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USSR Report

ENERGY

(FOUO 22/81)

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ENERGY

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ELECTRIC POWER

SYSTEMATIC FORECASTING OF NUCLEAR POWER INDUSTRY

Moscow SISTEMNOYE PROGNOZIROVANIYE YADERNOY ENERGETIKI in Russian 1980 (signed to press 3 November 1980) pp 1-12, 237-239

/Description, foreword, introduction, and table of contents from book by S. Ya. Chernavskiy "Systematic Forecasting of Nuclear Power Industry", edited by Academician M.A. Styrikovich, USSR Academy of Sciences' Working Consultative Group for Developing New Questions Regarding the Future Development of Power Engineering, Izdatel'stvo "Nauka", 1,200 copies, 238 pages/

/Text/ This monograph is devoted to one of the current pressing problems facing the power industry - the development of a theory and methods for estimating the long-term forecasting of the development of nuclear power engineering as systems. Various aspects of the long-term forecasting are examined: economic, technical, mathematical and psychological. The book basically contains the original developments of the author. A description of the models to be used for forecasting the development of the nuclear power industry is provided. Methods for selecting the optimal strategies in conditions of uncertainty are proposed.

The book was written for specialists in the field of systems research in power engineering, in forecasting methodology, and making decisions in conditions of uncertainty.

FOREWORD

To correctly evaluate the role of the nuclear power industry in the future power balance of the national economy is a complicated and difficult scientific task, the practical importance of which, however, is hard to overestimate. The problem is that the supplies of organic fuel in the world, while great, are limited. Also, they are distributed unequally throughout the world. The limitedness of the most convenient kinds of organic fuel - petroleum and natural gas - for the majority of energy consumers is felt by the majority of the world's nations even today. In seeking to preserve some petroleum and natural gas, coal and nuclear power move to the foreground in future evaluations. In spite of the impressive world supplies of coal, the rapid rates of increasing its extraction are fraught with great difficulties. Among the factors preventing the intensive growth of coal extraction is the relative high cost of mining operations, the difficulties of large-scale transporting of coal by land, and the growing requirements to protect the environment. And although there are several counter acting factors, it is highly unlikely that future power engineering will depend heavily upon coal.

It is more likely that there will be a joint development and use of various sources of energy - petroleum, natural gas, coal, uranium, the sun, geothermal heat and so forth. This "cooperation" will, apparently continue for some time; however, the role of nuclear power in the majority of sectors of power engineering will increase, although at a varied pace.

Even today it is important to understand the qualitative and quantitative changes that will take place during this period of growth. Two basic factors determine this prudence: the inert properties of the nuclear power industry and the many different ways that its structure can be developed. To develop a new type of nuclear reactor requires, as a rule, two to three decades. To evaluate its effectiveness it is necessary to look some 30 years into the future. In this manner the selection of a strategy for the development of the nuclear power industry must be compared with the need to forecast its development for the next 50 to 60 years. At the same time this must be done while predicting the development of the other power resources. Many factors need to be considered by the person doing the forecasting; and two dangers--the Scylla and Charybdis of forecasting--lie in wait on the road to a good forecast: whether to try to consider all the factors or to reject the majority of them. In the first case the time for making the forecast exceeds what is permissible; in the second case the model for the development is too rough to correctly reflect the essence of what has transpired in reality. For this reason the second option is not suitable for forecasting.

In order to find the correct path it is necessary to develop a scientific methodology. As this applies to the task of forecasting nuclear power this is also important because in addition to being the newest sector it is also one of the most capital intensive sectors of the power industry.

There have been many papers devoted to the future of the nuclear power industry; the majority of them contain quantitative evaluations of the technical and economic indicators of nuclear electric power stations and enterprises of the fuel cycle, evaluations of the role of nuclear power in future power balances. Some of these papers have been devoted to the development of the methodological aspects, including the use of the mathematical modeling method.

Soviet literature, however, has been devoid of scientific papers dealing with systematic descriptions of the theory and methods for forecasting the development of the nuclear power industry. No such work has been done in other countries either. This monograph fills this gap. It is of interest not only to specialists engaged in forecasting the nuclear power industry. The book contains material, which will be helpful to those who have an interest in the methodological and practical questions concerning the use of a systematic approach, and for methodological forecasters and also to specialists in the field of expert evaluations. The book also deals with questions on the psychology of the forecasting process, questions of selecting the optimal strategies in conditions of uncertainty and mathematical models of the developing nuclear power industry. The material used in the book, nonetheless, is not a conglomerate of developments which are weakly linked together. On the contrary, the book is very rigidly and logically put together. One central idea of the author can be seen in every section - to develop a practical tool for making forecasts. The logic of developing such a tool forces the author to turn to the methodology of a systematic analysis and psychology of forecasting and to methods of optimizing and mathematical modeling, while subordinating them to the common task of research.

For the most part the monograph contains the original developments of the author; for this reason several points need to be given special attention.

Usually, when people speak of the use of the systematic approach to the power industry they assume that systematic research is characterized by an examination of objects as systems. Moreover, they are distracted from examining the role of the subject in the very process of forecasting and from taking into consideration the role played by the psychological characteristics of the subject - the forecaster.

The author proposes another concept - not forecasting just the development of the system - the object, but the conception of systematic forecasting, in accordance with which for this purpose in order to understand the development of the object - the nuclear power industry in this case, it is necessary to take into consideration the psychological characteristics of the subject of forecasting. And on this basis to then construct the work of the prognostic groups. Including the forecaster within the system from a methodological point of view, of course, is correct and important; however, the author does not merely declare a correct methodological hypothesis, but he also demonstrates how one can take into consideration the psychological features of the forecasters during the organization of the forecasting process in a practical manner.

While doing this the forecaster relies upon the work of psychologists that was done in specific modeled situations. However, the real forecasting activity takes place in other than modeled situations when the forecaster is subjected to the influence of numerous and complex stimuli. It was necessary to move from the modeled to the real situation; the author has made this move having analyzed what is new in introducing the real situation into the forecasting process. Moreover it has turned out that the real forecasting situation is richer in content as compared to the modeled situation and that the real situation gives birth to the existence of various kinds of forecasting processes. Thus, if in some cases the control of the forecasting process must promote the penetration of thought into the substance of an object, in other cases it is expedient to restrict the fixation of empirical data. In this manner, the book gives fresh treatment to solving the problem of constructing an optimal forecasting system.

In one sense the developing approach contradicts the Delfa method, in which specific psychological characteristics of the forecasters are not taken into consideration and the forecaster is viewed like some sort of black box.

The book has given much attention to the exposition of the essence of the concept of uncertainty of the future. In specific examples the author shows that certain methodologists, including Soviet ones, perceive the essence of development mechanically, as just getting underway, in which nothing new is happening basically and in which something new is only superficial, an illusion that is seen as a new consequence of too little knowledge. According to these methodologists, the uncertainty of the future is the result of inadequate knowledge about the nature of an object rather than the manifestation of the substantial properties of an object.

In his book the auther develops another, correct dialectic view of the substance of development, according to which development is accompanied by the appearance of what is truly new. This means that in the trajectories of the development of an object one can encounter bifurcation points, after which the apriori trajectories branch out. Before crossing the bifurcation point the object is uncertain in the sense that it is impossible to say or determine exactly which path out of a number of possible paths the development process will take. This uncertainty in the object is overcome only by crossing the bifurcation point. In this manner the author has established that the forecaster who has found, or more to the point has predicted, the existence of a bifurcation point is unable to fully overcome (reveal) the uncertainty in an object, while improving the process of cognition. His true task is to study alternative possibilities for development and not to try to predict exactly which alternative will be realized.

The forecasting "strength" of a subject in the forecasting process is limited, in this manner, not only by the possibilities of recognizing the object, but by the object itself and the dialectic of its development. In accordance with these crucial methodological hypotheses the author then proceeds to construct methods for optimizing in conditions of uncertainty.

However, before proceeding to developing the more complicated portion of the forecasting tool, the author provides the development of several basic models of the system of nuclear power - models for the development of the structure of nuclear reactors and models of the development of a system of enterprises of the fuel cycle. There are many new elements in these designs. I will note two of them. First, the differentiation, which the author conducts between forecasting using mathematical models and research of mathematical models, which are only genetically connected with the object of forecasting; however, in the process of simplifying it turns out that they are quite unrelated. The second point is the proposed method of using models to consider the gradualness of improving new technical means, which is of utmost importance in the power industry. Other aspects of developed models are no less important; however, the reader would be better off reading the materials themselves, especially since the author subsequently tries to conduct the reader through his logic in the these developments, thereby simplifying the process of understanding the material.

The concluding section is devoted to the development of methods of optimizing in conditions of uncertainty. In developing these methods on a solid methodological basis, the author seeks to obtain practical working methods, without losing accuracy in so doing. This task was largely met. The examples cited in the book confirm this.

Thus, the reader has before him a book in which he can find not only a tool for making forecasts concerning the development of the nuclear power industry, but also a tool for determining the optimal strategies for the development and a tool for making a choice.

Of course, one need not expect from this monography an answer to all questions; but it is a good example of a comprehensive, systematic research of a very important scientific and practical task.

/Foreword written by Academician M.A. Styrikovich/

INTRODUCTION

Everyone knows that energy is one of the most important factors in the development of man's society. Supplies of energy in man's environment are unlimited; however, only certain kinds of energy and only a small part of what is available can be put to practical use.

At present organic fuel is mankind's basic energy resource. For a long time to come organic fuel will be used for various purposes. In certain spheres of power consumption it would be difficult if not almost impossible to replace it. The general purpose motor vehicle is a good example of this.

There are enormous supplies of organic fuel in the world, which, it would seem, can meet the needs for energy for hundreds of years to come. However, the question of meeting mankind's need for energy is in reality quite a bit more complex.

First, there are not so many inexpensive resources of organic fuel, the extraction fo which is economically feasible. This limitation is especially acutely noted in regard to resources of petroleum and natural gas, which are the very forms of fuel most preferred by the overwhelming majority of energy consumers and for the technical means for converting the forms of energy.

Secondly, the resources of organic fuel are distributed very unevenly throughout the world. Some nations of the world, for example Japan, have scarcely any at all. Power consumption in many other countries, particularly in the majority of West European nations, significantly exceed their own resources of organic fuel, which forces them to import oil, natural gas and coal. For example, in 1970 France imported nearly 67 percent of the energy that it needed; by 1977 imports increased to 74 percent. (116)

And lastly, a relatively small number of the world's nations are rich in organic fuel. The best example of this are the nations of the Persian Gulf.

In and of itself the unevenness of the distribution of energy resources might not create any problems if the locations of consumption were not far from the places where the fuel is extracted. In reality things stand quite differently: the places where the fuel is consumed are most often far away from where the fuel is extracted. For this reason organic fuel in these cases must be transported to distances ranging from a few hundred to several thousand kilometers. The distance involved in transporting organic fuel affects its cost and consumer in different ways. The transport of oil and coal by sea is relatively inexpensive and the need to move it several thousand kilometers does not significantly increase its cost to the consumer when compared with the outlays for its extraction. On the other hand, the transport of natural gas and the shipping of coal by railroad is relatively expensive. A distance of several hundreds of kilometers is a serious economic barrier to transporting both coal and natural gas. The transmission of electric power over great distances is also rather expensive, therefore both natural gas and coal that are located far from the seacoast, must be viewed as regional energy resources. This in turn worsens the problem of supplying energy to those nations and regions of the world which do not have adequate supplies of energy of their own.

Finally the key circumstance is the very fact of the dependence of the importers of organic fuel upon the conditions of import. The escalation of prices for oil in recent years has rather convincingly demonstrated the undesirable prospect of such dependence for the economy of the importing nations. In this manner, in spite of the enormous world supplies of organic fuel, there are very sound reasons for coming up with other strategies for developing the power industry, which are based not on organic fuel but on other power resources. This can be the energy that is obtained by splitting the heavy nuclei of uranium, plutonium or thorium (nuclear energy), solar energy and synthetic thermonuclear energy.

Of course, in any strategies that are being thought out, the switch in energy resources cannot be instantaneous. This is a long process, which may last for many decades. The nations of the world will accomplish this in various ways. In all likelihood, both the rates of this shift and the composition of the technical means used for adoption will vary.

In discussing strategies for switching the power industry from organic fuel to another resource base, we must not forget that organic fuel has not completely exhausted all of its options. First, many areas of the world have not been adequately surveyed for sources of fuel. It is likely that large deposits of oil, natural gas, and coal will be found. This is what happened recently in Mexico. Secondly, regional organic resources can be made into products that can more easily be transported. For example, natural gas can be converted into ammonia or methanol and coal into synthetic oil. And lastly, it is possible to use nonconventional (i.e., not ordinarily used) organic resources in the power industry. This includes, for example, oil that has been separated from bituminous sands and shales. Tertiary methods of extracting organic fuel can be used; this can increase their extraction from the earth. Nearly all of these and other additional possibilities for "extending the life" of organic fuel are not presently being pursued. In addition, the largest deposits of inexpensive organic fuel are being discovered infrequently; it appears that there is a limited number of them on the earth. The production of synthetic oil, gas and coal, just as the assimilation of nonconventional organic fuels, is still relatively expensive. For this reason these additional resources of organic fuel cannot weaken our interest in examining the abovementioned alternatives for the development of the power industry of the future.

The 1960's of the 20th century, when significant progress was achieved in the field of building nuclear reactors, can be seen as the beginning of the development of one of the most realistic alternatives - the nuclear power industry.

The question is whether or not nuclear power is capable of filling the role of a practically unlimited resource base for the power industry. And this is not an easy question. There are various points of view on this matter.

The problem is that the technology for utilizing the energy of fusion in nuclear reactors is dissimilar. The use of thermal neutrons in nuclear reactions makes it possible to use only 1 to 1.5 percent of the natural uranium - the basic natural fuel resource of the nuclear power industry. The known supplies of inexpensive natural uranium in the world are not great. At present, according to data (39, 46) (not counting the CEMA nations and the Korean Peoples' Republic) there are about 4 to 5 million tons of uranium. This is the equivalent of 50 to 70 billion tons of conventional fuel when using this amount of natural uranium in thermal reactors. Such an amount of energy, of course, is not enough for nuclear power to play a global role in meeting the needs of mankind for energy

There is, however, one other way to extract energy from uranium. This involves organizing the nuclear reaction using fast-neutrons. A fast-neutron reactor, or simply a fast reactor, can extract from natural uranium 60 to 70 times more energy than can be obtained from a thermal reactor. What is more, due to the low value of the fuel load the fast reactor expands the fuel base of the nuclear power industry, by making it competitive with more costly resources of natural uranium.

In this manner the use of fast reactors in principle is already making it possible to view the development of the nuclear power industry as a way to switch from limited to unlimited sources of energy. There are also several other additional possibilities for solving this task within the framework of the nuclear power industry. This includes the use of thorium. Lastly, the development of the nuclear power industry to a certain extent determines the prospects of developing a synthetic thermonuclear power source.

These considerations explain why over a rather long period of time the optimal strategy for the development of the power industry must be based upon the use of various sources of primary power rather than upon a single energy resource.

However, all of this is in the future, which underscores the importance of a systematic study of the future of the power industry, including the nuclear power industry.

The science of the future - forecasting - has been developing intensively in recent years. This development is supported not only by the practical urgency that we noted above, but also by a lively interest in the future per se.

The number of published works describing various aspects of the future of the nuclear power industry is extremely large; but very few works which discuss the nuclear power industry as an integral system. There are even few works which describe the theory and methods for forecasting the development of the nuclear power industry. There has been nothing written in world literature that deals with this subject.

The systematic approach is gradually finding its way into the methodology of forecasting.

Usually, when they speak of the use of the systematic approach, they are thinking about the need to examine an object of forecasting as a system. The methodology that is being developed in this manner for forecasting is becoming a continuation of the science concerning a given object. If it is a complex object, and the nuclear power industry is certainly a complex object, the appropriate methodology of forecasting becomes complex.

The systematic approach in forecasting, which is restricted by the framework of just the object of forecasting, is inadequate. The problem is that if the object is complex, data for forecasting must be gotten from experts. Such data are of a subjective nature. For this reason the methodological examination must include the subject of forecasting and the forecasting process as the specific interconnection of the subject and object in addition to the subject alone.

The methodology that is appropriate to this interpretation of the systematic approach is called systematic forecasting by the author. This name underscores the difference between the forecasting of an object as a system that is most often used. On the other hand, he manages to avoid the very generalized designations such as "systematic approach" and "systematic analysis" in designating a more specific methodology, which is developed below.

This book provides no specific forecasts or predictions. It does not provide an answer to just how the nuclear power industry will develop in this or that nation.

The book poses another task - to obtain an answer to the question of how one must forecast the development of the nuclear power industry. To answer this question means to create a tool for forecasting.

The examples provided in the book must be seen primarily as an illustration of how the proposed tool for forecasting works. Several results were obtained through the use of mathematical models. The problem of the conformity of the exogenous (input) data of any real system of nuclear power, which were obtained in the modeling procedure, is not discussed. For this reason the use of modeling results in a specific applied forecasting task exceeds the framework of the book.

The book is divided into three sections. The first section is devoted to the theoretical-methodological analysis of the stated task. The first chapter examines the basic circuitry of the conception of systematic forecasting and provides a psychological analysis of forecasting activity. The second chapter deals with the analysis of the basic properties of the nuclear power industry as a system. This analysis has made it possible to formulate the basic requirements for a method of forecasting on the part of the object.

The second section of the book develops the key components of a forecasting method - the mathematical models of a developing nulclear power industry.

The drafting of two basic models is provided - AES /nuclear electric power station/ systems (chapter 3) and fuel supply systems (chapter 6). Examples of estimates on models of AES system are given in chapter 5. Chapter 4 examines questions having to do with the evolution and equipment for modeling an AES system.

The somewhat unusual location of material (a review of known models - chapter 4 - follows a description of the proposed model in chapter 3) is explained primarily by a desire to introduce the reader using a subsequent outline of an AES system model as a whole. Following this introduction the reader will find it easier to follow the progress in analyzing various approaches and methods of modeling.

Another reason for this was a desire to shed light on several recent models, which are described in chapter 3, including that which was influenced by it.

The third section of the book is devoted to the development of a method for considering the fundamental phenomenon, which which one has to deal in forecasting - uncertainty.

Chapter 7 examines one narrower class of tasks - the selection of an optimal strategy when faced with uncertainty in economic indicators of the work of a system. In chapter 8 there is a description of a common instance of an uncertain situation. Chapter 7 is illustrated with an example of using a model to make estimates.

Of course, the list of methodological questions, which arise during forecasting, is considerably more extensively examined in the book. The author did not examine such important questions as the methods of forecasting the indicators of technical means; he restricts himself to just an examination of systematic tasks.

Everything that is dictated directly by the properties of some specific system of the nuclear power industry due to the common methodological trend, also, of course, is not covered in the book.

The book contains basically original developments of the author, which he devised personally, under his guidance or in which he participated; several of the materials in the book were published in journals previously by the author.

The author is deeply indebted to A. D. Virtser, with whom the author developed mathematical models of an AES system and a fuel supply system and also methods for optimizing in conditions of uncertainty. The author sincerely thanks D. B. Bogoyavlenskaya, to whom the author is largely indebted for the interpretation of the psychological problems of forecasting, V. L. Lokshin for cooperation in developing a fuel supply system and Yu. S. Lezner for all the work in developing the computer programs.

The author is very grateful to the responsible editor, Academician M. A. Styrikovich, for his considerable assistance in the preparation of the book.

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NEW BOOK DESCRIBES OPERATION AND MAINTENANCE OF WATER-TREATMENT FACILITIES

Moscow OPERATOR VODOPODGOTOVKI in Russian 1981 (signed to press 3 Feb 81) pp 1-5, 301-304

[Annotation, foreword and table of contents from book "Water Treatment Operator", by Semen Markovich Gurvich and Yuriy Maksimovich Kostrikin, Izdatel'stvo "Energoizdat", 30,000 copies, 304 pages]

[Text] This book presents the sum total of information needed by duty personnel of water-treatment facilities at electric-power stations and at industrial and central-heating boiler plants. It describes the properties of water and the methods for processing it in water-treatment facilities. The book describes in detail those operations which the duty personnel carry out in conducting analyses and in controlling the water-treatment equipment. The first edition of the book was published in 1974. The second edition was revised based on the readers' wishes.

This book is a practical aid for laboratory workers and shift personnel at power stations and boiler plants, as well as for heat engineers, mechanics, etc.

Foreword

The necessity for publishing the first edition of the book "Water Treatment Operator" was motivated by the fact that, in the first place, domestic literature on water treatment had not touched upon questions concerning the activity of the on-duty operational personnel in water-treatment installations at electric-power stations and in the power-production industry; in the second place, the duty staff in water-treatment installations at electric-power stations is basically comprised of persons who have obtained the bulk of their education in high school and who have some vocational and technical training. This does not provide them with the entire sum of knowledge that these personnel need; thirdly, a sizeable contingent of persons operating water-treatment installations in industrial boiler plants frequently do not have special training in water technology. Very often the operation of such installations at small industrial enterprises is accomplished by machinists, stokers, etc., doing double-duty.

While writing the manuscript for the first edition of "Water Treatment Operator," the authors began with the following considerations.

1. It was necessary to give the book's readers a brief but sufficiently complete idea about the modern state of water-treatment technology here and abroad. Addi-

tionally, taking into consideration the basic contingent of this book's readers, it was necessary to keep the book's style as understandable as possible, which, moreover, would facilitate its utilization by individuals in other professions (heat engineers, mechanics, etc.) for general familiarization with the basics of water-treatment.

2. Considering the content of the vocational and technical-training programs which the operational personnel at water-treatment facilities undergo and the availability of standardized service instructions and reference materials regarding questions of water-treatment, the authors have kept the presentation of these problems to a minimum in this book. In particular, with respect to these considerations, the authors felt it possible when describing equipment at water-treatment installations as well as various laboratory instruments and devices to limit themselves to the basic layouts of these devices, which would be sufficient to understand their technological essence.

3. In addition to fulfilling the current duties entrusted to him by prevailing instructions, the water-treatment operator must, on the basis of daily observation and a study of the equipment's operation and the technological processes occurring within it, have the possibility of introducing innovative suggestions with regard to improving the operational efficiency of the equipment and the installation on the whole. These suggestions contribute to the conservation of reagents and water expended for internal water-treatment facility needs and to a reduction in the cost of the processed water. Therefore, this book devotes particular attention to an examination of the essence of the physicochemical processes taking place in the water-treatment installation's equipment. This should assist the operational personnel in their work in improving the effectiveness and the efficiency of the equipment they service.

To what degree the content of the first edition of "Water Treatment Operator" insured the satisfactory fulfillment of the above-stated considerations one can judge by the positive responses from individual readers (as well as from several district power-station chemical services) which the publisher and the authors have received. Moreover, regardless of these responses, one must admit that the first edition of the popular handbook for operational personnel at water-treatment facilities needs further improvement. The book required considerable revision and additions, since water-treatment technology in the large and small-scale power industries had advanced significantly in the period since the publication of the first edition. One must also take into consideration the appearance each year of new personnel who require such a handbook. Thus, all the stated considerations present a convincing case for the expediency of republishing "Water Treatment Operator."

The most substantial major changes and additions introduced into the second edition of this book can be reduced to the following.

New, efficient production processes for water treatment and new equipment which have appeared in recent years are examined. Special water-treatment conditions and water regimes for steam generators at atomic electric-power stations are covered. The status of questions regarding the application of the so-called oxygen regime for boilers is examined. Detailed questions concerning the mechanization of water-treatment facilities and the value of continous water-treatment production processes are stated. An analysis is given of the application of the prevailing drinking and boiler-water standards by operations personnel at electric-power stations. In addition to general questions and the technology involved in disposing of electric-power station discharges, the book examines methods of switching to closed systems operating with full utilization of all or at least most of the wastes.

Certain chapters concerning the scope of operational physicochemical control over water and steam and touching upon information relating to basic methods of quantitative analysis and upon the operations executed in conducting this analysis have been revised and abridged.

The authors ask that all comments and suggestions regarding the second edition be sent to: 113114, Moscow, M-114, Shlyuzovaya naberezhnaya, 10, Energoizdat.

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ELECTRIC POWER

WAYS OF IMPROVING FUEL CONSUMPTION AT POWER MACHINEBUILDING PLANTS

Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 9, Sep 81 pp 2-4

/Article by Yu. A. Yefimov, deputy minister of power machinebuilding, and A. A. Barabaskin, chief of the administration of the chief mechanic and chief power engineer of the USSR Ministry of Power Machinebuilding: "Ways of Increasing the Efficiency of the Use of Fuel and Power Resources at Enterprises of the USSR Ministry of Power Machinebuilding in the 11th Five-Year Plan"/

/Text/ In the 10th Five-Year Plan 42,000 tons of conventional fuel, nearly 200 million kilowatt-hours of electricity and 325,000 Gcal of thermal energy were conserved at enterprises of the USSR Ministry of Power Machinebuilding. This was done by reducing the relative norms for the expenditure of fuel and energy resources (TER) for the production of basic product. These savings were accomplished through organizational-technical measures taken by the enterprises. These measures included: the modernization and replacement of outdated equipment, the elimination of small heating boilers, the switching of boilders to the combustion of natural gas and fuel oil, the adoption of operating schedules for boilers, heating furnaces and thermal furnaces, the carrying out of thermotechnical and electrotechnical tests of equipment that consumes large amount of energy. All of these measures were taken to establish the optimal expenditures of TER and others.

A great deal of attention has been devoted to the use of secondary power resources. Their use increased by 22 percent during the five-year plan, amounting to 394,000 Gcal in 1980, or 8.3 percent of the annual comsumption of thermal energy for production needs.

For the years 1981-1985 the ministry is to reduce fuel expenditure norms by 4.5 percent, electric power by 12 percent, and thermal energy by 7 percent. The ministry and enterprises have prepared organizational-technical measures aimed at fulfilling their assignments for conserving TER.

In the 11th Five-Year Plan work will be continued in improving the existing and introducing new, less power-consuming technological processes (at present nearly 40 percent of the normative fuel consumption, 70 percent of the electric power and 20 percent of thermal energy are expended for technological needs), the further development of comprehensive mechanization and automation of production processes, the adoption in the milling production work of technological processes which provide a significant improvement in the quality and an increase in the precision of sizes of the billets that are obtained.

In the mechanical processing work, where 35 percent of all electric power is consumed, there is an anticipated 2-fold increase in the productivity of all kinds of machine tools (lathes, milling tools, drills and boring tools, polishing tools, and others) and a 2.5- to 3-fold reduction in the labor intensiveness of mechanical processing. These indicators will be achieved through an improvement in the structure of the metal cutting machine tool park and the designs of machine tools, increasing the precision of obtaining billets (forged pieces, stampings, and castings), and the intensification of cutting modes.

Within the structure of the metal cutting machine tool park there will be a 15 to 16 percent increase in the number of high-productive specialized equipment. This will be done chiefly by increasing the number of computer numerically controlled (CNC) machine tools, including the machine tools of the "processing center" type, the use of which will lead to a 1.5 to 5-fold increase in labor productivity. The end result of optimizing the cutting modes will be a reduction in the expenditure of electric power per product unit.

In forging production work the existing processes will be improved and new technological processes for forming, aimed primarily at reducing the manufacturing cycle of a form and casting, will be developed.

Molding and core blends and coatings will be standardized. It is proposed to provide the small-series and individual production using four to six varieties of blends and one to two varieties of paints. By the end of the five-year plan nearly 80 percent of castings will be produced using new quick-setting blends, which will make it possible to save the fuel that is expended in drying furnaces to dry the sandy-argillaceous blends commonly used now (the amount of fuel consumed in the drying process accounts for 20 to 25 percent of the consumption for the smelting of metal).

Improving the smelting processes includes replacing the cupola smelting of pig iron with electroinductive smelting, which will result in a savings in the use of coke. In the open hearth production work a substantial savings of fuel is expected as a result of replacing some open hearth furnaces with electric arc furnaces (the Production Association "Izhorskiy Zavod" imeni A. A. Zhdanov is projected to carry out such a replacement).

In the forge and press and thermal production facilities existing equipment is to be modernized and new, highly productive equipment is to be adopted. The technological processes of forging, stamping, thermal processing in order to obtain precision in the billets obtained, and the conserving of materials and energy resources are to be improved. In addition it is planned to adopt highly-productive forging and press manipulator units, equipped with high-speed manipulators with automated control of their work. Such machine units are being created at the Production Association "Izhorskiy zavod" imeni A. A. Zhdanov and at the Kramatorsk Plant "Energomashspetsstal'" /special steel for power machinebuilding/. The productivity of the forging in the automated units is 1.8 to 2.2-fold greater than in free forging. The quality of the forged pieces is significantly higher. And there are few margins in size, which results in a savings of metal and electricity during the mechanical processing of the forged pieces.

In forge and press and thermal production work a large amount of fuel is expended on heating the metal in the heating and thermal furnaces. The basic trends in raising the efficiency of using fuel in these furnaces are: improving the designs, equipping with recovery units (using exhaust gases to heat the air entering the combustion chamber) and automatic temperature control systems and systems for maintaining the optimal correlation between gas and air, equipping with more efficient burners (for example, when using GTPS burners in place of TNP burners there is an approximate 5 to 8 percent reduction in fuel expenditure; such burners are used in several thermal furnaces at the Production Association "Izhorskiy zavod").

An effective method of reducing the relative expenditures of fuel in thermal and heating furnaces is to reduce losses of heat through the safety structures by using highly-efficient thermal insulating materials (in place of the traditionally used firebrick) for the lining of furnaces, for example the fibriform refractory slabs, which were developed by the VNIPIteploproyekt /All-Union Scientific Research and Designing Institute of Thermal Equipment/.

Tests of new designs of linings at the Production Association "Izhorskiy zavod" have shown that when using the fibriform slabs there is a reduction in heat losses and fuel and electric power consumption of 15 to 20 percent. There is an 8 to 10-fold reduction in the weight of the linings and a 2 to 3-fold reduction in labor expenditures for constructing and repairing linings; the productivity of the furnaces rises and there is a 10 to 15 percent reduction in the thermal processing cycle.

In accordance with the plan that the ministry devised in the 11th Five-Year Plan the modernization of existing and the construction of new thermal and heating furnaces using fibriform refractory materials will be continued. This will provide an opportunity to significantly reduce the expenditure of fuel and electric power during heating and the thermal processing of manufactured articles (in the production associations "Izhorskiy zavod", "Atommash", "Khar'kov turbine plant" imeni S. M. Kirov, and at the Kramatorsk Plant "Energomashspetsstal'").

The enterprises of the USSR Ministry of Power Machinebuilding have their own power generating plants, industrial boilers, a TETs, compressor, pump and oxygen facilities. These plants consume a significant amount of primary energy resources (the boiler facilities and

TETs, for example, consume nearly 60 percent of the total normative expenditure of fuel and the compressor facilities consume nearly 18 percent of the electricity expenditure). For this reason a great deal of attention will be devoted to the rational use of fuel and energy at these plants and to improving their operation. The trends for increasing the efficiency of the use of TER in the power generating converter and transmission plants and the pipelines along with replacing outdated equipment and networks with new ones include: modernization and rebuilding in order to increase efficiency and reliability, reducing to a minimum the losses of the produced power carriers, and optimizing their use.

The planned modernization of the enterprises' boiler equipment includes equipping the boilers with automated combustion, automated gas analyzers for monitoring the quality of combustion of fuel and more improved designs of economizers and blast heaters, replacing burners with new progressive designs and replacing the convection heat surfaces of the boilers with membrane surfaces. Wear-resistant coatings will be applied to the heating surfaces of the pipes of the boiler units (this includes gas-powder smelting) in order to increase their service life, to cut repair costs and to decrease losses of TER, caused by emergency shutdowns of the boilers.

During the last five-year plan in several boiler facilities the PTVM-50 boilers were modernized: the nozzles were replaced, the heating surfaces were rebuilt, additional two-light screens were installed, and automated burner devices and gas analyzers were installed. In addition, operating mode measures were undertaken. As a result the productivity of the boilers was increased by 10 percent and efficiency reached 89 percent. Similar work will be done during the 11th Five-Year Plan.

A substantial savings in electricity will be obtained through the modernization of the compressor plants and the rebuilding of the air pipes. The compressor plants will be equipped with units that regulate productivity and with devices for drying and heating compressed air. The replacement of the circular valves of the piston compressors with direct-flow valves will be continued. This will make it possible to reduce the losses of compressed air and this in turn will result in a reduction in the expenditure of electricity. Replacing the machine energizers of the compressor engines with thyristor converters will ensure a reduction in the expenditure of electricity by one cubic meter of compressed air.

An extensive program is planned in organizing and improving the accounting and monitoring of the expenditure of TER. The accounting and monitoring is to be done on an individual shop basis, including machine units that consume large amount of energy. At several of the large enterprises of the power machinebuilding sector in the 11th Five-Year Plan it is planned to put into operation automated information-measuring systems for keeping track of and monitoring electric power.

The automation of the regulation of the parameters of the heat carriers in the thermal networks is to provide considerable savings of thermal energy. Toward this end the Ministry of Power Machinebuilding and the Ministry of the Electronics Industry have jointly developed a plan to cooperate in the production of electronic heating regulators. Tests of an experimental model of a regulator, which was installed in 1980 in the administrative building of the Production Association "Nevskiy zavod" imeni V. I. Lenin demonstrated that when the temperature of the feed water is automatically lowered at night in the sector that is equipped with an automatic regulator, the savings of thermal energy amounts to 25 to 30 percent.

One of the trends in conserving thermal energy at enterprises of the power machinebuilding sector is to reduce heat losses of buildings. For these purposes the plans that are being drawn up call for rational space-planning and design solutions: the maximum obstruction of industrial buildings, reducing the perimeter of external walls and the amount of glass, improving the insulation of the enclosing designs of the buildings, and adopting more rational heating systems. Such measures are to be accomplished during the capital repair work on existing industrial buildings.

In order to use the low-potential heat of the vented discharges at, several enterprises of the power machinebuilding sector they are manufacturing experimental models of revolving regenerative heat exchangers.

Several organizational measures aimed at increasing the savings and the efficient use of TER are to be taken. Toward these goals at each enterprise of the power machinebuilding sector they have created permanent operating commissions, which are made up of designers, production engineers, metallurgists, material-technical supply workers, and representatives from public organizations, as well as power engineers. The job of these commissions is to: look for ways to conserve fuel, thermal and electric power, to monitor their expenditure, to adopt measures for their conservation, and to undertake an extensive education program among the collectives of the enterprises. These tasks can be successfully solved only with the constant work in this direction of the entire collective of each enterprise.

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