

RUSSIAN ACADEMY OF SCIENCES  
SIBERIAN BRANCH  
MELENTIEV ENERGY SYSTEMS INSTITUTE

**METHODOLOGICAL PROBLEMS  
IN RELIABILITY STUDY  
OF LARGE ENERGY SYSTEMS**

INTERNATIONAL  
SCIENTIFIC WORKSHOP  
named after Yu.N. RUDENKO

Irkutsk  
2010

**International Scientific Workshop “Methodological problems in reliability study of large energy systems”**. Booklet. – Irkutsk: Energy Systems Institute, SB of RAS, 2010, 56 p.

The standing Scientific Workshop “Methodological problems in reliability study of large energy systems” was organized at Siberian Energy Institute, Siberian Branch of the USSR Academy of Sciences, in 1973 by the decision of the Scientific Council of the USSR Academy of Sciences for Complex Energy Problems. Nowadays it is the International Scientific Workshop named after Yu. N. Rudenko, which is well known in the community of scientists and experts in the energy field in Russia and other countries. This booklet contains the history of the Workshop creation and development; the directions of scientific research and analysis of the obtained results; the lists of meetings, main publications and members of the Organizing Committee; the Workshop Regulations; the reminiscences of veterans about some Workshop meetings and its first leader; and photos of some meetings.

The booklet can be useful for present and future participants in the Workshop and those interested in reliability problems in energy systems and their facilities.

Compiling editor  
Dr. G.A. Fedotova

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## **PREFACE**

Reliability of energy systems (ESs) – electricity, heat, gas, oil and oil product supply and other systems – is based on the fundamental concepts of reliability theory of engineering systems. Historically this theory evolved primarily in the context of the electronic industry requirements. Later as the experience in problem formalization was accumulated and extended to other systems, the reliability theory gradually took features of a general scientific discipline with its sufficiently universal methods applicable to any engineering systems.

As a rule, the general approaches of reliability theory to specific engineering systems prove to be insufficient because of their features to be taken into consideration when studying reliability of these systems. This situation is typical of energy systems as well. Firstly, the methods that emerged in reliability theory are mainly intended to solve reliability problems arising at the level of individual devices, complexes and local systems whereas in the energy sector we have to deal with large spatially distributed systems. Secondly, energy systems are characterized by highly specific and yet diverse physical nature of their components and subsystems (power units of power plants and transmission lines, oil and gas pipelines, oil refineries, etc.). Thirdly, the structure of energy production and consumption, and ES properties are such that they naturally require new operability criteria and new indices of operation reliability and efficiency. This in turn makes it necessary to develop special mathematical models and methods for studying and providing ES reliability.

At the same time, it should be emphasized that energy systems despite their different physical nature and features have many common properties allowing the use of the same terms, similar procedures and methods for studying their reliability.

The foregoing considerations objectively led Yu.N. Rudenko to an idea of the Scientific Workshop “Methodological problems in reliability study of large energy systems” 37 years ago. Since then the Workshop has come a long way: 81 meetings have been held, above 60 subject collections of papers, 8 books, 4 volumes of the reference book on ES reliability, 2 issues of ES reliability terminology and collection of energy security terms have been published. Scores of young researchers started their work on ES reliability problem within the framework of this Workshop. The main body of the Workshop was formed as a community of highly qualified experts in ES reliability. This booklet gives some insight into the Workshop history and its achievements.

Today the International Scientific Workshop “Methodological problems in reliability study of large energy systems” solves new serious scientific and applied problems. During the 1990s and early 2000s the economic paradigm changed in Russia and other NIS countries. As a result some energy systems underwent and some are currently undergoing a process of liberalization of relations among the subjects involved in their operation and expansion. Consequently, the ES reliability problems were substantially transformed and the ES structure and content changed for the following reasons:

- emergence of new organizational structures in energy industries that do not coincide with the technological structure of corresponding energy systems;

- contradictory interests of many subjects of relations that are represented by multiple criteria, when operating and expanding energy systems, providing their reliability and also reliability of energy supply to consumers;

- transformation of and increase in the role of economic mechanisms to ensure ES reliability on the basis of rational combination of market incentives and state regulation;

- formation of a new system of sharing responsibility for ensuring different components of fuel and energy supply reliability among the subjects of relations on a new economic basis.

Only first steps in solving these new problems of ES reliability have been made, yet numerous comprehensive studies lie ahead before the outlines of methodology adequate to new realities take shape. The main trends in such studies seem to be the following.

1. Structuring the reliability problems of fuel and energy supply to consumers in a market environment in accordance with the existing and prospective organizational structures in energy industries. Establishing correspondence between these problems and the system of reliability properties of energy systems as industrial engineering systems.

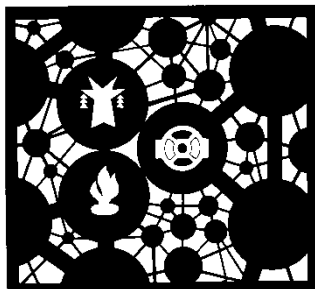
2. Development of a system of requirements and measures to provide ES reliability in a market environment by revising the previous requirements and measures, if they are considered as repayable services when applying the market mechanisms of compensation for expenses on these services.

3. Development of new effective mathematical models and methods for solving different traditional and new problems of studying and ensuring ES reliability on the basis of advances in computational mathematics, computer modeling and information technologies.

At present the studies on ES reliability problem are at a critical stage. It is vitally important that a new structure of problems, a new system of requirements to reliability measures, new mathematical models and methods for studying and ensuring ES reliability in a market environment should be worked out on the basis of previous developments and rest on the experience accumulated by many researchers in this field over the past decades.

N.I. Voropai  
Chair of the Workshop Organizing Committee

## EXCURSUS ON THE HISTORY OF WORKSHOP



The Scientific Workshop “Methodological problems in reliability study of large energy systems” was organized in 1973 at Siberian Energy Institute (SEI)\* of Siberian Branch of the USSR Academy of Sciences on Yury N. Rudenko’s initiative and approved by the decision of the Scientific Council of the USSR Academy of Sciences for Complex Energy Problems. Currently this is a successfully operating, standing International Scientific Workshop named after Yury N. Rudenko. The logo of the Workshop is known to all its participants. It can be found on information letters, programs

of meetings and covers of the Workshop proceedings.

The objects of scientific research of the Workshop are the energy complex of the country and its specialized energy systems: electricity, oil, gas, coal and heat supply systems.

The goals of the Workshop, the problems to be solved and the forms of work were formulated by the Workshop organizer and its first chair Yury N. Rudenko in the Regulations of the Workshop. Their original text is presented in *Appendix 1*. For 37 years the Workshop has been following their guidelines virtually without deviations. Corresponding Member of the Russian Academy of Electrotechnical Sciences Professor E.M. Chervonny, one of the Workshop’s veterans, wrote in his memoirs:

*“Reading now the Regulations of the Workshop on ES reliability that were worked out by Yury N. Rudenko in 1973 we are simply amazed at the extent to which he took into consideration all the challenges to be encountered by the Workshop. I will not analyze in detail the text of the Regulations and only note that the goals indicated there, the principles of organizing and holding the Workshop, the choice of experts to participate in meetings, the rules for selection of topics for the meetings to be held, the ways of discussing reports and the terms of their publication, the forms and guidance of the Workshop work envisaged in the Regulations have been observed over many years. Some amendments to the Regulations suggested by Yury N. Rudenko only improved them. Creation and implementation of the Regulations made the Workshop work highly efficient, especially as all their points were in complete agreement with the vital principles of their developer and the interests of active participants in the Workshop”.*

Currently the major objectives of the Workshop are:

- to raise awareness of the reliability problem, its theoretical and methodological aspects with respect to different energy systems and the energy complex as a whole under present-day conditions of energy sector operation;
- to analyze current methodological developments and choose the prospective directions for further scientific research on ES reliability;
- to discuss statements of the most topical and complex scientific and applied problems in the field of ES reliability and create theoretical and methodological framework, methods and means to solve them in a market environment;
- to study foreign experience in the area of ES reliability analysis and synthesis, and elaborate suggestions on its application in Russia;

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\* By the Resolution of the Presidium of SB of RAS in 1997 Siberian Energy Institute was given a new name – Melentiev Energy Systems Institute (ESI), SB of RAS.

- to develop approaches and models for solving ES reliability problems on the basis of common theoretical and methodological principles that rest on the advanced mathematical methods and high information technologies.

The Workshop topics cover a wide scope of problems on ES reliability analysis and synthesis in normal conditions and in extreme situations caused by different factors. When choosing the topics of meetings, special attention is paid to methodological aspects of intersectoral studies that are based on the common properties of different energy systems.

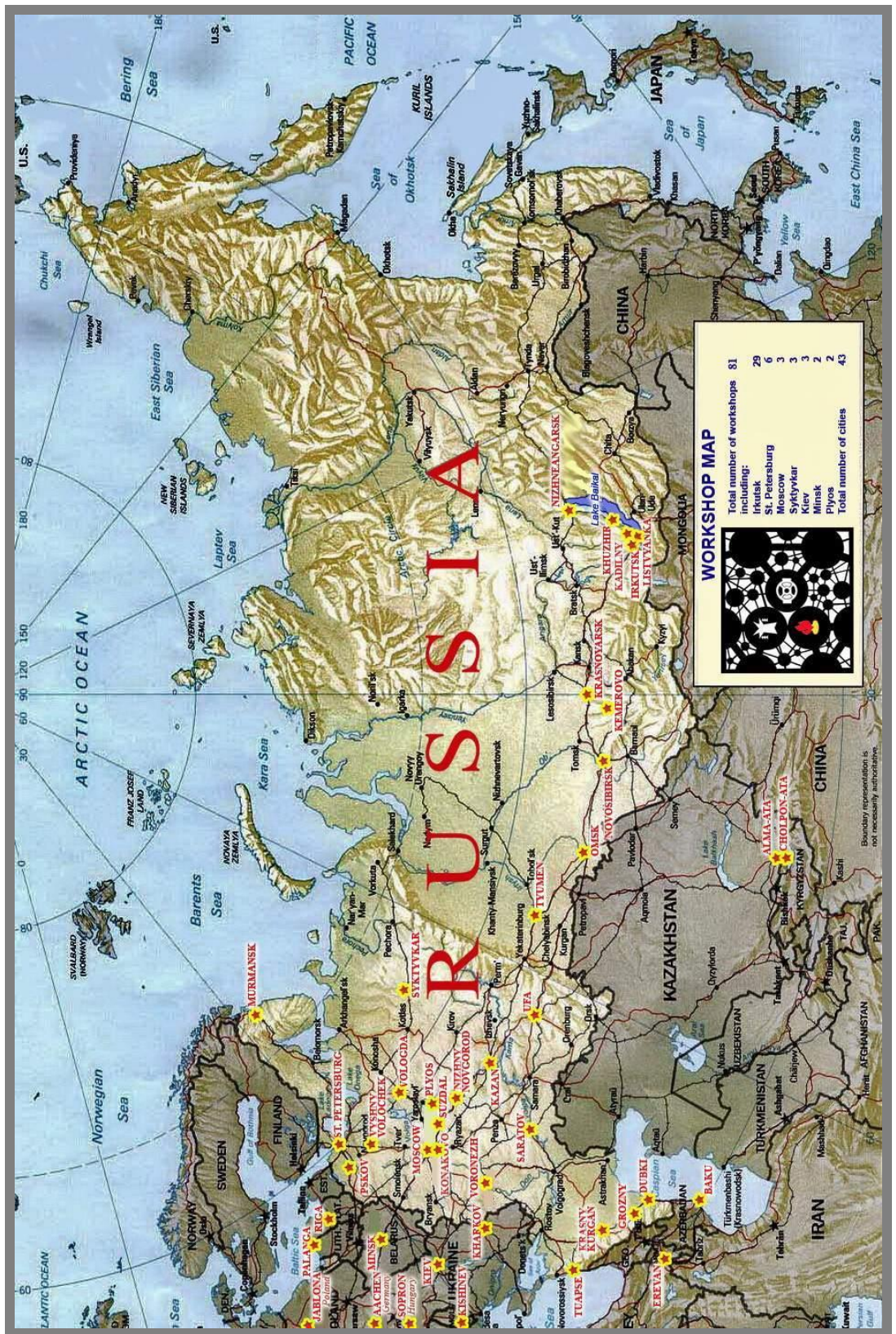
Along with the methodological issues the Workshop attaches great significance to approaches, mathematical models and algorithms to solve applied reliability problems, search for and development of the up-to-date methods based on new information technologies. The ES reliability research done by different institutions is coordinated within the framework of the Workshop. The theses related to the Workshop topics and prepared for defense are also discussed at the meetings.

The Workshop work is arranged in accordance with the plans of meetings. The topics of the meetings are chosen by the Organizing Committee that consists of 37 highly qualified specialists in ES reliability from research institutes, higher educational institutions and different energy enterprises (*see Organizing Committee*). The Workshop meetings are held jointly with other scientific or industrial conferences in which operational services of energy enterprises participate when needed. The 23<sup>rd</sup> meeting, for example, was organized jointly with the Scientific and Technical Commission at the State Committee of the Soviet of Ministers of the USSR on Science and Technology that was engaged in elaboration of suggestions on design and introduction of new relay protection devices in electric power systems. The 39<sup>th</sup> meeting was held jointly with the Plenary Session of the Scientific Council of the USSR Academy of Sciences for Complex Energy Problems. The 45<sup>th</sup> meeting was held within the framework of the 6<sup>th</sup> Session of the Scientific Council of the Siberian Branch of the USSR Academy of Sciences concerning the problem “Development of the oil and gas complex of Tyumen region”, etc.

When analyzing the history of the Workshop, we can note that its meetings were held with a different degree of intensity from year to year. During the first 3 years the Workshop worked most intensively, the active process of “immersion” into the studied field and accumulation of initial knowledge took place. Altogether 18 meetings (including 13 in Irkutsk) were held and 10 collections of papers were published. Gradually the Workshop meetings moved from Irkutsk to other cities of the Soviet Union, Russia and abroad. Nowadays there are more than 40 cities in Russia, NIS and other countries, where the meetings were held in different years (*see Map of the Workshop meetings*). In Irkutsk the Workshops were held 29 times, in St. Petersburg – 6 times, in Moscow, Kiev, Syktyvkar – 3 times in each, in Minsk and Plyos – 2 times in each, etc. (*see Workshop meetings*).

The Workshop gained in popularity with the scientific circles and reliability experts from higher educational institutions, design and operational energy organizations very quickly. The circle of specialists interested in the Workshop constantly widened. Whereas the number of participants in the first twenty meetings varied from 9 to 67 people, in the next twenty meetings – from 20 to 120. The scientific potential of the Workshop increased simultaneously with the number of participants. In January 1978 Academician L.A. Melentiev sent the letter of thanks to Yu.N. Rudenko with positive





appraisal of the Workshop work by the Committee of the Scientific Council of the USSR Academy of Sciences for Complex Energy Problems.

In the mid -1970s the need for development of science-based terminology in the area of ES reliability became obvious. Absence of the unique and ordered terminology in this sphere prevented reliability specialists from mutual understanding and led to practical mistakes. In 1976 the Committee on Scientific and Technical Terminology of the USSR Academy of Sciences and the Scientific Council for Complex Energy Problems of the USSR Academy of Sciences formed the Commission for elaboration of ES reliability terminology. The Commission included top national specialists in ES reliability and was headed by Corresponding Member of the USSR Academy of Sciences Yu.N. Rudenko. The first version of terminology was based on the suggestions made at the Workshop. After its thorough analysis, multiple revisions, introduction of the required adjustments and changes the work on the terminology was completed and its fifth version was approved. This was one of the stages in the collaborative work performed by the top reliability experts within the framework of the Workshop. In 1980 this work was completed with publication of the energy system reliability terminology that was edited by Yu.N. Rudenko [1]. The terminology represents a system of terms and definitions that along with the specific notions of energy system reliability covers necessary notions from the general reliability theory, energy sector and related disciplines. A specific character of energy systems made it necessary to revise some notions existing in the general reliability theory. The document was very important for methodological and applied studies on energy system reliability.

After 10 years of the Workshop work the question on validity of independent existence of energy system reliability theory was put on the agenda. In 1983 two meetings in Irkutsk were devoted to methodological problems of reliability. In February the 40<sup>th</sup> anniversary meeting discussed the current methodological developments in the area of ES reliability and the directions for their further advance. The results of the meeting were compiled in the collection of papers and the most significant of them were published in the journal "Izvestiya AN SSSR. Energetika i transport" (1986, No. 6). In April the first International Workshop gathered scientists from six socialist countries. A large team of authors including foreign scientists prepared two monographs. One of them was devoted to theoretical and methodological problems of ES reliability [2], the other – to the problems of ensuring reliability and optimizing capacity reserve in electric power systems (EPSs) [3].

To a certain extent this was the time when the Workshop results were summed up, collective creative work was performed and new problems were studied. In 1986 the regular meeting on the problem of ES controllability was held in Irkutsk. This aspect of reliability is considered as one of its single properties. The general methodological issues of controllability, means and ways of ensuring it were analyzed at the meeting. The methods and models to study survivability of energy systems were considered in 1987 at the 49<sup>th</sup> meeting of the Workshop. Based on the results of these meetings the Siberian Branch of the Publishing Company "Nauka" (Novosibirsk) issued two monographs [4, 6]. In 1986 the Publishing Company "Nauka" (Moscow) issued the book by Yu.N. Rudenko and I.A. Ushakov that was devoted to the methodological aspects of system reliability. In 1989 its second edition edited by B.V. Gnedenko was revised and extended [5]. Along with the general methods of reliability analysis and synthesis of engineering systems, the book described special procedures which could be effectively applied to energy systems. It substantially generalized scientific results of the Workshop work for 10 years and determined the place of reliability theory in energy. Here are the words from the book by



one of its authors Yu.N. Rudenko: “...*the reliability theory of energy systems has the right not only to exist, but it should be separated in the nearest time as a special discipline to offer thus a required instrument to the developers of energy systems and a huge party of specialists involved in operation of these systems*”.

Development of reliability standards for energy systems was one of the Workshop activities. In early 1984 the Commission for development of reliability standards and the Working Groups on specialized energy systems (electricity, gas, oil and heat supply systems) and the energy complex as a whole were created within the framework of the Workshop. The first results of their work were discussed in September of the same year in Irkutsk at the 44<sup>th</sup> meeting of the Workshop. In June 1985 the members of the Commission and Working Groups were approved by the Scientific Council of the USSR Academy of Sciences for Complex Energy Problems. By mid-1988 the current status of reliability standards for specialized energy systems and the energy complex as a whole was analyzed in detail. In October 1988 the 52<sup>nd</sup> meeting of the Workshop devoted to reliability standardization problem in energy systems was held in Kiev. The reports were submitted by participants from more than 40 institutions, in particular from the USSR AS, its Siberian and Ural Branches, AS of UkSSR, AS of LithSSR, Gosplan of the USSR, Ministry of Energy of the USSR, Ministry of Gas Industry of the USSR, Ministry of Oil Industry of the USSR and other organizations. The problem of ES reliability standardization was discussed at the other meetings as well, it remains urgent even now.

Great interest in the Workshop was and is currently exhibited by both Russian and foreign scientists. The first meeting of the Workshop abroad was held in Poland (the city of Jablona) in 1986 jointly with the Committee on energy problems of the Polish AS. It was devoted to the methods for studying and ensuring reliability in electric power and pipeline systems. In 1990 the second meeting abroad took place in Hungary (the city of Sopron) that dealt with methodological issues, estimation of ES reliability and security. The proceedings of the first meeting were published as a subject collection. The papers presented by the Russian authors at the second meeting were published in the journal “Izvestiya AN SSSR. Energetika i transport” (1991, No. 6).

In 1993 the Russian-German Workshop on scientific-methodological and applied problems of EPS reliability started its work within the framework of the Workshop on ES reliability. This Workshop was aimed at mutual acquaintance with the methods and algorithms of studying and ensuring EPS reliability in Russia and Germany, their improvement and practical application. Professor H.-J. Haubrich was its organizer from the German side and Yu.N. Rudenko – from the Russian side. The first meeting of the Workshop was held in Russia (in the town of Plyos, Ivanovo region) in September 1993. Ivanovo State Energy University and the Organizing Committee were engaged in preparation of the meeting from the Russian side, Institute of Power Systems and Power Economics (the city of Aachen) – from the German side. The second meeting of the Russian-German Workshop was held in Germany (the city of Aachen) in August 1994. In September 1998 the third meeting devoted to the current problems of globalization and liberalization in the European electric power industry was held in St. Petersburg. The reports presented at the meeting were published as subject collections in German, Russian and English [7, 8, 14].

Special attention at the Workshop on ES reliability has always been paid to young researchers and improvement of their skills in the reliability area. Two meetings of the Workshop dealing with scientific and applied problems of ES reliability were held as schools intended for a wide circle of young researchers engaged in the ES reliability studies. Their goal was to give an insight into the most important reliability problems in

the energy sector and the up-to-date methods of the general reliability theory for engineering systems that can be applied for solving these problems. The first School-Workshop was held in the town of Plyos (Ivanovo region) in 1989. The top reliability specialists of our country delivered lectures to young participants. Among the lecturers were: Academician of AS of UkSSR B.V. Gnedenko, Academician of the USSR AS Yu.N. Rudenko, Doctors A.P. Merenkov, V.G. Kitushin, M.G. Sukharev, G.N. Cherkosov, E.M. Yasin and others. There were 100 participants from 40 organizations. The contest of ideas about solving topical unsolved methodological problems on reliability of ESs and their equipment was organized within the framework of this School. In 2004 the second School-Workshop was held in Minsk and the lectures delivered were published as a collection of lectures [19].

In 1994 the Foundation "Reliability of energy systems" was created on the initiative of Academician Yu.N. Rudenko. In the first years one of its activities was the financial and scientific-technical support of the Workshop. Now the Foundation is named in honor of its first President Yu.N. Rudenko and aims to assist in approval and introduction of advanced energy- and resource-saving environmentally sound technologies, coordinate scientific efforts to improve reliability of fuel and energy complexes.

An essential result of the 20-year joint work of the Workshop participants was the manual on reliability in 4 volumes edited by Yu.N. Rudenko. Such a manual was required for a wide circle of experts in planning the development, design and operation of specialized energy systems (electricity, gas, oil and heat supply systems) to provide the possibility of applying the existing methods, algorithms and mathematical models to solve the problems of reliable energy supply to consumers. In the preface to the first volume Yu.N. Rudenko underlined the necessity of the manual:

*"The multi-year work of the Workshop and analysis of the degree to which the problem of studying and providing reliability of energy systems and the energy sector as a whole is solved have led to the conclusion that it is necessary to create a reference book including the methods and algorithms to be used for calculation and provision of ES reliability, and intended for decision making when planning ES expansion and operation under certain conditions. Many profound works published both in the area of reliability of electric power systems, pipeline systems and the energy complex as a whole and in the area of improvement of the general reliability theory of engineering systems provide a good foundation for the book".*

The first volume of the reference book was published in 1994 [9]. It addresses specialized energy systems (electricity, gas, oil, heat and water supply systems) including their main equipment. The general methods and mathematical models for their reliability analysis and synthesis based on the common properties of technologically different ESs are described. Some mathematical models for solving reliability problems of the energy complex as a body of specialized energy systems are presented. The following volumes describe methods and mathematical models for solving reliability problems in expansion planning, design and operation of different energy systems in terms of their specific features. The second volume is devoted to reliability problems in electric power systems and their equipment [15]. The methods for estimation and optimization of power system reliability are considered based on three components: energy resources, generation capacities and electric networks. The methods for determination of customers' damage caused by interruption of electricity supply and the current reliability standards are presented. In the third volume the reliability models of the unified systems of gas and oil supply, and the enterprises for production and transportation of hydrocarbons are suggested [10]. The fourth volume is devoted to the problem of studying and providing

reliability of heat supply systems [16]. It presents reliability characteristics for equipment of heat energy sources and heat networks; describes mathematical models, decomposition methods and algorithms for solving the problem of creating systems with a given reliability level. The structure, composition and numerical values of reliability standards for heat supply systems are given.

Several meetings, one of them held abroad, were devoted to the energy security problem. Based on the decision of the Scientific Council of RAS for Complex Energy Problems of 17.04.1997 the Commission and the Working Group for elaboration of terminology in the area of energy security were created within the Workshop to rule out ambiguous interpretation of notions. The result of their work was coordination of basic notions, terms and definitions in this field and elaboration of new ones. The collection of terms was issued by the Publishing Information Center "Energiya" [20].

In February 1998 the Workshop celebrated its 25<sup>th</sup> anniversary. Its jubilee meeting "Reliability of energy systems: achievements, problems, perspectives" devoted to the memory of Yu.N. Rudenko was held on Baikal (Kadilny cape). The papers presented at the Workshop covered a wide scope of issues: state of the art and problems of ES reliability; methodological principles of ES reliability; energy security problems in Russia; economic aspects of reliability control in energy systems; diagnosis of equipment state in ES reliability problems, etc. The results of the meeting were compiled in the monograph issued by the Siberian Branch of Publishing Company "Nauka" (Novosibirsk) [11].

In July 1999 Syktyvkar hosted the 70<sup>th</sup> Workshop. It was organized by the Institute of Socioeconomic and Energy Problems of the North of Komi Scientific Center of Urals Branch of RAS; the Energy Systems Institute, SB of RAS; the Department of Physical and Technical Problems of Energy at RAS; the Research Council of RAS for the problems of reliability and security of large energy systems; the Foundation "Reliability of energy systems" named after Yu.N. Rudenko; and by Power Engineering Society IEEE, Russian Chapter. The meeting was dedicated to the memory of Corresponding Member of RAS A.P. Merenkov who headed the Workshop in 1994-1997. The Workshop gathered 85 experts in the field of energy system reliability from 35 organizations in Moscow, Saint-Petersburg, Irkutsk, Kiev, Riga, Ekaterinburg, Nizhny Novgorod, Syktyvkar, Tyumen and other cities in Russia and NIS countries. The participants presented and discussed 47 papers which were then published as a subject collection. It also included the papers and proceedings that had an impact on the Workshop creation, and reminiscences of the Workshop participants [12]. The topics discussed at the meeting included a wide range of issues related to:

- intersectoral and interdisciplinary aspects of reliability and security of specialized energy systems and fuel and energy complex in Russia in a modern economic environment;
- comprehensive consideration of natural, technical, economic and social factors for ensuring reliability and security of energy systems;
- structure of management and market relations in the energy sector.

The 71<sup>st</sup> Workshop was held jointly with the Russian State University of Oil and Gas named after I.M. Gubkin in 2000 (the city of Vyshny Volochok). A collective monograph was published. It focused on the formation and evolution of market relations in Russia's energy. The monograph presented new methodological approaches, mathematical models and information technologies intended to ensure reliability of energy systems [13]. In September 2001 the 72<sup>nd</sup> Workshop was held in the framework of Russia's National Symposium on Energy (Kazan). It was devoted to the ES reliability problems and their solving with account taken of modern trends in energy development and progress in

information technologies. The papers were published as a subject collection in the Russian language and were included into the fourth volume of Symposium proceedings in the English language [17].

The reliability problems of liberalized energy systems were discussed at the 73<sup>rd</sup> Workshop (Tuapse, 2002). A monograph was prepared. It addressed the current problems of energy system reliability including its structural and parametric aspects, methods, algorithms and information technologies for solving the reliability problems when operating and expanding energy systems in a market environment [18].

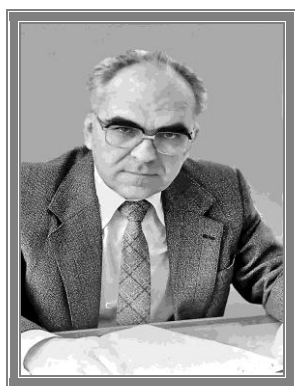
The topics of the last Workshops mirror modern reliability problems of energy systems in a new economic and sociopolitical environment in Russia. The necessity to solve them in modern conditions called for revision of terms and definitions. In 1998 the participants in the 69<sup>th</sup> Workshop made a decision to organize special work in this direction. Commission was created to develop and improve the terminology. The issues of energy system reliability terminology were considered at the anniversary Workshop that took place in Irkutsk in July, 2003. The Workshop marked its 30<sup>th</sup> anniversary. It addressed the problems of energy system reliability and energy security at the current stage of energy development in Russia. The draft terminology was discussed and approved at the joint meeting of the Scientific Council of RAS for Reliability and Security Problems in Large Energy Systems and the Scientific and Technical Council at RAO "EES Rossii" on April 28, 2006. In 2007 the work was completed and a new collection of terms on power system reliability was issued [21]. The new terminology was based on the first edition that was supplemented and changed to meet the modern requirements and reflect modern understanding of structure and content of the complex property of energy system reliability. Additional sections were introduced. These concerned the problems of standardization, estimation and optimization of reliability as well as economic aspects of energy supply system reliability.

The reliability problems of restructured energy systems and methods for their solving in a market environment were dealt with at all the subsequent meetings of the Workshop. The participants discussed new approaches, mathematical models and methods for estimating and providing reliability of energy systems and their facilities in the market economy, the methods for coordinating responsibility for reliability of energy facilities for different subjects of relations, and the measures and means for reliability enhancement under new conditions of energy operation and development. New statements of ES reliability problems and tools for their solving in a market environment in energy were considered. Three last Workshops focused on reliability problems of liberalized energy systems. The first one was held in Vologda jointly with the enterprise "MES Tsentra" within the Federal Network Company of Russia's Unified Energy System and Vologda State Technical University. Consideration was given to the methodological and applied problems of reliability in liberalized energy systems, advanced methods and tools for maintaining reliability of energy facilities on the basis of equipment state diagnosing, and new information technologies as applied to reliability problems of energy systems, their software and information support. The second Workshop was held in Irkutsk (Lake Baikal). Participants in the Workshop discussed new statements of reliability problems of restructured energy systems operating in a market environment, approaches, mathematical models and methods for their solving. They also paid attention to the problems related to coordination of responsibility for reliability of energy facilities among different subjects of relations in a market environment. The third Workshop was held in St. Petersburg on the basis of St. Petersburg Energy Institute of Professional Development in collaboration with Russian National Committee of CIGRE. Consideration was given to the problems of

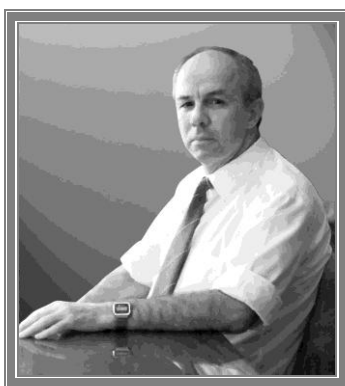
studying and ensuring reliability of energy systems in modern conditions, new information technologies in energy, methods and tools for diagnosing energy equipment state.

Altogether 81 Workshops were held over the period from 1973 to 2009 (*the topics are given in the section “Workshop meetings”*). Above 2500 presentations were made. The Workshop resulted in publication of 8 books, 4 volumes of the reference book on energy system reliability, terminology collections of energy system reliability and energy security, and above 60 collections of papers related to the subject of the Workshop. Over the 37-year period the Workshop has become a source of manpower and a school for young researchers. More than 70 theses on the subject of the Workshop were discussed. The list of permanent Workshop participants has more than 300 names of specialists in reliability of different energy systems, researchers and experts from 140 organizations. The number of the Workshop participants is great which can be seen from the photos of some Workshops in *Appendix 3*.

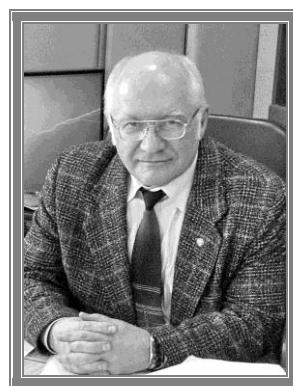
Three directors of Siberian Energy Institute (Melentiev Energy Systems Institute, SB of RAS, since 1997) have headed the Workshop: Yury N. Rudenko (1973-1994), Anatoly P. Merenkov (1994-1997) and Nikolai I. Voropai (since 1997 up to date). The Energy Systems Institute has published the books of reminiscences by researchers, relatives and friends, colleagues and students that cover various aspects of life and activity of Yu.N. Rudenko\* and A.P. Merenkov\*\*. Below in the text and in *Appendix 2* given are the fragments of the reminiscences by the Workshop veterans from these books.



*Yury N. Rudenko*



*Anatoly P. Merenkov*



*Nikolai I. Voropai*

Eleven employees of the Institute were Scientific Secretaries of the Workshop: I.A. Aleksandrov (1973), G.V. Kolosok (1973-1976), M.A. Dubitsky (1976-1983), R.B. Fattakhov (1983-1985), V.A. Volostnykh (1985-1990), E.V. Volostnykh (1990-1992), V.V. Ivanov (1992-1996), G.A. Fedotova (1996-2002), L.M. Lebedeva (2003), E.L. Stepanova (2004), L.M. Efimova (since 2005 up to date).

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\* Yury N. Rudenko: Reminiscences on life and activity. – Novosibirsk Publishing Company of RAS Series “Science of Siberia in personalities”, 2002. – 328 p.

\*\* Anatoly P. Merenkov: Scientific heritage. Reminiscences of his nearest and dearest ones. Documents. – Irkutsk: Energy Systems Institute, SB of RAS, 2006. – 654 p.

## MAIN PUBLICATIONS OF THE WORKSHOP

1. Reliability of energy systems: Terminology / Ed. by Yu.N. Rudenko. – Moscow: Nauka, 1980, Iss. 95, 44 p. (in Russian)
2. Theoretical and methodological problems of reliability in energy systems / Ed. by Yu.N. Rudenko. – Novosibirsk: Nauka SB, 1985, 220 p. (in Russian)
3. Capacity reserves in electric power systems in the member countries of CMEA / Ed. by M.N. Rozanov and G.A. Fedotova. – Novosibirsk: Nauka SB, 1988, 150 p. (in Russian)
4. Controllability of energy systems / Ed. by V.G. Kitushin. – Novosibirsk: Nauka SB, 1988, 234 p. (in Russian)
5. Rudenko Yu.N., Ushakov I.A. Reliability of energy systems, 2<sup>nd</sup> edition, revised and enlarged / Ed. by B.V. Gnedenko. – Novosibirsk: Nauka SB, 1989, 328 p. (in Russian)
6. Methods and models for survivability study of energy systems / Ed. by Yu.N. Rudenko. – Novosibirsk: Nauka SB, 1990, 285 p. (in Russian)
7. Reliability of energy supply systems // The First Russian-German Workshop Proceedings / Ed. by H.-Jü. Haubrich. Plyos / Russia, September 6-11, 1993. – Westfalen, Aachen: Augustinus, 1993, Vol. 1. – 215 p., Vol. 2. – 173 p. (in Germany)
8. Reliability of electric power systems / The Second Russian - German Workshop Proceedings / Ed. by H.-Jü. Haubrich and N.I. Voropai. Aachen / Germany, August 23-25, 1994. – Irkutsk: ESI SB RAS, 1998, 221 p. (in Russian)
9. Reliability of energy systems and their equipment: reference book in 4 volumes / Ed. by Yu.N. Rudenko.  
Vol. 1: Reference book on general models for analysis and synthesis of energy system reliability / Ed. by Yu. N. Rudenko. – Moscow: Energoatomizdat, 1994, 414 p. (in Russian)
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The question naturally arises how to write the reminiscences on the object which is doing well and is successfully functioning? So I will try to make it clear why I have decided to write about it. The group of active Workshop participants has been essentially renewed over the period of its work. Most of what was created in the beginning now is taken as self-evident. Not all today's Workshop participants know the history of its organization and development. To my mind the Workshop represents a fairly extraordinary phenomenon in the national energy and that will be a pity if the scientific community forgets about its existence and role in the creation of scientifically grounded methods for analysis and calculation of energy system reliability.

Before 1970 the methodological developments concerning reliability of energy facilities had been based on the authors' own ideas, specific features of problem statements, which required reliability to be taken into account, and on the other considerations that were inconsistent with the works of other authors. The first attempt to unite the efforts of different researchers and develop common approaches to solution of the reliability problems was made by Deputy Head of the Main Technical Department at Ministry of Energy of the USSR, F.I. Sinchugov. He allotted some amount of money for the studies on power system reliability and in 1971 the contracts with the experts and research organizations intensely working in this field were concluded via the All-Union Research Energy Institute (VNIIE). The goal of the group of experts was to develop a single system of reliability standards for designing and operating power plants, substations, networks and electric power system as a whole. Soon it became clear that different authors worked like performers of the "Dutch concert". It goes without saying that none of the specialists involved in this work was ready to a general statement of the problem. Then the VNIIE laboratory headed by Dr. E.V. Tsvetkov developed a Program for the work of the group of experts to determine the approach to standardization of power supply reliability in energy systems and electric networks. A special meeting was arranged to discuss the problem. It was held at Moscow Energy Institute.

Discussion of the problems posed by the Workshop participants encountered considerable terminological confusion because of the absence of common uniform terminology. Certainly the results achieved by the above collective of authors were very useful yet the necessity to conduct the long-term studies in more extended groups of experts was revealed.

One of the meeting participants was Deputy Director of Siberian Energy Institute Yu.N. Rudenko. Neither he nor the Institute at that time was among the participants in the contract work. I do not know for sure if he was specially invited or it was his personal initiative for which he had many reasons. Shortly before the meeting he had successfully defended his doctoral thesis "The problems of reliability studies of electric power systems" at Leningrad Polytechnic Institute. To my mind it was the first approved doctoral thesis on reliability in the electric power industry. All five days he actively participated in the work of the meeting. As a result he made a conclusion or confirmed the one he had arrived at earlier on the necessity to carry out a long-term coordinated work of a large group of

experts to solve the whole set of methodological problems in the field of energy system reliability. Composition of participants in the meeting showed him that the basis for creation of such a group already existed.

The founder of Siberian Energy Institute Academician L.A. Melentiev forwarded the efforts of his collective to comprehensively solve the problems in the energy sector as a whole, including electric power industry. Obviously that was why Yu.N. Rudenko extended the reliability problem to the entire energy complex. He placed a special emphasis on the problem of terminology framework development because without it the studies of the large group of experts would be impossible. At the same time being aware of the impossibility of getting big money necessary to perform the above work he relied on enthusiasts. The group of experts was supposed to work at their institutes and meet regularly at the Workshops. First, to accelerate the implementation of the idea the decision was made to create a branch on the “Methodological problems in reliability study of large energy systems” at Siberian Energy Institute on the basis of the Scientific Workshop “Cybernetics of electric power systems” headed by Professor V.A. Venikov. All the participants in the above meeting and other experts concerned received an information letter with the following content.

*The Workshop on the Methodological problems in reliability study of large energy systems has been organized at Siberian Energy Institute, SB of the USSR AS. The Workshop aims to discuss research works addressing reliability and stability problems of electric power systems and reliability problems of pipeline systems (gas-, heat supply, etc). The Workshop meetings will take place on the second Tuesday every month at the premises of Siberian Energy Institute. Additionally, an annual two- or three-day Workshop concerning the target topic (to be determined for a year) is planned in October-November with subsequent publication of a subject collection including presented and recommended papers, a summary of new works and assessment of situation with the reliability problem solution. Currently the plan for the work is being made for the years 1973-1974. We are therefore asking for your proposals: on presentations for the Workshop and their potential dates; on the expediency of a two- or three- day annual meeting for discussion of the topic determined for the year; on the topic of the nearest meeting, its dates and potential papers to be presented.*

Very soon it became clear that holding the Workshop in Irkutsk alone reduces essentially the number of participants. Therefore, the decision was made to hold the Workshops in places where all the necessary conditions were provided. The first guest Workshop (the ninth one) “Reliability in Designing Electric Power Systems” was held in Syktyvkar in May 1974. Eventually the number of cities hosting the Workshop increased. It also became necessary to reduce the number of annual meetings since each meeting called for long preparation. Thus, the Workshop grew into an independent All-Union Scientific Workshop quite fast.

The major merit of the Workshop activists and, first of all, its Chairman Yu.N. Rudenko is development of the collection of terms on reliability of energy systems. To perform the work on its creation the Committee for Scientific and Technical Terminology of the USSR AS and the Scientific Council for Complex Energy Problems of the USSR AS founded the Scientific Commission chaired by Yu.N. Rudenko in 1976. Publication of the collection allowed one to eliminate the differences in interpretation of the main terms and definitions in the field of reliability of energy systems, ensure high degree of mutual understanding among both Russian and foreign experts, coordinate the studies concerning reliability of electricity-, heat-, gas-, oil- and water supply systems with account taken of

the specific features of solving modern problems of their expansion on the basis of the single system methodology.

When the total period of the Workshop activity reached 20 years the Organizing Committee made a suggestion to publish the reference book on reliability of energy systems and energy equipment. The suggestion was approved by the Head of the Workshop who later undertook editing and supervising the preparation and publication of the reference book. Unfortunately, the death of Yu.N. Rudenko and financial problems encountered during reforms slowed down the work but by the end of 2000 all the 4 volumes of the reference book had been published.

The style of the Workshop work, the limited number of participants, their readiness for discussion of posed issues and personal concern in the discussion made the Workshop very efficient. Its many participants set a goal to prepare and defend their theses. The Workshop facilitates the accomplishment of this goal. The Organizing Committee of the Workshop decided to regularly discuss doctoral theses starting in 1977. The participants most competent in the topic of the thesis perform the functions of opponents while the rest of the participants play the role of a specialized council. Since the general competence of the audience is high enough the discussions of theses are very efficient. In the case of negative decision, however, these discussions are taken by authors rather painfully. Nevertheless the participants willingly present their theses at the Workshop.

Successful work of the Workshop has drawn close attention from Russian and foreign scientific community. Even at its first meetings there were about 20 doctors of sciences who specialized in various aspects of reliability of large systems and not only energy systems. The foreign scientists vividly expressed their interest in the Workshop during the meetings of the Workshop in Poland, Hungary and Germany. In 1993 the Russian-German Workshop was organized on the basis of the Reliability Workshop. The scientists from different countries well known for their work in the field of energy system reliability have taken an active part in it. I have participated twice in these International Workshops and can confirm that the presentations made by our experts looked adequate and convincing.

The Workshop has been successful thanks to high activity of researchers taking part in it. The role of its founder and leader Academician Yu.N. Rudenko should be particularly emphasized. Only a highly respected leader could create and unite a large scientific group including many renowned experts for the work on an exclusively voluntary basis.

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The need for scientific contacts among the experts in reliability of large systems was realized in the 1960s when the works boomed in this field. There were several scientific reliability – oriented schools in the USSR, mainly in Leningrad and Moscow. These schools periodically held scientific meetings and workshops. With development of a general technical reliability theory the scientific forums started to gather experts from most diverse technical areas as well as specialists in the field of applied mathematics. In the mid- 1960s the Workshop at the Institute of Machine Science of the USSR Academy of

Sciences in Moscow that was headed by Academician N.G. Bruevich became the most representative scientific reliability forum in the USSR. However, despite the usefulness of these general technical workshops the need for scientific contacts in specific technical areas soon became quite obvious.

The systematic reliability studies in energy started in the second half of the 1940s in the USA. The mathematical theory of reliability that appeared at the turn of the 1950s-1960s encouraged these studies. All the more so, reliability in energy was always considered a very important property for choosing decisions in terms of economic efficiency. The father founder of system studies in energy, the organizer of Siberian Energy Institute, Academician L. A. Melentiev, understood very well the place of reliability in a rich palette of energy system properties. Not coincidentally one of the energy reliability schools started to develop at Siberian Energy Institute. It was headed by Deputy Director for Science Yu.N. Rudenko. In 1971 he brilliantly defended his doctoral thesis "The problems of reliability study in electric power systems" at Leningrad Polytechnic Institute (I am saying "brilliantly" with good reason, because I attended the thesis defense) and in 1973 headed the Scientific Workshop on reliability problems in energy systems.

In May 1974 the first guest Workshop devoted to reliability problems in EPS design was held in Syktyvkar. Since for the participants from the European part of the Soviet Union Syktyvkar was much closer than Irkutsk and owing to a well done job of the organizers the number of participants was quite impressive. The Workshop was a success, the scientific contacts were established, the core of the Workshop started to form and everybody felt the atmosphere of trust and team spirit. In a month and half after the Syktyvkar Workshop Yu.N. Rudenko held the second Workshop in Saratov but this time on reliability of gas supply systems.

Almost all the Workshops were conducted by Yu.N. Rudenko. At the beginning of each meeting he gathered the Organizing Committee, they thoroughly distributed the submitted papers among the groups (subtopics), assigned leaders of these groups, determined opponents for each paper and solved other organizational issues. Before the end of the Workshop meeting the Organizing Committee met again to select the papers for publication (no allowances were made for anyone, the only criterion was quality of paper), plan the topics and venues for next meetings and then announced this information at closing. Yu.N. Rudenko edited most of the Workshop proceedings. He edited altogether 30 collections and two of the four volumes of energy system reliability reference book. To speak of the Workshop on reliability of large energy systems is primarily to speak of its founder who put his soul and heart into the Workshop.

Energy Department of Komi Scientific Center of Ural Branch of RAS and I were in charge of three Workshops in Syktyvkar. Besides, I took part in the organization of the Workshop on relay protection reliability in Riga in 1977. The Workshop is part of my life. I believe its many participants can say the same. The Workshop is a great school and I would like this school to have a long life as the reliability problem of energy systems is eternal.

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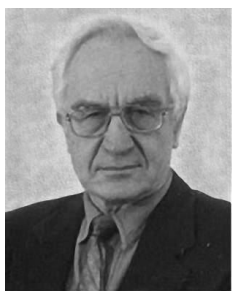
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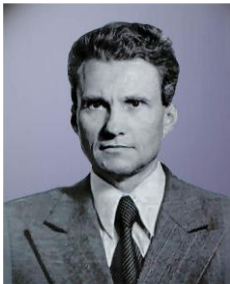
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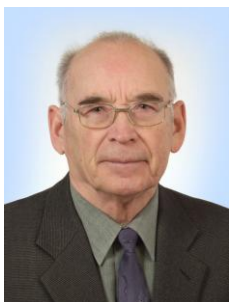
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## WORKSHOP MEETINGS

№	Topic	Time	Place, Proceedings
1-5	Reliability optimization of gas supply systems	February April June October November 1973	Irkutsk Collection of Papers No. 1
6	Reliability standardization in energy systems	January 1974	Irkutsk
7	Estimation of specific damages due to power supply interruptions	March 1974	Irkutsk
8	The problems of improving the quality of initial information, including statistical reliability assessment of system components	April 1974	Irkutsk
9	Reliability in designing electric power systems	May 1974	Syktyvkar Collection of Papers No. 2
10	Reliability in designing energy systems	July 1974	Saratov Collection of Papers No. 3
11	Stability problems in the study of energy system reliability	September 1974	Irkutsk
12	Mathematical models of reliability analysis	October 1974	Irkutsk Collection of Papers No. 4
13	Reliability studies of energy equipment as complex systems	November 1974	Irkutsk Collection of Papers No. 5
14	Redundancy in energy systems	February 1975	Irkutsk Collection of Papers No. 6
15	Influence of initial conditions and data on the numerical values of reliability indices	April 1975	Irkutsk Collection of Papers No. 7

16	Reliability in designing and operating energy systems	July 1975	Novosibirsk Collection of Papers No. 8
17	Reliability analysis and synthesis of distribution electric and pipeline networks	September 1975	Gorky Collection of Papers No. 9
18	Acquisition, processing and analysis of retrospective information on reliability of energy system equipment	November 1975	Moscow Collection of Papers No. 10
19	Energy system reliability terminology	March 1976	Irkutsk
20	Energy supply reliability indices and the fields of their application	June 1976	Kiev Collection of Papers No. 11
21	Mathematical models to study large energy system reliability	September 1976	Cholpon-Ata (Kyrgyzstan) Collection of Papers No. 12
22	Issues of fuel supply reliability in the fuel and energy complex	November-December 1976	Irkutsk Collection of Papers No. 13
23	Reliability of relay protection and emergency control systems in electric power systems	April 1977	Riga Collection of Papers No. 14
24	Methods for optimization of target product shortage in the study of energy system reliability	July 1977	Irkutsk Collection of Papers No. 15
25	Retrospective analysis of energy supply reliability in large energy systems	September 1977	Grozny Collection of Papers No. 16
26	Standardization of reliability in energy systems	February 1978	Irkutsk Collection of Papers No. 17
27	Determination of damage due to energy supply failures	June 1978	Toliatty Collection of Papers No. 18
28	Reliability in operation of energy systems	October 1978	Omsk Collection of Papers No. 19

29	State of the art and prospects for development of the reliability calculation methods and their use for applied problems	March-April 1979	Alma-Ata Collection of Papers (restricted publication)
30	Survivability of energy systems	July 1979	Nizhneangarsk (Lake Baikal) Collection of Papers No. 20
31	Methods for maintenance planning in energy systems	September 1979	Baku Collection of Papers No. 21
32	Software for study and optimization of energy system reliability	March 1980	Irkutsk Listvyanka (Lake Baikal) Collection of Papers No. 22
33	Results of study and optimization of energy system reliability	October 1980	Leningrad Collection of Papers No. 23
34	Reliability of planning prospective FEC development and operational fuel supply control	November 1980	Yerevan Collection of Papers No. 24
35	State of the art and prospects for software development for active power reserve allocation and maintenance planning of the main equipment in power systems	June 1981	Kemerovo
36	Methods for determining reliability of designed equipment of energy systems	September 1981	Minsk Collection of Papers No. 25
37	Methods and algorithms for reliability study and optimization when designing systems	May 1982	Palanga Collection of Papers No. 26
38	Organization and methods of equipment maintenance planning in energy systems	September-October 1982	Konakovo (Tver region) Collection of Papers No. 27
39	Scientific and engineering problems of energy system reliability	October 1982	Moscow

40	State of the art of methodological studies on energy system reliability and directions for their further development	February 1983	Irkutsk “Izvestiya Akademii Nauk SSSR. Energetika i Transport”, 1986, No. 6 Collection of Papers No. 28
41	Theoretical and methodological problems of studying and ensuring reliability of large energy systems	April 1983	Irkutsk Listvyanka (Lake Baikal) Book
42	System for collection, processing and analysis of retrospective data on reliability of energy system equipment	September 1983	Kishinev Collection of Papers No. 29
43	Reliability of energy supply and quality of energy system products	May-June 1984	Krasnoyarsk Collection of Papers No. 30
44	Standard requirements to reliability of energy systems and their application	September 1984	Bolshoi Lug (Irkutsk region) Collection of Papers No. 31
45	Reliability analysis of energy systems of West-Siberian oil and gas complex and the ways of its improvement	April 1985	Tyumen Collection of Papers No. 32
46	Security as a property of energy system reliability: evaluation and provision	September 1985	Voronezh Collection of Papers No. 33
47	Methods of studying and ensuring reliability of electric power and pipeline systems	May 1986	Jablona (Poland) Collection of Papers No. 34
48	Controllability of energy systems: evaluation and provision	September 1986	Irkutsk Book
49	Methods and models for studying energy system survivability	June-July 1987	Irkutsk Khuzhir (Lake Baikal) Book
50	Methods for optimization of oil and gas pipeline system reliability	October 1987	Krasny Kurgan (Stavropol Territory) Collection of Papers No. 35

51	Methods for optimization of reserves and margins in energy systems	May 1988	Tsymlyansk (Rostov region) Collection of Papers No. 36 (2 Volumes)
52	Reliability standardization in energy systems	October 1988	Kiev Collection of Papers No. 37
53	Reliability of energy systems in the Northern regions	June 1989	Syktyvkar Collection of Papers No. 38 (2 Volumes )
54	Scientific and applied problems of reliability in energy systems (School-Workshop)	September 1989	Plyos (Ivanovo region) Collection of Papers No. 39
55	Methodology for estimation of reliability and security of energy systems	April 1990	Sopron (Hungary) “Izvestiya Akademii Nauk SSSR. Energetika i Transport”, 1991, No. 6
56	Methodological issues of studying and ensuring reliability of energy systems in a new economic environment	June 1990	Ufa Collection of Papers No. 40
57	Comparison of mathematical models for calculation and optimization of electric power system reliability	October 1990	Irkutsk Collection of Papers No. 41
58	Studies and developments of Research Institute of Electrical Machinery on ensuring reliability of electrical machines and devices	April 1991	Leningrad Collection of Papers No. 42
59	Reliability analysis of energy supply systems under extreme conditions on the example of West-Siberian oil and gas complex and the ways of its improvement	May 1991	Irkutsk Collection of Papers No. 43
60	Methods for diagnosing the condition of energy system equipment during operation	May 1992	Suzdal Collection of Papers No. 44



61	Creation and utilization of data (and knowledge) bases on reliability of energy system equipment	September 1992	Dubki (Dagestan)
62	Methodological issues of reliability (including survivability) of autonomous, emergency and special energy systems	April 1993	St. Petersburg Collection of Papers No. 46
63	Reliability of electric power systems. Methods of research. Tools (The First Russian - German Workshop)	September 1993	Plyos (Ivanovo region) Collection of Papers ( <i>in Russian and German</i> )
64	Reliability of electric power systems. Methods of research. Tools (The Second Russian-German Workshop)	August 1994	Aachen (Germany) Collection of Papers ( <i>in Russian and German</i> )
65	Reliability and security of aging energy systems	October 1995	Kiev Collection of Papers No. 47
66	Topical problems of energy system reliability in a new environment	July 1996	Murmansk Collection of Papers No. 48
67	Reliability of energy systems: economic and information aspects	April 1997	St. Petersburg (Pavlovsk) Collection of Papers No. 49
68	Reliability of energy systems: achievements, problems, prospects	July 1998	Irkutsk Kadilny Cape (Lake Baikal) Book “Izvestiya RAN. Energetika”, 1999, No. 4 Collection of Papers No. 50
69	Globalization and liberalization in European power industry (The Third Russian-German Workshop)	September 1998	St. Petersburg Collection of Papers ( <i>in English</i> )
70	Intersectoral and interdisciplinary aspects of large power system reliability	July 1999	Syktyvkar Collection of Papers No. 51
71	Reliability problems when controlling operation, modernization and expansion of energy systems	June 2000	Vyshny Volochek (Tver region) Book

72	Reliability of energy systems with regard to trends in their expansion and progress in the information technologies	September 2001	Kazan Proceedings of the Russian National Energy Symposium ( <i>in English</i> ) Collection of Papers
73	Reliability of liberalized energy systems	September 2002	Tuapse Book
74	Problems of ensuring energy system reliability and methods for solving them	July 2003	Irkutsk Khuzhir (Lake Baikal) Collection of Papers No. 54
75	Methodological and applied problems of energy system reliability (School-Workshop)	September 2004	Minsk Collection of lectures Collection of Papers No. 55
76	Problems of restructured energy system reliability and methods for solving them	July 2005	Pskov Collection of Energy security terms Collection of Papers No. 56
77	Problems of energy system reliability for subjects of relations in energy markets	April 2006	Kharkov Collection of Papers No. 57
78	Reliability of energy systems: terminology on reliability of energy systems	July 2006	Moscow Collection of terms on reliability of energy systems
79	Mathematical models and methods for studying reliability of liberalized energy systems	July 2007	Vologda Collection of Papers No. 58
80	Methodological and applied problems of liberalized energy system reliability	July 2008	Irkutsk (Lake Baikal) Collection of Papers No. 59 “Izvestiya RAN. Energetika”, 2009, No. 5
81	Methods and tools for studying and ensuring energy system reliability	July 2009	St. Petersburg Collection of Papers No. 60

## REGULANIONS

*of the standing Scientific Workshop  
"Methodological problems in reliability study of large energy systems"  
of the Scientific Council of the USSR Academy of Sciences for Complex  
Energy Problems*

1. The Scientific Workshop "Methodological problems in reliability study of large energy systems" (hereinafter referred to as Workshop) was organized as a standing one by the Scientific Council of the USSR Academy of Sciences for Complex Energy Problems at the beginning of 1973. The first meeting of the Workshop was held in February 1973.

2. It is an intersectoral Workshop that unites reliability specialists from different energy industries. The reliability problems are studied as applied to the energy complex as a whole and also specialized energy systems: electricity-, gas-, oil- and oil products-, heat- and water supply.

3. The key tasks of the Workshop are:

- exchange of opinions on the latest achievements and on controversial issues in solving the problem of reliability for the energy systems (ESs) and energy complex (EC);

- discussion of problem statements and directions of studies in the area of ES and EC reliability;

- comparison of the level of studies in this area in Russia and abroad;

- analysis and estimation of the results of the most important scientific and applied studies performed on this problem;

- generation of the common standpoints on the considered issues and their use as a basis for preparation and publication of mutually agreed intersectoral methodological documents (reliability terminology and in the future - its standards), coordination of corresponding studies.

4. When making working plans, choosing topics of the Workshop meetings and reports for discussion, main attention is paid to methodological aspects of intersectoral studies that are based on the available common properties of different ESs.

5. The Workshop operates on the basis of Siberian Energy Institute of Siberian Branch of the USSR Academy of Sciences. The Committee of the Scientific Council of the USSR Academy of Sciences for Complex Energy Problems provides scientific guidance of the Workshop, to which the Organizing Committee of the Workshop is accountable.

6. The Workshops are chiefly held on the basis of regular subject meetings in accordance with the plans. The plans for the coming 3-5 years are submitted by the Organizing Committee of the Workshop to the Committee of the Scientific Council of the USSR Academy of Sciences for Complex Energy Problems for consideration and approval. The yearly plans are approved by the Organizing Committee of the Workshop and sent to interested organizations and specialists in November of the previous year.

The yearly plans embrace topics of the meetings; problems to be discussed at each meeting (on each topic); venue and time of the meetings to be held. Applications for reports are accepted together with an abstract no later than 2 months before the meeting. The selected reports on the topic of the meeting are included in the program of the particular meeting that is sent to the specialists invited to the meeting of the Workshop 1-2

months prior to its beginning. Only authors of the reports, members of the Organizing Committee and a limited number (4-5) of specialists, who do not present reports and are not members of the Organizing Committee, but whose work at this meeting can be useful are invited to the meeting of the Workshop. The number of participants in each meeting should not exceed 60-70 people.

7. The meetings of the Workshop are held on specific, relatively narrow subjects at the base organization or in other cities of the country, having scientific and research institutions engaged in the problems to be discussed at the corresponding meeting. The topics of the meetings are chosen based on the scientific investigations of reliability of energy systems and energy complex in accordance with the 5-year plans of the USSR Academy of Sciences, the State Committee on Science and Technology of the USSR and the USSR Ministries of Energy.

8. The meetings of the Workshop ensure: discussion of the papers included in the agenda; discussion of the invited papers that characterize the status of studies on the considered scope of issues (including review papers); lectures by experts on the subject discussed at the meeting; comparison of methods, algorithms and programs devised for solving similar reliability problems; organization of specific work to be performed by the temporary working groups; coordination of studies carried out by different institutions on the subject to be discussed at the meeting; discussion of subjects of the studies to be carried out by the candidates for academic degrees and doctoral theses that correspond to the topics of the Workshop and are prepared for defense.

The disputable issues and recommendations, problem statements, directions of future studies and similar problems are discussed at the specially organized "round tables" on concrete clearly defined issues.

The Workshop meetings can be conducted jointly with other scientific meetings (Scientific Councils, workshops, commissions, etc.).

9. In compliance with the results of discussion of the problems posed at the meetings the relevant decisions and suggestions for concrete Ministries, departments and organizations are made, if necessary (and feasible).

10. Reports delivered at the Workshop meetings and recommended for publication after reviewing by the Organizing Committee are issued in special subject collections with serial numbering, common title ("Methodological problems in reliability study of large energy systems") and a title of the specific issue corresponding to the topic of the meeting. The reports for publication in subject collections are prepared in accordance with the requirements of the Organizing Committee of the Workshop. The subject collections are prepared for publication and issued by an organization responsible for this meeting.

In addition to the collection of reports the materials discussed at the meeting can be published in scientific journals; collective monographs may also be prepared on the basis of reports and other materials of the Workshop.

11. Besides the subject meetings the other forms of the Workshop work on the considered problems are also possible. Temporary Working Groups or Commissions headed by the qualified (and recognized) specialists in the relevant areas are created for solving specific problems by the resolution of the Organizing Committee, or if necessary, by the Committee of the Scientific Council of the USSR Academy of Sciences for Complex Energy Problems. The examples of problems solved by the Temporary Working Groups or Commissions are: compilation of intersectoral terminology in the area of ES reliability, preparation of test calculation schemes for comparison of methods and algorithms for solving different reliability problems, elaboration of the system of reliability standards in energy and preparation of reference books.

12. The routine work of the Workshop is directed by the Organizing Committee approved by the Committee of the Scientific Council of the USSR Academy of Sciences for Complex Energy Problems. It consists of Chairman (Leader of the Workshop), his deputies, scientific secretary and members. *Obligations of the Organizing Committee are:*

- selection of reports for discussion at each meeting from those submitted or recommended by the relevant organizations or individual specialists;
- preparation of invited papers and subject lectures;
- choice of opponents for discussion of doctoral and candidate theses;
- creation of organizing committees for particular meetings in some cases (in particular when the Workshop meetings are held jointly with other scientific meetings);
- preparation of decisions and suggestions of individual meetings;
- selection of reports for publication in subject collections, formation of the editorial board, support of publication and sale of the collections of reports; organization of other forms of publishing activity (subject collections of papers, collective monographs, etc.);
- formation of Temporary Working Groups and Commissions from the specialists regularly participating in the Workshop to solve specific problems;
- promotion of the Workshop's decisions and suggestions;
- periodic reporting to the Committee of the Scientific Council of the USSR Academy of Sciences for Complex Energy Problems.

Yu.N. Rudenko

## THEY WERE WITH US

### YURY N. RUDENKO

#### ABOUT LIFE AND CAREER

Yury N. Rudenko, Academician of the Russian Academy of Sciences (RAS), is an outstanding scientist in the energy field of the world significance, the founder of reliability theory in energy, a recognized leader of the scientific school in the field of reliability of energy systems, the author of more than 200 scientific works.

Yury N. Rudenko was born on August 30, 1931 in the town of Makeyevka (Donetsk region). His father B.V. Konokotin soon left his family and Yury was adopted by N.M. Rudenko. In 1937 his foster-father was repressed. Soon his mother was arrested too and was released “before the appointed time“ only in 1946. Therefore, in the pre-war and war years Yury N. Rudenko and his stepbrother O.N. Rudenko found themselves without parents. They lived in Feodosiya with their grandmother, who had died shortly before the Crimea was liberated, and they survived by a miracle.

His diaries that were kept even in those years contain many unchildish evidences of war, occupation, hunger and also formation of his character. After finishing a *three*-year course at school in 1941, he continued to learn by himself in the years of occupation, therefore in 1944 he could enter right the sixth class, thus catching up with his school age.

In 1947 Yury Rudenko finished Orsk technical secondary school as a specialist in electric facilities for industrial plants and then worked in the electric shop of the Orsk-Khalilovsk metallurgical plant up to 1956. At the same time from 1950 he studied at Leningrad Correspondence Industrial Institute, in 1960 finished the post-graduate studies of Leningrad Polytechnic Institute and defended a candidate thesis.

The Siberian period in Yu.N. Rudenko’s life begins in May 1960 – he works at the Regional Dispatching Center (RDC) of the West-Siberian power system (the city of Kemerovo). In his reference of 1963 we find: “*Yu. N. Rudenko worked at RDC during the period of its formation. He organized the work of operation service, including the two-year advanced training for personnel of RDC services, and establishment of contacts with research institutes and higher educational institutions*”.

Yu.N. Rudenko initiates scientific and research works at RDC, in particular: on parallel work of bulk power systems, distribution and utilization of reserves, consideration of load variations, on the calculation methods of steady-state and transient stability, optimization of operating conditions in the power systems of Siberia, etc. He participated in the creation of the computation center with the computer URAL-2, analog machines and calculation models that was the first in power interconnections of the country. The years of work at RDC became an excellent training school and provided a sound base and deep knowledge of the subject for his future activity.

At the invitation of Academician L.A. Melentiev in December 1963 Yu.N. Rudenko comes to Irkutsk, marking the beginning of his 25-year period of work at Siberian Energy Institute (SEI). At first he is Head of the Laboratory for Electric Power Industry and Power Systems, Deputy Director from May 1965 and Director of the Institute from April 1965 to August 1988 (i.e. for more than 15 years). It is at SEI that he becomes a

distinguished world-renowned scientist in the energy field, an outstanding organizer and public figure.

In the first years of work at SEI Yury Rudenko performed original and in many respects pioneering studies on the methods for calculation, control of operating conditions and provision of reliability in electric power systems. In 1974 he successfully defended a doctoral thesis at Leningrad Polytechnic Institute.

Later on the sphere of scientific interests of Yury Rudenko substantially broadened and embraced not only electric power industry, but the energy sector as a whole at the level of regions, country, world, including the Unified systems of electricity, oil and gas supply, intersectoral problems of the energy sector (reliability, survivability and security) and also the problems of creating international, global (worldwide) and even space power systems.

The Scientific Workshop “Methodological problems in reliability study of large energy systems” that was organized and headed by him from 1973 for more than 20 years was the unique All-Union (later on All-Russia and then International) Scientific Workshop. During these years 64 Workshop meetings were held, above 45 proceedings, 4 collective monographs and terminology on energy system reliability were published. However, significance of this Workshop was not only in its scientific products. Its democratic and at the same time exacting and objective atmosphere was no less important. It attracted many specialists in energy, mathematics, cybernetics from different cities, regions and countries to a new topical subject matter. Scores of them tested their candidate and doctoral theses at this Workshop. For a series of works on reliability of energy systems and fuel and energy complex Yu.N. Rudenko (jointly with I.A. Ushakov) was awarded the G.M. Krzhizhanovsky Prize of RAS in 1993.

Yu.N. Rudenko became Director of SEI in 1973 at the age of 41. Owing to the scientific leadership of Academician L.A. Melentiev, existing traditions and methods of feedforward and feedback with the Institute’s body Yury Rudenko managed to preserve and develop SEI’s scientific potential and achievements. In the years of his Directorship the number of Institute employees increased, a new topical theme was formed, links with research and design institutions were strengthened and the Institute entered the international arena. Many things in Irkutsk and Irkutsk region are associated with Yu.N. Rudenko’s name. In the 1970s he initiated creation of the Scientific-Production Association “Energiya” that united the specialists in the energy field of the region to solve urgent applied problems. For many years he headed the Regional Interdepartmental Coordination Council on introduction of computer machinery into the national economy.

In June 1988 Yury N. Rudenko was elected Academician-Secretary of the Department of Physical and Technical Problems in Energy of the USSR Academy of Sciences (later on the Russian Academy of Sciences, RAS). At the new place of work he did a lot to improve the Department activity, establish constructive contacts of the Department of RAS and its institutes with the Ministry of Fuel and Energy, RAO “EES Rossii”, RAO “Gazprom”, the Security Council of the RF, International Fuel and Energy Association, and to expand international relations. At the same time he continued an active scientific activity, headed councils, workshops, etc. It is precisely in those years that he published the unique and encyclopaedic (in contents) four-volume reference book. Though very busy, he continued to actively communicate with Siberian Energy Institute and regularly visit Irkutsk.

Yu.N. Rudenko gave much strength and time to the young. He was a permanent chair of the School Commission in Akademgorodok (Academic township) where the computer training of schoolchildren was organized with his support and assistance. He was an initiator of creating a basically new (in those days) form of training young specialists –

Education-Scientific-Production Complex of Irkutsk Polytechnic Institute and Siberian Energy Institute. Yu.N. Rudenko headed its Council for about 10 years. Under his scientific direction more than 20 scientists defended their doctoral and candidate theses, the scientific school in the field of reliability of energy systems was formed. In 1998 the Rudenko annual scholarship was established for promising young researchers engaged in the studies on energy systems, their reliability and security.

Yu.N. Rudenko did not imagine himself without active social activity: he was Deputy of Irkutsk Regional Soviet of People's Deputies and Supreme Soviet of the USSR, Head of different councils, committees and commissions at the Academy of Sciences and other departments. Yu.N. Rudenko was decorated with: the orders "Red Banner of Labor", "October Revolution", "People's Friendship" and the medal "For Valorous Work". He was a great personality, honest to the limit, responsive, reliable and fascinating. All who worked with him were charmed by his personality, really system thinking, great capacity for work, highest responsibility and liability and at the same time gentleness and refinement in communication.

The blessed memory about Yury N. Rudenko who made the outstanding contribution to science in the energy field, a patriot of Irkutsk and Siberia will remain in the hearts and works of his disciples, his home SEI and also the history of the Siberian Branch of RAS and the energy science for ever.

A.P. Merenkov  
N.I. Voropai

P.S. Yury N. Rudenko passed away on November 7, 1994 in Moscow, was buried at the Kuntsevo cemetery.



# ANATOLY P. MERENKOV

## LIFE MILESTONES

Anatoly P. Merenkov, Corresponding Member of RAS, is a major mathematician, energy expert and renowned leader of scientific school in the field of mathematical modeling, calculation and optimization of pipeline systems, the author of more than 150 scientific works.

Anatoly Merenkov was born on August 30, 1936 in the city of Stary Oskol in Belgorod region. He had a wartime childhood. In 1941 his father was killed on the frontline and in 1942 he with his mother and two sisters had to move to Kazakhstan where they lived for 2 years. At the end of the war after a one-year course at elementary school he entered Kursk Suvorov Military School and finished it with honors in 1953. In the same year he entered the Mechanics and Mathematics Department at Moscow State University named after M.V. Lomonosov.

In 1958 after graduating with honors from Moscow State University A. Merenkov was hired as a junior researcher at the Institute of Mathematics in Novosibirsk. The Institute was headed by Academician S.L. Sobolev, one of the founders of the Scientific Center in Siberia. Describing his work in Novosibirsk A. Merenkov wrote: ...*“when the installation of the M-20 computer started we had two goals: to put it into service as soon as possible and to familiarize everybody with it. Endless programs, tests, debugs – we spent days and nights in the computer room. I can say I am proud to have a diploma from Novosibirsk Regional Committee of All-Union Leninist Young Communist League for putting into operation the first computer in Siberia”*.

While studying at Moscow State University A. Merenkov got interested in computer science. As a successful four-year student, he was hired as a senior laboratory assistant (for half pay) at the Computer Center of the Mechanics and Mathematics Department. There he carried out calculations on the computers created in the Soviet Union. Thus he identified his speciality. At the Institute of Mathematics A. Merenkov worked in the Department headed by A.P. Ershov.

In January 1961 at the invitation of Director of Siberian Energy Institute of SB of the USSR AS L.A. Melentiev the young researcher arrived in Irkutsk and was appointed Head of the Laboratory for Applied Mathematics and Cybernetics. The rest of A. Merenkov's life was linked to Siberian Energy Institute, even in 1982-1987 when he lived in Moscow and headed a laboratory at All-Union Gas Research Institute (VNIIGaz). In January 1988 A. Merenkov came back to Irkutsk and in August of the same year he was elected Director of the Institute. He happened to be in charge of Siberian Energy Institute during the critical time for the country and for the Russian Academy of Sciences. However, owing to his personal efforts the Institute maintained and developed the atmosphere of creativity, social democracy and collective self-administration.

The research conducted by A.P. Merenkov can be divided into two areas: the methods for controlling large energy systems and fuel and energy complex as a whole, and the theory and methods for calculating hydraulic systems. From the very beginning of his work at Siberian Energy Institute A. Merenkov actively collaborated with V.Ya. Khasilev, taking part in the studies on mathematical modeling, calculation and optimization of pipeline systems. Involving like-minded people in his unique research he started to work on creation of the hydraulic circuits theory. During his work at VNIIGaz A.P. Merenkov remained a research supervisor at the laboratory of SEI. He kept on intense work on the

theory of hydraulic circuits and eventually completed his fundamental monograph “The Theory of Hydraulic Circuits”, which V.Ya. Khasilev had dreamed of so much.

Starting in 1987 A.P. Merenkov headed the All-Union (then All-Russia) Scientific Workshop on Intersectoral Problems of Pipeline and Hydraulic Systems that became the Communication Center for experts from many cities in Russia and NIS. In 1994, continuing the work of Academician Yu.N. Rudenko A.P. Merenkov took the lead of the All-Russia Scientific Workshop “Methodical problems of reliability study in large energy systems”, which was highly respected in Russia and abroad.

A.P. Merenkov paid much attention to training young personnel. He performed great scientific, social and pedagogical work. For 17 years he was lecturer and full professor at the Chair of Optimization Methods of Irkutsk State University, a member of the Council and Head of the Chair of Pipeline Systems of Education-Scientific-Production Complex of Irkutsk Polytechnic Institute and Siberian Energy Institute. Under his supervision more than 20 theses were defended and the scientific school in the field of pipeline systems was created. In 1998 Melentiev Energy Systems Institute, SB of RAS, established a scholarship in honor of A.P. Merenkov for young promising researchers engaged in the studies on hydraulic circuits and systems, applied mathematics and information science. He contributed to the development of Irkutsk and Irkutsk region by helping the Administration and heads of enterprises make decisions concerning management and development of energy in the region. A.P. Merenkov is the Krzhizhanovsky Prize Laureate, holder of the order “Badge of Honor”, Honored Worker of the Unified Energy System of Russia. Also he was awarded the medal “For Valorous Work”.

Anatoly Merenkov gave all his efforts, time and heart to the Institute and its employees. He wrote: *“The years at SEI were unforgettable, particularly the early period. There was a common goal, we went through troubles and shared joy not noticing hardships. We lived as one family. This was the time when the spirit of SEI formed which determined the success and the unique character of the Institute. I think I am very lucky. Instead of languishing in some organization and learning about great achievements and construction projects only from newspapers, radio and TV I became a participant in the unique experiment on the creation of Siberian Branch of the USSR Academy of Sciences, got acquainted with outstanding and remarkable personalities and scientists, was involved in research and creative work, and gained wisdom...All these years I have lived and worked looking forward”*.

E.V. Sennova

P.S. Anatoly P. Merenkov passed away in Moscow on April 27, 1997 and was buried in the Mamonovo cemetery.

WORKSHOP IN PICTURES AND PHOTOS



*Normal conditions*



*Emergency conditions*



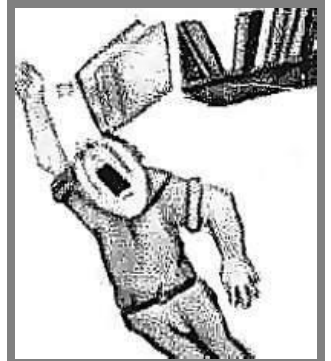
*Measures on  
survivability  
improvement*



*Mathematical  
expectation of damage*



**S.V. Sumarokov**  
*(author of pictures)*



*Random action*



*Looping*



*Optimal redundancy*



*Flow controller*



*The 40<sup>th</sup> Workshop meeting (Listvyanka , Lake Baikal, February 1983)*





*The 41<sup>st</sup> Workshop meeting (Listvyanka, Lake Baikal, May 1983)*



*The 43<sup>rd</sup> Workshop meeting (Krasnoyarsk, May-June 1984)*





*The 68<sup>th</sup> Workshop meeting (Irkutsk, July 1998)*





*The 68<sup>th</sup> Workshop meeting (Kadilny Cape, Lake Baikal, July 1998)*





*The 73<sup>rd</sup> Workshop meeting (Tuapse, September 2002)*



*The 74<sup>th</sup> Workshop meeting (Khuzhir, Lake Baikal, July 2003)*





*The 77<sup>th</sup> Workshop meeting (Kharkov, July 2006)*



*The 80<sup>th</sup> Workshop meeting (Irkutsk, Lake Baikal, July 2008)*

## CONTENTS

Preface	3
Excursus on the History of Workshop	5
<i>Workshop Map</i>	7
<i>Main Publications of the Workshop</i>	14
<i>Reminiscences by the Workshop Veterans</i>	16
Organizing Committee of the Workshop	20
Workshop Meetings	30
<i>Appendix 1. Regulations of the Workshop</i>	37
<i>Appendix 2. They Were with Us</i>	40
<i>Appendix 3. Workshop in Pictures and Photos</i>	45

# **METHODOLOGICAL PROBLEMS IN RELIABILITY STUDY OF LARGE ENERGY SYSTEMS**

INTERNATIONAL SCIENTIFIC WORKSHOP  
named after Yu.N. RUDENKO

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