste management problems at INPP.

In 2002 Laboratory experts together with experts from SwedPower, Sweden, accomplished a study on the selection of technology for sediment removal of liquid radioactive waste and prevention of their subsequent formation. Our experts together with experts from ES-Konsult, Westinghouse Atom and SKB International accomplished the project on *Decision-Making Basis for a New System for Short-Lived Solid Waste Management at INPP*. Laboratory also participates in the Framatome ANP GmbH project *Installation of a Cement Solidification Facility for Treatment of Liquid Radioactive Waste and Erection of a Temporary Storage Building for INPP*. Together with Framatome ANP Gmbh *Preliminary Safety Analysis Report and Environmental Impact Assessment Program and Report* have been prepared and approved by competent institutions of the Republic of Lithuania.

**Long-term safety evaluation of radioactive waste repositories.** Since 1996 laboratory experts have been participating in projects related to the long-term safety assessment of existing radioactive waste storage facilities at Maisiagala and Ignalina sites. Important conclusions were drawn about limitations and possibilities to convert these storage facilities into repositories. Also Laboratory participated in the IAEA coordinated research programme *Improving Long-Term Safety Assessment Methodologies for a Near Surface Radioactive Waste Disposal Facilities (ISAM)*, in SKB-SWECO International-Westinghouse Atom Joint Venture project *Reference Design for a Near Surface Repository for Low- and Intermediate-Level Short-Lived Radioactive Waste in Lithuania*.

In 2002 Laboratory staff together with Swedish experts drafted regulations *General Radioactive Waste Acceptance Criteria for Disposal in Near Surface Repository*. Since 2002 Laboratory participates in IAEA coordinated research project *Application of Safety Assessment Methodologies for Near Surface Waste Disposal Facilities (ASAM)*.

**Evaluation of different factors for decommissioning of NPPs**. In 1998 Laboratory scientists started a new branch of research activity related to the planning of the decommissioning of Ignalina NPP.

The Laboratory experts participated in examining different preliminary INPP decommissioning scenarios during preparation of technical part of INPP Unit 1 decommissioning programme. One of our experts was involved in the IAEA expert group to define INPP decommissioning strategy. Law on INPP decommissioning fund (draft) has been also prepared.

In 2002 Laboratory experts commenced preparing final decommissioning project for INPP decommissioning department paying basic attention on radioactive contamination evaluation of the most important systems. For this purpose LLWAA-DECOM software of Belgium Company TRACTEBEL was used, which was adjusted to RBMK type reactor, also additional software means created in Laboratory were used.

Since 2002 Laboratory participates in IAEA coordinated research project *Disposal Aspects of Low and Intermediate Level Ignalina NPP Decommissioning Waste*.

***Prof. Dr. Habil. Povilas POSKAS***
*Head of the Laboratory of Nuclear Engineering*
*Tel.: +370 37 401891*
*E-mail: poskas@mail.lei.lt*

# LABORATORY OF RENEWABLE ENERGY

**Main directions of research of the Laboratory:**

- Modelling of heat transfer and hydrodynamic processes in the water reservoirs-coolers;
- Determination of renewable energy resources (RES), assessment of their utilization prospects and solution of environmental protection problems;
- Search for updated technologies of utilization of local and RES, feasibility assessment, preparation of regulation norms, legislation and project documents, formation of databases, services and consulting for customers;
- Investigation of application of the heat cost allocators by implementing the method of payment for actual energy consumption of separate flats in the multi-storey building. Creation of calibration equipment for the heat and fluid flowrate metering devices.

**Modelling of heat transfer and hydrodynamic processes in the water reservoirs-coolers.** Numerical modelling of the thermo-hydrodynamical state of the water reservoirs – coolers was carried out in the Laboratory with evaluation of influence of external factors as well as water surface (waviness), atmospheric radiation, depth and terrain influence on the main processes. Numerical modelling encompass stationary as well as transient processes. The codes PHOENICS, FLUENT, MAPLE V and others were used for investigations.

**Determination of renewable energy resources, assessment of their utilization prospects and solution of environmental protection issues**. The Laboratory was also engaged in investigations of utilization of biomass for heat and electricity production. The greater part (67% and most easy to harness for use) consists of wood, its waste and straw. The problems related to biogas and green plantations growing for energy production, biofuel for transport vehicles purposes on the basis of rape oil and ethanol were also dealt with. Contacts with foreign professionals working in this field were maintained and there was exchange of information on these problems. Close ties were main-timed also with local firms manufacturing biomass utilization equipment as well as with equipment users.

Kinetics of biomass (wood, straw, etc.) thermochemical conversion processes taking place in grate firing boilers, formation of pollutants (CO, $NO_x$, etc.) and search for reduction means for the latter emissions were investigated. Experiments in this field were carried out in cooperation with the Technical University of Denmark.

Investigations of the RES used in the agriculture were carried out according to program supported by the Lithuanian State Science and Studies Foundation – *Conversion of Solar Energy and its Use.* Fundamental research and applied investigations were carried out linked to use of solar, wind and water energy, and monitoring station net was created. Recommendations were prepared for demonstration projects.

**The international projects and programmes, related to RES utilisation and heat account in flats of multi buildings were carried out in the Laboratory:**

- *Development of the Elements of Innovative New Wind Turbines* (Cooperation: Ukraine);
- *Enhancement of the Utilisation of Local and Renewable Energy Resources* (Cooperation: Danish Energy Management A/S);
- *Establishing Energy-Efficiency in the Lithuanian Housing and Building Sector*. Support with the legal harmonisation and effective implementation of EU requirements (MATO/LT/9/1) (Cooperation: Netherlands Energy Research Foundation ECN);
- *ERA Bioenergy Strategy – Short Term Measures to Develop the European Research Area for Bioenergy RTD.* Project executed according to FP5 programme.
- *Organisation for the Promotion of Energy Technologies Lithuania (OPET Lithuania).* Project is carried out according to FP5 programme together with 115 organisations from 48 European and other world countries.

The aim of these programs is to evaluate RES resources in the country and find effective means to intensify their utilization. In the course of implementation of the *OPET Lithuania* program the Laboratory in cooperation with the institutions of other countries carry out investigations of biomass, wind and solar energy, biogas, landfill gas and other RES resources and of possible utilisation of other technologies.

The experts of the Laboratory took part in preparation of the *Lithuanian National Solar Program 2000–2005,* supported by UNESCO, which in turn will be included into the *World Solar Program 1996–2005.* This program includes not only solar energy but also other RES sources (biomass, wind, water and geothermal energy and etc.). Researches of our Laboratory in close cooperation with enterprises working in the field of energy solve technical problems relative to RES and local energy utilisation.

Possible use of the passive heating systems using solar energy for heating buildings was investigated and changes taking place in the heating systems and their regulation in all seasons of the year were evaluated.

The problems of biogas production and utilization for power application were investigated using the agricultural firm VYCIA with the demonstration biogas power plant as a research base.

For evaluation of wind energy utilization potential the wind parameters were measured using modem, measuring equipment, in Giruliai and in the center of the country (Kaunas district). Computer codes were created to calculate wind integral characteristics (velocity. direction, velocity profiles, windrose, wind energy, Veilbul parameters and others). *The Wind Power Handbook* was prepared and published.

**Utilisation of landfill gas and municipal waste.** Work of evaluation of landfill gas collection and usage possibilities in Lithuania is performed. Information about the greatest landfill sites and about the waste management in them is gathered and accumulated.

**Account of heat consumption residential buildings**. Heat saving possibilities in the multi-storey buildings in various Lithuanian cities by introducing a new method of accounting for actual heat consumption in each flat, based on the data gathered by heat allocator-indicator, mounted on the radiators, were examined. Engineering specifications of the equipment used for heat and flow meter checking and validation were prepared and construction of validation rigs was continued.

***Prof. Dr. Habil. Vladislovas KATINAS***
*Head of the Laboratory of Renewable Energy*
*Tel.: +370 37 401 841*
*E-mail: res@isag.lei.lt*

# LABORATORY OF HEAT-EQUIPMENT RESEARCH AND TESTING

**Main directions of scientific research and applied works of the Laboratory:**

- Provision of metrological support to the Lithuanian energy sector in the field of fluid flow parameter measurements, establishment and maintenance of the state flow standards and ensuring measurement traceability to national and international standards;
- Tests of the thermal equipment and gas appliances carried out with the aim to determine its conformity to the requirements of national norms and European directives and mutual harmonization of these requirements;
- Scientific research aimed at improving methods of measurement of liquid and gas flows, to determine influence by various factors on the accuracy of measurement and to predict supply/ consumption imbalances of the energy resources.

The Laboratory, fulfilling the assignments and authorization of 1997 by the Government of Lithuania to create and maintain four state flow standards, presented to the State Commission for acceptance four completed aerodynamic facilities designed for restoring air velocity (at ranges 0.2 to 30(60) m/s), air volume and flow (within the ranges from 0.005 to 6500 $m^3/h$) unit values and for conveying them to the working standards.

Research and improvement works on the three remaining facilities designed for restoring flow and volume units of water and oil products are continued further with the aim to achieve their completion in 2003. Upon completion of these works, covering design of the standards, their investigation and inter-laboratory comparisons, all standards created by the Laboratory will correspond to the international level and will satisfy all needs of the economy and science of Lithuania.

Another important achievement by the Laboratory was evaluation of the quality system and accreditation by the National Accreditation Bureau of Lithuania in accordance with LST EN ISO/IEC 17025. The total compliance of the quality system of the Laboratory with this norm was confirmed also by the international experts.

**Table 1. The values provided by the standards of the laboratory**

| *Physical quantity* | *Measurement range* | *Best measurement capability, %* |
|---|---|---|
| *Air (gas) velocity: local* | *0.2–3; 3–60 m/s* | *±(7–2); ±(2–1)* |
| *average* | *0.2–30 m/s* | *<2.5* |
| *Air (gas) volume/flow rate using:* | | |
| *bell-type prover* | *0.005–16 $m^3/h$* | *±0.13* |
| *facility with critical nozzles* | *5.7–308.8 $m^3/h$* | *±0.17* |
| *facility with reference meters and nozzles* | *160–6500 $m^3/h$* | *±(0.25–0,30)* |
| *Water volume/flow rate* | *0.01–30 $m^3/h$* | *±0.08 (volume)* *±0.12 (flow)* |
| *Liquid fuel volume/flow rate* | *1.5–140 $m^3/h$* | *±0.17* |

**Table 2. Other accredited fields of calibration**

| *Physical quantity* | *Measurement range* | *Best measurement capability* |
|---|---|---|
| *Heat volume* | *0.01–30 $m^3/h$* *3°C ≤ Δh ≤ 120°C* | *±0.95%* |
| *Pressure* | *0–6.0 MPa* | *±0.06%* |
| *Temperature* | *-30–+200°C* | *±0.07°C* |
| *Length (level of liquid)* | *0–3500 mm* | *±0.26 mm* |

The values provided by the standards of the Laboratory together with their accredited areas are presented in the Tables 1 and 2. The Laboratory is also accredited to calibrate the facilities used for verification of air (gas) velocity, air and water volume/flow and heat metering devices in the metrological departments of organizations and firms.

In the field of testing the Laboratory provides services evaluating conformity with requirements of the European directives and standards of gas appliances including hot water boilers up to 70 kW and air heaters up to 300 kW, cookers and valves up to DN 200 as well as water and heat meters and electronic gas volume conversion devices supplied to the Lithuanian market.

*Water meter testing facility*

In the sphere of scientific research, the most important works are related to improvement of the state standards, particularly to restoring values of small velocities and flow rates. Considerable attention is paid to investigation of energy resource supply and consumption balance.

The Laboratory takes active part in fulfillment and implementation of the aims envisaged in the plan of measures of *The development program of the infrastructure (testing laboratories, certification bodies) of conformity assessment* and seeks the appointment by the Ministry of Economy in 2003 to become an authorized body to evaluate conformity to the requirements and to carry out itype examination of water, gas and liquid fuel meters, hot water boilers uop to 400 kW burning gaseous and liquid fuels and gas appliances.

By the decision of the Government of Lithuania the Laboratory was appointed to carry out the state safety examination of thermal equipment and gas appliances.

The Laboratory was accepted as corresponding member-correspondent by the EUROMET technical committee FLOW.

***Dr. Habil. Antanas PEDISIUS***
*Head of the Laboratory of Heat-Equipment Research and Testing*
*Tel.: +370 37 401863*
*E-mail: testlab@isag.lei.lt*

**The aim of activities of Energy Efficiency Research and Information Center is** to accumulate, analyze and convey to experts and public the best experience of efficient energy production, distribution and use abroad and in Lithuania.

# ENERGY EFFICIENCY RESEARCH AND INFORMATION CENTER

**In pursuit of selected aims the Center:**

- Gathers, accumulates and analyzes information concerning energy sources, efficient generation of various kinds of energy, energy distribution and consumption, provides information and consults about these subjects;
- Investigates utilization possibilities of renewable and recoverable energy sources and makes known importance of their utilization in the economy sector of the county;
- Executes energy audits in energy enterprises, industrial firms and buildings;
- Helps to implement means enhancing energy consumption efficiency envisaged during energy inspection;
- Participates in preparation and implementation of the National Energy Efficiency Programme;
- Prepares energy saving legal acts and standard specifications;
- Takes part in the international projects related to work effectiveness of energy sector of the country;
- Arranges seminars, conferences and courses of lectures about energy efficiency;
- Promotes publishing activities related to energy efficiency and information about new technologies.

**Main activities of the Center in 2002:**

- Research works;
- Works aimed at realization of the National Energy Efficiency Programme;
- Participation in the international projects;
- Organization of seminars and lecture courses.

In 2002 the research work, financed from state budget – ***Investigation of Possibilities of Energy Consumption Efficiency Enhancement in Buildings and Industry by Implementation of New Technologies and Preparation of the Recommendations*** was completed.

Analysis of energy consumption in industry in 1996–2001 is done, possibilities of energy consumption efficiency enhancement in industry and buildings presented. According to data of members of Lithuanian Industrial Energy Efficiency Network (IEEN) detailed analysis results of production proceeding are done. Specific energy consumption of bread and pastry, dairy and meat processing industry enterprises are defined and data are compared with analogical enterprises in western Europe.

**Appliance of heat pumps for heating of individual houses.**

Research shows that by implementation of heat pumps for heating of individual houses, a price of produced heat is less than the prices of heat from traditional fuels (diesel fuel, natural gas and liquid gas). The price of installation of individual house heating systems with heat pumps is 8–13% more than traditional solid fuel, liquid and gas fuel stokehold systems.

The possibilities of use of mini cogeneration power stations in industry and buildings were analyzed in such work also.

In the course of carrying out this research 10 articles were published, 8 local and international conferences were attended, 7 popular articles were published. A book – *Energy Efficiency in Bread and Pastry Industry* was prepared and published.

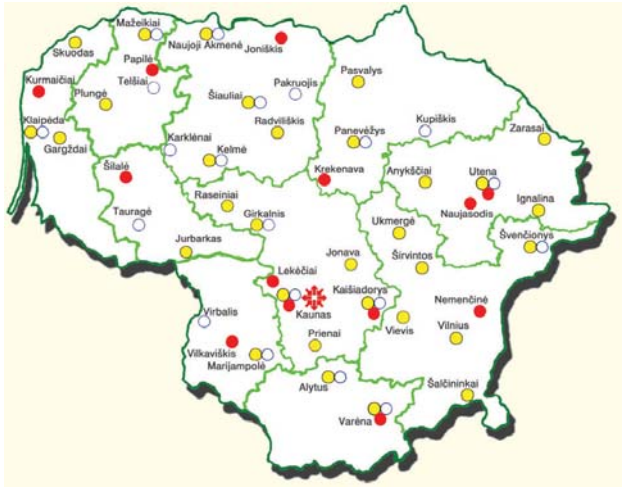
The Center took part in the implementation of the National Energy Efficiency Programme. Series of legal documents for Heat Law was prepared: regulations of heat supply and consumption, methodologies of heat allotment in residential buildings (10 methodies), regulations of license for heat supply and other.

In 2002 five international projects were carried out. The main tasks of project *OPET Lithuania Network* (Organization for the Promotion of Energy Technologies) was a promotion of the results of new energy technologies and their introduction in society. Its activities support European policy in terms of improving energy efficiency, increasing the diversity of supply and broadening the use of renewable energy sources. The project has been supported by the European Commission (DG TREN: Energy and Transport).

Objectives of project *Energy Service Companies in Lithuania* (EC SAVE II Programme, partners – AF International AB, Sweden, Maicon, UK) was to overcome barriers for implementation of energy efficiency investment in the building and industry sectors by introduction of energy Service Companies (ESCO's).

Project *Increasing Efficiency of Energy Consumption in Public Buildings of Lithuania* (Financed by European Bank for Reconstruction and Development) undertook the following tasks: estimation of the overall market potential for energy efficiency investments in the universe of public buildings, which receive a budget allocation from the public sector. These buildings included public hospitals, buildings of the Ministry of Internal Affairs, education facilities administered by the Ministry of Education as well as housing and office buildings of the Ministry of Defense.

In 2002 four international seminars took place organized together with partners from Germany, Sweden, Great Britain and other countries.




*Lithuanian Industrial Energy Efficiency Network 2000–2001: ● – bread and pastry, ○ – dairy, ● – meat processing industry*

***Dr. Romualdas SKEMA***
*Head of the Energy Efficiency Research and Information Center*
*Tel.: +370 37 401 802*
*E-mail: skema@isag.lei.lt*

# LABORATORY OF SYSTEMS CONTROL AND AUTOMATION

**The main areas of fundamental and applied research:**
- Investigation of energy system control and modelling;
- Modelling and optimization of control and data aquisition systems.

**Investigation of energy system control and modelling**. The laboratory carried out fundamental and applied research works in the area of energy system control and modelling. The aim of scientific investigations was to create mathematical models of energy systems and consumers and technical means enabling optimization of energy generation, transfer and consumption processes, to automate their control and enhance energy efficiency.

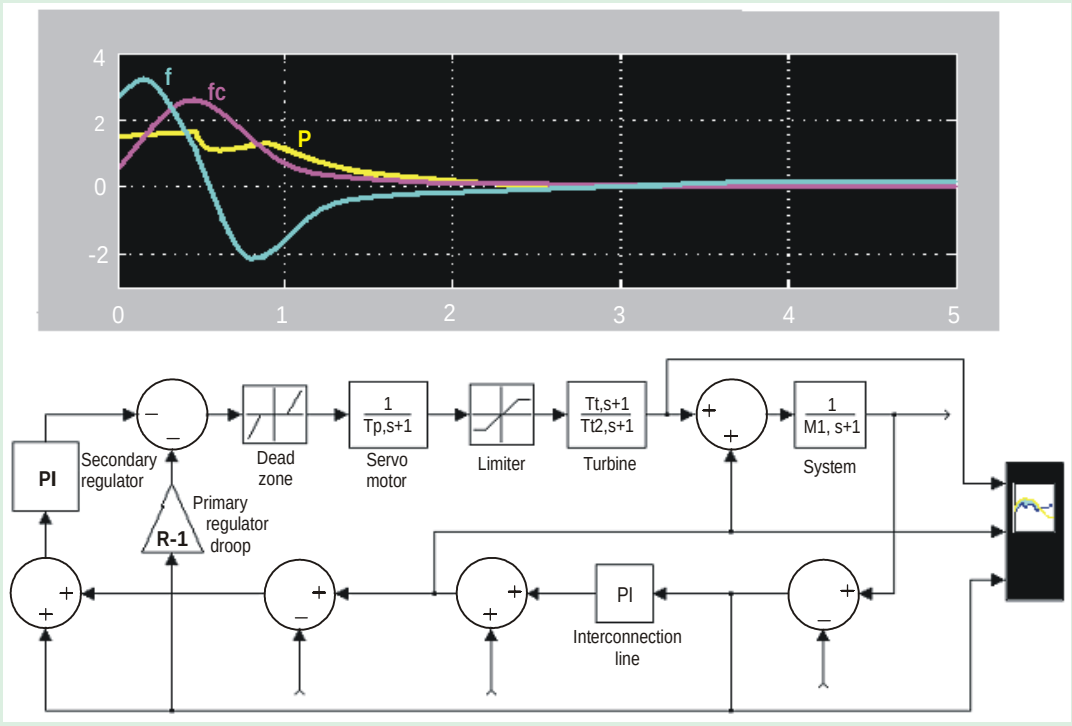
New **advanced** models were created for the investigations of restructured power system of Lithuania, which has been prepared to work in the competitive conditions of open market. The models of control systems, in which so-called fuzzy set methods were employed, were investigated. The carried out analysis indicated advantages of the fuzzy method used for the solution of the problems mentioned above. As a result of these investigations the models of electric energy system of Lithuania were created in order to investigate the processes of frequency and capacity regulation.

More exact dynamic models of heating process were created in order to investigate energy saving possibilities. Their application enabled to analyze peculiarities of control of building heating systems and determine heating regime and energy consumption dependencies. The possibilities of reduction of heat consumption for buildings heating in our climatic zone were determined.

Scientists of the laboratory took part in the preparation of legal acts, standard and engineering specifications necessary for the creation of energy market. The work was carried out in close cooperation with supervising governmental institutions and the Joint Stock Company *Lietuvos energija*.

**Modelling and optimization of control and data aquisition systems.** Systems of computerized control, data gathering and analysis (SCADA) used for control of large energy systems or objects were created, updated and implemented worldwide. The analysis of these systems was carried out and the main trends of development were determined. Attention was also focused on investigations of computerized systems designed for counting and controlling rational demand of power in large power industry enterprises. This becomes particularly important now when Lithuanian power system is being prepared for work in the conditions of open market.

Systems created together with the software developed for them were implemented in several enterprises.




*Model of Lithuanian Power System interconnected in United Power System*

***Dr. Romanas ANDRUSKEVICIUS***
*Head of the Laboratory of Systems Control and Automation*
*Tel.: +370 37 401943*
*E-mail: romanas@isag.lei.lt*

**Main research areas of Laboratory:**

- Fundamental research of durability of constructional elements of energy systems and technologies of recent multifunctional materials;
- Applied materials science;
- Services provided by Accredited Laboratory in testing construction heat resistant, thermal insulation and plastics materials and products.

# LABORATORY OF MATERIALS RESEARCH AND TESTING

The changes of main research area of Laboratory were made in 2002 because significant results were achieved in synthesis of inorganic thin films with the use of physical vapor deposition technologies and it much more reflect priorities of Lithuania in technology research area.

Investigations in the **Synthesis of hydrogen storage alloys employing vapour deposition technologies** were initiated together with Sandia National Laboratory (USA). Investigations in the thin $Ti0_2$ film synthesis area were developed together with the Nanotechnology Scientific Centre of the Oslo University. In cooperation with the Pouters University (France) and with scientists of Kaunas University of Technology, Vytautas Magnus University and Vilnius University works related to ***Development of Solid Oxide Fuel Cell Electrolyte Employing Vapour Deposition Technologies*** were carried out. Comprehensive investigations of thin films structures were carried out using AFM, SEM, SIMS and XRD methods. The investigations of the related subjects according to COST international program ***Advanced Electro-ceramics: Ceramic Grain Boundary Engineering*** were developed together with Laboratory of Plasma Technologies of LEI. The results of scientific cooperation with the Platforma Solar de Almeria (CIEMAT, Spain) were summarized by performing the project in the EC-5$^{th}$ Framework Programme – ***Improving Human Potential the Socio-economic Knowledge Base Enhancing Access to Research Infrastructure***.

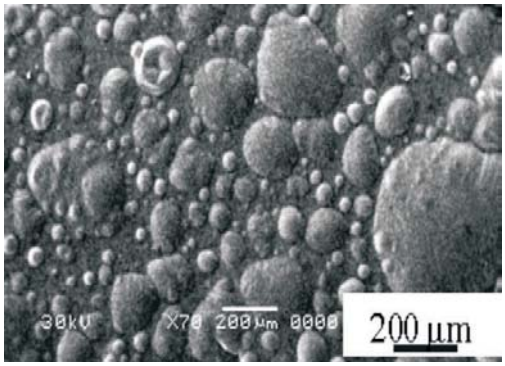
Significant progress has been made since 1998 participating in International Atomic Energy Agency co-ordinated research programme ***Hydrogen and hydride induced degradation of the mechanical and physical properties of zirconium-based alloys***. During this project investigations of hydrogen induced cracking process were done and main aspects influencing hydride crack propagation were established. Exploring mechanism of hydride cracking in zirconium alloys investigations of controlled thermal diffusion of hydrogen from the surface hydride layer to the alloy matrix were done.

On the basis of the EUREKA project ***New Technology for Boiler Water Chemical Treatment in the Energy Industry*** the influence of corrosion inhibitor – temperature resistant amine Kotamina Plus (made by the Polish Institute of Heavy Organic Synthesis *Blachovnia*) on corrosion of boiler steel have been investigated by cathodic polarisation method in temperatures 60–500°C.

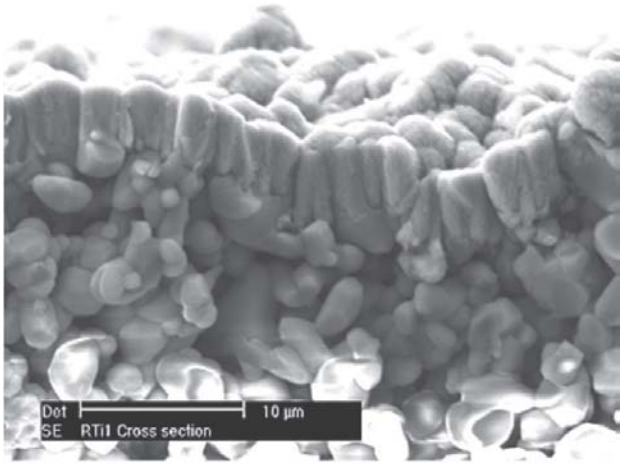
The year 2002 was successful for the Laboratory in extending applied materials science and services provided by the accredited testing of materials. The first Accreditation Certificate was issued in 1996. Accreditation area encompasses more than 16 testing objects. Lithuanian National Accreditation Bureau as a signatory of the Multilateral Agreements of the European cooperation for Accreditation for calibration, testing and certification of products evaluated the quality system of the Laboratory and issued to the Laboratory the Accreditation Certificate No LA.01.006. On the basis of this Certificate the National Accreditation Bureau certifies that the Laboratory of Materials Research and Testing complies with the requirements of LST EN ISO/IEC 17025:2000 and it is accredited to carry out tests of building mortars, adhesives for tiles, putties, plastics pipes, preinsulated pipes, rigid foam polyurethane insulation, bitumen and polymer bitumen sheeting and felts, thermal insulating products, gypsum, gypsum products, ceramics bricks, refractory materials and products. The Laboratory is a member of the following Technical Committees of Lithuanian Technical Standardization Department: *Thermal Insulation Materials*, *Refractories*, *Coatings*, *Oil and Oil products* and takes part in preparation of national and adaptation of international standards for Lithuania.

The new international project was initiated with Institute for Problems of Materials Sciences of National Ukrainian Academy of Sciences under the programme *Scientific and Technical Collaboration between Lithuania and Ukraine*.

During 2002, the staff of the Laboratory published 12 articles in Lithuanian and 20 in foreign journals and conferences materials as well as presented 18 papers in international and 16 in Lithuanian conferences. The results of more than 40 years investigations in research area of creation and modification of polymers and composites were summarized by Dr. Habil. A. J. Kviklys in the book *The research of polymer materials in the Lithuanian Energy Institute*.




*General surface view of Al-Al(H)($Al_2O_3$) film hydrided at 240°C*




*$TiO_2$ thin film on porous substrate*

***Dr. Rimantas LEVINSKAS***
*Head of the Laboratory of Material Research and Testing*
*Tel.: +370 37 401 804, 401 909*
*E-mail: levin@isag.lei.lt*

# LABORATORY OF COMBUSTION PROCESSES

**Main directions of scientific activities:**

- Combustion of heavy fuel oil: investigation of atomization and dynamics of droplets, heterogenic gasification and combustion phenomena and their practical applications;
- Development of numerical methods of particle dynamics and their application for modeling of heat and mass transfer and turbulence phenomena in the combustors and other devices;
- Investigation of thermo-hydrodynamic processes in micro-systems and application of its results to the new combustion technologies.

**Research work**

*Heavy fuel oil combustion.* In 2002 investigations on improvement of heavy fuel oil combustion processes were continued. Combustion of small heavy fuel oil droplets interacting with hot surfaces and thermal heavy fuel oil decomposition on the surface was investigated. Heavy fuel oil droplets were sprayed on the quartz glass surface as well as on smooth or rough steel surface at temperature of approximately 450–700°C at different surface slopes. Times of devolatilization and of burn-up of remaining coke particles were established as they decrease with rising temperature and greater plate material thermal conductivity and better incoming oxygen supply.

With volatile substances being released, the surface has carbon composition on it. Composition structure depends on volatile substance evaporation rate and properties of the surface itself. Carbon residue burn-up measurement data were compared with the numerical modelling results obtained using code FLUENT. The calculation results close to experimental ones were obtained when two stages of carbon oxidation reactions $C \rightarrow CO \rightarrow CO_2$ with standard reaction rate constants were taken for simulations.

The experimental burner having power of 1 MW was manufactured and tested in which certain part of heavy fuel oil droplets settle down on the hot ceramic surface. Short duration experiments confirmed possibility to work in this regime. The further aim is to optimize the heavy fuel oil amount burnt on the surface to the amount burnt in the burner stream ratio.

**Investigations of hydrocarbon composition changes caused by heavy fuel oil decomposition in an atmosphere with different oxygen amount.** To model of a new type heavy fuel oil burner the new high temperature rig for spraying, splitting and burning heavy fuel oil was constructed. It is necessary for improvement of carbon burning to break quickly chemical bonds at high temperatures. Fine spraying of heavy fuel oil, high ambient temperatures and favorable oxidation conditions are basic prerequisites for effective heavy fuel oil burning with low environment pollution.

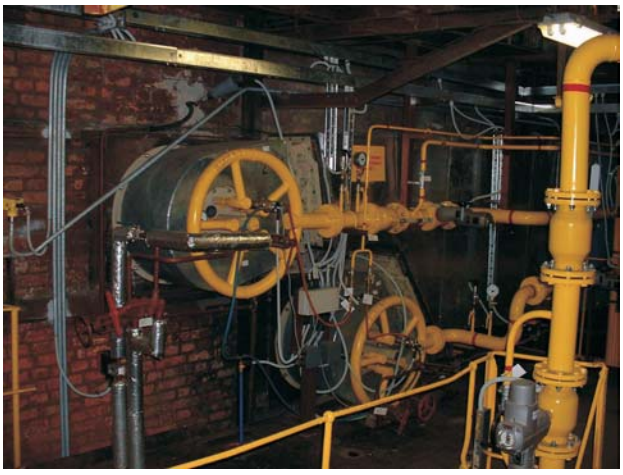
**Numerical simulation of free-flowing bulk material.** Together with the researchers of the Karlsruhe Research Center in Germany the program package was prepared, which enables calculations of free-flowing bulk material. It is adapted for modeling of thermal decomposition of the hard residue in the combustors and other analogous processes. The calculation methods are based on direct calculation of each granule movement. The particles are described using the Object Oriented Programming method (OOP). That allows flexible usage of the package when calculating three-dimensional flowing particle movement in the rotating kiln, on the moving grate and in other systems. This program package can be easily adapted for other problems of the free-flowing bulk material.

The results obtained are in good agreement with experimental results. For example, calculations of granule movement on the moving grate gave not only the same average granule stay on grate duration value, but also led to understanding that because of granule separation into layers according to their size, the small granules remain longer on the grate and this considerably affects and changes the processes on the grate.

**Services**

**The main works were carried out by the Laboratory in 2002**:

- Gas-heavy fuel oil burners D10 created in the Laboratory were implemented in the JSC *Kedainiu cukrus* being installed in the boilers GM-50/14 and E-25/14. This work was carried out together with the JSC *Termatika,* which implemented computerized control of burners and boilers system.
- Burners for water heating boilers PTVM-30 in the district boiler houses of Mazeikiai and Silute and in the boiler PVTM-50 of the heating network of Panevezys were modified. The number of burners in boilers was reduced according to the project prepared by the Laboratory using upper burner nozzles for over fire air streams to reduce $NO_x$ formation.
- Burners for the water-heating boiler KVGM-50 of the local heating networks in Taurage were modified. The reconstruction enabled to reduce the minimum boiler load to 5 MW while maintaining normal efficiency and environmental protection parameters.
- The combustion process in the new 84 t/h steam boilers of the firm JSC *Klaipedos nafta* was optimized. The project prepared by the Laboratory was implemented reducing air surplus from 35–40 to 15–20% and saving about 1.5% of fuel in these steam boilers.
- Burners were reconstructed for the JSC *Achema* for the production line of fertilizers being moved from Germany adapting them to burn natural gas instead of technological gas only as used in Germany.
- Assessment of the effects of fluc gas treatment equipment on environment was performed. The equipment removing hard particles and sulphure dioxide are to be erected in the firm JSC *Lietuvos elektrine.*



***Prof. Dr. Habil. Anupras SLANCIAUSKAS***
*Head of the Laboratory of Combustion Processes*
*Tel.: +370 37 401 876*
*E-mail: slanc@isag.lei.lt*

# LABORATORY OF PLASMA TECHNOLOGIES

**Main directions of scientific activities:**

- Research and development of arc-plasma sources and reactors;
- Investigation of interaction of plasma with dispersed particles;
- Diagnostics of plasma jets and flows;
- Research of gas dynamic and heat-mass transfer;
- Synthesis and characterisation of catalytic and tribological coatings;
- Synthesis of plasma polymers employing atmospheric and low pressure plasma.

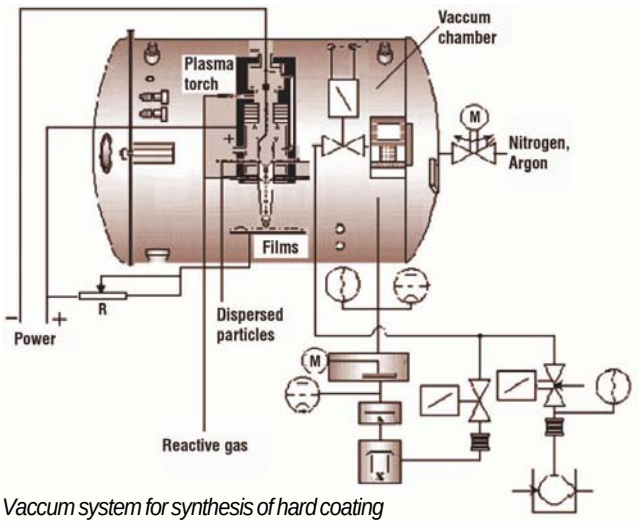
**Scientific activities.** Laws governing generation of high temperature gas flows and its dynamics, heat transfer in the channels with various forms and various dimensions and in the models of heat exchanger components, were investigated in the laboratory. Operation regimes of the linear electric arc gas heating devices and reactors at atmospheric and reduced pressure were investigated and their operational characteristics and the conditions of prolongation of their service life were established. Methods of turbulization of the electric arc and efficient energy consumption by the device were also investigated. Conditions of thermal unsteadiness of plasma equilibrium were investigated using contact methods and velocity, temperature and their pulsation distribution regularities.

With the aim of obtaining very narrow high temperature beam and neutralizing hazardous substances, while seeking to form new coatings and synthesize new materials, the interaction between plasma and the electric arc on one side, and amorphous and disperse materials on other side were investigated. Physical, chemical and mechanical properties of materials and coatings obtained were determined.

**New technologies.** The plasma-chemical reactor designed for neutralization of hazardous substances was built and tested. It satisfies all requirements and conditions of environment protection (materials to be rendered harmless were exposed longer than for 2 seconds to 1200°C temperature). Its technical characteristics were examined and established.

The plasma torch, using water vapor, intended for waste processing and pyrolysis was updated and its electrical and thermal properties were examined and determined. For gasification of solid fuel by plasma means, water vapor, heated up to 2000–3000 K was used instead of water vapor-oxygen mixture.

Anticorrosive, tribological and catalyst coatings were formed with specific surfaces reaching 100 $m^2/g$ and more. For investigation of coating catalyst properties the device generating combustion product flow having constant chemical composition and constant combustion characteristics was built. Catalyst properties of the new model oxide catalysts were examined. The investigation of catalytic combustion behavior on CO evidenced that presence of CuO is necessary for production of highly active catalysts, whose performance improves with increasing of copper content.



*Vaccum system for synthesis of hard coating*

New plasma technology equipment was created and applied for synthesis diamond like carbon and other kind of hard coatings. It consists of a vacuum chamber, vacuum devices, plasma torch of special construction, high temperature arc evaporators of solid substances and auxiliaries. It has been found that for atmospheric and reduced pressure non-equilibrium plasma assisted deposition of thin amorphous carbon films are suitable method for synthesis of films for plasma polymerization process, microarcing and diamond phase nucleation.

Nitrification of steels and their alloys with ion streams in vacuum increased their resistance to erosion five to seven times and resistance to corrosion – $10^2$ to $10^3$ times. Ion beam technologies allow formation of thin (d<1 μm) surface layers with improved mechanical and chemical properties. In practice, nitrified layer thickness at least of 10 μm is required while costly ion beam technology must be replaced by cheaper one using the plasma torch at atmospheric pressure. Experiments with nitrogen plasma at atmospheric pressure confirmed that main process influencing nitrification effectiveness was determined by activated atom flux. The record thickness of the nitrified surfaces was obtained in nitrogen plasma (up to 150 μm) at atmospheric pressure.

Investigations of compacted coatings that were intended for production of the fuel cells electrolytes and search of new substances as well as their synthesis were carried out. Processes of synthesis of fullerenes, plasma polymers and cluster structures in plasma are also under the investigations.

**International programs.** Scientists of the Laboratory take part in following international programs:

- **COST-525** *Advanced Electro-ceramics: Ceramics Grain Boundary Engineering;*
- **COST-527** *Plasma Polymers and Related Materials;*
- **COST-532** *Triboscience and Tribotechnology – Superior Friction and Wear Control in Engines and Transmissions;*
- **COST-530** *Life Cycle Inventories for Environmentally – Conscious Manufacturing Processes;*
- **Eureka!2776** *Innovative Coatings Application in Forming;*
- **Project under the programme of scientific-technical cooperation between Ukraine and Lithuania** *Research of Low Temperature Plasma Processes and Equipment.*

***Dr. Pranas VALATKEVICIUS***
*Head of the Laboratory of Plasma Technologies*
*Tel.: +370 37 401 900*
*E-mail: pranas@isag.lei.lt*

# LABORATORY OF HYDROLOGY

**Main directions of research activities:**

- Evaluation of effects on water bodies by the power industry and transport;
- Creation of database about Lithuanian water bodies (rivers, ponds, Curonian Lagoon and Baltic Sea).

**Investigations of physical-geographical conditions influence on the river runoff.** Based on the hydrometric observations and the database compiled in the Laboratory, river runoff distribution regularities were investigated. Gathered data was used for development of the calculation methods for rivers that has not been investigated earlier and for determining the main runoff characteristics.

**Evaluation of the human activities impacts on condition of water bodies.** Economic activity changes the state of the surface water resources. The environmental changes which are calculated by modelling the activity of energy and transport objects under concrete hydrometeorological conditions make the base of environmental impact assessment.

The following very important issues were solved by modelling water body hydrodynamic regime:

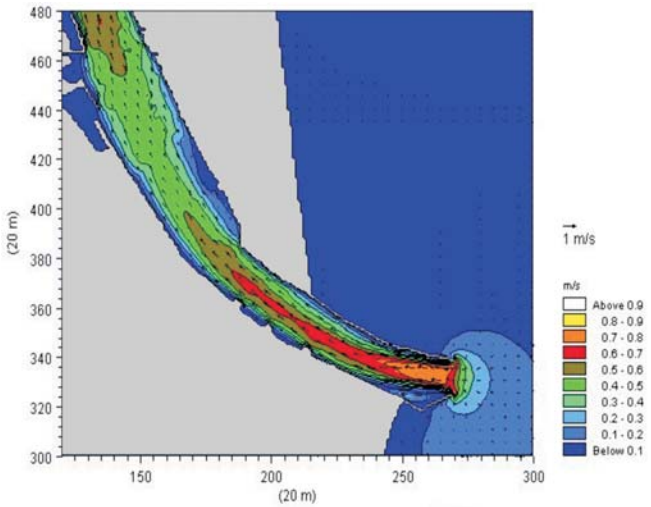
- determination of the extreme meteorological, hydrological and hydraulic parameters when there are no direct measurements available;
- transportation water sediments and formation of deposits and erosion sites;
- determination of operation conditions of the hydro-technical constructions (dams, quays) and seaports;
- calculation of current and wave loading on the engineer constructions;
- substantion of the mitigation measures for the environmental impact from the proposed human activity.

**Thermal state of the Druksiai lake.** The Ignalina Power Plant using water of the Druksiai Lake for reactor cooling has changed the thermal state of the lake. It considerably affected flora and fauna of the Druksiai lake. Temperature distribution in the lake is modelled using data gathered and generalized during the previous years of the observation and monitoring, taking into account its dependence on operating power of the Ignalina NPP and the environmental factors.

**Solution of the problems of development and deepening of Klaipeda State Seaport.** Under the order of Klaipeda State Seaport Authority the following works were carried out:

- *Environmental Impact Assessment Report and Project* for dredging of Klaipëda Seaport up to 12.5 m;
- model of slopes formation of Harbour Entrance of seaport and recommendations to ensure the slopes stability;
- evaluation of the port seagate reconstruction influence on waves in water territory of the port;
- forecast of the sediments load accumulation and erosion sites in the water territory of port.

The two-dimensional simulation water bodies modelling system MIKE-21 was used to solve these problems.




*Flow structure of Klaipeda Strait (discharge of 2200 m³/s flows from the Baltic Sea to Curonian Lagoon)*

***Prof. Dr. Habil. Brunonas GAILIUSIS***
*Head of the Laboratory of Hydrology*
*Tel.: +370 37 401 961*
*E-mail: hydro@isag.lei.lt*

# FINANCIAL HIGHLIGHTS

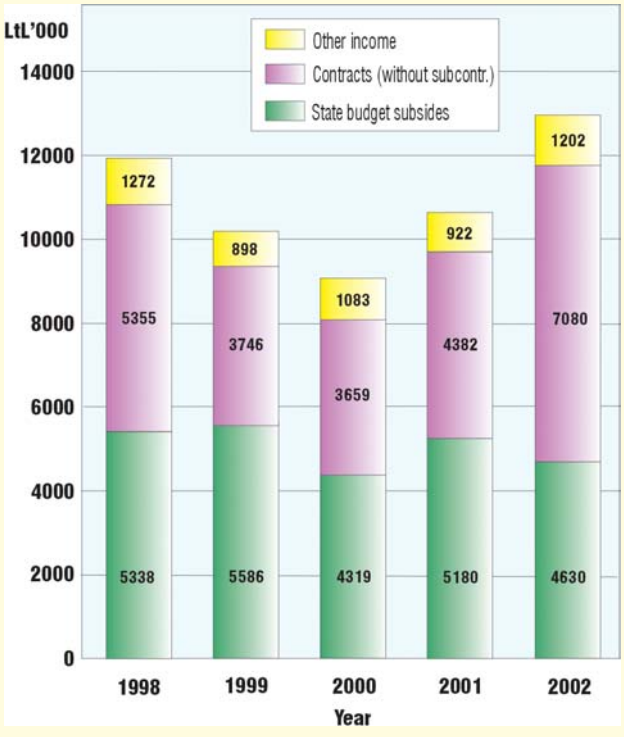
**The financial sources of the Institute consists of:**

- State budget subsidies;
- Financing for research programmes and education of specialists;
- Financing received from Lithuanian and foreign enterprises and organizations for contract works, realization of products and services;
- Funds received from various international research programmes and funding organizations;
- Subsidies, received from enterprises and associations for participation in joint activities and training of specialist.

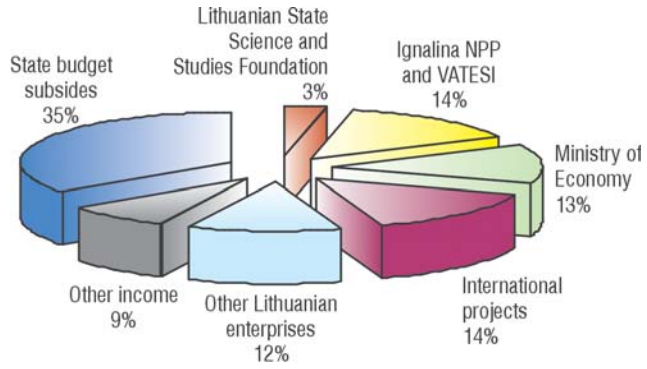
**Structure of income and total expenses *(LtL'000)***

| | *1998* | *1999* | *2000* | *2001* | *2002* |
|---|---|---|---|---|---|
| ***Income:*** | | | | | |
| ***State budget subsidies*** | ***5338*** | ***5586*** | ***4319*** | ***5180*** | ***4630*** |
| ***Contracts (incl. subcontr.)*** | ***6685*** | ***4061*** | ***4224*** | ***4684*** | ***7785*** |
| ***Other income*** | ***1272*** | ***898*** | ***1083*** | ***922*** | ***1202*** |
| ***Total:*** | ***13295*** | ***10545*** | ***9626*** | ***10786*** | ***13617*** |
| ***Expenses:*** | | | | | |
| ***Salaries (soc. ins. incl.)*** | ***5979*** | ***7492*** | ***7002*** | ***6362*** | ***7181*** |
| ***Operating expenses*** | ***4247*** | ***2766*** | ***1573*** | ***2544*** | ***2842*** |
| ***Acquisition of equipment*** | ***1374*** | ***1246*** | ***935*** | ***659*** | ***1887*** |
| ***Subcontracts*** | ***1330*** | ***316*** | ***565*** | ***302*** | ***705*** |
| ***Total:*** | ***14443*** | ***11330*** | ***9435*** | ***10178*** | ***12615*** |
| ***Remainder to end of the year*** | ***941*** | ***156*** | ***346*** | ***954*** | ***1956*** |

**Variation of financial structure**




**Structure of income 2002**



# MAIN PUBLICATIONS

## Books

1. **Katinas V., Markevicius A.** The wind power. Handbook. – Kaunas: LEI, 2002. 78 p.
2. **Kviklys A. J**. Research or polymer materials in the Lithuanian Energy Institute. – Kaunas: LEI, 2002. 87 p.

## Articles

**Publicated in Lithuania**

1. **Augutis J.** The assessment and uncerntainty analysis of gas gap between graphite and fuel channels in reactors of the Ignalina NPP // Energetika (Power Engineering). 2002. N 2. P. 3–11.
2. **Babilas E., Rimkevicius S., Urbonavicius E.** Reliability management of coolant flow indicator SHARD 32-M system in RBMK-1500 reactor // Energetika (Power Engineering). 2002. N 4. P. 27–42.
3. **Babilas E., Rimkevicius S., Urbonavicius E.** Influence of building structure modeling of the results of thermo-hydraulic evaluation of Ignalina NPP ALS // Energetika (Power Engineering). 2002. N 4. P. 3–11.
4. **Bachanovas P.** Optimal mathematical model for information treatment in computer systems of monitoring and energy accounting // Energetika (Power Engineering). 2002. N 4. P. 20–26.
5. **Baltrenas P., Masilevicius R., Dziugys A., Peters B**. Numerical modelling of electrified particle layer formation on the surface of filtration fabric // Aplinkos inzinerija (Environmental Engineering). 2001. T. IX. N 4. P. 191–197.
6. **Bubelis E., Pabarcius R., Tonkunas A.** Modelling of CPS cooling circuit voiding, using QUABOX/CUBBOX-HYCA code / / Energetika (Power Engineering). 2002. N 4. P. 33–42.
7. **Burneikis J., Streimikiene D**. New EU directive on promoting electricity production from renewable sources and issues of its implementation in Lithuania // Energetika (Power Engineering). 2002. N 1. P. 41–45.
8. **Burneikis J**., **Streimikiene D., Punys P.** Electricity market and hydro energy // Inzinerine ekonomika (Engineering Economics). 2002. N 1. P. 37–42.
9. **Cesniene J**. The influence of retarders on phosphogypsum binding materials // Chemine technologija (Chemical Technology). 2002. N 2. P. 13–18.
10. **Daugele A**., **Ilgarubis V., Janusas V.** National standard of air velocity. Methods of realization // Matavimai (Measurements). 2002. N 3. P. 13–17.
11. **Dzenajaviciene E. F., Tamonis M.** Evaluation of the role in development of the use of wood waste for fuel in wood processing and furniture industries // Technologijos mokslo darbai Vakaru Lietuvoje (Technologies Research in Western Lithuania). Vol. III. Klaipeda, 2002. P. 125–129.
12. **Gaigalis V., Skema R., Zinevicius F.** Effective energy use in bakeries // Energetika (Power Engineering). 2002. N 1. P. 19–30.
13. **Gaigalis V, Skema R, Zinevicius F.** Energy saving measures in bread baking industry enterprises // Energetika (Power Engineering). 2002. N 2. P. 42–50.
14. **GailiuSis B.**, **Kriauciuniene J., Kovalenkoviene M.** Hydrodynamic modeling in near-shore zone of the Baltic Sea / / Aplinkos tyrimai, inzinerija ir vadyba (Environmental Research, Engineering and Management). 2002. N 3. P. 3–12.
15. **Grigoniene J.**, **Kveselis V.** Renovation efficiency at different consumption level in buildings, supplied from DH system // Technologijos mokslo darbai Vakaru Lietuvoje (Technologies Research in Western Lithuania). Vol. III. Klaipeda, 2002. P. 190–194.
16. **Kadisa S.**, **Klementavicius A.** Energy network modelling needs at the turn of the century // Energetika (Power Engineering). 2002. N 2. P. 12–22.
17. **Katinas V., Petkeviciene J., Vaitiekunas P**. Numerical simulation of hydrothermal three-dimensional processes in lake Druksiai. 3. Wind // Energetika (Power Engineering). 2002. N 1. P. 46–52.
18. **Konstantinaviciute I**., **Miskinis V.** Simulation modeling of atmosphere pollution in energy sector // Energetika (Power Engineering). 2002. N 2. P. 23–28.
19. **Krusinskaite V**., **Valincius V., Valatkevicius P.** Electric and thermal characteristics of the plasma torch employed for plasma coatings deposition // Energetika (Power Engineering). 2002. N 2. P. 36–41.
20. **Krusinskaite V**., **Valincius V., Valatkevicius P.** Electric and thermal characteristics of the plasma torch employed for plasma coatings deposition // Energetika (Power Engineering). 2002. N 4. P. 12–19.
21. **Lapieniene A., Slezas R**. The influence of nozzle shape on $NO_x$ formation in swirling methane and air flame // Energetika (Power Engineering). 2002. N 1. P. 9–18.
22. **Levinskas R**. Research of deformations and stresses in polyurethane foam isolated layer of heat supply pipe // Technologijos mokslo darbai Vakaru Lietuvoje (Technologies Research in Western Lithuania). Vol. III. Klaipeda, 2002. P. 229–232.
23. **Levinskas R**. A model of polymeric composite structure for evaluation thermal conductivity // Technologijos mokslo darbai Vakaru Lietuvoje (Technologies Research in Western Lithuania). Vol. III. Klaipeda, 2002. P. 225–228.
24. **Levinskas R., Grybenas A., Makarevicius V.** Influence of temperature on the axial hydride cracking rate of the fuel channel pressure tube // Materials Science( Medziagotyra). 2002. Vol. 8. N 4. P. 388–391.
25. **Lukosiute I, Levinskas R**. Application of polyamide solutions for surface deactivation and for shielding from ionizing radiation // Sveikatos mokslai (Health Sciences). 2002. N 2. P. 78–79.
26. **Marcinauskas K., Bubelis E.** Heat in Lithuanian cottages: prerequisites and predictions // Energetika (Power Engineering). 2002. N 3. P. 56–66.
27. **Miskinis V.** Economic development: energy sector // Subalansuotas pletros ágyvendinimo nacionaline ataskaita (National Report on Sustainable Development). Vilnius: Lutute, 2002. P. 83–88.
28. **Poskas R.**, **Poskas P., Sinkunas S.** Opposing flow turbulent mixed convection heat transfer along inclined flat channel// Energetika (Power Engineering). 2002. N 3. P. 12–17.
29. **Pranevicius L., Templier C., Riviere J.-P., Pranevicius L. L., Valatkevicius P.**, **Valincius V.**, **Milcius D.**, **Nomgaudyte J**. Mass transport driven by atomic relocations under high flux ion irradiation at elevated temperatures // Materials Science (Medziagotyra). 2002. Vol. 8. N 2. P. 166–171.
30. **Pranevicius L., Milcius D, Dudonis J**. Atomic mixing induced by ballistic relocation of surface atoms // Materials Science (Medziagotyra). 2002. Vol. 8. N 2. P. 172–176.
31. **Stankevicius A.**, **Tonkonogij J., Pedisius A.** National standard of air volume and flow rate. Bell type prover // Matavimai (Measurements). 2002. N 3. P. 7–12.
32. **Sarauskiene D.**, **Rimaviciute E.** Modelling the current structure of lake Druksiai using the hydrodynamic module of

the Mike 21 modelling system // Energetika (Power Engineering). 2002. N 3. P. 42–55.

33. **Siauciunas R.**, **Baltusnikas A., Baltakys K.** Influence of $SiO_2$ modification on hydrogarnets formation during hydrothermal synthesis // Materials Science (Medziagotyra). 2002. Vol. 8. N 1. P. 68–72.
34. **Smaizys A., Poskas P., Ragaisis V.** Assessment of radiation safety of operating storage for solid high level waste at Ignalina NPP // Sveikatos mokslai (Health Sciences). 2002. N 2. P. 28–33.
35. **Smaizys A., Poskas P., Ragaisis V.** Assessment of radiation characteristics of operating storage for solid radwaste at the Ignalina NPP // Energetika (Power Engineering). 2002. N 1. P. 3–8.
36. **Streimikiene D**. Global and local issues of sustainable energy development in Lithuania // Energetika (Power Engineering). 2002. N 1. P. 53–60.
37. **Streimikiene D.** Applying multi-criteria aid for decision making in favor of clean coal technologies // Aplinkos tyrimai, inzinerija ir vadyba (Environmental Research, Engineering and Management). 2001. N 4. P. 11–18.
38. **Streimikiene D.** Towards a total energy costs assesment // Aplinkos inzinerija (Environmental Engineering). 2001. Vol. IX. N 1. P. 52–59.
39. **Tonkonogij J., Pedisius A., Janulionis J.** Natural gas supply – consumption balance in Lithuanian economy // Energetika (Power Engineering). 2002. N 2. P. 29–35.
40. **Tonkonogij J.**, **Pedisius A., Janulionis J.** Natural gas supply – consumption balance in Lithuanian economy and model of its mathematical analysis // Energetika (Power Engineering). 2002. N 3. P. 17–22.
41. **Tonkonogij J.**, **Ilgarubis V., Pedisius A.** Sonic nozzles standard facility for verification of small gasmeters // Matavimai (Measurements). 2002. N 3. P. 18–20.
42. **Urbonas R**. Uncertainty and sensitivity analysis of Elektrogorsk-108 test facility RELAP5 model // Energetika (Power Engineering). 2002. N 1. P. 31–40.
43. **Vaitiekunas P.**, **Petkeviciene J., Katinas V.** Numerical simulation of heat exchange in cooling pond // Aplinkos inzinerija (Environmental Engineering). 2002. T. 10. N 2. P. 56–60.
44. **Vilemas J.**, **Miskinis V., Galinis A.** Strategy of the energy sector development until 2015 // Lietuvos mokslas (Science and Arts of Lithuania). 2002. Book 41. P. 301–362.
45. **Zujus Ren.**, **Makarevicius R., Poskas P.** Numerical simulation of turbulent mixed convection heat transfer along vertical flat channel for aiding flows // Energetika (Power Engineering). 2002. N 4. P .43–49.

**Publicated Abroad**

46. **Gailiusis B., Kriauciuniene J., Kriauciunas R.** Changes of hydrodynamic processes in the Klaipeda Strait due to development of port // Hydrotechnical development. 2002. N 7. P. 41–44.
47. **Galdikas A.** Thin film deposition onto the rough surface: phenomeological investigations // Thin Solid Films. 2002. N 418. P. 112–118.
48. **Galdikas A., Levinskas R.** Depth profiling of multilayers at elevated temperatures and at changeable ion beam parameters // Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms. Vol. 193. Issues 1–4. 2002. P. 860–866.
49. **Kaliatka A.**, **Uspuras E.** Thermal hydraulic analysis of accidents leading to local coolant flow decrease in the main circulation circuit of RBMK-1500 // Nuclear Engineering and Design. 2002. Vol. 217. P. 91–101.
50. **Kaliatka A.**, **Uspuras E.** Development and evaluation of additional shut-down system at the Ignalina NPP by employing RELAP5 code // Nuclear Engineering and Design. 2002. Vol. 217. P. 129–139.
51. **Knizikevicius R., Galdikas A.**, **Grigonis A**. Real dimensional simulation of silicon in $CF_4$+$O_2$ plasma // Vacuum. 2002. Vol. 66. P. 39–47.
52. **Milcius D.**, **Templier C., Riviere J.-P., Pranevicius L. L., Pranevicius L.** High-flux, low-energy implantation effect on the composition of altered layers // Surface and Coatings Technology. 2002. Vol.156. P. 214–218.
53. **Miskinis V.** Energy demand forecasting in economies in transition // Energy Studies Review. 2002. Vol. 10. N 2. P. 100–120.
54. **Pedisius N**. Bio fuel usage experience from the EAES program // Integration of Forest Fuel Handling in the Ordinatory Forestry, Studies on Forestry, Technology and Economy of Forest Fuel Production in Lithuania. Swedish Energy Agency. Vilnius, 2002. P. 18–21.
55. **Peters B.**, **Dziugys A.** Numerical simulation of the motion of granular material using object-oriented techniques // Computer Methods in Applied Mechanics and Engineering. 2002. Vol.191. Issues 17–18. P. 1983–2007.
56. **Poskas P**. Lithuania's approach to disposal of radioactive waste and spent nuclear fuel // Geological Challenges in Radioactive Waste Isolation. Third Worldwide Review. Ed. P.A.Witherspoon, G. S. Bodvarsson. USA, 2001. P. 195–198.
57. **Poskas P., Poskas R**. Experimental investigation of local heat transfer and skin friction in tube coils // Journal of Thermal Science. 2002. Vol. 11. N 3. P. 235–240.
58. **Pranevicius L.**, **Milcius D., Templier C., Riviere J.-P., Pranevicius L. L.** Mass transport driven by atomic relocations under high flux ion irradiation at elevated temperatures // Surface Engineering. 2002. Vol.18. N 3. P. 1–6.
59. **Pranevicius L. L., Valatkevicius P., Valincius V., Templier C., Riviere J-P., Pranevicius L.** Nitriding of an austenitic stainless steel in plasma torch at atmospheric pressure // Surface and Coatings Technology. 2002. Vol. 156. P. 219–224.
60. **Pranevicius L.,Templier C, Riviere J.-P, Muzard S., Dudonis J., Pranevicius L. L.**, **Milcius D.**, **Abrasonis G**. Mass-transport in an austenitic stainless steel under high-flux, low energy nitrogen ion bombardment at elevated temperature // Chemical Physics of Thin Film Deposition Processes for Micro-and Nano Technologies. Dordrecht, Boston, London: Kluwer Academic Publishers, 2002. P. 335–360.
61. **Rimkevicius S., Urbonavicius E., Cesna B**. Simulation of Ignalina NPP accident localisation system behavior employing code RALOC4 in the case of group distribution header rupture // Nuclear Engineering and Design. 2002. Vol. 216. N 1–3. P. 99–111.
62. **Sarauskiene D.** Thermal regime database of Ignalina Nuclear Power Plant cooler lake Druksiai // Environmental Monitoring and Assessment. 2002. Vol. 79. P. 1–12.
63. **Streimikiene D**. Strategy for implementation of the Eu's directives targeting power plant pollution // Latvian Journal of Physics and Technical Sciences. 2002. N 4. P. 22–29.
64. **Streimikiene D., Konstantinaviciute I.** The possibilities of Lithuania to comply with Kyoto requirements // Nuclear and Radiation Technologies. Kiev, Ukraine, 2001. Vol. 1. N 1. P. 12–21.
65. **Urbonavicius E., Rimkevicius S.** RALOC4 code validation against measured data at Ignalina NPP during single main safety valve opening // Nuclear Engineering and Design. 2002. Vol. 216. N1–3. P. 89–97.
66. **Vilemas J.** The economics, politics and safety dimensions of the Ignalina Nuclear Power Plant // In book: The NEBI Yearbook 2001/2002. North European and Baltic Sea Integration. Berlin: Springer, 2002. P 147–158.
67. **Vilemas J., Galdikas A.** IEA agreement on the production and utilization of hydrogen. Lithuania // 2000 Annual Report. Golden, USA, 2000. P. 25–30.

## Reports in International Conferences

**Held in Lithuania**

68. **Antinucci M.**, **Borchgrave C., Henaux C., Klevas V.** Eu support for formation of regional energy development: problems and possible solutions // Proceed. of the II Intern. Scientific Conf. Decentralization of Energetics: the Future of Urban Energetics, Klaipeda, 9–11 May 2002. Kaunas: LEI, JSC „Eksponente", 2002. P. 31–36.
69. **Cesniene J.**, **JauniSkiene G., Juozapavicius A., Matulioniene V.** The investigations on cellular insulating construction materials // Proceed. of the Intern. Conf. Lithuanian Science and Industry: Technology of Siliceous Materials, 2–3 May 2002. Kaunas: Technologija, 2002. P. 38–39.
70. **Cesniene J., Levinskas R.** The influence of temperature on the properties of foam polyurethane // Proceed. of the Baltic Polymer Symposium 2002, Nida, 18–20 September 2002. Vilnius, 2002. P. 143–145.
71. **Dzenajaviciene E. F., Kveselis V., Tamonis M.** Macro-economic efficiency analysis on the issue of biomass for energy production // Proceed. of the Intern. Conf. Environmental Problems in the Energy and Transport Sectors, 19–21 September 2002. Kaunas, Lithuania, 2002. P. 1–2.
72. **Glemziene R., Klevas V**. Renewable energy projects, financed by structural funds as innovative components of Lithuanian agriculture development // Proceed. of the Intern Conf. Progressive ECO-Frendly Technological Processes in Agricultural Engineering, 19–20 September 2002. Kaunas, 2002. P. 209–214.
73. **Grigoniene J.**, **Kveselis V.** Statistical analysis of heat demand in residential buildings of city // Proceed. of 5th Intern. Conf. of Environmental Engineering: Energy Supply for Buildings, Vilnius, 23–24 May 2002. Vilnius: Technika, 2002. P. 42–50.
74. **Klevas V**. The outline of energy projects integration into regional development programs // Proceed. of the II Intern. Scientific Conf. Decentralization of Energetics: the Future of Urban Energetics, Klaipeda, 9–11 May 2002. Kaunas: LEI, JSC „Eksponente", 2002. P. 77–82.
75. **Krusinskaite V.** Synthesis of plasmic coatings and investigation of their catalytic properties // Proceed. of the Intern. Conf. Environmental Problems in the Energy and Transport Sectors, 19–21 September 2002. Kaunas, Lithuania, 2002. P. 1–5.
76. **Kukliauskas A.**, **Kalpokaite-Dickuviene R.** The thermographic analysis of heavy fuel oil // Proceed. of the Intern Conf. Lithuanian Science and Industry: Technology of Siliceous Materials, 2–3 May 2002. Kaunas: Technologija, 2002. P. 87–90.
77. **Kveselis V., Grigoniene J., Strazdas D.** Evaluation of Lithuania's municipal energy sector and possible strategic directions of development // Proceed. of the II Intern. Scientific Conf. Decentralization of Energetics: the Future of Urban Energetics, Klaipeda, 9–11 May 2002. Kaunas: LEI, JSC „Eksponente", 2002. P. 21–29.
78. **Kveselis V.**, **Strazdas D., Urbonas P.** Technical and economic aspects modernization of heat supply networks // Proceed. of 5th Intern. Conf. of Environmental Engineering: Energy Supply for Buildings, Vilnius, 23–24 May 2002. Vilnius: Technika, 2002. P. 202–209.
79. **Levinskas R., Jarmokas R.** Testing of heat saving materials and preparation of technical documentation for accession to European Union // Proceed. of the Intern. Conf. Lithuanian Science and Industry: Technology of Siliceous Materials, 2–3 May 2002. Kaunas: Technologija, 2002. P. 15–19.
80. **Lisauskas A., Kveselis V., Tamonis M.** Perspectives of energy production in cogeneration cycle // Proceed. of the Intern. Conf. Environmental Problems in the Energy and Transport Sectors, 19–21 September 2002. Kaunas, 2002. P. 1–2.
81. **Minkstimas R., Sidlauskas V.** Information systems for energy planning // Proceed. of the II Intern. Scientific Conf. Decentralization of Energetics: the Future of Urban Energetics, Klaipeda, 9–11 May 2002. Kaunas: LEI, JSC „Eksponente", 2002. P. 89–94.
82. **Pedisius N.** Experience of wood fuel use for heat production in Lithuania // Proceed. of 5th Intern. Conf. of Environmental Engineering: Energy Supply for Buildings, Vilnius, 23–24 May 2002. Vilnius: Technika, 2002. P. 214–230.
82. **Tamonis M.** The state of municipal energy sector and tendencies of it's development following National Energy Strategy // Technologijos mokslo darbai Vakaru Lietuvoje (Technologies Research in Western Lithuania). Vol. III. Klaipeda, 2002. P. 245–250.
84. **Tamonis M.**, **Kveselis V., Tutlyte O.** Formation of functional model of financial flows for assessment and planning the activity of district heating companies // Proceed. of 5th Intern. Conf. of Environmental Engineering: Energy Supply for Buildings, Vilnius, 23–24 May 2002. Vilnius: Technika, 2002. P. 251–258.
85. **Tamonis M., Dzenajaviciene E. F., Lisauskas A., Tutlyte O.** The issues of district heating optimization and planning of sustainable development // Proceed. of the II Intern. Scientific Conf. Decentralization of Energetics: the Future of Urban Energetics, Klaipeda, 9–11 May 2002. Kaunas: LEI, JSC „Eksponente", 2002. P. 83–88.

**Abroad**

86. **Almenas K., Pabarcius R., Seporaitis M.** Development of a pulser for the controlled initiation of condensation implosion events // Heat Transfer 2002: Proceed. of Twelfth Intern. Heat Transfer Conf. Grenoble, France, 18–23 August 2002. Paris: Elsevier, 2002. Vol. 3. P. 815–821.
87. **Alzbutas R.** Application of probabilistic risk assessment for pipelines inspection optimization // Proceed. of 2002 ANS/ASME Student Conf. Back to the Future of Nuclear Technology, 10–14 April 2002. Penn State, USA, 2002. P. 1–20.
88. **Alzbutas R**. Risk-informed decisions optimization in inspection and maintenance // Proceed. of ICONE10: 10th Intern. Conf. on Nuclear Engineering, 14–18 April 2002. Arlington, Virginia (Washington, DC), USA, 2002. P. 1–8.
89. **Augutis J**. Assessment of gas gap evaluation for the Ignalina NPP RBMK-1500 // Proceed. of 6th Intern. Information Exchange Forum on Safety Analysis for Nuclear Power Plants of VVER and RBMK Types (Forum-6), 8–12 April 2002. Kiev, Ukraine. 2002. 8 p.
90. **Bubelis E., Kaliatka A., Uspuras E**. RELAP5-3D code appli-cation for RBMK-1500 reactor core analysis **//** Proceed. of ICONE10: 10th Intern. Conf. on Nuclear Engineering, 14–18 April 2002. Arlington, Virginia (Washington, DC), USA, 2002. P. 1–9.
91. **Bubelis E., Kaliatka A., Uspuras E.** RELAP5-3D code applications for RBMK-1500 reactor core analysis // Proceed. of 6th Intern. Information Exchange Forum on Safety Analysis for Nuclear Power Plants of VVER and RBMK Types (Forum-6), 8–12 April 2002. Kiev, Ukraine, 2002. 21 p.
92. **Bubelis E.**, **Kaliatka A., Uspuras E.** Application of coupled RELAP5-3D code for analysis of RBMK-1500 reactor neutron kinetic-thermal-hydraulics transient // Proceed. of ANS Reactor Physics Topical Meeting: PHYSOR 2002, 7–10 October 2002. Seouls, Korea, 2002. P. 1–14.
93. **Burneikis J.**, **Streimikiene D., Punys P.** More support is needed for promoting private investments into the hydro energy development in Lithuania // Proceed. of the Intern. Conf. & Exhibition Conf. et Exposition Internationales: Hidroenergia 2002, July 3 – July 6 2002. Mulhouse, France, 2002. P. 65–72.
94. **Brickstad B.**, **Letzter A., Klimasauskas A., Alzbutas**

**R., Nedzinskas L., Kopustinskas V.** Risk based inspection pilot study of Ignalina Nuclear Power Plant, unit 2 // Proceed. of ICONE10: 10th Intern. Conf. on Nuclear Engineering, 14–18 April 2002. Arlington, Virginia (Washington, DC), USA, 2002. P. 1–7.

95. **Brinkiene K**. Restoration of the eroded surfaces of the structural ceramics in the high temperature fas flow // Proceed. of the Intern. Conf. BALTECHMASH-2002, Progresive Technologies and Equipment in Mechanical Engineering. Kaliningrad, 2002. P. 101–105.
96. **Caikovska M., Miskinis V., Rudi Ü., Slihta G., Zeltiòs N.** Aktuelle Wirtschafts- und Energieprobleme der Baltischen Staaten // Zittauer Seminar zur Osteuropaischen Energiewirtshaft. 2002. P. 1–16.
97. **Cesna B**. Thermo-hydraulic characteristics in rod bundle with opposite wire-wrapped tubes // Proceed. of the Intern. Symposium on Compact Heat Exchangers, Grenoble, France, 24 August 2002. Pisa: Edizioni ETS, 2002. P. 311–316.
98. **Cesna B**., **Rimkevicius S.** Accident localization system response in the case of main steam relief valve opening // Heat Transfer 2002: Proceed. of Twelfth Intern. Heat Transfer Conf., Grenoble, France, 18–23 August 2002. Paris: Elsevier, 2002. Vol. 4. P. 645–651.
99. **Dundulis G., Kulak R., Marchertas A**. GDH pipe break transient analysis of the RBMK-1500 // Proceed. of the 7th Intern. Conf. on Material Issues in Design, Manufacturing and Operation of Nuclear Power Plants Equipment, 17–21 June 2002. St. Petersburg, Russia, 2002. Vol. 2. P. 100–109.
100. **Dundulis G**., **Nedzinskas L., Klimasauskas A.** Ageing of austenitic pipes in Ignalina NPP // Proceed. of Intern. Symposium on Nuclear Power Plant Life Management, Book of Extended Synopses, 4–8 November 2002. Budapest, Hungary, 2002. P. 72–73.
101. **Dundulis G., Kulak R., Marchertas A**., **Narvydas E., Petri M. C., Uspuras E**. Evaluation of pipe whip impacts on neighboring piping and walls of the Ignalina Nuclear Power Plant // Proceed. of ICONE10: 10th Intern. Conf. on Nuclear Engineering, 14–18 April 2002. Arlington, Virginia (Washington, DC), USA, 2002. P. 1–9.
102. **Dundulis G., Kulak R., Marchertas A., Petri M., Uspuras E**. Pipe whip transient analysis of the Ignalina NPP // Proceed. of 6th Intern. Information Exchange Forum on Safety Analysis for Nuclear Power Plants of VVER and RBMK Types (Forum-6), 8–12 April 2002. Kiev, Ukraine, 2002. P. 1–19.
103. **Gailiusis B**., **Kriauciuniene J.** Modeling the effect of hydroelectric pumped storage power plant on Kaunas reservoir, Lithuania // Proceed. of the XXII Nordic Hydrological Programme, 4–7 August 2002. Raras, Norway, 2002. Vol. 1. NHP Report N 47. P. 143–151.
104. **Gatautis R.** Lithuanian energy sector development and its envoronmental impact // Proceed. of 25th Annual IAEE Intern. Conf. Innovation and Maturity in Energy Markets: Experience and Prospects, 26–29 June 2002. Aberdeen, Scotland, 2002. P. 1–7.
105. **Kadisa S.**, **Nemura A.** Modelling of transit flows in future Baltic sea region internal power market // Proceed. of 5th Intern. Conf. Control of Power and Heating Systems. Zlin, Czech Republik, 2002. P. 1–10.
106. **Kaliatka A.** Re-evaluation of anticipated operational occurrences, DBAs and BDBs in SAR-2 project of Ignalina NPP // Working Material Status of Safety Analysis Related to Life Extension of Nuclear Power Plants: Report of the Technical Meeting Organised by the Intern. Atomic Energy Agency, 9–11 September 2002. Vienna, Austria, 2002. P. 1–9.
107. **Kaliatka A.**, **Uspuras E.** Thermal-hydraulic analysis of loss of long-term core cooling accidents at RBMK-1500 // Heat Transfer 2002: Proceed. of Twelfth Intern. Heat Transfer Conf., Grenoble, France, 18–23 August 2002. Paris: Elsevier, 2002. Vol. 4. P. 657–663.
108. **Katinas V.** Flow and vibration problems of heat exchanger tubes in cross flow // Proceed. of the Intern. Symposium on Compact Heat Exchangers, Grenoble, France, 24 August 2002. Pisa: Edizioni ETS, 2002. P. 245–249.
109. **Kazakevicius E., JaraSunas V., Skema R.** "Best practice" projects and measures in Lithuania // Proceed. of the Intern. Seminar Climate Technology Initiative , Capacity Building, 5–9 December 2001. Ostritz, Germany, 2002. P. 118–128.
110. **Kezelis R.**, **Brinkiene K.** Correlation between processing parameters and microstructure for YSZ films produced by plasma spray technique // Proceed. of the 8th Intern. Conf. on Electronic Ceramics and Their Applications: Electroceramics VIII-2002, 25–28 August 2002. Rome, Italy, 2002. Abstract book, P. 118–119.
111. **Klevas V., Dzenajaviciene E. F., Minkstimas R**. The guidelines for renewable energy projects integration into regional development programs in Lithuania // Proceed. of 25th Annual IAEE Intern. Conf. Innovation and Maturity in Energy Markets: Experience and Prospects, 26–29 June 2002. Aberdeen, Scotland, 2002. P. 1–8.
112. **Klimasauskas A., Alzbutas R., Nedzinskas L., Alejev A**. Risk based inspection application for austenitic piping of RBMK nuclear power plants // Proceed. of the 7th Intern. Conf. on Material Issues in Design, Manufacturing and Operation of Nuclear Power Plants Equipment, 17–21 June 2002. St. Petersburg, Russia, 2002. Vol. 2. P. 56–65.
113. **Kviklys A**., **Levinskas R.** The model of the structure with intermediate layer // Polychar World Forum on Polymer Applications and Theory: POLYCHAR-10, 8–11 January 2002. Denton: University of North Texas, USA, 2002. Book of Abstract, P. 1–56.
114. **Levinskas R.** Investigation of delayed hydride cracking of zirconium based alloys // Report on the Final Research Co-ordination Meeting of the Co-ordination Research Project on Hydrogen Pick-up and Hydrogen Induced Degradation of the Mechanical and Physical Properties of Zirconium-Based Alloys, Sweden, 1–5 July 2002. Sweden, 2002. P. 274–337.
115. **Levinskas R., Grybenas A., Makarevicius V.** Hydride induced cracking in the Ignalina NPP pressure tube // Proceed. of the Seventh Intern. Conf. on Material Issues in Design, Manufacturing and Operation of Nuclear Power Plants Equipment, 17–21 June 2002. St. Petersburg, 2002. Vol. 2. P. 433–438.
116. **Levinskas R., Grybenas A., Makarevicius V., Lukosiute I.** Influence of temperature resistant amine on passivation of corrosion process of boiler steel // Proceed. of the Intern. Scientific-technical Conf. Aminy Primene™ i Kierunki ich Zastosowania w Energetyce, Tarda, Poland, 21–23 May 2002. Tarda, 2002. P. 53–57.
117. **Levinskas R., Kviklys A.** Thermal conductivity of polymeric composites filled with perlite particles of different porosity // Proceed. of the XII Intern. Conf. Mechanics of Composite Materials, 9–13 June 2002. Riga, Latvia, 2002. Book of Abstract, 106 p.
118. **Levinskas R., Sapragonas J., Kviklys A.** The influence of plasticized polyvinyl chloride filler particles on the strength characteristics of epoxy composites // Proceed. of the XII Intern. Conf. Mechanics of Composite Materials, 9–13 June 2002. Riga, Latvia, 2002. Book of Abstract, 107 p.
119. **Levinskas R.**, **Grybenas A., Makarevicius V., Rodriques J., Martinez D.** Structural integrity changes in the Zr-Nb alloy during hydride phase transformation under the thermal shock // Proceed. of the 2nd Users Workshop: Improving Human Potential Programme, 26 February 2002. Almeria, Spain, 2002. P. 163–170.
120. **Levinskas R, Lukosiute L, Makarevicius V., Grybenas A.** Influence of temperature resistant amine on passivation of corrosion process of boiler steel // Proceed. of the Intern.

Conf. BALTECHMASH-2002, Progresive Technologies and Equipment in Mechanical Engineering. Kaliningrad, 2002. P. 114–116.

121. **Liaukonis M., Augutis J**. Data analysis with uncertainty evaluation for the Ignalina NPP RMBK-1500 gas-gap closure evaluation // Proceed. of the 3th Intern. Conf. on Computer Simulation in Risk Analysis and Hazard Mitigation RISK ANALYSIS III, 19–21 June 2002. Sintra, Portugal, WIT Press Sauthampton, Boston, 2002. P. 425–436.
122. **Masaitis S.** Development of the use of biomass in energy production in the context of the regional cooperation // Proceed. of the Workshop Future of Bioenergy in the Baltic Sea Region, 6–7 March 2002. Jyvaskyla, Finland, 2002. 2 p.
123. **Miskinis V., Galinis A.** Changes in the Lithuanian power system after closure of the Ignalina Nuclear Power Plant and measures for reduction of $CO_2$ emissions // Proceed. of 25th Annual IAEE Intern. Conf. Innovation and Maturity in Energy Markets: Experience and Prospects, 26–29 June 2002. Aberdeen, Scotland, 2002. 9 p.
124. **Pedisius A**. Metrological service of Lithuanian energy sector // Proceed. of the Baltic-Finnish Conf. Energetics: from Research to Innovation, Tallinn, 1–2 November 2001. Finland, 2002. P. 111–117.
125. **Pedisius N**. Analysis of operation of bioconverted standard boilers // Heat Transfer 2002: Proceed. of Twelfth Intern. Heat Transfer Conf., Grenoble, France, 18–23 August 2002. Paris: Elsevier, 2002. Vol. 2. P. 893–899.
126. **Penkov V**., **Poskas P.** INPP experience with CASTOR and CONSTOR casks loading // Proceed. of Technical Meeting/ Workshop, 10–14 June 2002. St. Petersburg, Russian Federation, 2002. 20 p.
127. **Poskas P., Poskas R.** Experimental investigation of local heat transfer and skin friction in tube coils // Proceed. of the First Intern. Symposium on Thermal Science and Engineering, 23–26 October 2002. USTB, Beijing, China, 2002. P. 79–87.
128. **Poskas P., Poskas R.** Turbulent mixed convection heat transfer in an inclined flat channel with opposing // Heat Transfer 2002: Proceed. of Twelfth Intern. Heat Transfer Conf., Grenoble, France, 18–23 August 2002. Paris: Elsevier, 2002. Vol. 2. P. 243–249.
129. **Poskas P.**, **Poskas R., Zujus Rim.** Planning for decommissioning of Ignalina Nuclear Power Plant, Unit 1 // Proceed. of the Intern. Conf. on Safe Decommissioning for Nuclear Activities: Assuring the Safe Termination of Practices Involving Radioactive Materials, 14–18 October 2002. Berlin, Germany, 2002. P. 99–103.
130. **Pranevicius L., Pranevicius L. L., Milcius D., Templier C., Riviere J.-P.** Mass-transport driven by surface instabilities under high-flux, low-energy reactive ion irradiation at elevated temperatures // Proceed. of the IV Intern. Symposium, ION Implantation and other Application of IONS and Electrons,10–13 June 2002. Kazimierz Dolny, Poland, 2002. P. 41.
131. **Rimkevicius S**., **Vilemas J., Uspuras E.** Experimental investigation of thermalhydraulic characteristics in pebble beds, placed in thin annular slots with axial gas flows // Proceed. of the European Nuclear Conf. ENC 2002, 7–9 October 2002. Lille, France, 2002. P. 1–5.
132. **Rodriquez J**., **Martinez D., Levinskas R., Dudonis J., Milcius D., Sirvinskaite V.** Synthesis of YSZ thin films by solar energy annealing of Zr–Y layered structures in solar furnace at PSA // Proceed. of the 2nd Users Workshop: Improving Human Potential Programme, 26 February 2002. Almeria, Spain, 2002. P. 157–162.
133. **Steenberg C**. **M., Kriauciuniene J.** Klaipeda Port entrance rehabilitation project // Maritime Engineering & Ports III: Third Intern. Conf. on the Management, Operation, Design and Building of Ports, Marinas and other Maritime Works. Southampton, Boston: WIT Press, 2002. P. 203–212.
134. **Seporaitis M., Pabarcius R., Almenas K**. Investigation of condensation implosion phenomenon // Proceed. of 2002 ANS/ASME Student Conf. Back to the Future of Nuclear Technology, 10–14 April 2002. Penn State, USA, 2002. P. 1–9.
135. **Seporaitis M., Pabarcius R., Almenas K.** Study of controlled condensation implosion events // Proceed. of ICONE10: 10th Intern. Conf. on Nuclear Engineering, 14–18 April 2002. Arlington, Virginia (Washington, DC), USA, 2002. P. 1–7.
136. **Slezas R.** Implementation of the $NO_x$ control for industrial boilers in Lithuania // Proceed. of the Baltic-Finnish Conf. Energetics: from Research to Innovation, Tallinn, 1–2 November 2001. Finland, 2002. P. 101–109.
137. **Slanciauskas A**. The better burning of more heavier oil // Proceed. of 6th European Conf. Furnaces and Boiler Operation, 2–5 April 2002. Lisbon, Portugal, 2002. Vol. 2. P. 1–8.
138. **Urbonas R.** Uncertainty evaluation of simulation of E-108 test facility experiments // Heat Transfer 2002: Proceed. of Twelfth Intern. Heat Transfer Conf., Grenoble, France, 18–23 August 2002. Paris: Elsevier, 2002. Vol. 4. P. 639–645.
139. **Urbonas R**. Sensitivity and uncertainty analysis of the group distribution header blocking at Ignalina NPP // Proceed. of 2002 ANS/ASME Student Conf. Back to the Future of Nuclear Technology, 10–14 April 2002. Penn State, USA, 2002. P. 1–9.
140. **Urbonas R., Kaliatka A., Liaukonis M.** Uncertainty analysis of RBMK-related experimental data // Proceed. of ICONE10: 10th Intern. Conf. on Nuclear Engineering, 14–18 April 2002. Arlington, Virginia, (Washington, DC), USA. 2002. P. 1–7.
141. **Urbonas R., Kaliatka A., Uspuras E**. Sensitivity and uncertainty analysis of the blocking of coolant flow rate in GDH event at Ignalina NPP // Proceed. of 4th Intern. Conf. on Nuclear Option in Countries with Small and Medium Electricity Grids, 16–20 June 2002. Dubrovnik, Croatia, 2002. 8 p.
142. **Urbonavicius E., Rimkevicius S**. Mass/energy release influence to thermal hydraulics of accident localisation system at Ignalina NPP in case of MDBA // Proceed. of ICONE10: 10th Intern. Conf. on Nuclear Engineering, 14–18 April 2002. Arlington, Virginia (Washington, DC), USA. 2002. P. 1–7.
143. **Uspuras E**., **Kaliatka A.** Implementation of preventive measures against local flow degradation in the primary circuit of RBMK-1500 // Heat Transfer 2002: Proceed. of Twelfth Intern. Heat Transfer Conf., Grenoble, France, 18–23 August 2002. Paris: Elsevier, 2002. Vol. 4. P. 651–657.
144. **Uspuras E., Kaliatka A.** RBMK-1500 accident management for loss of long-term core cooling // Proceed. of 6th Intern. Information Exchange Forum on Safety Analysis for Nuclear Power Plants of VVER and RBMK Types (Forum-6), 8–12 April 2002. Kiev, Ukraine, 2002.12 p.
145. **Uspuras E., Simaityte J.** Kaunas dam overtopping probability estimation // Proceed. of the 3th Intern. Conf. on Computer Simulation in Risk Analysis and Hazard Mitigation RISK ANALYSIS III, 19–21 June 2002. Sintra, Portugal, WIT Press Sauthampton, Boston, 2002. P. 541–550.
146. **Vaskys A.**, **Zinevicius F., Grimming M.** Potential of reducing energy demand for lighting in Lithuania // Proceed. of the 5th Intern. Conf. on Energy Efficient Lighting, 29–31 May 2002. Nice, France, 2002. P. 337–344.
147. **Vileiniskis V., Urbonas R., Kaliatka A**. Investigation of natural circulation phenomenon using Ignalina NPP RELAP5 model // Proceed. of 4th Intern. Conf. on Nuclear Option in Countries with Small and Medium Electricity Grids, 16–20 June 2002. Dubrovnik, Croatia. 2002. P. 1–8.
148. **Vilemas J.** Lithuanian energy policy and its influence on the energy research and development priorities // Proceed. of the Baltic-Finnish Conf. Energetics: from Research to Innovation, Tallinn, 1–2 November 2001. Finland, 2002. P. 39–44.

149. **Vilemas J., Uspuras E., Rimkevicius S., Kaliatka A., Pabarcius R**. Overview of LEI investigations on heat transfer and flow structure in gas-cooled spheres packings and channels // Transactions of 1st Intern. Topical Meeting on High Temperature Reactor Technology (HTR), 22–24 April 2002. Petten, Netherlands, 2002. P. 266–270.

150. **Vrubliauskas S**. Biomass utilization for energy purposes in Lithuania // Proceed. of the World Renewable Energy Congress VII, Cologne, Germany, 29 June – 5 July 2002. Pergamon, 2002. P. 1–5.

Fax: +370 37 351271
http://www.lei.lt