FLOATING NUCLEAR POWER PLANTS IN RUSSIA:
A THREAT TO THE ARCTIC, WORLD OCEANS AND NON-PROLIFERATION TREATY

Green Cross Russia (GCR) is a public, non-governmental organization which promotes protection of the environment, the education of the public on how to lead sustainable lifestyles which are in harmony with nature, and the safeguarding of natural resources for future generations. GCR adopts a pragmatic approach to the solution of ecological challenges. The organization promotes cooperation in lieu of confrontation in its work with other public organizations, the business community and central and local governmental authorities. GCR aims to raise public awareness on the environmental situation in the Russian Federation – both with regards to the current challenges and the progress which has been made. It is felt that the experience, knowledge, and scientific potential of public organizations should be used to facilitate the implementation of environmental protective measures. GCR has representative branches at the regional and local level which enable the organization to adopt a multi-layered, integrated approach to its tasks and activities.

Green Cross Russia
Chernyakhovskovo ul. 16, office 117
125319 Moscow
Russia
Phone (095) 152 57 51, Fax (095) 152 06 92
E-mail: kuznetso@online.ru, gcrus@online.ru

Green Cross Russia
Third edition
Edited and published by
"Agenstwo Rakurs Production" Ltd
Moscow, 2004
ISBN

The third edition has been edited by: V. M. Kuznetsov, St. Robinson and V. Rossi.

Green Cross Russia
V. M. Kuznetsov, A. V. Yablokov, I. B. Kolton, E. J. Simonov, V. M. Desyatov, I. V. Forofontov, A. K. Nikitin

Floating Nuclear Power Plants in Russia: A Threat to the Arctic, World Oceans and Non-Proliferation Treaty

A brief description is given of the floating nuclear power plants (FNPPs) which are currently being developed in Russia and an analysis is made of the environmental, economic and political consequences of the implementation of this FNPP project by the Russian Ministry of Atomic Energy (Minatom). The main conclusions which are drawn are as follows: floating nuclear power plants pose a potential danger to the environment; their profitability is highly questionable; the realization of the FNPP project would create a situation in which nuclear fissile materials suitable for the production of nuclear weapons were much more easily available, thereby undermining the nuclear non-proliferation treaty; and the potential for international nuclear espionage and terrorism would be greatly increased. Furthermore, violations of operating regulations at naval nuclear installations are highlighted and an analysis is made of Russian Normative Documents governing nuclear and radiation safety for naval nuclear installations.

This publication is written for a wide readership interested in the issues of nuclear and radiation safety, the global ecology, the Arctic and the World Oceans.

This edition has been issued with the support of Green Cross Switzerland and the Nuclear and Radiation Safety Programs of Green Cross Russia

CONTENTS

THE FOREWORD TO THE ENGLISH EDITION

In 2000-2001, Green Cross Russia and the Centre for Russian Environmental Policy published a 1st and 2nd English edition of the book "Floating Nuclear Power Plants: A Threat to the Arctic, World Oceans and Non-Proliferation Treaty" (originally printed in Russian). Following the extensive interest shown in this book by the world community, Green Cross Russia with the support of Green Cross Switzerland has decided to publish this revised edition in English.

The nuclear reactor model selected for use on board Floating Nuclear Power Plants (FNPPs) is similar in design to the submarine reactors which employ enriched uranium. This 3rd edition describes the concept of FNPPs on the basis of projects which have been prepared for Severodvinsk (Arkhangelsk Oblast) and Pevetsk (Chukotka Autonomous Region). It analyses the potential ecological, environmental and political implications should the Russian Ministry for Atomic Energy realize its plans to build such FNPPs in Russia and abroad (China, Indonesia, Algeria, Argentina, etc.).

The authors of this book conclude amongst other things that:

- The construction and international sale of FNPPs would drastically increase the likelihood of weapon-grade nuclear materials being illegally acquired, thereby undermining international (non-)proliferation regimes;
- FNPPs would be a prime target for terrorist attacks and nuclear blackmail;
- Infringed safety regulations and problems with naval nuclear reactors have brought to light the fact that the FNPP design is inherently unsafe and that FNPPs present a greater risk than conventional land-based nuclear power plants;
- FNPPs are economically unviable, even in the long term, due to the high costs of electricity generation, servicing, refueling and finally decommissioning.

This 3rd edition has been written with a large readership in mind interested in questions of nuclear and radiation safety, environmental issues, the Arctic and the world oceans.

S. I. Baranovsky
President
Green Cross Russia

PREFACE

In April 2000 the first edition of the book «Floating Nuclear Power Plants in Russia: A Threat to the Arctic, World Oceans and Non-Proliferation Treaty» was published. The speed with which the edition was sold out demonstrated the level of interest on the part of the Russian public in domestic atomic energy issues. It also showed that, despite an apparent abundance of information on atomic engineering subjects, the public remains relatively poorly informed. As a result, the authors have decided to release a second edition which includes extensive new material that has come to light since the book was first published.

One of the most significant new sections focuses on the findings of the public environmental expert review of the FNPP project, which was carried out between August and December 2000 in Pevek. This expert review was initiated at the end of 1999 at the request of the residents of the Chukotsky independent district, who were worried about the future development of a nuclear power complex in the region and, in particular, about the lack of objective information on the proposed construction in Pevek of a floating nuclear power plant (FNPP) with KLT-40C reactors. The public environmental review, in which many experts from state and public organizations participated, was jointly organized by the 'International Social Ecological Union' and the 'Kayra Club' (a Chukot public ecological association located in Anadir). The main funding body was Green Cross Russia's Program on Nuclear and Radiation Safety. The findings of this expert review highlight a series of errors in the documentation for the project, as well as violations of operating standards and Russian legislation on the safe use of atomic energy and protection of the environment. Significantly, once 'Rosenergoatom' familiarized itself with the results of the public expert review, it withdrew from the Pevek project.

Nevertheless, the concept of developing so-called 'low-power engineering' in the remote areas of Northern Russia was not totally forgotten and, at present, a FNPP is being planned for Severodvinsk (Arkhangelsk region) in accordance with the proposals of the Russian Ministry of Atomic Energy (Minatom).

Following the search for the most appropriate location for a pilot FNPP, a "Declaration on the intention of constructing a pilot low-power thermal nuclear plant on the basis of a floating energy unit with KLT-40C reactor installations in Severodvinsk" was developed and agreed in 2000. Order № 739 (dated 30 November 2000) of the Russian Minister for Atomic Energy, E. Adamov, confirmed the development of the Justification of Investment for the Floating Nuclear Power Plant for Severodvinsk and declared that the appropriate licenses would be distributed to start construction of a FNPP in 2001.

The aim of the authors was to take account of all the above-mentioned facts when preparing this edition. They hope that the materials collated will help a wide range of readers to come to their own conclusions on the topic under consideration.

The following is a brief summary of the authors of this publication:

Vladimir Mikhailovich Kuznetsov is a former head (1986-1993) of the Russian Federal Inspectorate for Nuclear and Radiation Safety's (GosAtomNadzor) department for supervision and inspection of nuclear and radiation safety at atomic engineering installations. He is the main editor of the "**Radiation and Society**" journal, a member of the Higher Ecological Committee of the Russian State Duma, director of Green Cross Russia's Program on Nuclear and Radiation Safety and a member of the International Technical Committee on TC-322 "Nuclear Technology" Standardization. Furthermore, he is the author of many publications addressing safety issues at atomic engineering installations, including **"State of Radiation**" (1994), **"Russian nuclear engineering. Yesterday, today, tomorrow. The observations of an independent expert"** (2000) and **"The Main Problems and Current Con-**

dition of Safety at Nuclear Fuel Enterprises" (2002, 2003). He was chairman of the public environmental expert review body which investigated the Pevek FNPP project.

Alexey Vladimirovich Yablokov is a corresponding member of the Russian Academy of Science. He is a former environmental adviser to the Russian President (1991-1993), former chairman of the governmental commission on sea-dumping of radioactive wastes (1993) and is the author of many publications on radiation and environmental problems (including the "**Nuclear mythology"** report 1993, 1995, 1997.)

Ilya Borisovich Kolton was a scientific collaborator in the Kurchatov Institute within the technological-scientific centre of GosAtomNadzor (the Russian Federal Inspectorate for Nuclear and Radiation Safety) (1997-2000). In 1962 and again in 1972, he participated in a nuclear submarine expedition to the North Pole. He was a member of the public environmental expert review body which investigated the Pevek FNPP project and is the author of several publications discussing the safe exploitation of nuclear energy.

Yevgeney Yakovlevic Simonov is a senior engineer and chief of shift at the Obninsk Nuclear Power Plant (NPP), a nuclear operator on board the 900 series nuclear submarines and one of the heads of laboratory involved in the technical expert review of NPP project documentation. He was also a State inspector for Nuclear Safety at GosAtomNadzor. He is a member of the public environmental expert review body which investigated the Pevek FNPP project and the author of a number of publications discussing the safe exploitation of nuclear energy in Russia.

Igor Victorovich Forofontov is the coordinator of the Greenpeace nuclear campaign in Russia. He graduated from the physics faculty of Leningrad State University.

Vladimir Mikhailovich Desyatov is a trained shipbuilding engineer. In Soviet times, he worked for a nuclear submarine construction plant in Komsomolsk-upon-Amur, after which he became a deputy of the Higher Soviet and a member of the Ecological Committee of the Higher Soviet (1989-1991). He has also been a representative of the President of Russia in the Khabarovsk region (1991-1993) and is the author of a number of publications addressing safety at atomic engineering installations.

Alexandr Konstantinovich Nikitin is a retired first rank captain and a former nuclear installations safety inspector for the Russian Ministry of Defense (1987-1992). He is co-author of the report **"Northern fleet. Potential hazard of radioactive pollution in the region"** (1996) and a number of other publications concerning the problems of radiation safety in the northern seas.

INTRODUCTION

For the last fifteen years, the Russian Ministry of Atomic Energy (Minatom) has been promoting the idea of installing low-power Floating Nuclear Power Plants (FNPP) in the North and Far East of the Russian Federation. These would be based on reactor installations which use highly-enriched uranium (such as the KLT-40C series) and which have been in operation on board the "Sevmorput" lighter and several Soviet nuclear-powered icebreakers.

"The Minatom press information service has declared that, given the current need for conversion, it has been proposed that a series of FNPPs, based on highly reliable nuclear reactors tested through long term operations aboard icebreakers, should be constructed. Such FNPPs with an output of up to 80 MW could resolve the most pressing power supply problems experienced by coastal regions in northern and eastern Russia. According to current proposals, the first such FNPP is to be built within the next 4 years. A return on such a FNPP can be expected within 5 to 6 years of the start of operations." **Moscow, January 21, 1999, ITAR-TASS correspondent Leonid Raitsin.**

One would have imagined that the Chernobyl catastrophe would have taught us to treat nuclear technologies with caution. It is true that, following the Chernobyl experience, many Normative Documents (laws, rules, instructions) governing the construction of new nuclear plants appeared in Russia. However, the developers of the KLT-40C reactor FNPP project always referred to experience made with nuclear ship reactors in general when discussing the safety of this novel reactor type.

Official statistics on the number of violations of operating regulations on ship-borne nuclear installations remain classified and the available published data gives only a partial (and probably minimized) overview of incidents (Osipenko et al. 1996; Nillsen et al. 1996; H. Handler, 1995, etc.) Nevertheless, there is available data on at least 6 serious accidents on nuclear-powered icebreakers, in which radioactive emissions were released into the environment (“Lenin” - in 1965, 1966 and 1967; “Russia” - in 1988; and “Arctica” - in 1993 and 1996; see table 1). Bearing in mind the extent of Soviet bureaucracy, however, there were almost certainly many more accidents which have remained unreported.

Table 1

Known accidents on nuclear-powered icebreakers
(Information taken from various sources)

Date	Place	Name of vessel	Notes
February 1965	Murmansk	Nuclear icebreaker "Lenin"	Accident at reactor No 2 during repairs resulting in damage of a major part of the reactor core. Irradiation of the crew.
1966	Murmansk	Nuclear icebreaker "Lenin"	Deformation of fuel rods during fuel replacement operations.
1967	Murmansk	Nuclear icebreaker "Lenin"	Release of radioactive emissions following a leak in the 3rd cooling circuit.
18 August 1988	Arctic Region	Nuclear icebreaker "Russia"	Fusion of reactor core.
25 January 1993	Kara Sea	Nuclear icebreaker "Arctica"	Flooding of the reactor cover. Release of radioactive substances (total activity not less than $5.5*10^{10}$ Bq for several days). Irradiation of the crew.
22 Feb-	Murmansk	Nuclear icebreaker	Leak in the 1st cooling circuit (up to

ruary 1996		"Arctica"	70 l/h)

On the basis of available information, an analysis of malfunctions in Soviet nuclear reactors designed for powering nuclear submarines and nuclear icebreakers forces one to have concerns about the implementation of any similar projects.

Chart 1 shows the number of malfunctions of nuclear installations on board atomic icebreakers in the period 1994-2002.

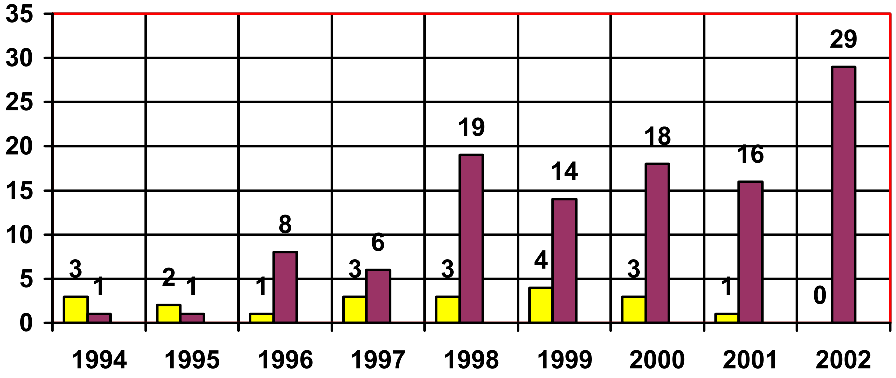


Chart.1. Number of malfunctions of nuclear installations on board atomic icebreakers in the period 1994-2002 (yellow = malfunctions leading to a start of the emergency response systems, violet = all other incidents).

It is important to bear in mind that the nuclear and radiation safety of a FNPP is regulated by Normative Documents that were put in place many years ago. These norms and standards were developed to support Minatom’s drive for a large-scale increase in atomic engineering installations. A number of these regulations, such as the "General regulation for NPP safety GRS-88/97" and the "Rules for nuclear safety of reactor installations RNS RI NP - 89", contain statements permitting sharp reductions in expenditure on safety controls and protection of the population and environment. This out-dated normative base does not guarantee the creation of safe FNPPs, and, furthermore, no new safety operational standards are currently under elaboration.

The brochure discusses in the following different subjects:

Part I is dedicated to the history of (chapter 1 by V. M. Kuznetsov, A. V. Yablokov, V. M. Desyatov) and to a brief technical description of FNPPs (chapters 2-4 by V. M. Kuznetsov, U. Y. Simonov).

Part II discusses economic aspects of the project (chapter 5 by I. V. Foropontov, A. V. Yablokov, V. M. Desyatov and V. M. Kuznetsov).

In part III, the consequences of the exploitation of FNPPs in the Arctic Region and Indonesia are analyzed (chapters 6-7 by A. V. Yablokov and V. M. Kuznetsov).

Part IV is dedicated to the environmental impact of the FNPP project of FNPP (chapters 8-10 by V. M. Kuznetsov, A. V. Yablokov and U. Y. Simonov).

Small in size, but very important, is part V, devoted to geopolitical problems and questions concerning the physical protection of FNPPs (chapter 11 by V. M. Kuznetsov, A. V. Yablokov and U. Y. Simonov).

Part VI discusses legal aspects of FNPP construction and operation (chapter 12 by V. M. Kuznetsov, A. V. Yablokov and U. Y. Simonov).

In the last part VII, an overview is given on violations of safety regulations for the operation of naval nuclear engines - which are prototypes for the FNPPs, and also disadvantages of creation of the database violations in operation of ship (chapter 13, 14, written by I. B. Kolton, V. M. Kuznetsov).

The final text of the brochure has been agreed upon by all participating authors and expresses their general consensus.

Acknowledgements:
Valuable contributions were made to the first issue of this book by V. I. Bulatov (Novosibirsk), M. A. German (Rostov-upon-Don), I. V. Lisovsky (St. Petersburg), Y. Y. Krisanova, K. K. Krillova, D. V. Kuznetsova (Moscow), I. V. Kudrik (Oslo, Norway), S. E. Paschenko (Novosibirsk), E. A. Tagirov (Obninsk), G. Handler (Boston, USA), O. V. Fedoruk, B. A. Chepenko and V. N. Yakimets (Moscow). The authors of this book are grateful to the experts who participated in the public environmental expert review on the FNPP project in Pevek for their valuable comments: G. P. Smirnov, H. E. Kuznetsova, A. D. Shramchenko, Y. S. Kokurin, G. V. Matushhevsky, I. M. Kabatchenko and N. G. Ovsyannikov.

All remarks and suggestions concerning the content of this book should be addressed to Green Cross Russia, Chernyakhovskovo ul. 16, office 117, 125319 Moscow, Russia, Phone (095) 152 57 51, Fax (095) 152 06 92, email: gcrus@online.ru.

The electronic version of this book is available at: www.atomsafe.ru

PART I. THE HISTORY AND TECHNICAL PROPERTIES OF FLOATING NUCLEAR POWER PLANTS

This section presents the origin and development of the idea of constructing Floating Nuclear Power Plants, together with the main technical properties and drawbacks of this concept.

Chapter 1. A Brief History of Floating Nuclear Power Plants

It would seem that the idea of building floating nuclear power plants (FNPPs) was first put forward in 1969 by Richard Eckert, vice-president of the "New Jersey Public Services Electric and Gas Company" (USA) (Grossman, 1980). At the time, the energy giant "Westinghouse" went as far as to create a special subsidiary energy company called "Offshore Power Systems", which planned to construct eight floating nuclear power plants with an output of 1,150 MW each by 1980-1981. The plan did not come to fruition, however, despite a corporate investment of around 180 million US dollars. The reasons were twofold: firstly, there was tremendous resistance on the part of the authorities, and some citizens, of certain coastal states; and secondly, the project was plagued with economic drawbacks.

During the implementation of the Russian Government's Decree 389 (dated 9 June 1992) on 'Ways to overcome the fuel crisis in the Far East and Eastern Siberian Regions', a commission of the Russian Ministry of Atomic Energy (Minatom) experts proposed in 1993 the use of low-power NPPs (100-180 MW thermal output) in the form of nuclear reactors installed on board ships. The decree itself was made (after consultation with the main regional authorities) on the suggestion of Minatom. According to Minatom, there were more than 50 regions in Russia where there was already, or would soon be, a large demand for low-power nuclear plants and where their use would be highly expedient (Brief annotated reference, 1997). Furthermore, a number of "energy crises" had occurred in Far Eastern regions, where Minatom intended to build new NPPs, for example, in 1991 in Khabarovsk at the height of a media campaign surrounding a NPP.

In the years 1991-1994, Minatom ordered that a series of competitions be held with the aim of finding the best proposals for the construction of low-power nuclear plants. These competitions were run by the joint-stock company "Low-power Engineering", under the auspices of the Russian Federation Nuclear Society, the International Nuclear Society (Moscow) and Minatom itself. Competing proposals included:

- The "Helena" thermo-electric nuclear installation with a 4 MW thermal output. This unit is made of a light-water reactor with natural coolant circulation and direct conversion of thermal energy to electrical energy. The installation is intended to provide electricity and heating to small, remote industrial settlements, with a population of less than 2,000 inhabitants. The project envisages the creation of an automated, un-manned station capable of running for up to 25 years.
- The "Ruta" reactor installation with 20 MW thermal output (a pool reactor). This unit is intended to provide heating to settlements with a population of 14,000-15,000. The development of "Ruta" is based on experience already gained during the development and operation of other pool reactors. Currently, a proposal has been put forward for the construction of a "Ruta"-based heating plant in Apatity (Murmansk area). Moreover, the general designer NIKIET (Scientific-Construction Institute for Energo-Technique) plans to use this project for the provision of central heating to some residential areas of Moscow. These plans are going ahead despite resolution № 46 of the Presidium of the MosSoviet to "terminate the operation of nuclear reactors in Moscow" dated 11 March 1991.
- The "Angstrom" high-safety thermal power station with an electrical power output of 6 MW, a thermal output of 12 Gcal/h and a liquid-metal cooling system using lead and bismuth. This power station is assembled in its entirety at the production factory, from where it is transported to the designated site. The 'Angstrom' NTPP should supply consumers with both electricity and heating. The project is based on relevant experience of similar installations on nuclear-powered ships. An important feature of this type of reactor is its lead-bismuth first cooling circuit. As a result of neutron

capture by bismuth with ensuing beta-decay, polonium-210 is created. At the end of a fuel cycle, the polonium-210 activity in the first cooling circuit is 107×10^{10} Bq/l. The high activity and permeability of polonium–210, which is an alpha-emitter, essentially influences radiation conditions during the maintenance of a reactor and the unloading and reloading of the active zone.

- The ATEZ-80 [ATEZ = Atomnaya TEplo Zentral or Thermal Nuclear Power Station] thermal nuclear power system with a light-water reactor yielding 250 MW of thermal power (this system does not generate electricity). It is based on designs used for nuclear submarines and icebreakers. A characteristic feature of the ATEZ-80 is that it can be assembled at the factory and needs only small on-site adjustments.
- The ATU-2 reactor with an electrical power output of 26 MW and a thermal output of 58 Gcal/h is intended for operation as part of a Thermal Nuclear Power Station. ATU-2 combines the engineering solutions used at the Obninsk NPP, the 1st and 2nd blocks of the Beloyarsk NPP, and the 1st block at the Bilibino NPP.
- Another project was the KLT-40C double reactor installation, which will be discussed in more details in the following chapter. This proposal was finally awarded first place in the competition for reactor installations on a floating platform with more than 50 MW thermal power.

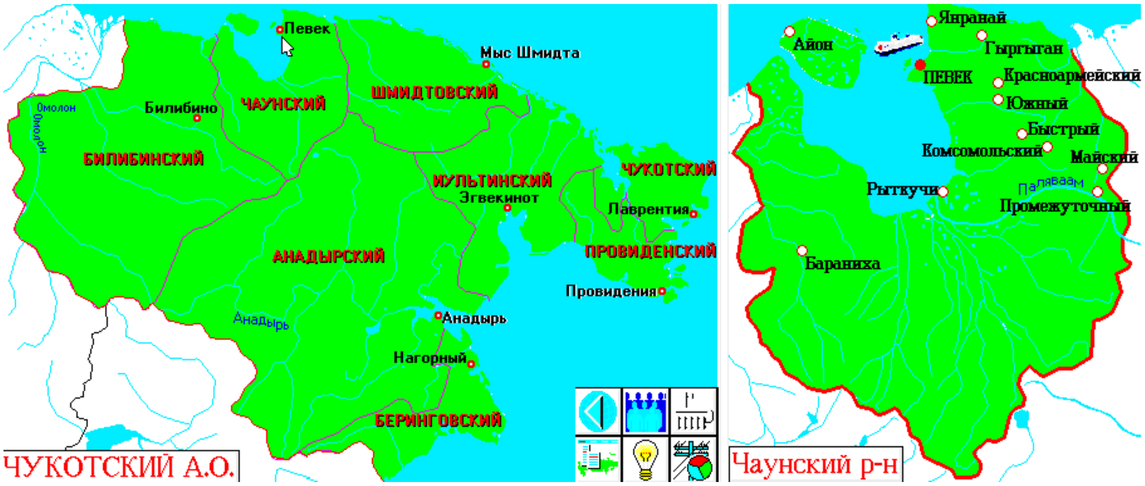
A predominant view was summarized in a statement by U. Ignatenko, General Director of the state enterprise "Rosenergoatom", during a press conference at the central office of Interfax in Moscow, 3rd August 1998.

"The construction of NPPs on board sea vessels is one of the developments that can be observed within the scope of Russian atomic engineering... Wide experience of using nuclear ship installations has already been accumulated. This experience is necessary when constructing floating energy units (FEU), which can be used to supply remote regions with energy – regions in which otherwise it would be difficult to build power stations and to which it would be comparatively expensive to deliver fuel...

As calculations show, such FEUs can be economically viable. Moreover, certain foreign companies have already shown interest in this type of energy installation.

... The Russian Federation's development programme for atomic engineering, for the period up until 2005, foresees the construction of two vessels with nuclear energy reactors... "

In 1993-1994, the joint-stock company "Low-power Engineering", under the instructions of Minatom, carried out a technical and economic feasibility study into potential locations for FNPPs in Extreme Northern and Eastern regions. In the report, the following primary locations for a KLT-40C reactor installation were proposed: Pevek, Schmidt's Cape, the Egvekinot settlement in the Chukotsky Autonomous Area, and a number of settlements in the Primorsky and Khabarovsk areas such as Bolshoy Kamen, Nakhodka, Okhots and Nikolaevsk-upon-Amur. In 1994, Minatom's investigations into potential FNPP sites in the Russian North and Far East revealed that the key regional administrations of more than 80 settlements were in favour of using atomic energy (Veksler, Preobrazhenskaya, 1995).



Pic. 2 Map of Pevek, Chukotsky autonomous area.

In the meantime, the joint-stock company "Atomenergo" was created to take charge of the practical implementation of constructing FNPPs. This joint-stock company was established in 1993 between the "Special Design Bureau for Engineering" (Nizhny Novgorod), the construction and design bureau "Iceberg" (St.-Petersburg), the joint-stock company "Baltic Shipbuilding Factory" (St.-Petersburg), the Murmansk Marine Shipping Company, the Technical and Overhaul Factory "Atomflot" (Murmansk) and the Nizhny Novgorod Engineering Plant. The aim of "Atomenergo" was to promote naval nuclear power installations both in the domestic and foreign markets. By 1994, the FNPP project ABV-6 (Another FNPP project designated for powering the nuclear test facility on Novaya Zemlya, but which is no longer being pursued.) was ready for implementation and in spring of the same year the "Baltic Shipbuilding Factory" signed a contract with the Russian Navy’s Main Department of Shipbuilding for the construction of FNPPs with two ABV-6 reactors.

In July 1994, according to Minatom, the vice-president of the Russian Federation Government, O. Soskovets, signed two decrees: firstly, “On the development of the technical and economic justification for the construction of FNPPs with reactor installations such as the KLT-40 in Pevek, Chukotsky Autonomous Area" (№ OS-P7-23250, dated 27 July 1994); and secondly, “On the organization of work for the selection of a suitable site and the construction design for low-power nuclear plants in the form of floating energy units with reactor installations such as KLT-40C" (№ OS - P7-23260, dated 27 July 1994). Minatom was entrusted namely with the development of the technical and economic justification for the construction of the FNPP in Pevek.

The state enterprise "Rosenergoatom" was designated customer and operator for the FNPP (Declaration..., 1996) and the project was financed by the federal budget’s Conversion Fund (Veksler, Preobrazhenskaya, 1995).

In 1994, with the accord of Minatom, "Rosenergoatom" ordered the joint-stock company "Atomenergo" to develop the Pevek FNPP project which foresaw a power output of 70 MW electrical and 50 Gcal/h thermal. During an interdepartmental commission meeting in September 1994, this project was given top priority in the field of small nuclear installations for applied use. However, a review by the expert board of the Russian Union of Industrialists and Businessmen revealed that non-governmental investments and commercial credits would only be available upon completion of the technical and economic justification report, and once the construction license had been obtained by the Russian Federal Inspectorate for Nuclear and Radiation Safety (GosAtomNadzor) (Brief reference…, 1997).

As a result, "Rosenergoatom", with the consent of the Russian Economics Ministry and Finance Ministry, decided to fund the project from NPP electricity power tariffs set aside for special projects. Contracts were then signed with the joint-stock company "Low-power Engineering" and the joint-stock company "Atomenergo" (according to the order by Minatom № 515, dated 8 December 1994).

The financial sums involved were cited in TASS - Business News. St.-Petersburg, 14 August 1999 (Correspondent ITAR-TASS Lev Frolov):

"... To reserve funds for 1995... on an interest-free base:

Technical-economical justification of the construction of a FNPP with KLT-40C reactor and mooring installations in the Primorsky Area - 8 billion RUR.

The technical-economical report on the allocation of nuclear low-power plants in the regions of the Far East (for finishing current works) - 2 billion RUR."

In accordance with Minatom order № 523, dated 29 November 1995, regarding "The responsibilities of the participants of the project for the creation of nuclear power plants with reactor units such as the KLT-40C", the joint-stock company "Low-power Engineering" was designated general contractor for the project. The joint-stock company "Atomenergo" was responsible for: developing the project; constructing and delivering a tested floating energy unit, including solving the challenges of adequate mooring installations and coastal infrastructure; solving questions of the entire fuel cycle; repairing and refuelling the FNPP; and finally of decommissioning. Included in the estimate put forward by Minatom for the development of the technical and economic justification for the project was a special budgetary item entitled, "The organisation of work with local scientists, public organisations and the population, in order to explain the necessity and the safety of the proposed construction" (Kuznetsov, 1996).

Without awaiting completion of either the design process or the license for the construction site from the GosAtomNadzor, machine-engineering factories received orders to manufacture the equipment for reactor installations (Minatom order № 227, 14 April 1997). In March 1998, an agreement was reached between the Russian Stock Company "Norilsk Nickel", Minatom, and the administration of the Taymirsk Autonomous Area, on the “Decree setting out plans for the construction, in the Dudinki region, of a thermal nuclear power station in the form of a floating energy unit with KLT-40C reactor installations "(Brief reference..., 1997). This work was to be carried out by the joint-stock company "Low-power Engineering", the "Special Design Bureau for Engineering, Main Engineering Office” (Nizhny Novgorod), the joint-stock company "Atomenergo", the state enterprise "Rosenergoatom" and the "Baltic Shipbuilding Factory".

"At the beginning of December [1999], the Russian Federation Minister of Atomic Energy, U. Adamov, visited Pevek and the Bilibinsk NPP. During his trip, the Minister met with the governor of the Chukotsky autonomous area, A.Nazarov. At this meeting matters concerning the construction of a FNPP in Pevek were considered. Both sides recognised the need for a short time delay in the construction of the FNPP and agreed on mutual cooperation in their search for the needed investments to implement the project.

"Atompress", № 44 (375), December 1999, p. 4.

The intention to develop FNPPs is reaffirmed by the Russian Federation decree № 815, "Declaration of the development of a programme of atomic engineering by the Russian Federation in the period 1998-2005 and perspectives until 2010", dated 21 July 1998. It considers the building of low-power energy sources based on nuclear fuel in order to provide energy to the remote regions of the Far North (Chukotsky Autonomous Area) and the Far East (Primorsky Area). The programme stipulates that the development of a new generation of NPPs is to be financed by the federal budget.

Also E.Ignatenko, the general director of the state enterprise "Rosenergoatom", confirmed the programme of operations for 1998, including the development of a document addressing, "The grounds for investing in the construction of a low-power nuclear plant in Dudinka". In August 1998, Minatom presented the FNPP-project for Dudinka. As owner and operating organisation of the project, "Rosenergoatom" has taken responsibility for financing the construction of the floating thermal reactor and the mooring and coastal infrastructure. In 1998, "Rosenergoatom" began work on the documentation substantiating "investments in the construction of a floating nuclear power plant with KLT-40C reactor installations in the Dudinka region", and in 2005, as approval has already been given by GosAtomNadzor, a FNPP should begin operations in Severodvinsk.

The "Declaration of the development of a programme of atomic engineering by the Russian Federation in the period 1998-2005 and perspectives until 2010" foresees a total state investment in atomic engineering of 2,600 million RUR (81% of which was to be made available in 1998) to be included in the "Federal address investment programme in nuclear industry for 1999", (part of the Federal budget of Russia for 1999) and the list "…of the Russian Federation Government's major priorities". These resources should also have been channelled into the development of the technical and economic justification for promoting the development of FNPPs" (Yablokov, 1999).

With regard to the manufacturing of reactor equipment and the long production time needed, orders were already made several years before the necessary permits were received from GosAtomNadzor in 2003. As a consequence, a great deal of equipment was already produced before safety and quality requirements were defined by GosAtomNadzor.

From an interview with the chief engineer of the "Izhorsk factories" V.Petrova (Pinchuk, 1999).

"In the near future, five new energy units will be constructed at Russian nuclear power plants to substitute present units... The Petersburg machine-building firm will be contracted to manufacture reactors and reactor equipment for these new units... It is possible that the Petersburg machine-building firm will also produce reactors with a power output of 40 MW for a FNPP in Pevek, which is currently being designed in Chukotka..."

Summary

The idea of creating FNPPs originated in the USA, but did not come to fruition due to obvious inherent economic drawbacks. Today, a number of large organisations from several Russian cities are involved in the implementation of a project aimed at constructing FNPPs consisting of two KLT-40C reactor installations. Minatom has obtained permission from all involved state departments, up to and including the Government and the State Duma of the Russian Federation, for completion of these projects. The planned FNPP in the Pevek region (North-Eastern Siberian Sea) is viewed by Minatom as the first in a series of FNPPs. Further FNPPs are planned for the Yenisei region (Dudinka), the Laptev Sea (Tiksi), the Bering Sea (Providenie and Egvenikot), the Okhotsk Sea (Evensk, Okhotsk), the Kamchatka Peninsula (Viluchinsk), the Sea of Japan (Pudnaya Pristan, Nakhotka, Bolshoi Kamen) and the Arkhangelsk Area (Severodvinsk).

Chapter 2. The Main Properties of the FNPP Project

The FNPP consists of two nuclear reactors, 2 turbo-generators, electro-technical equipment, a backup diesel and boiler installation, and residential premises for servicing staff. (Hereinafter all descriptions of technical characteristics of the floating NPP are given according to the Declaration..., 1996; Appeal..., 1997; Brief reference..., 1997; Task..., 1998, A. Kuznetsov, 2000). It is a non-propelled construction with a rectangular, smooth deck, a design which has been copied from ice-breaker vessels (Pic.3).

Pic.3. Design of a FNPP (longitudinal section).

1 - Living area
2 - NPP operating room
3 - Reactors
4 - Steam turbine installation
5 - Power generation area
6 - Storage area for spent fuel

The main technical properties of the FNPP project are listed in Table 2.

The Main Technical Properties of the FNPP for Pevek
(Brief reference …, 1997)

Table 2

Parameter	***Value***
Length	140.0 m
Width	30.0 m
Height	10.0 m
Section under water (draught)	4.5 m (*)
Displacement	18,400 m^3
Type of reactor	KLT-40C (Pressurised light-water reactor)
Number of reactors	2
Thermal power	2 x 148 MW
Steam generation	2 x 240 t/h
Steam pressure	3.8 MPa
Steam temperature	290°C

Water temperature in second cooling circuit	105° - 170°C
Output properties when running in:	
Maximum electrical energy mode	2x35 MW
Electrical energy & heat/hot water mode	2x30 MW
Maximum heat generation	2x35 Gcal/h
Fuel load (Uranium-235)	2x996 kg
U-235 enrichment	60 %
Maximum operation period until fuel exchange	608 days
Operational hours per year	7,200 hours
Energy generation	432,000,000 kW/h
- of which reused for systems operation	30,240,000 kW/h
- net energy generation	401,760,000 kW/h
Heat generation	360,000 Gcal
- net heat generation	360,000 Gcal

(*) If spent fuel is stored on the FNPP, the maximum draught is 5.6 m, which requires a minimum mooring depth of 9 m in order to have sufficient water for cooling purposes.

Water inlets and outlets are placed on the sides of the vessel. The draught of the vessel can vary depending on whether it is used simultaneously to store spent fuel. The FNPP project foresees a variant which includes all the necessary installations for autonomously refuelling the reactors and storing spent fuel. This would allow for operations for 10-12 years until the next major maintenance cycle.

The main equipment has a projected operational life span of 40 years and it is anticipated that the steam turbines will be in continuous operation for 7,000 hours. The maintenance cycle foresees that when a FNPP is undergoing repairs, a replacement vessel will be commissioned. After completing the scheduled overhaul and replacement of fuel, the operations concept foresees that the FNPP will be used at an alternative location.

All newly assembled FNPPs will undergo test cycles to ensure the safe and efficient production of energy and heat. Following the elimination of any detected malfunctions, the FNPP will then be towed to its place of use. Here it is moored on a jetty or just fixed by anchors. In its place of operation, a ring of protective buffers should shield the FNPP from waves and/or the build-up of ice. Additionally, infrastructure needs to be installed at the shore which is capable of distributing the generated power and heat (Pic.4).

Pic.4. A FNPP attached to its protective mooring.

The Murmansk Marine Shipbuilding Company has proposed to train operators of the future FNPPs, as they possess relevant experience with the exploitation of nuclear powered icebreaker.

The experience of Russia with nuclear naval reactors is large. Until the beginning of the 1990s, the USSR built 256 nuclear powered ships, including 243 submarines, 3 cruisers, 1 spy ship, 8 icebreakers and one transport vessel (lighter). Based on open source information, between 466 and 481 nuclear reactors were in operation on board of these ships. However, doubts have surfaced as to the advisability of using nuclear energy on FNPPs as well as to the reactor type selected by the projectors designers. The reason for these doubts stems from the fact that five of the nuclear submarines have sunk following accidents on board. Furthermore, there has been a spate of problems with the fleet of nuclear icebreakers and around 150 of the nuclear reactors serving in the Russian North and Far East.

Chapter 3. Properties of the FNPP Reactor and Steam Turbine Installations

The KLT-40C steam-producing reactor is an installation with a pressurised light-water reactor. The reactor, steam generators and main circulating pumps are basic elements of the first circuit and are built as a mono-block. The block is installed in a metal-clad water tank.

3.1. Properties of the Reactor Installation

The reactor consists of a body, a top cover, and a reactor core, which can be lifted out for servicing. On the cover of the reactor, two different groups of regulating drives are installed. One group of drives (SGs) with five suspended B_4C-filled rods is used for regulating the chain reaction during normal operations and thus increasing and lowering the energy generated in the reactor. In the case of an emergency, four accident-protection mechanisms (APMs) consisting of a spring mechanism, a servo-drive and an asynchronous electromotor would insert additional B_4C-rods and thus stop the chain reaction.

Also on the top of the reactor are two devices regulating the reactor pressure (PRDs). They serve as backup systems in the event of an emergency resulting from a safety system failure. If the pressure in the first circuit exceeds 200 kg/cm^2, one of the PRDs will switch off the four electrical motors operating the APMs, whilst the other PRD will de-energise the SG step motors. As a result, the B_4C-rods fall into the reactor by the force of gravity. To restore power to the APM and SG drives, the PRDs must first return to their initial positions, which can occur only after pressure in the first circuit has decreased to atmospheric levels. The PRDs are returned to their initial position manually using a special lever system for making adjustments to the reactor cover.

When compared to icebreaker reactors, the design of the FNPP reactors includes fundamental modifications. In order to increase reactor power, steel screens cladding the inside of the reactor were removed. To protect the personnel from the thus increased stream of neutrons produced in the reactor, the water layer (which serves as a neutron-absorbing shield) between the reactor core and the outside vessel needed to be enlarged. This results in an overall increase of the reactor diameter.

The reactor core itself follows a classical design of fuel rods which can be replaced, once they are spent, and sent for reprocessing.

The steam generators are straight-flow, vertical, cylindrical, tube-like devices. This tubal system is made up of spiral pipe coils.

All sources of ionizing radiation (i.e. reactor, steam generator, pumps in the first cooling circuit, special water purifying system, storage area for spent fuel, etc.) are installed in a steel and concrete tank which itself is installed in a water basin. The whole area is hermetically sealed and can be accessed only through a system of sluices. This design is intended to withstand pressure increases even in the most extreme emergency situation imaginable (which would be a full rupture of a pipe in the first circuit). In the event of an emergency pressure increase inside the steel and concrete tank, emergency valves will open and the air-vapour mixture will be directed into the surrounding water basin.

The security system of a KLT-40C reactor is made up of:

- A reactor control and protection system
- An emergency core cooling system
- A emergency protection system for the reactor core in the event of over-pressurisation
- Emergency valves depressurising the first cooling circuit into the surrounding water basin
- A heat condenser system
- A system for putting a liquid absorber (CdNO3) into the primary coolant, which will transport it into the reactor core
- Pressure-regulating devices (PRDs) cutting off the power supply to the SG and APM drive mechanisms at core pressure levels exceeding 200 kg/cm2.

As described above, the emergency shutdown of a reactor is achieved by inserting absorber rods into the reactor core. In the event of power failure to the absorber rod drives, the rods are pulled down into the reactor core by their own weight and the help of springs. The retaining electromagnets are switched off either by a PRD signal triggering the start of an automatic "APM" programme, or manually by a control operator pressing the "APM" button.

As an option to prevent a renewed increase of reactor reactivity once the absorber rods are returned to their initial position, and before the reactivation of the reactor’s APM system, a liquid absorber (CdNO3) can be fed into the primary coolant. The CdNO3 solution is stored in an external tank connected with a pipe to the first cooling circuit.

The emergency cooling system for the reactor core consists of three high-pressure electric pumps and a separate tank which contains normal water. After the lowering of pressure in the reactor core, cooling continues by means of a backup feed pump. In order to continue cooling the reactor core once the emergency cooling water tank is empty, it is possible to recirculate water from the water basin surrounding the reactor by using an additional set of pumps.

Heat is removed from the first cooling circuit during normal operations as well as emergency situations by two different independent systems: firstly, by water evaporated in the second circuit which then powers the steam generator; and secondly, by a third cooling circuit in the surrounding water basin which goes through a heat exchanger.

A further component of the emergency localisation system is its containment. This dense steel shield is designed to withstand pressure increases expected in the worst case scenario, namely the full rupture of a pipe in the first cooling circuit. The containment totally encloses the surrounding water basin. Within the protective shell, an emergency blowdown system is installed, which consists of a water basin, to which fresh water can be added, and a sprinkler system for reducing gas and pressure build-up.

3.2. Properties of the Steam Turbine

The TK-35/38-3.4 steam turbine includes a steam flow control system, a shaft-turning gear, a steam distribution system with shut-off valves, and a regulating and protection system. The technical properties of the turbines are presented in Table 3.

Tab. 3.

Technical Properties of the TK-35/38-3.4 Steam Turbine
(Brief reference …, 1997)

Parameter	Value
Electrical power on the generator terminals (assuming a generator efficiency of nominal 98%)	35 MW
Heat generation	25 Gcal/h
Steam production Steam reaching the turbine (the remainder is condensed in the second cooling circuit)	221 t/h 220 t/h
Steam properties at entry of turbine section: - Pressure - Temperature	 3.43 MPa 285
Consumption of sea water for cooling purposes (entire FNPP)	5,400 m^3 /h
Consumption of sea water for cooling of steam generators	5,000 m^3 /h
Steam consumption in the turbines	6.31 kg /kW*h
Temperature of water on return into the sea	23.4° C
Turbine efficiency	32.7 %

Note: The technical properties of the steam turbines are given for an average sea water temperature of 10° C. The temperature of this cooling water can range from 5 to 25C. The anticipated operation span of the steam turbines is estimated at 40 years, the time between servicing/repair at 10-12 years, and the period of continuous operation at 8,000 hours per year.

Chapter 4. Drawbacks and Risks of the FNPP Design

Both the designers of the KLT-40C reactor and those responsible for assessing safety and providing an estimate of total expenditure for the FNPP project as a whole, claim that all their efforts have been in accordance with the requirements of Normative Documents (ND) regulating equipment reliability and nuclear and radiation safety. However, it can be proven that certain elements of the reactor installation and the FNPP do not correspond to, or are in fact violating, these ND requirements.

In view of all the errors made in the design and justification for the project, it is difficult to believe the FNPP developers' claim to have in-service experience on the USSR/Russian nuclear icebreaker fleet (which employ similar nuclear reactors). Moreover, this in-service experience itself could lead one to doubt even more the KLT-40C reactor's reliability and safety given the string of difficulties which have plagued the icebreaker fleet (see Appendixes 2 through 4). Even the general designer of the KLT-40C reactor, Academician F. N. Mitenkov, has recognised the need for modifying the construction design from that of the icebreakers as the ND for military fleet vary fundamentally in comparison with civil nuclear installations (V. Kuznetsov, 1996).

However, it is clear from the FNPP design that no *major* alterations have been made in the design of the reactor compared to that used in the nuclear icebreaker fleet. At the same time, those *minor* changes which *have* been made in the reactor design (i.e. radiation-shielding) prove that experience gained in the operation of an icebreaker reactor has no validity vis-à-vis a KLT-40C reactor installation (V. Kuznetsov, 2000). The most noticeable change is the removal of the steel screens around the reactor core in order to increase power output. So as to still provide sufficient shielding from the neutron stream of the reactor core, the water basin enclosing the core has been enlarged resulting in an increased reactor diameter. It is important to note that for the construction of a nuclear reactor with an enlarged body, considerable changes are needed in technology and quality control. Such a design modification has not been tried and tested for reliability, especially over the projected 40-year operational period.

Nuclear engineers themselves admit that, in general, pressurised light-water reactors do not provide an adequate level of safety. In these reactors, water is used at the same time as a neutron-moderator and a coolant. If in the first circuit of a water-cooled reactor there is an uncontrolled water leak, or if the water stops circulating in the cooling system for other reasons, the destruction of the reactor core and a subsequent emission of radioactive particles are possible.

Academician V. I. Subbotin, 'Speculations About Nuclear Engineering', 1994, p. 53 and p. 101.
"Water-cooled reactors, despite all the experience gained in operating them, are generally not very safe... It is impossible to create safe nuclear engineering solutions on the basis of water-cooled reactors."

Possible reasons for emergencies in water-cooled reactors are:

- If the sealing of the fuel rods deteriorates, fission products leak into the water, increasing radioactivity in the first circuit. For Soviet reactor models such as the B-230 and B-179, the average deterioration in sealing is 3.5×10^{-5} occurrences/year. For reactors such as the B-1000 the rate is 1.2×10^{-5} occurrences/year.
- For various reasons, intensive evaporation can occur in the first circuit leading to a steam explosion.
- Construction materials used in the walls of the reactor body and the pipes could be faulty.

Another novel element introduced in the KLT-40C design is the PRD device for emergency shutdown of the reactor. However, there is insufficient relevant in-service experience with this new design. Firstly, the PRDs were not subjected to the necessary comprehensive checks by installing and testing them on an operating, reliable reactor system. There is limited experience with PRDs both in terms of the length of time they have been in use, as well as in terms of the number of accidents during which pressure in the first circuit rose to 200 kg/cm^2 or more. Secondly, the PRDs link the electric circuits of all the SGs and APMs thus creating inter-dependence between these elements. This PRD design infringes normative documents regulating the full independence of reactor control devices, which is a fundamental nuclear safety requirement. The PRD design solution is not further justified in the project and there is no confirmation of its reliability by in-service experience.

However, the most critical element in the KLT-40C reactor installation, for which adequate in-service experience is still lacking, is the "liquid absorber system". This system contains an aqueous solution of cadmium-nitrate ($CdNO_3$, cadmium is a neutron absorber), which can be fed directly into the reactor. The liquid absorber should be used in case of a failure of the SG and APM safety (i.e. the absorber rods do not fall into the reactor core). However, the operation of the "liquid absorber system" is awkward and needs several hours for mounting and start-up. Furthermore, it does not comply with different ND requirements and is so complex that it would probably fail when needed, which all in all makes it unsuitable for an emergency situation.

Also the analysis of emergency situations which have occurred to date in boat and submarine reactors (Pavlov, 1997) and subsequent comparison with the properties of the FNPP show **important omissions in the current FNPP documentation**:

1. Despite the fact that on a light-water reactor one cannot exclude the possibility of an emergency resulting from the fusion of the reactor core, no calculations have been made for such an emergency scenario. This is an important omission since the failure to design a sufficiently strong containment could lead to radioactive releases into the environment.
2. There is no consideration of the fact that the majority of accidents at NPPs occur due to errors, or violation of regulations, on the part of staff members. Current FNPP documentation does not specify how work regimes are to be established to minimise the possibility of human errors.
3. No details are provided on how the reactor should continue to be cooled during normal operations and maintenance, or in an emergency, if the reactor does not provide electricity.
4. There has been no discussion on how the catastrophic drying-up of the reactor core could be reliably prevented in the event of a rupture of the primary cooling circuit.
5. No consideration is given to how to reliably prevent the unauthorized start-up of a reactor.
6. There are no provisions for inspecting the integrity and safety of the reactor area.
7. Project documentation does not discuss an emergency where the absorber rods do not fall into the reactor and a core meltdown occurs.
8. Based on the argument that such a situation has never occurred in history, no analysis has been made of an emergency in which the entire reactor installation is destroyed.

The designers of the floating NPP claim that, "... the probability of a serious emergency resulting in fusion of the reactor core and destruction of the containment is considered to lie within internationally accepted standards " (Veksler and Panov, 1994, p. 41). This statement is poorly justified given the wide range of new design solutions and the wide range of possible minor faults - each of which could potentially spark a catastrophe.

Whilst carrying out the public expert review of the FNPP project, the group highlighted the following issues:

1) There is no NDs on nuclear, radiation and environmental safety for FNPPs. The development of relevant NDs would automatically lead to a full re-evaluation of the already existing design documentation.
2) The FNPP design documentation contains a large number of faulty or weak approaches to safety. Many technical, technological, organisational and methodological solutions have not been thoroughly worked out. Nor does the design documentation comply with the normative requirements for nuclear and radiation safety in atomic engineering.
3) Project design needs to include a non-destructive method to control the primary cooling circuit during operation and also a method of detecting micro leakages in the primary circuit's pipe system and equipment.
4) The safety analysis describes a series of initial events leading to an emergency. However, no consideration has been given to the so-called "human factor". And yet human errors could lead to:

    i) A ship sitting on a bank with a tilt of e.g. 30 degrees. This can make it more difficult to use cold seawater to cool the reactor.
    ii) The overturning of the entire platform leading to damage to the reactor core equipment and making it impossible to insert the absorber rods.
    iii) The sinking of the platform.

Furthermore, due to insufficient knowledge of the future mooring areas for FNPPs, it is not possible to calculate the risk from natural catastrophes such as earthquakes. In short, the simplified approach which has been used to review the FNPP project, together with the lack of consideration given to the series of potential emergency scenarios, suggest that not all the necessary substantiations have in fact been made. Substantiations concluded to date are no more than an analysis of the incidents in which the limits and conditions of safe operation would be infringed.

Further, no investigation has been made into the measures to be taken, in the event of an emergency, to *contain the development* of a dangerous situation.

- There is no established emergency communication system between staff at the FNPP and the operating organisation "Rosenergoatom", or the GosAtomNadzor, or supervising authorities, or the municipal authorities, or even the civil protection organisation.
- There are no control systems for monitoring normal and emergency situations in the reactor.
- No consideration has been given to how to minimise risks during exceptional and rare activities like the exchange of fuel rods in the reactor.

The FNPP programme also does not provide sufficient substantiation of safety levels in the case of:

- Defects in the materials of the reactor area.
- A crash of an airplane, helicopter, etc. onto the FNPP.

In addition:

- There are no coefficients of thermal reliability for used system components.
- The assumed temperature range for seawater used for cooling the reactor (5-25 ^{0}C) is incorrect, as the water temperature in the Arctic sea is much lower and can even drop below zero degrees (because of its salt-content). Despite this fact, the current design does not foresee pre-heating of seawater before its insertion into the main condenser.

Further omissions in design documentation include information on what to do in the event of:

- The destruction of a nipple or large size steam conduit in the steam generator in the secondary circuit.
- The inability of the PRD-system to introduce the absorber rods in the course of an emergency combined with an inability to feed the liquid absorber into the reactor core.
- The freezing of the emergency third cooling circuit (which goes directly from the outside to the reactor core) due to the use of cold overboard water (-2^{0}C).

Closer consideration should also be given to the claims by the FNPP developers that the reactor installation can operate for a 40-year period at a rate of 7,000 hours/year. Over the course of 40 years this would constitute 280,000 hours of operational activity.

> The question of, "The extension of the operational capacity of equipment of nuclear-powered icebreakers and container ships in the NSTI-system" was discussed at the Interdepartmental Section № 9 of the Technological Council № 1 of Minatom on 26 June 1997. At first, NSTI [=Scientific-Technical Council] equipment had a projected operational capacity of 50-60,000 hours over a 10-12 year period. These figures suggest that FNPP equipment would need to be replaced 2 or 3 times during a 40 year period. Normative documents regulating icebreaker nuclear reactors do not currently stipulate the need to install so-called "rod-witnesses" (which are used to assess material fatigue due to the intense radiation level in the reactor core). In 1998, however, Minatom together with the Scientific Research Centre "Kurchatov Institute" and the St.Petersburg Institute "Prometheus" analysed metal pieces from the stopped reactor of the atomic-powered icebreaker "Lenin". This research work was successful in extending the operational period of existing nuclear-powered icebreakers to a total of 175,000 hours (report contained in the Centre SRI publication Atominform № 5, 2001, p. 64). However, even with this ex-

tension, the equipment would still appear to have 1.6 times less operational capacity than that claimed for the KLT-40C reactor!

Thus it follows that when operations begin at the FNPP reactor installation in Pevek, or in Severodvinsk, it will only be viable to speak of a projected 25 years of use and not of the claimed 40 years. Further, on the basis of in-service experience on nuclear-powered icebreakers, it is necessary to adjust all FNPP technological and economical parameters to the weakest element in the energy production chain, i.e. the steam generator of type 18-T. This would further reduce the operation time to 35,000–65,000 hours. There is no doubt that one consequence of these corrections will be a considerable increase in the price of the energy produced by the FNPPs.

The above summary of flaws in the FNPP project shows the impossibility of simply using a nuclear icebreaker reactor for power generation on a FNPP without applying fundamental changes to the reactor design, as has also been recognised by the general designer, Academician F. Mitenkov.

Given the design solutions currently proposed for the FNPP project and the main equipment chosen, there is little hope that the high accident risk of a KLT-40C reactor system can be substantially reduced in any way.

According to the experience gained from previous accidents on mobile reactor installations (see Appendixes 2 through 4) and also taking into account what has already been said in this chapter, we can assume that the probability of a major accident on a FNPP is much higher than at a traditional, large NPP. Furthermore:

> ***"In the period from 1 January 1991 to 31 December 2002, there were 1,247 violations of operational procedures at Russian NPPs. These violations took place despite the fact that Russian NPPs were only working at an average of 55-60% of their capacity (international average is 80-85 %). Output capacity is down not only because of limitations in the load balancing, but also because of limitations introduced in connection with the insufficiencies of some NPPs (blocks 1 and 2 of the Kursk NPP). Two thirds of the problems happen on reactors of type WWER-440 and WWER-1000. The poor state of NPPs is aggravated by considerable physical wear and tear on equipment, and lack of reliability and inconsistencies in design solutions which date from the early days of nuclear power exploitation. The poor state of NPPs comes also from the long-term use of nuclear energy for peace and defence purposes without any statutory regulation. This has produced numerous problems requiring an urgent solution (like the shut down of reactor blocks of first and second generation, the need for upgrading the other operating reactor blocks, storing and handling of radioactive wastes etc.). During the last 20 years there have been repeated incidents, for which Russian nuclear engineers were not able to work out solutions. For example, the total number of steam generators at NPPs which have had to be replaced at WWER-1000 reactors, has already exceeded 30. The latest replacement of all steam generators was carried out in 1999 on the second block of the Balakovskaya NPP. Despite a projected operational period of 30 years, the generators had to be replaced after only 12 years. (Note: the same situation with steam generators also occurs on nuclear powered ships). Currently, none of the operating NPPs have a complete and procedurally correct substantiation of safety containing reliable conclusions about the state of safety and the analysis of possible consequences of discovered safety issues".***
> **(V.M. Kuznetsov, 2004, Ref. http: // www.greencross.ru)**

To summarise, it is clear from the information presented in this chapter that the designers of the KLT-40C reactor installation and the proponents of the FNPP have neither added

anything important or new to the reactor safety mechanisms, nor have they increased the efficiency of the present systems. At the same time, the PRDs, which they have incorporated into the control and safety systems of the reactor, have rendered the reactors even more dangerous and have highlighted the inconsistencies of this project with regards to requirements in the Normative Documents for NPP safety. It is, therefore, difficult to agree with the projectors' claims (Appeal ..., 1997, p. 25) that the probability of a serious damage to a reactor core is less than 10^{-5} per year, and that the probability of an emergency with a release of radioactivity into the environment is less than 10^{-7} per year (that is lower than the values for traditional NPPs).

PART II. CAN A FNPP BE PROFITABLE?

Part II will consider and analyse available data on the major economic aspects related to the FNPP project.

Chapter 5. Economic Perspectives for the FNPP

During the Soviet era, the costs of constructing a NPP were covered by governmental funding, and nuclear engineers were not overly concerned about providing accurate cost calculations, since they knew that any additional expenditure incurred would eventually be covered by a revised budget.

The designs for the current FNPP project were also carried out with federal budget financing under article 2 of Minatom order № 523 dated 29 November 1995. However, changes in the economy over the last few years have resulted in a considerable increase in the conditions which need to be met before an expensive and long-term project can be authorized. Purely ideological arguments can no longer take precedence over economic feasibility. Furthermore, policy approaches to issues of environmental safety are also changing. With regard to the allocation of land for nuclear installations, for example, the relevant authorities are coming under increasing pressure to tighten safety legislation governing these sites. This is essential if we are to avoid the reoccurrence of the kinds of nuclear disasters we have witnessed both in Russia and overseas.

Let us consider in greater detail the way in which funding of new NPP projects has undergone fundamental changes. At present, the federal budget can no longer be considered as the main source of financing for the construction and subsequent operation of a FNPP. Under these conditions, NPP project funding can only be secured through commercial loans which subsequently need to be repaid. What impact is this new approach to funding likely to have on the FNPP project?

In 1997, the total cost of designing and building a pilot installation in Pevek was estimated by Minatom at $254 million (Brief reference..., 1997). Adding the costs of construction of social infrastructure (about 10%), the FNPP pilot facility was estimated to cost $279.4 million (see Table 4).

According to the same data, no finances have been earmarked for effecting changes to the technical design between the pilot installation and the serial production. In shipbuilding, however, the inclusion of such expenses is normal practice. In the past, design changes have tended to cost several million dollars and, although this does not constitute a major increase in the overall costs for the project, it does demonstrate the way in which Minatom has a tendency to mislead private and state investors.

The figures posted on the Minatom website in January 2001, concerning the costs for installing a FNPP in Severodvinsk, greatly underestimated the real expenses. Referring to anonymous international experts, the Minatom press office stated the ‘approximate’ costs for the project as $150 million: namely, the platform would cost $120 million and the on-shore installations an additional $30 million. These costs are lower than the $149 million and $43 million estimated by the designers of the FNPP (see lines 4 and 5 of Table 4) and considerably lower than the costs of the similar FNPP in Pevek (estimated at $280 million).

As already stated earlier in this chapter, expenditure for the design phase of the project was covered by budgetary funds (i.e. with ‘taxpayers’ money). Nevertheless, four significant line items, which are listed in Table 4, appear to have been forgotten.

Tab. 4

Costs of FNPP construction (in 1991 prices, based on the FNPP project in Pevek)

(Brief reference …, 1997)

Item	Pilot facility in Pevek (USD)	Serial unit (USD)
Technical-economic justification	4.000.000	4.000.000
R&D and construction of test items	15.000.000	0
Facility design	43.000.000	5.000.000
Construction of FNPP including elaboration of operation documentation	149.000.000	133.000.000
Creation of on-shore facilities and infrastructure for technical services	43.000.000	43.000.000
TOTAL	254.000.000	185.000.000
Total construction costs for FNPP (including 10% cost increase for social infrastructure construction)*	279.400.000	203.500.000
Decommissioning of the FNPP	55.880.000	40.700.000

*According to Decree № 763 issued by the Government of the Russian Federation on 15 October 1992, entitled “About measures for social protection of the population living in territories within proximity of nuclear power plants”

The figures in Table 4 would indicate that Minatom has grossly underestimated the costs of constructing a FNPP. Furthermore, it must be noted that the figures in Table 4, which were provided by the designers of the FNPP, fail to mention such significant expenditure items as coastal infrastructure construction under the harsh conditions of the North; land and underwater security installations; construction and servicing of small sized vessels for maintenance and of a specialized tug boat capable of quickly towing the FNPP to a safe location in the event of an emergency.

Let us focus now on the cost of decommissioning FNPPs once they have completed 40 years of operations. Recent Minatom design documents have, for the first time, made reference to the need to include plans for decommissioning NPPs. However, in current financial calculations no consideration is given to the need to generate a decommissioning fund, though this would impact the costs of the generated energy.

Given that there have already been gross underestimations of expenditure, it might well be that the cost proposals currently put forward for the purpose of decommissioning (55 million US dollars) are also well below the sums which will, in reality, be needed. In the case of a normal NPP, expenditure needed for decommissioning down to a green field can exceed half of the initial construction costs. If this is also the case for a FNPP, then decommissioning would necessitate approximately $150 million. However, it is quite probable that Minatom will try to cut costs in this area, which leads one to question how expenditure can be reduced whilst, at the same time, ensuring the safe storage of radioactive waste from decommissioning.

There are grounds for believing that Minatom will prolong as long as possible the practice of burdening taxpayers with a considerable proportion of its expenditure. Table 5 summarises some of the economic parameters surrounding the FNPP project.

Tab. 5

Main economic parameters of FNPPs (in 1991 prices) *.

(Brief reference …, 1997)

Parameter	value
Life time of FNPP	40 years
Return on invest (from plant start-up)	8 - 10 years
Estimated cost price for electrical power	0.1-0.12 USD/kWh
Estimated cost price for heat	80-100 USD/Gcal
Number of staff at plant	55 persons
Cost of fuel	91,670 RUR/(kg U-235)
Costs of fuel change	182.97 million RUR per reactor
Cost of final storage of spent fuel	1,670 RUR/(kg U-235)

Note: The value of 1 RUR in 1991 has been fixed at 1 US-Dollar in the design documentation ("White book of nuclear power engineering". Edited by Y. O. Adamov, 1998, page 269).

Looking at the nuclear fuel costs contained in Table 5, it is clear that the Russian prices given are too low and do not reflect real costs incurred.

In the course of the last 10 years, "Rosenergoatom", as the federal body responsible for all Russian NPPs (except for the Leningrad NPP), has carried out the decommissioning of the Beloyarsk and Novo-Voronezh NPPs. However, Minatom is also known to have made repeated requests to the Russian Government for state funding for work in the field of decommissioning. With regard to submarine reactors, the costs of decommissioning nuclear submarines has, until recently, been largely financed by Norway and the USA.

Because there is such a wide margin of variability between one project and another, practically all the economic parameters listed in Tables 4 and 5 are questionable. For example, conditions in Dudinka should lead to lower expenditures as compared to a similar project in Pevek. Also, where two FNPPs are operating side by side, costs can be considerably reduced. Moreover, it is not clear to whom in Dudinka Minatom intends to sell such huge quantities of energy (see also further below).

Continuing with the issue of decommissioning, it is unclear as to where in the designers' calculations the following costs are accounted for:

- total cost of storage and recycling of radioactive wastes (including transportation);
- costs of refuelling;
- costs for the delivery of fresh fuel and the transportation of spent fuel;
- costs for transportation of the FNPP after 10-12 years of operations to its servicing site;
- costs of servicing and repairs (tens of millions of dollars);
- docking costs during the servicing of underwater components of the FNPP;
- interest repayments and repayment of credits;
- increase in costs due to the effects of inflation;
- costs of decommissioning the FNPP (in other countries, analogue costs equate to roughly 10% of the cost of each kW/h of spent electricity over the whole operational period);
- costs of insurance; and
- costs for creating a compensation fund for potential damage incurred during FNPP operations.

In calculations produced by Russian nuclear engineers, no estimations have been given for variations in the costs of fuel during the lifespan of a NPP. This leads one to believe that the main source of fuel is to be the uranium from decommissioned nuclear warheads. This uranium was received by Minatom 'free of charge', respectively at the expense of past defence budgets financing the production of weapons uranium.

It is quite likely that a detailed economic analysis would reveal additional factors which could contribute to an increase in the costs of the project and which, nevertheless, remain unaccounted for. One such example is the question of terrorism. This growing concern has been entirely overlooked by the Minatom economists, despite the fact that the installation of a reliable security system is essential if a FNPP is to be effectively protected against a terrorist attack and/or the theft of several tons of highly-enriched uranium suitable for the production of a nuclear bomb. Suffice it to say that any guard unit in the Russian Arctic Region would need to include military ships with hundreds of servicemen and a reliable warning and communication system. Furthermore, in the event that a FNPP were sold abroad, it would doubtlessly need to be accompanied to its new site by a group of Russian guard ships. This would, needless to say, increase operating expenditure considerably.

Two additional points need to be considered in order to complete this economic appraisal of the FNPP project:

Firstly, in accordance with the design papers, a FNPP requires a complete overhaul every 10 - 12 years. In order to maintain power production during this maintenance period, another FNPP will of course be necessary. In the words of the developers, “The main problem is not the construction of a pilot installation, but the construction of a series of FNPPs to ensure maximum economic efficiency and reliability...” (Veksler, Preobrazhenskaya, 1995, p. 5). That is to say, it will be necessary to have an additional FNPP in reserve to ensure that Pevek (or any other place which is being supplied by a FNPP) can receive a regular supply of heat and electricity in all eventualities. The need for a replacement FNPP is likely to arise long before the actual infrastructure is in place. An alternative scenario which may well occur is that, at the moment the reserve FNPP is needed, it is discovered that the installation has in fact already been commissioned at another site with the result that a new reserve FNPP would then have to be built. Despite these considerations, Minatom currently makes no provision for the building of such a chain of reserve FNPPs.

Secondly, insurance premiums worth several tens of millions of USD will have to be paid if Minatom-owned FNPPs are to be commissioned. This, naturally, will increase the cost of the project quite dramatically.

The FNPP project will only appeal to a potential investor if its expected profits exceed those which could be gained on a different investment with a similar risk factor. Let us, therefore, try to evaluate the on-going expenditure needed for the FNPP project taking into account interest rate payments. We will use as a starting point the official (but underestimated) figure of $279.4 million. With regard to the rate at which interest might be set, it is generally agreed that the lowest available interest rate for capital invested in the FNPP project is likely to be 10 %, however, a rate of 15-20% might be a more realistic figure. In Table 6, two scenarios are considered using interest rates of 10 % and 15 % respectively.

Tab. 6

Annual capital investment for the construction of a pilot FNPP in Pevek and incurred capital costs (million USD in 1991 prices)

(Brief reference …, 1997)

Expenditure	1st year	2nd year	3rd year	4th year	5th year	6th year	Operation launch	
	Justification of Investment and Technical Design		Construction			Tests	Total credit + accumulated credit costs	Annual capital costs
Capital investment (+ costs of initial fuelling)	12.6	25.2	75.3	84.0	78.1	4.2 (+70.0)		
Total expenditure (including 10% interest rate on invested capital)	12.6	39.06	118.266	214.093	313.602	419.162	461.078	46.108

Total expenditure (including 15% interest rate on invested capital)	12.6	39.69	120.944	223.08	334.649	459.046	527.903	79.185

The figures in Table 6 representing the costs for construction of a FNPP are more accurate than the calculations produced to date by Minatom.

Let us now estimate the revenue which might be generated by the FNPP operation.

5.1. Production of thermal and electrical power by the FNPP installation.

Given that the technical data for the KLT-40C reactor vary from one set of documents to another, the following calculations have been based on the highest envisaged power output as quoted in those documents:

Power output:
Maximum electrical energy mode: 2 x 35 MW
Electrical energy & heat/hot water mode: 2 x 35 MW (2 x 30 MW energy, 2 x 5 MW thermal)
Maximum heat generation: 2 x 35 Gcal/h

Tab. 7.

Basic characteristics of operational modes of FNPP

(Brief reference …, 1997)

Annual power production, per hour		7,200 hours
Total power generation	electrical power heat	432,000,000 kW/h 360,000 Gcal
- of which reused for systems operation	electrical power heat	30.240.000 kW/h 0 Gcal
- net energy generation	electrical power heat	401.760.000 kW/h 360.000 Gcal

The productivity of the plant is determined by several main factors, all of which contribute to the so-called capacity factor (CF). The CF describes the ratio of real (annual) output produced by the plant versus the output it could produce if it operated constantly and at full power. It should be borne in mind that no power plant works permanently at full capacity, and that there are daily and seasonal fluctuations in the use of energy.

The FNPP project specifies 7,200 hours of operation per year. Given that one year has a total of 8,760 hours, the capacity factor of a FNPP would equal 82%. However, the design documentation also stipulates that a total of two months per year are required for maintenance and repair work (24 hours x 60 days = 1’440 hours). For the annual CF to be 82%, therefore, the reactor would need to work with a CF of 98% in the remaining 10 months, something which is simply not possible. Furthermore, it is to be expected that the FNPP reactors will experience a daytime variation in demand for energy, which would compromise even further the projected annual CF of 82%.

Let us consider for a moment the operational parameters of the Bilibino NPP, which works under similar conditions to those anticipated for the FNPP. Since 1995, the CF of the Bilibino NPP has oscillated between 35 % and 40 % - a relatively low figure. It follows that, if the CF of the FNPPs should be similar to that of the Bilibino NPP, how will the project ever be profitable?

With regard to the operations forecast for Pevek, it should be remembered that the electrical power output of a FNPP is 60 -70 MW, depending on its mode of operations. Thus, a FNPP should be capable of generating enough power to adequately supply the town’s requirements. However, in order to meet the demand for energy during scheduled and emergency stops at the FNPP, backup capacities of at least 40 MW of power need to be constructed (e.g. coal thermal plant). Naturally, such backup energy production facilities should not lie idle. Together with the power produced by the FNPP, this would result in a total energy production capacity of 100-110 MW, which is an obvious surplus of the real needs. If the whole complex of energy installations including backup capacities were to work together, the CF would not reach 40% before the year 2010, at the very earliest, and even this will only be possible if the questionable forecasts by Minatom turn out to be correct.

Let us now define the CF of the Bilibino NPP up until 2015 (Table 8) using estimations found in the Minatom documentation.

Tab. 8

Predicted power consumption and maximum electrical power generation for the Chaun-Bilibino Region in the time period 2000 - 2015

	2000	2005	2010	2015
Power consumption,	295-320 million kW/h	315-365 million kW/h	360-420 million kW/h	410-475 million kW/h
Maximum electrical power generated	58-61 MW	60-66 MW	66-73 MW	72-81 MW
CF for a energy system with designed 110 MW power output*	31-33 %	33-38 %	37-44 %	43-49 %

*NOTE: the row containing the CF values has been added by the authors of this book.

Similar results are obtained with regard to the proposed FNPP in Dudinka. The projected electrical power consumption in Dudinka and its seaport, in the year 2005, is 330 million kW/h, with a CF of not more than 35-40 %.

A further question surrounds the distribution of the energy from the FNPP to Dudinka and beyond. Today, Dudinka is linked with Norilsk via an old 110 kW energy line on wooden supports, built 50 years ago. In the event that an FNPP should be installed there, the capacity of the present 110 kW line would be insufficient, and an entire new overland electricity line would need to be constructed. This would result in large additional costs which would put a further question mark on the economic viability of the FNPP project.

In order to further investigate the current capacity for heat generation in Dudinka and to be able to compare this with the power output of a FNPP, let us use statistics supplied by Minatom. According to these figures, the annual heat consumption of Dudinka is 930,000 Gcal. At present, heating for the town is generated by a range of gas boiler-houses with a total power generation capacity of approximately 250 Gcal/h. Calculations, which take into account seasonal fluctuations, result in an annual CF for the current heating system equal to 42%. In contrast, with a heat generating capacity of only 2 x 25 Gcal/h, the FNPP could provide only 20 % of the present output capabilities, which means that a single FNPP would not suffice to heat the town in the harsh conditions of a Northern Siberian winter. This does not, therefore, seem to create any economic incentive to move away from the much cheaper gas boiler-houses.

In line with the above estimations, it can be seen that financial returns on the sale of electricity and heat could be almost 50 % lower than Minatom would have potential investors believe (stated CF - 82 %, real CF - 40 %). Under these conditions, it is not simply a question that the payback period for the project will be much longer, rather it would appear that, taking into account interest repayments, the project would in fact turn out to be wholly unprofitable.

5.2. The cost of produced heat and electric power

Minatom calculated the price for electrical power generated by an FNPP as equal to 0,1-0,12 USD/(kW/h) and for heat as 80-100 USD/Gcal. However, it is difficult to understand how this number was calculated:

According to decree № 53/2 dated 1 December 1999, the Federal Energy Commission of Russia, in implementing the instruction No1651-r of the Government of the Russian Federation dated 16 October 1999, and also in view of the request of the Bilibino NPP to revise the price of electrical and heat energy, determined the following maximum prices for the Chukotsky Autonomous Area as of 1 January 2000:

Supplier	Cost of electricity (RUR / thousand kW/h)
“Bilibino NPP”	RUR 578,65 (approx. 0.022 USD per kW/h)

Supplier	Cost of heat (RUR / Gcal)
“Bilibino NPP”	RUR 279,13 (approx. 10.45 USD per Gcal)

Thus, the revenue generated from the sale of electricity can be calculated as follows:

0.022 USD/kW/h	(cost of electricity)
x 2 x 35 MW	(maximum electrical power generated at FNPP)
x 8,760 hours	(hours per year)
x 40%	(electrical CF of the FNPP)
= **5,396,160 USD**	(annual income from the sale of electricity)

The revenue generated from the sale of heat can be calculated as follows:

10.45 USD/Gcal	(cost of heat)
x 2 x 35 Gcal/h	(maximum heat generated at FNPP)
x 8,760 hours	(hours per year)
x 40%	(heat CF of the FNPP)
= **2,563,176 USD**	(annual income from the sale of heat)

Thus the total annual revenue amounts to **7,959,336 USD**

Let us now compare these figures with the annual operation costs of the FNPP (Tab. 9).

Table 9

Annual operational costs of a FNPP during its first 12 years (using 1991 USD prices). (Declaration … 1997)

	Item	USD
1	Annual expenditure on personnel	7,200,000
2	Annual expenditure on nuclear fuel	740,740
3	Annual expenditure on lubricants	80,436
4	Annual expenditure on consumables	43,353
5	Annual expenditure on running repairs of FNPP	425,920
6	Annual expenditure on repairs of hydraulic installations and mooring facilities	121,691
7	Annual expenditure on fuel reloading	112,396
8	Annual averaged expenditure on the lease of an tug boat/icebreaker to tow the FNPP to a place of maintenance	48,170
9	Annual averaged expenditure on the full overhaul of the	4,431,599

	FNPP	
10	Payments to the decommissioning fund	1,210,310
11	Amortization payments	19,163,237
12	TOTAL:	**33,577,851**

Summary:

In conclusion, our calculations show that the construction of an FNPP will require considerably more funding than is currently stated by Minatom – this increase might total up to an additional 500 million USD (see Table 6). This would result in annual capital costs of at least 50 million USD. The annual operation costs of a FNPP are estimated at approximately 33 million USD (Table 9). However, the plant will not be able to generate more than 10 million USD in sales annually.

PART III. IS THERE NEED OF FNPP ANYWHERE ?

In this part the problem concerning the necessity of FNPP in those two regions, about which Minatom speaks when planning the use of these nuclear plants, will be inevitably briefly considered.

Chapter 6. Is there need of FNPP in the Arctic region ?

Without regard to quality of the project, before beginning the construction of floating NPP it would seem to be necessary to answer the question: is there any need of FNPP in the Arctic region at all? It is more correct to formulate this question as follows: are there any other less ecologically dangerous ways of power supply of the Arctic regions of Russia costing the same (or smaller) amount of money, which is supposed to be spent on construction, use and putting out of work of floating NPP? Let's remind, that in this particular case we consider the sum about 335 million US dollars (according to atomic engineers' calculations) or, probably, twice greater sum (in real life) for one floating NPP in the region of Pevek.

Judging by the fact that there are no comparative economic calculations for alternatives (for example, the projects of constructing HECS (heat energy central systems) using gas, petroleum or coal in the regions, and also developing wind energy) in the project materials of FNPP for Pevek it is possible to approve, that the cost of any of these alternatives of electrical power supply will be considerably less than for « nuclear electricity ».

Electrical power supply of Pevek is provided by Chaun HES, electrical power supply of industry of the Chaun region - by Chaun HES and, partially, by Bilibino CNTS working for the general network of Chaun-Billibino energy power assembly. Energy power consumption of Chaun-Billibino energy power assembly achieved the maximum rating - 520 million kWt/h in 1988, and since 1990 it has been reducing steadily (in 1995 - 260 million kWt/h). Therefore we may speak about the substitution of running-out powers with spent resources**.** It also means that existing there powers are charged less than half and for the nearest years the problem concerning the lack of energy should not arise. There are some plans of prolongation of the life period of Chaun HES and Bilibino CNTS up to 2010. These plans are being realized now. Only after 2010 there can be the necessity for any new energy powers.

However such new energy powers should not be nuclear. At first, the reserves of wind energy are large in Chukotsky peninsula. Here the total potential power of wind energy is not less than 20000-25000 MWt. The considerable advantage of the industrial wind energy engineering in this region is their self-sufficiency. The modern wind turbine can reliably supply scattered in the large territories and isolated from trunk networks settlements and factories with energy. For wind energy produced by wind energy complexes there will not any need of building of expensive line of electrical transfers in which the appreciable part of produced is lost. Besides, the cost of wind energy received by means of the modern devices since mid 90s has become lower than at coal stations (less than 5 cents for 1 kWt/h). Let's also take into account the world tendencies in the development of wind energy: the increase of these powers for the last decade occurs avalanchely, and it forces out the traditional ways of producing of the electric power in a number of regions of Northern America and Western Europe and in other regions of the world. So, for example, in California the wind energy complexes partially substitute NPP ending their life.

Today the most expensive wind energy complex with power of 5 kw in Russia costs about 10 000 US dollars. For power compensation of FNPP it is necessary to have 14 000 such wind energy complexes. It will require only 140 million US dollars. Remained 195 million US dollars (from planed by atomic engineers for the construction of Pevek NPP 335 million US dollars: 335 - 140 = 195) will appear to be sufficient for adjustment of steady energy supply of the whole Chukotsky national region, the rise of its economy and culture development. The development of wind energy in Chukotka will allow to provide more people with work for a longer period than the use of FNPP will. According to the

Program of the development of fuel and energy complex of Far East (1993) nowadays the work on putting into operation of wind energy installations (WEI) in the Magadan area is being carried out. Here a station with power of 1MWt is under construction and also TEG of the wind energy complex with power of 50 MWt is being developed. In the Kamchatka area the Siberian Energy Institute plans the construction of WEI with power of 1 MWt for the work of the energy complex DES-GES-WES in Bering island. More than hundreds meteosettlements in Far East have been receiving energy supply from wind energy installations.

Heat power engineering that can work not only on coal but also on petroleum, fuel-oil and gas has considerable reserves in perspective. Chaun HES works on coal that is enough here. There are huge reserves of petroleum and gas in this arctic region . The authorities of the Chukotsky autonomous area is known to develop the schedule of the opening up of them and in perspective, even of export out of the region. It seems absurd and economically unjustifiable to us to put a question about the necessity of development of atomic engineering in the region having such reserves of petroleum and gas. Doubtlessly, 300 million US dollars will be enough to find, to extract and organize gas industry not only in Pevek, but also in the major part of Chukotka. By the way, and in « the Program of stabilization and development of power engineering in the Chaun-Bilibino industrial - economic region at the period till 2015 » prepared according to the order of the authorities of Chukotka, atomic engineering is not considered as the only possible solution of energy supply of Chukotka.

It is also necessary to notice that the population of Far North and Far East of Russia lives in the administrative centers in hard-to-reach places, in very small groups and at considerable distances, therefore realization of centralized heat central systems is unlikely to be economically justified.

In our opinion, in such areas it is more expedient to use the mobile steam-gaseous installations (they are produced in Kaluga) or more powerful fixed ones (they are produced in Samara) that have the total efficiency (electric power + heat) more than 80 %, that is the higher the lower the environmental temperature. Moreover these installations have minimum operating expenditures and can work practically on any kind of fuel.

The cost of such installations is cheaper than the cost of reactor installations, suggested in the project, KLT-40C, the service life is more and what is the most important in comparison with nuclear and even other ones, practically they are ecologically safe. The steam-gaseous installations can be set up on the ground, under the ground or on the water.

For your notice: the gas electric generators are used in gas industry for providing work of transferring gas-pipe stations. They work under very hard climatic conditions. RJSC ”UES” is building some electricity generating plants of a similar type at the Samara plant.

The similar remarks also concern economic expediency of constructing FNPP for Dudinka (the Norilsk industrial region). All the data promulgated by Minatom till now about economic ground of allocation of floating NPP in the region of Dudinka are of only declarative character. In these materials there are no data about economic expediency of construction of NPP in this region and there are no calculations of construction of HES used gas or wind energy installations with the same power in Dudinki .

In the Chukotka region as well as in Taimir peninsular there are rather large reserves of gas and gas condensate. Thus, if three of them (Severo-Soleninskoe, Messoyakhskoe and Yuzhno-Soleninskoe) have been developed or are in stage of dropping extraction, that the large Pelyatkinskoe deposit can give necessary for development of the region energy resources for the near future.

Also the calculations show economic inexpediency of construction of FNPP in the Dvinsky bay at Severodvinsk. The reason is the following: the high rates for electric energy and heat will not be acceptable at all for "Sevmashpredpriyatie" and urban municipal services because of the lack of perspectives of effective demand for electrical and heat energy of the plant.

It is absolutely clear, that there is no instant economic necessity of construction of nuclear stations for development and support of energy supply of the Russian Arctic Region. The intention of Minatom to build these plants is determined only by its desire to use remote arctic regions as experimental polygon for testing the new dangerous technologies. The support by regional authorities of the plans of Minatom concerning the construction of FNPP is largely determined by their tendency to receive extra financing at the expense of the federal budget.

Chapter 7. Is there need of FNPP in Indonesia ?

Certainly, each country only itself can decide to build or not to build this or that construction in its territory, to buy or not to buy this or that technology, to conclude or not to conclude leasing agreement of the use of floating NPP. And, nevertheless, it is rather interesting to analyze the proclaimed interest of Indonesia in acquisition (leasing) of Russian floating NPP.

> «..The Indonesian party shows interest in acquisition of the Russian floating nuclear electric power plant. Now it is supposed the variant according to the principle - " I project, build, bring, use, take away », Reshetnikov said..» To sign the contract it is necessary to create the first such station, to put it into operation, to accumulate statistical material. And the first Russian floating NPP that is under construction for Pevek (Chukotka) will come into operation, according to Minister Deputy's words, not earlier than in 3 years»
>
> RIA - Hot line dated back November 29, 1997 (Lebedev, 1997).

Now Indonesia is among medium-developed countries and its reserves of energy savings are comparable to Russian ones. In Indonesia, as well as in Russia, the energy capacity of a unit of the gross national product 3-5 times higher, than in developed countries. Therefore, the main and determining for many years forwards economic tendency of development of industrial regions of Indonesia should be the development of energy savings. It will give much greater energy effect and will demand less expenditures, than putting new energy sources into operation.

At the same time the fact itself of attempts of Minatom to offer FNPP to other countries, in particular, Indonesia, causes serious fears. The project of FNPP, as it was shown above, has essential principled disadvantages. It is based on a reactor installation KLT-40C with the dangerous reactor when being used. The boundaries of a sanitary - protective zone of FNPP are determined incorrectly and they do not correspond to a number of important requirements and regulations of the Russian normative documents (for more detail see below). The top management of Minatom as well as the Government of the Russian Federation must realize the situation as a whole clearly in case the opponents of atomic engineering of national or international "origin" detect inevitable radioactive wastes outside FNPP, exceeding the natural contents of radioactivity in the environment. In this case the requirements of the victim state, in particular, Indonesia, concerning indemnification of the caused damage to ecology, population is certain to appear. And the result of this "leasing" of FNPP will appear economic damage for Russia, probably, exceeding the expenditures on construction, towing, use and protection of FNPP as well as income from implementation of the produced electric power. Let's add to this inevitable rise in price of use of FNPP in warm waters, the necessity of implementation of measures on warning of overheating of the environment (the temperature rise of seawater at some degrees can cause death of the marine inhabitants). It is known, that in the territory and in inshore waters of Indonesia there are large petroleum deposits. By the prospected reserves of petroleum Indonesia is included in the number of ten most oilrich countries of the world (more than 5 % of the global reserves of petroleum). Mastering of these deposits is capable to give to this country energy carriers for all the future. Let's add to this enormous reserves renewable wood and other biomass that is capable to supply steady local power supply as the practice of other countries situated in tropical and subtropical climatic belts shows. Let's mention considerable capabilities of development of solar power engineering under conditions of Indonesia.

Even a brief analysis shows the presence of a wide range of energy sources in Indonesia, the country, in which Minatom plans to put (on the basis of leasing) FNPP. Difficulties and perils concerned with the operation of FNPP behind boundaries of marginal waters of Russia make the capability of economic profit from such bargains even more fantastic.

PART IV. THE EFFECT OF FLOATING NPP ON THE ENVIRONMENT AND POPULATION.

The possible effect of FNPP on the environment when working in the nominal mode and consequences of possible emergency situations are considered in this part. Those regions that are ready to take risks of setting up in their territory this dangerous construction must be prepared for such emergencies, as the wide experience of operating of transport reactors put in the basis of FNPP design testifies.

Chapter 8. The effect of nominal radioactive wastes

When normal operating of NPP the designers establish dose limits « within the limits of a natural background » for the population. Therefore the radiation effect of FNPP on the population and the environment cannot, as the designers assert, make a noticeable contribution to the natural background radiation, that is received by them for the region of Dudinki in 2.4 mZv per year (240 millirem/year), under condition of normal operating and project emergencies.

The term "within the limits of a natural background" causes objection. The fact that any wastes of FNPP will be complementary to a natural background is immutable.

According to the calculations of the designers, the limits of damage of fuel elements, expressed through a fragmentation radioactivity of the heat carrier of a primary circuit by the sum of radiodines normalized by the second hour outside of the circuit in count on a rated power level, should not exceed:

- Operational limit - $3,7x10^{7}$ Bk./kg ($1x10^{-3}$ Ku/kg);
- Limit of safe operation - $18,5x10^{7}$ Bk./kg ($5x10^{-3}$ Ku/kg).

According to the calculations of the developers of the project « total annual emission » of inert radioactive gases (IRG) from one reactor in the atmosphere should not exceed $3,7x10^{11}$ Bk. (10 Ku), and thus complementary to the natural radiation dose of the population should not exceed 10 mkZv per year (0,01 millirem/year).

We pay attention to that fact, that in the project of FNPP the danger of appearance of technical radionuclides, whose effect on health of a person is not studied, in the environment is not regarded.

At first let's consider possible consequences of emission of so-called "inert" radioactive gases (IRG). Under the conditions of the Arctic Region the effect of these IRGs on conductance of the atmosphere is possible. For example, the consequences of emission of such usual IRG, as krypton-85 are not clear yet. Krypton - 85, ejected by NPP, magnifies conductance of the atmosphere abruptly (Legasov and oth.., 1984; Orlova, 1994). The consequences of such emissions are unpredictable. Is it possible to guarantee that they will not break a friable radiation balance? The arctic magnetospheric storms concerned with disturbances of the ionosphere are expressed outwardly in the way of known polar auroras. Will not the emissions of IRG of floating NPP in the Arctic Region appear to be that last drop, which the irreversible changes in «the world weather cooking» as the Arctic is called, will follow? In the Arctic Region the slightest disturbance of the ionosphere is enough for its parameters to change. These changes in the way of the trigger effect can have influence on the climatic features not only the Arctic Region, but also some remote regions of our planet. This aspect of work of FNPP in the Arctic Region requires a profound special analysis, that is completely absent in the developments of Minatom.

Now let's pay attention to the outwardly harmless concept « total annual emission ». To show insufficiency of the estimation of "total annual emission" we shall remind that the total annual activity by I^{131} (half-life - 8 days) has appeared in the course of Chernobyl catastrophe to be not very big. But the exposure obtained from short-lived isotopes has resulted in thousand cases of cancer of a thyroid gland in the territories staggered by the Chernobyl emission. Thus, for the estimation of a degree of the dangerous effect of radioactive emissions of FNPP on biothat and the population it would be important to know the amount of planed not only "average annual", but also mean diurnal and even by the hour (FNPP will be placed very close to the populated area) emission of radioactive gases and aerosols.

The analysis of the possible effect of radioactive emissions from FNPP should include the phenomenon of bio-accumulation of long-lived radionuclides (including - tritium) for the whole period of supposed operation of FNPP (40 years) as well as for the period of decay of the indicated radionuclides. Even minor, at the first sight, quantities of long-lived radionuclides, under condition of their bioaccumulation, on the one hand, and the summing up the effect of operation in the sequence of generations, on the other hand, are capable to cause negative results.

One more problem is completely bypassed in the materials of Minatom, that is migration of radionuclides on ecological circuits. During a long arctic winter (the blanket of snow is more than 9 months) the gas-aerosolic emissions will fall partially on the snow in the way of a wind rose. There are no data of a wind rose in Pevek and Dudinki in the project materials and it may be not incidentally: the projectors have not presented the gas-aerosolic emissions of FNPP as the special danger for these towns. During a rough arctic spring all accumulated in the blanket of snow in winter radionuclides will turn to a volley drop of radioactivity. What is a path of these radioactive flows in the arctic ecosystem? It is known, that due to considerable coefficients of bio-accumulation and bioconcentration, the arctic peoples received considerable doses of internal irradiation by means of a chain – reindeer moss-deer-man. This aspect of operating of FNPP requires the analysis and forecast that are absent in the materials of the project.

It is necessary to note, that the technique of calculation of spreading of pollutions in the atmosphere from nominal emissions used in the materials of the project is grounded on the application of the recommendations which were not intended for the arctic conditions. In these techniques, for example, the index of registration of the meteorologic features under conditions of super-low cold inversion whose share for the arctic regions is great is not included. Therefore it is possible to suggest that given above calculations of dispersion fields for floating nuclear power plants are likely to represent « the game with a pencil in a hand », as one of the experts in atmospheric aerosols S.Pashenko said. As a result, the divergence of the received data can reach two orders at the distances from a source of emissions in several kilometers (Pashenko, Sabelfeld, 1993).

The experts in atmospheric physics also prevent from other, more common perils concerned with peculiarities of circulation of the arctic air masses in the Northern hemisphere. It is known, that there are regular breaks of cold air masses from the Arctic Region thousand kilometers to the south of the coast of the Arctic ocean (in Northern Eurasia - minimum up to 50° n.l.). This is the regularity, known to meteorologists, called as a latitude circulation. The value of such latitude circulation in connection with anthropogenesis climatic changes accrues (Kozlov and oth., 1997) abruptly. As a result, the pollution from the Arctic Region can be transferred to low latitudes. These problems are under study now, but it is already clear that few of the experts in atmospheric transmissions will sign the calculations of Minatom concerning spreading of pollutions under nominal and emergency conditions for these latitudes.

Now we shall consider a problem of liquid and solid radioactive wastes produced by a nominal operation of FNPP. Basing on the available materials of the project, all liquid and solid radioactive wastes in the operation period are stored in the floating energy unit and transported by specialized vessels to the base storehouses at plant maintenances. For the assembly and temporary storage of low-active and mid-active wastes there are special tanks and containers located in protective cells at FEU.

According to the developers “ the average annual emission of radioactive wastes” of one reactor makes:

- Liquid - no more than 8 м3 ($5,92x10^{10}$ Bk or 1,6 Кu);
- Solid (highly active) - no more than 0,5 $м^3$ ($4,07x10^{11}$ Bk or 11 Кu).

It is supposed that these wastes will be transmitted for further recycling and utilization to the base of Murmansk marine shipping company. The overcharge of active zones is supposed to be executed with periodicity once per 3 years with putting spent fuel into the storehouse of floating NPP during an overhaul life (10-12 years).

According to given data it is clear that "temporary" storage of SNF instead of usual for land NPP 3-5 years becomes longer for FNPP up to 12 years. For this period of time 4 recharges of fuel will be made, and about 8 tons of SNF can be accumulated at FNPP. With respect to integral part of SNF, taken out metallic irradiated part of a reactor core the total amount of highly active wastes will make not less than 20 tons for each reactor. Thus, by spreading FNPP Minatom as a matter of fact creates in the Arctic Region storehouses for highly radioactive wastes. It has extra threat to the nature and the population of the whole Arctic Region.

In the materials of the project there are no data about a structure of radioactive operational wastes as well as wastes produced by withdrawal of NPP from operating. It does not allow to evaluate the project authors’ assurances about full safety when dealing with solid and liquid radioactive wastes. It is possible, however, to approve confidently, that the satisfactory - safe picture drawn by the designers will have little in common with reality. The atomic-powered icebreakers and nuclear submarines are known to be serviced by a powerful developed infrastructure on shore after each navigation. Anything similar is not supposed in case with FNPP. It means that FNPP will be completely autonomous and its staff should solve all problems not only with permanent, but also with not established radioactive waste (RW) and situations itself. It is clear, that "excesses" of RW will be drained and thrown away here, with all possible consequences for pollution of a water area and adjoining territories.

As a whole, it is completely clear that the operation of floating NPP even in a nominal mode without any deviations (that practically are impossible!) bears serious threat of the effect of gas-aerosolic radioactive waste to the nature of the Arctic Region and to the population in the zone of large territories. The conclusion of the authors of the project that « КLT-40C is an ecologically clear source of electrical power » (Petition..., 1997, page 42) is groundless.

Except for the mentioned above, it would be desirable to point out a number of mismatches (or incomplete conformity) of the project of FNPP to the requirements of the normative documents GRS - 88/97 and SP NPP - 88/93 providing radiation safety:

- In the project materials there are no rules regulating the presence of a service of radiation safety (special subdivision) at the station, that is considered by item 1.2.10 GRS -88/97 and item 5.30 of SP NPP - 88/93;
- The creation of the automated system for the control of providing radiation safety of staff and population (with a central station of radiation monitoring) is not provided, that contradicts to the requirements of extract 5 of SP NPP - 88/93 and item 5.5.5 GRS -88/97;
- In the materials of the project there are no requirements concerning testing « a zero gamma - background » in the territories and water area around FNPP, that means the requirements for OVOS are not taken into account;
- formation of radioactive waste (RW) always surpasses the design volumes of storehouses and capability of technologies of operating with liquid radioactive waste (LRW) in volume and a rate of ac-

tivity; for conditions of Pevek the substantiation of reserving of powers of system of operating with RW is necessary;

- expense of quantity of means of decontamination and washing-up liquids in practice also is much more than the project values, that require to provide their considerable accumulations, especially in winter;
- the work of a radiation safety service (RSS) of FNPP should be organized in three shifts with continuous watchkeeping at the central post of radiation monitoring, in accordance with the requirements of ND;
- there are no data about possible activation of bottom sediments caused by long presence of FNPP in the place of basing.

In the materials of the project «... the boundary of a sanitary - protective zone for FNPP coincides with the boundary of the body of FEU... ». However this boundary is not substantiated and should be moved apart, as its project does not correspond to some rules and requirements GRS-88/97.

The projectors assert that the project conforms the requirements and rules of a number of ND to safety of NPP, including GRS -88/97. So the project should correspond to the main criteria and principles of safety, in particular, indicated in items 1.2.3, 1.2.4 GRS-88/97, in the part of physical barriers systems on the way of spreading of ionizing radiation and radioactive substances in the environment. However, the 3-rd barrier (after a fuel matrix and a shell of fuel element) representing the boundary of a coolant circuit of the reactor (i.e. primary circuit), periodically in accordance with the project will be violated by appearing of thin nesses in the tubal clusters of a steam generator (SG). It is proved by the experience of operating of NSGI of atomic-powered icebreakers with similar SG. Therefore, during the periods of time from the moment of appearing of leaks from the radioactive coolant of a primary circuit into the 2-nd circuit of SG before detecting and taking measures on switching-off this SG from the 2-nd circuit the radioactivity will leave eventually outside of boundaries of the body of FNPP, i.e. « in the street ». In spite of the fact that a cavity of the 2-nd circuit in SG and its feed piping and steam pipes are not a safety barrier, in the project the operational mode of RI with partially switched - off nonsense SG is supposed. Therefore, the boundaries of a sanitary - protective zone should be determined in the project outside the body of FNPP. The same "properties" of SG prove a discrepancy of a primary circuit to the requirements of item 4.1.2 GRS - 88/97: the primary circuit does not provide keeping radioactive substances in its boundaries by letting them go through arising thinnesses in SG to the 2-nd circuit.

In the greater way the boundaries of the 1-st circuit with a radioactive (about 10-2 Ku/l) coolant in the primary circuit open by tearing off and demounting of the upper plug-in units of the reactor, filled by this coolant, when preparing RI for overloading of nuclear fuel. In this case the uncontrolled going out of radioactive tritium and radioactive gases (RG) even out of a side of FNPP is inevitable. It is also necessary to notice that in this situation on the way of going out of radioactive substances (RS) into the environment there are only two much loosed barriers: "swollen" fuel matrix and less hermetic (in comparison with the initial state of fuel elements) shell of fuel elements of fresh fuel assemblies (FA).

FNPP is equipped with a vent pipe, through which, as it is indicated in materials of the project, radioactive gases and aerosols collecting in the cavity of a protective shell (and in the operating room, in particular), but not held back by filters are planned to pump into the environment. Therefore, radioactive gases and aerosols will leave far from the boundaries of the body of FNPP. If it does not correspond to reality, this pipe should be excepted from the considered project by the developers of FNPP. So the maximum distance from this pipe to the completion of "noticeable" for measuring devices of deposition of radioactivity from a plume of wastes from a pipe will define the radius of a sanitary - protective zone. The capital and working expenditures with respect to increase of a number of operational staff, that should be determined and showed in the project, will be required for arrangement in the part of providing an appropriate control of radiological contamination and means for possible realization of decontamination of sites of the territory of this zone.

The protective shell is defined as rather "holey" by the project, as its encapsulation at a level providing a leak rate of the radioactive medium from a protective shell into the environment (i.e. out of a side of FNPP) is about 1 % from its volume. It will also provide seeping out of radioactivity into the environment during emergencies concerned with thinning of a primary circuit.

Thus, during normal operating FNPP provides complementary to natural dose working loads and capability of implementation of emergencies and creates serious threat to the nature and the population of the Arctic Region. The population of the region under conditions of the Polar Regions and remoteness from the help will appear to be unprotected from the effect of radiation for a long time. As technically it is impossible to eliminate the leakage from the first circuit of radioactive aerosols permanently generated in the nuclear reactor, working at power, and around of its body completely, the last ones will penetrate permanently into the environment of the population of Pevek as transit through a cavity of a protective shell and a vent pipe.

Chapter 9. Radiation pollution in case of emergencies.

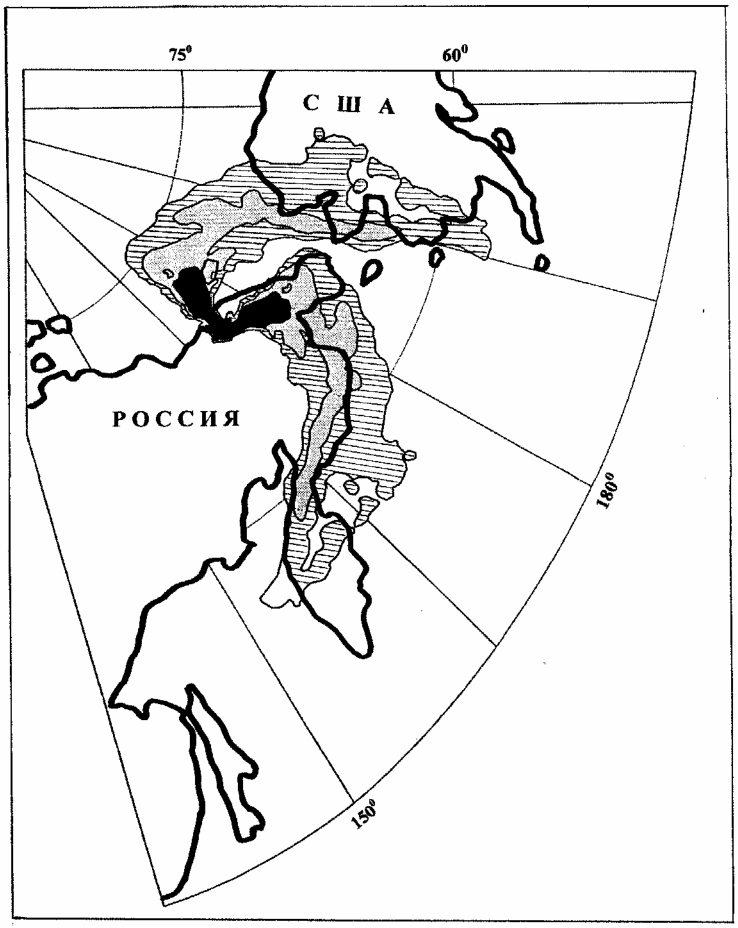
The designers consider that for the population in case of project emergencies at NPP the expected radiation doses of a restricted part of the population (so-called « of a crucial group ») on the boundary of a sanitary - protective zone and out of it limits should not exceed 5 мZv (0,5 rem) for the whole body and 50 мZv (5 rem) for separate organs for the first year after emergency.

In case of out-project emergencies at NPP radiation doses of a restricted part of the population (a crucial group) on the boundary of a planning zone of protective measures and out of its limits should not exceed 5 мZv (0,5 rem) for separate organs for the first year after emergency.

According to the project materials the radiation safety of floating NPP should be provided with a usual for NPP complex of technical means and organizational measures at the site of a station, water area and surrounding territories (establishing a sanitary - protective zone and an observation zone; security systems of the reactor (see above); a closed system of ventilation; a protective system from penetration of radioactive substances from the first circuit, etc. Despite of a long list of these means and measures, there can not be an absolute guarantee that they will operate in the way the developers suppose. Trouble-free operations of FNPP can not be in principle. The only question is how serious the emergency and its consequences can be. The developers assert that « the presence of effective safety barriers and localizing systems of FNPP completely eliminate the emission of activity outside of the station even in case of the hardest project emergencies » (Declaration .., 1996, p. 13).

Let's pay attention to the expression « project emergencies ». The designers refer the gap of a pipe full section of the first circuit to a maximum project emergency. The concept «a project emergency » is invented by atomic engineers for calming down the public opinion. Actually in all cases of large nuclear catastrophes (Windscale in Great Britain, Three-Mile-Island in the USA, the emergency at Leningrad NPP in 1975 and the Chernobyl catastrophe in the USSR, at last, at the Japanese plant in Tokaymura in 1999) were not project emergencies but out-project ones. According to the minister of Environmental protection of Germany Mr.Trittin’s apt remark at the Bundeschag auditions concerning the catastrophe in Tokaymura, « accidents are more inventive than all experts on safety » (Chupakhin, 1999).

That’s why we shall analyze the consequences of a possible maximum out-project emergency, that is such emergency, in case of that the reactor core will be melted and there will be an emission of radioactive substances out of limits of the reactor. The results of such emergency are seen in the picture with the calculations of radiation pollution made for the similar in value reactor of a nuclear submarine (pic. 5).



Pic. 5 Two variants (1 and 2) of a hypothetical emergency of a nuclear reactor, similar to KLT-40C in power, in the region of Pevek. The figure is obtained as a result of imposing of the density of radioactive contamination Cs^{137} on the 5-th day after possible emergency at a nuclear reactor ASM in Ara-guba, Kolsky peninsula (Bergman, Baklanov, 1998) on the map of the north-east part of Eurasia and the northwest part of Northern America.

It appears, that depending on particular weather conditions (wind force at different altitude and rainfalls) the radioactive cloud from the Chaun bay can cover the whole area of the Chukotsky peninsula, the considerable proportion of Alaska and even the Kamchatka peninsula. In case of such emergency the engaging of any serious rescuing forces and means will be extremely difficult because of remoteness and usually unfavorable weather conditions.

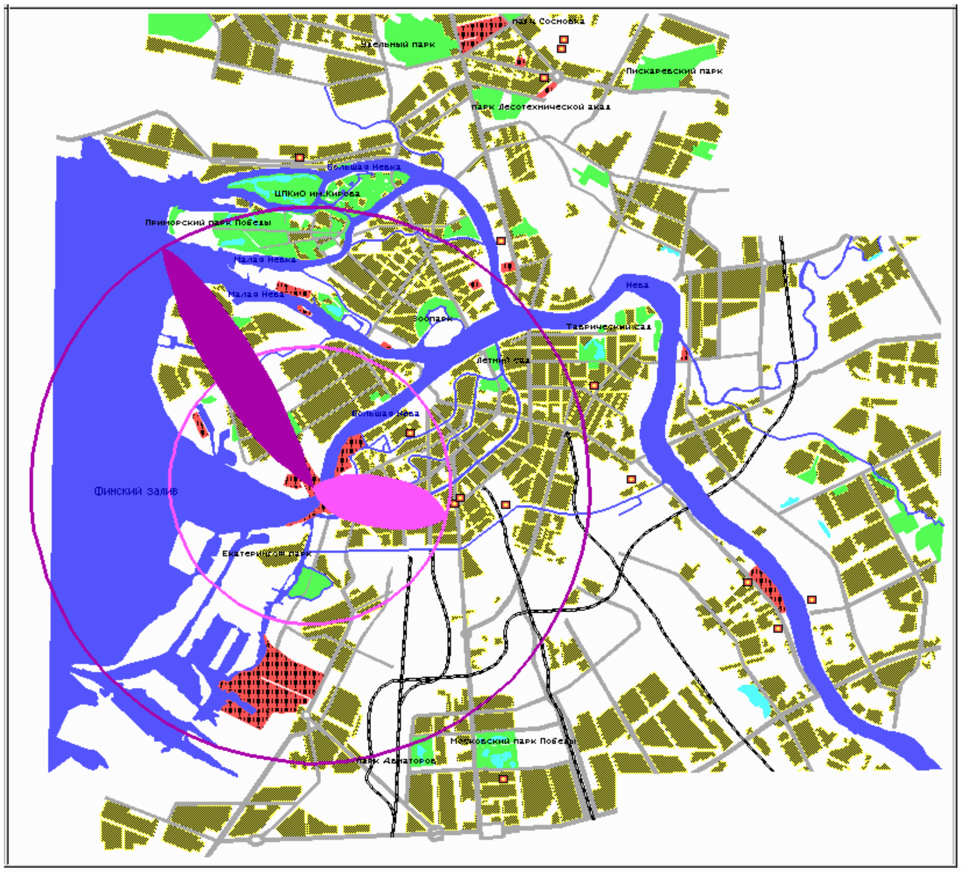
One more additional aspect of the problem of emergencies is that circumstance, that FNPP will be placed nears the populated area. It means, that the consequences of any emergency with the emission of radioactivity outside of a vessel with a high scale of probability affect these bystational settlements. The principle of distance protection that in any way weakens the effect of land NPP (thirty-mile zone etc.), in case with FNPP is impossible to apply. The closeness of FNPP to settlements in emergency situations practically does not keep time for realization of any protective measures in these settlements. Under these conditions it is even impossible the well-timed warning, and the well-timed evacuation of the population are simply unreal. The inhabitants of Pevek and Dudinki, and Severodvinsk, certainly, appear to be real hostages of nuclear stations.

Thus, it is completely clear, that floating NPP creates serious threat to the nature and the population of the Arctic Region. Let's add that if threat to the arctic nature can be somehow compensated by preservation of the nature in other places of the Arctic Region (the arctic nature is rather uniform on the structure of species in Northern Eurasia and Northern America). But such approach to the problem of safety of the local population is simply immoral. During the out-project emergency of floating NPP the damage to a gene pool of small in number populations of the native born peoples can be disastrous.

To what has been said above it is necessary to add fears concerned with the construction and tests of FNPP at plants in the direct nearness (or even in the territory, as a joint-stock company « the Baltic plant ») with the second-largest city of Russia with its five-million population. It is necessary to point that in the project materials the development and the organizational-technical support of plans of measures on protection of the population of the city are not provided. As the analysis conducted for the out-project radiation emergency at an atomic ship, which is close in sizes of the reactor (Baranovsky, Samosuk, 1999), has shown that three types of emergencies are possible:

- during uncontrolled chain reaction in the reactor core after carrying out the tests of a nuclear energy installation;
- similar emergency in the fresh reactor core;
- maximum project emergency after tests.

The hardest according to the radiation consequences it appears to be the emergency with a flash of SCR after carrying out tests. If such emergency happens in 30 days after tests, the evacuation of the population in the radius up to 10 km of a crash scene can be demanded and practically the whole historical center of St.-Petersburg will be subjected to an inadmissible radiation effect (see pic.6).



Pic. 6. The scales of possible radiological contamination at a level more than 10G Bk./m² in St.-Petersburg during the out-project emergency in an atomic ship in the joint-stock company « the Baltic plant » under different atmospheric conditions. Dash-and-dot - pollution at unstable atmosphere; solid radius - at stable atmosphere (Baranovsky, Samosuk, 1999).

Is it worthwhile to subject our second capital to such a fatal risk for the sake of an illusive profit of Minatom ?

In the conclusion of this chapter we will enumerate the violations of the normative documents, which were detected during the expertise of the project materials:

- the requirements (i.5.1.4. GRS-88/97) are not fulfilled because there are no substantiations and presentation of signs of happening events, the state of a reactor installation and the forecast of expected conditions in the process of developing of emergencies, important for limitation of radiation consequences of emergency;
- the data stated in the project about out-project emergencies are of a sketchy and badly argued character, that as a matter of fact makes the result of the considered serious emergency with the worst consequences ungrounded. In this connection it is difficult to explain why the out-project emergency with simultaneous fusion of a reactor core, with the gap of a primary circuit in a steam generator and the destruction of a protective shell is not considered (such situation is quite possible in case of falling of an airplane on the plant and the explosion of fuel at the side of the plant in the region of reactor compartments);
- the shock wave is not considered as an initial event of emergency during an underwater explosion; the ways of occurring and consequences of such emergency are not considered; the case of unauthorized taking out of rods of a shim group during the recharge of a reactor is not considered;
- the requirements of i. 1.2.19 and i. 1.2.17 GRS-88/97 are broken because there are no probabilistic analyses of safety,;
- the requirements GRS-88/97 (see i.5.5.7.) and SP NPP - 88/93 (see i. 9.5.) are ignored because in the project documents the problems of the contents and volume of initial data for the development of plans of measures on protection of staff and the population in case of out-project emergency with the hardest radiation consequences are not established;
- in the description of radiation consequences of emergency with melting of fuel elements there are no initial data on the radionuclide structure and the activity of a coolant. The description of the technique of the analyses is not enclosed and that contradicts item 4.8.4 GRS-88/97.
- there are no calculations of a spread rate of a radioactive cloud during project and out-project emergencies and regulated works concerned with recharging of reactor cores in the reactor installations.

The designers absolutely consciously have underestimated the probability of appearing of emergencies and have diminished the consequences of such emergencies. Judging by the service experience of ship and transport nuclear reactors, close in their design to KLT-40C, such emergencies will happen inevitably. Their effect on the nature and the man under the conditions of the Arctic Region can be catastrophic.

Chapter 10. Thermal and other possible effects of FNPP

According to the designers' calculations the emissions of heat into the environment during the operation of one RU KLT-40C at 100 % power will make:

- into the atmosphere with air from a ventilating system - 270 kWt / h;
- into the overboard water with water of the 4-th circuit - 1650 kWt / h.

Dropping of huge quantity (5400 м^3 per an hour) of water with temperature 23 – 27 C^0 into the environmental water which temperature in winter can be lowered up to – 2 C^0 will create the real natural catastrophe for all local biogeocenosis - fishes, the invertebrate, plants and micro-organisms. In the project materials there are not any estimations of scales and manifestations of the effect of this lens of warm waters.

Among other predicted (either obligatory or rather probable) consequences of the operation of floating NPP in the Arctic region we shall call:

- forming of steady mists;
- change of an insolation of the region;
- change of the character of rainfalls;
- complementary icing of buildings and facilities, and also icicles.

Under the conditions of pumping heat into the water and the atmosphere from floating NPP the consequences of such sort as appearing of dangerous geomorphological processes in the result of technical effect (warming of the grounds of permafrost, the development of landslides and etc.) are inevitable.

Huge emissions of heat in winter under the conditions of a polar night and lowering of the air temperature up to - 50 C^0 and water up to - 2 C^0 can appear to be especially dangerous for ecosystems, the populations and buildings. The analysis of all these possible consequences in the project materials is missed.

Floating NPP will use a plenty of overboard water for cooling of a steam turbine installation and other purposes - about 5400 м^3/h. It will create a technical flow around the floating NPP that can also affect bottom layers. Settling of FNPP is about 4,5-5,6 m, and a water-collector will be placed near the bottom.

The analysis of these effects in the project materials is missed. It is possible to assume that under some conditions muddy bottom precipitations can influence functionability of NPP extremely negatively by having created emergency conditions in the reactor coolant system.

The cases of possible pollution of the water area by petroleum (as a result of intensive mastering of the shelf the oil pollution of the Arctic Region is magnified quickly and the appearing of large emergency overflows in the regions of the allocating of FNPP cannot be excluded) are not considered in the project.

On developing the materials «Estimations of the effect on the environmental of the construction and operating of FNPP in the region of Pevek » the developers of the project made the following mistakes:

- the estimation of the extreme wind characteristics consists of mechanical connection of all available to the authors of the project data without their critical understanding. There are completely incorrect recommendations of the definition of calculated wind speeds. The recommended rate of the period of these speeds recurrence (the period of 100 years for FNPP is obviously little) is not clear;
- practically there is no estimation of wave conditions in the areas of building sites (the background and extreme characteristics of waves with the indication of their quasi-stationary security is meant);
- the wrong method (wind energy) of power and direction of long shore flows of pumps estimating is offered. It has not been applied in the world for years. This problem gains the special urgency in case of constructing of wavebreakers and moles, which block flows of pumps. it is known from the world practice (for example, the Sochi port), in what disastrous consequences it results;
- In the materials of OVOS according to the estimation of the vegetative and fauna state and possible effect of the construction and operating of FNPP on them essentially are a simple description of inventory control of the vegetative and fauna in the region of Pevek. By the present time the reviews of the inventory researches of the land vegetation (species compound and the geobotanical characteristic) and the aquatic flora and fauna (the invertebrate and fish) has been carried out more detailed and precisely. The materials of ornithofaune are represented only by a surface fauna list. These mate-

rials are not enough to estimate the effect of the construction, operating and possible emergencies of FNPP on birds, as well as possible participation of birds in spreading of radionuclides and chemical pollutions. There are no ecological characteristics even for the most popular kinds of birds. In particular, there are no data concerning feeding and migratory communications of particular kinds of birds, nesting in the region of Pevek or visiting it during flyovers. On the basis of these data the estimations of possible participation of these kinds in accumulation of long-lived radionuclides of products of pollution and spreading them on trophic circuits should be made. The materials dealing with insects are extremely poor (that is objectively connected with extremely poor study of ethnomofauna of this region), and contain neither qualitative nor quantitative parameters necessary for the substantiated conclusions on the this group;

- the materials on sea and land mammal are represented inferiorly and inaccurately. As a matter of fact, they are limited only by the list of species, which appearance is possible in the Chaun bay and in the close tundra's, and by sketchy mention of the value of particular kinds of mammals in the economic activity of the man. Such list does not give the basis for any conclusions. During the preparation of the substantiation the results of the recent Russian-American (the 1990-s) researches of sea mammals of the region are not used. In "Materials…" the only report on sea mammals published in 1949 is quoted. The Chaun bay is a part of the Chukotka-Alaska natural habitat of the population of the white bear and, thus, it is a part of the zone of the Russian liability for preservation of this population in accordance to the double-sided Agreement between Government of the Russian Federation and Government of the United States of America about preservation and use the Chukotka-Alaska population of the white bear signed 16.10.2000. At the same time, all white bears of the Chukotka-Alaska population are an object that is under the act of preparing for being signed Agreement between the native peoples of Chukotka and Alaska. Any measures that are able to influence this population should be agreed by appropriate double-sided commissions;

- in the materials of OVOS it is indicated that in the region of supposed allocation of FNPP there is the Vrangel island, being a national park. However that fact that the Vrangel and Gerald islands are the main region of reproduction for all the Chukotka-Alaska population of white bears - on these two islands up to 80 % of all she-bears of this population lie down in the clan dens - is not mentioned at all. Besides clan dens can be found in the northern coast from the Ion up to the Schmidt Cape (and towards the east). In other words, the allocation of the Pevek FNPP is provided by the project close to the most important region of reproduction and foraging of a genesial core of the Chukotka-Alaska population of the white bear;

- the materials of the project do not contain calculations of possible drift of radionuclides and chemical contaminants of the environment from FNPP on trophic circuits of sea ecosystems in the area of allocation and effect of FNPP. At the same time, the Russian-Norwegian researches having conducted by the present time, in the western sector of the Russian Arctic Region have shown, that the white bear is the final store of radionuclides and heavy metals, originally accumulated at the low levels of trophic circuits. As a result of the effect of accumulation, the concentration of these contaminants in the tissues of white bears reaches values, at which there is a violation of genesial physiology, behavior and genotype;

- as to walruses the materials of OVOS do not contain the characteristic of a spatial structure and a demographic structure of that group of pacific walruses that spend summer in the eastern sector of the East-Siberian sea and visit the Chaun bay. And they are mainly walruses from a grouping, spending summer in the region of the Vrangel island, that is the walruses included into the structure of a genesial core of the whole population of the pacific walrus, including mainly females with cubs. In « Materials... » there is neither the analysis of possible getting and accumulating of radionuclides and chemical contaminants into the fodder objects of the walrus nor the estimation of further drift of these substances along trophic circuits, which top in this region is taken by people who are the representatives of the native peoples of Chukotka and Alaska. In addition it is necessary to say that the stream of waters from the place of offered allocation of FNPP (at any variant of allocation) appears to be in the eastern part of the East-Siberian sea, that is in the area of water, where not only the considerable proportion of all Chukotka-Alaska population of the white bear and the pacific walrus, but also other sea mammals – the polar and gray whale, the white whale, the annulated nerpa and etc.;

- the guarded water areas around the Vrangel and Gerald islands, having had the status of a national park (12 nautical miles around of the both islands) and its restricted area (plus 24 nautical miles) since 1997, are in the zone of possible effect of FNPP. In case of emergencies at FNPP these water areas and the land of the whole national park are subjected to the effect of radioactive wastes and accompanying environmental pollutants. In OVOS there are no calculations and results of simulation of possible spreading and accumulation of contaminants during the normal operating and in the situations of catastrophes;
- the conclusions of the documents of OVOS concerning the possible effect of consequences of dredging activities, dropping of warm waters and the radiation effect on the aquatic flora and fauna are not confirmed by the calculations, by the data of laboratory experiments or computer simulation and have only declarative character. Apparently, that the effect of these factors will be considerable, as it will entail the violation of a substratum, temperature and chemical mode in the most biologically active zone of coastal shallow waters. The basis for the conclusions about admissibility of such violations is not adduced. There is no analysis of trophic connections in ecosystems, that is necessary for the skilled conclusion concerning all biological objects considered in the materials of the project. At the same time, from the materials of the substantiation it follows, that the region of proposed allocation is the area of the concentration of life, high biovariety and increased biological efficiency. Their sea ecosystems provide the ecological stability of the whole region and a fodder base for many kinds of fishes and mammals, important, as objects of hunting and the traditional use of nature of the native peoples of Chukotka and Alaska. The absence of the intensive hunting mastering of these resources is not the basis for allocation of the object, which operation is connected with high risk of radiological pollution of the environment in Chaun bay now;
- the area of the deployment of FNPP is characterized by a high level of presence of separate kinds of plants-endemics as well as relict communities of plants. Near the place of allocation of FNPP there are at any rate two Bering relicts: firstly, the spots of relict tundra-steppes; secondly, in the area of possible radiological pollution in case of emergency conditions there is a national park “the Vrangel island” (established as the object of the world nature heritage). The whole land of the park is the Bering relict, which genetic appearance will be irreversible broken in case of radiological pollution;
- at present time the slopes above the eastern shore of the Pevek bay close to the place of allocation of FNPP are populated by the ptarmigan, other kinds of small-sized tundra birds, the white hear and are used by the inhabitants of Pevek, as a recreational zone. The constructional works will make this zone unsuitable for settlement of animals and the inhabitants will not use this area for rest;
- high ecological significance of the Chaun bay, in particular, the high biological variety and efficiency of sea and coast ecosystems in this region make it extremely perspective for the development of ecotourism and connected with it branches of economy in the region. The allocation of FNPP in the region of Pevek in this context is the factor of not only ecological, but also economic risk, as the radioactive pollutions owing to possible emergency will make the development of ecotourism in this region impossible.

The designers only in a small degree realize the effect of non- radiation pollution, concerned with the operation of FNPP, on the close territories and water areas. Such effect will be considerable and in some respects irreversible, resulting in degradations of the natural environment.

PART V. GEOPOLITICAL PROBLEMS CONCERNED WITH FLOATING NPP

Using of floating NPP puts unexpected questions of strengthening the danger of proliferation of nuclear weapons and nuclear terrorism for the world community.

Chapter 11. Floating NPP is an attractive object of the nuclear terrorism.

The reactor installation such as KLT-40C works by means of highly enriched uranium (36 % and 47 % of U^{235}), that without special further recycling can be used for creation of the nuclear explosive device of a nuclear bomb. It is known, that 25 kg of U^{235} are enough for creation the nuclear ammunition. If to use more perfect and accessible technologies, only 3 kg U^{235} with enrichment in 20 % are enough for creation of a nuclear bomb. Only one reactor of FNPP, thus, contains the fissionable material, sufficient for creating of many tens of nuclear bombs!

Let's add to this, that after starting operation of the reactor KLT-40C it accumulates the great amount of plutonium that is required some times less than U^{235} for creation of a nuclear bomb. The declared by Minatom terms of delivery of floating NPP abroad according to the principle « I project, I build, I bring, I use, I take away » are proceed from that fact that FNPP is the property of Russia. All possible contracts of such deliveries should provide for problems of protection of this property and the rights of the owner, taking into account the requirements of the Russian legislation of providing physical protection of the atomic energy objects and control of non-proliferation of nuclear materials.

It is known how difficult (if it is probable at all) to defend a large vessel from the outer attack. The physical protection of a station will demand to contain considerable militarized guards, that are to provide the participation of the Russian naval forces. But even under these conditions it is practically impossible to provide the station from the side of its underwater part with absolute protection from torpedo attack or from the underwater saboteurs, and on the surface - from a rocket-bombing strike.

In case of capture of FNPP the large quantity of highly enriched uranium (HEU) can be stolen by the criminals, on the one hand, and that can be even more dangerous, they get an unprecedented chance for nuclear blackmail.

It is known, that the piracy capture of the transport with uranium in the Mediterranean sea in 1968 has put forward the development of the Israeli program of creation of a nuclear bomb: in five years after capture of uranium Israel had already a nuclear bomb (Kurkin, 1989, p. 205).

« The possibility of using such captured materials (with NPP (the author)) for creation of the elementary nuclear explosive devices with the purpose of realization of subversive and terroristic acts, blackmail and extortion is not excluded ».

The newspaper "Truth", September 25, 1986 (Kurkin, 1989, p. 207).

Spreading of FNPP all over the world will allow to repeat this script much easier and with more efficiency because each FNPP contains the ready material for tens nuclear bombs in the way of enriched uranium of weapon quality. Those terrorists who will steal uranium from FNPP, will not require 5 years. According to the expert estimations, several months will be enough for creation of a nuclear bomb with such sort of uranium that they will have.

The main disadvantages allowed by the developers of the project from the point of view of providing FNPP with physical protection are formulated below:

- the obligatory protection of the water area zone (both underwater and above-water parts) is not supposed: «... water area (it is possible to be restricted by protective moles / fencing dikes)... ». The sufficiency of means of guards in the lack of physical barriers is not substantiated.
- the direct guards of the object is supposed to execute by means of the departmental guards that is settled in the territory of a coast technological site and is formed by the local inhabitants of

Pevek. There is no information about special, concerned with the specificity of the object preparation of staff of guards and, in particular, about the possible presence of a group of divers - professionals in the staff who will provide the underwater part of FEU with protection (even by means of periodic checks).

- it is stated that the automated system of security can (at the same time) conduct separate functions (without concretizating the last) for representation of the Crisis center of the concern "Rosenergoatom". However, the analysis of a suggested structure of a system does not allow to make a conclusion about the possibility of combining any its functions with the functions of protection of FNPP. For such combining the Crisis center should be placed in the territory of the plant. At the general tendency to reducing the number of the staff (including, with the purpose of increase of safety of the object), placing in the territory of FNPP complementary industrial powers is not substantiated. Besides, there is no information concerning the character of activities executed by the Crisis center.
- describing a physical protection system (PPS) the principles of organization of the protection from different kind of infringers (read as terrorists) are only revealed. However the physical protection of objects of atomic energy using supposes also the protection from unauthorized moving of radioactive substances (RS) and nuclear fissile materials (NFM). In fact this part of PPS is not described (except for the means of television supervision inside of FNPP).
- in the materials of the project there is no information about organization of the physical protection during driving FEU, for example, during repair campaign, in accordance to the requirements of providing of the physical protection when transportating RS, NM and RW (thus the radioelements of the equipment, gear and etc. can be referred to the latter).
- As normative providing the project of PPS, “the Rule about providing vessels having nuclear energy installations and atomic-technological service with the physical protection. RD.31.21.16-95” is used, that according to the code of the document is referred to the managing documents of the Ministry of Defense of Russia. Legitimacy of its practicing of the object of civil assignment is doubtful.

The towage from St.-Petersburg to Pevek by seas with open (surface) and latent (underwater) shipping industry ready for operation of FNPP, installed on the “engineless” vessel is provided.. This operation is dangerous and inadmissible, as:

- the diversion acts with the purpose of stealing the fuel assembly with nuclear fuel enriched by isotope U^{235} of the weight contents up to 36 % and 47 %, or organization of situations with unfavorable consequences for the people accompanying FNPP on the route of the towage are possible. The disadvantage of the rule of item 1.2.9 GRS-88/97 provokes this. According to this rule the physical protection of NFM is assigned to the operating organization that has not its own armed subdivisions. In this connection the acceptance by Government of the Russian Federation of the Decree about measures on the protection of FNPP from the acts of sabotage during construction, tests, towage and its operating near Pevek should be initiated.
- at FNPP NFM in fresh fuel assembly will be concentrated in reactors and storehouses in the quantity that is sufficient for manufacturing of many tens simple nuclear explosive devices. To prevent it being stolen it will need more careful, massive protection by means of naval forces of Russian Federation towed unarmed floating equipment from FNPP.

The designers as a matter of fact have ignored the necessity of creation of an effective system of physical protection of FNPP against possible terrorist attacks. It is likely to have been done not incidentally - it is impossible to protect FNPP from terrorist attack reliably. Finally, in case of their spreading all over the world FNPP make the non-proliferation regime of nuclear weapons meaningless. With their appearing in the world the fissionable materials will become many times more accessible.

PART VI. LEGAL ASPECTS OF FLOATING NPP

In this part the legal problems arising with possible appearance of floating nuclear power plants in the World ocean are considered in general.

Chapter 12. The Russian legislation and FNPP

The law of RSFSR « About the environment protection » (1991) has been already broken at the stage of designing and choosing the site for FNPP in the water area of the Chaun bay. According to art. 48, item 3 of this law "...It is forbidden to place, to project and to build nuclear stations near large natural reservoirs of the federal importance..". That fact that inshore waters of Russia are natural reservoirs of the federal importance is hardly to be doubtful.

Thus, according to the present Russian legislation, FNPP can not be located in the seas surrounding the Russian Federation at all.

Making decisions about the construction and allocation of floating NPP Minatom also broke roughly the federal Act «About using of nuclear energy» (1995), article 28 that establishes:

« The decisions about allocation and construction of nuclear installations, radiation sources and points of storage are made on the basis of the conclusions of the state ecological expertise and with respect to the conclusion of expertises conducted by public organizations ».

" the compulsory state ecological expertise conducted at the federal level the following documents are subjected:

« the projects of… the federal investment programs...

...technical-economical grounds and the projects of construction... irrespective to their estimate cost, departmental membership and forms of ownership, which implementation can affect the environment within the limits of territory of two or more subjects of the Russian Federation...

... other kinds of the documentation justifying economic and other activity, which is capable to make a direct or indirect effect on the environment within the limits of territories of two and more subjects of the Russian Federation... ».

Article 11 of the Federal law « About the ecological expertise » (1995)

Thus, it is doubtless that all technical-economical grounds and the materials of the project of FNPP concerning new technology as well as particular projects of FNPP, on which construction the agreements between Minatom and appropriate administrations have been concluded, should be objects of several state ecological expertises of the federal level. Any of such expertises has not been conducted.

Article 30 of the Federal law « About ecological expertise » (1995) establishes, that:

« Violations of the Russian Federation legislation about the ecological expertise made by the customer of the documentation being subjected the ecological expertise, and interested persons are... realization of the object of the ecological expertise without positive conclusion of the state ecological expertise... »;

«.. Violations of the Russian Federation legislation about the ecological expertise made by bank organizations, their officials, other legal persons, and also citizens are financing and crediting of realization of the objects of the ecological expertise without positive conclusion of the state ecological expertise ».

As it is known, neither technical-economical grounds of FNPP nor the project of FNPP for Pevek, Dudinki and Severodvinsk have been represented by Minatom for conducting the state ecological expertise. Thus, the financing of the works on the projects by the concern "Rosenergoatom" is illegal.

The public organizations conducting the public ecological expertise addressed "Rosenergoatom" the inquiries about granting of the design documentation necessary for realization of the ecological expertise. "Rosenergoatom" didn't give required documentation and even didn't give written answers to the inquiries. So, article 27 of the Federal law: « About ecological expertise » and also article 30 of the Federal law « About nuclear energy using », according to which the customer of the design documentation is obliged to grant it for carrying out of the public ecological expertise were broken.

« The Regulation about the estimation of the effect of planned economic or other activity on the environment » (2000) in item 2.9 says: « In case the planned economic or other activity can have a translimiting effect, conducting the researches and preparation of the materials concerning the estimation of the effect on the environment implements with respect to the regulations of the Convention of UEC OUN about the estimation of the effect on the environment in the translimiting context ». The planned construction, certainly, can have a translimiting effect, especially in case of emergency. Nevertheless, on preparing the materials of OVOS, the regulations of the Convention of UEC OUN were not taken into account.

One more regulation of the law « About nuclear energy using » will be broken, if FNPP is located in the cities of Pevek, Dudinki and Severodvinsk. According to the law « About nuclear energy using », all the population near the nuclear constructions should be insured by the owner of these constructions. In the represented materials of the project this problem was not considered by the concern "Rosenergoatom".

Besides, the solution made by interested departments, concerning constructing and power tests of FNPP in the joint-stock company « the Baltic plant » in St.-Petersburg located on the coast of the Finnish bay along the Neva, breaks the legislation, in particular, the Law of RSFSR «About the environmental protection». The indicated natural water reservoirs are of the Federal importance and article 48 (items 3) of this Law prohibits designing, construction, working on power of nuclear power objects near such natural water reservoirs.

In this connection it is necessary to mark the following:

St.-Petersburg with the multimillion population and compactly concentrated around the numerous settlements are in the zone of potential danger of repeating the destiny of Prepyat – the city of energy engineers from Chernobyl NPP, because of the planned carrying out the nuclear-dangerous works when finishing the construction of FNPP and its tests (loading nuclear fuel and physical start of reactor installations KLT-40C and operating at the energy levels of power).

The works mentioned above will be conducted without any consent of the inhabitants of the historical, cultural and scientific center of the world importance. It means, that the concern "Rosenergoatom" breaks the Law of RSFSR «About the environmental protection», the Constitution of the Russian Federation, articles 9 (item 1), 20 (items 1,2), 21 (i. 1, 2), 41 (i.3), 42, 58 of chapter 2 « the Rights and freedoms of the person and the citizen ». At the same time article 15, item 2 of the Constitution of the Russian Federation is broken. It determines, that « bodies of the Government... are obliged to respect the Constitution of the Russian Federation and laws ».

In many cases the materials of the project do not quite correspond, or do not correspond at all, or even contradict the requirements of the whole number of the normative statements and documents that act in the field of atomic engineering, the environmental protection and etc.

PART VII. DANGER OF NUCLEAR ENERGY INSTALLATIONS OF VESSELS (NEI) – the PROTOTYPES of FNPP.

For substantiation of nuclear, radiation and ecological safety the developers of FNPP apply a certain multi-purpose criterion - « the positive experience of operating ship NEI » illegally, instead of particular normative criteria of the estimation of safety.

Indeed, in the general strategic plan of domestic prototypes of NEI in the civil and military fleet their operational experience could be a generalizing criterion in the substantiation of choice of this or that type of energy installations for the solution of power problem in Far North and Far East of Russia.

However, then this operational experience should be studied deeply by all participants of creation and operation of transport NEI. It should be transparent for the public and the state and, if it were really positive, its application would be justified, that cannot be told about actual (present) operational experience of transport NEI. Officially it is known to nobody - this is very secret information, and during more than 40 years it is in the zone of an uncertainty, as the acts of emergencies and incidents occurred on NEI in the civil and military fleet, are known to the public only from the mass media or other publications, which cannot be related to the category of the official information.

Chapter 13. Low safety culture is the reason of emergencies at transport NEI

For the objective estimation of operational experience and increase of safety of nuclear energy using, only one way is known from the world and domestic practice. This is organizing the effective and stable system of feedback of the operational experience, in which with the purposes of safety all the participants of creation and operation of NEI co-operate. Also the state organs of control and regulations of nuclear energy (for example, Gosatomnadzor of Russia), held in this process, should constantly control all events that are significant for safety (e.g. emergencies, incidents, occurrences) of the objects that are under supervision. Note: in Russia the public state supervision of safety of the military assignment transport NEI does not exist.

Analyzing and classifying all violations in the operation of NEI, the participants of this system, starting with the operational organization, as a primary source of information, should create and permanently store the database in this way.

The creation of databases of the violations in the operation of NEI is not end in itself. The main problem is the detection of weak points from the point of view of safety and taking the appropriate correcting measures for all phases of the life of NEI with the purpose of possible exception of repeating the revealed violations, the own estimation of a level of safety and implementation of real licensing NEI at the operation stage. Unfortunately, for the transport trend such feedback system of the operational experience has not been created yet. Therefore there is the database of the operational safety, and also there is no appropriate real licensing.

The emergency at the Chernobyl NPP should have made the chiefs of all ranks re-consider their attitude to the earlier used principle: « there are no consequences, there are no problems ». However, in the transport trend all remained without changing. Moreover, in the transport nuclear power engineering the principle is still professed: « there are no personal consequences for the chiefs, there are no problems ».

The domestic operational experience of NEI frequently confirmed that fact, that neglecting the experience of safe usage of nuclear energy as well as hiding emergencies and premises to them by all categories of the operational staff, especially in its high instances, characterizes the low level of safety culture and inevitably results in the next emergencies and catastrophes.

In Appendix № 2-4 there are some examples from the operational experience of NEI of the transport trend. They show that the lack of a feedback system of the operational experience and low level of « the safety culture » result in the most tragically consequences. At this concept we shall consider in more detail.

What is «the safety culture»? It is such set of characteristics and features of the activity of organizations participating in creation and operation of NEI, and of separate persons' behavior, first of all, those of administrative board, that establish that the best attention, defined by its significance, is paid to the problems of atomic engineering safety. « The safety culture » requires that all duties, important for safety, should be executed precisely, with caution, on the basis of personal knowledge, common sense and responsibility.

As the exponential example of low « safety culture » and the lack of feedback about the incident can be radiation emergency at the nuclear rocket submarine cruiser of strategic assignment "K- 253" of the Northern Navy in 1975. This radiation emergency, as well as many other emergencies at AS of Navy, was not put down into any documents even under the seal "Top secret". Even the personal staff of the formation, where this submarine was included, did not know about it. Even during the epoch of publicity it was the only, perhaps, about which the wide public did not know anything from the mass media, and the events at AS developed as follows.

The atomic submarine "K-253" in the connection with the working out of the main equipment safe life and the upper limit of the violation of hermeticity of the shells of fuel elements (specific activity of water of the primary circuit makes $8x10^{-3}$ Ku/l), and also with the fault of technical means was removed from the battle core of the Navy for preparation of being put into the scheduled depot maintenance. However, in the violation of the top documents prohibiting the operation of the atomic submarine (AS), the commanding has scheduled it's going into the sea for practicing of 4 crews of newly constructing AS. After practicing of the crews the technical state of NEI worsened abruptly, especially the state of a reactor core (the specific activity of water of the primary circuit made 0,6 - 0,8 Ku/l). Besides, taking into account that AS, in accordance to the plan, should be towed to the place of repair in Severodvinsk with the installation, taken out from operation, the commanding has made a decision to give the part of the serviceable equipment and some elements of the automatic units of NEI to the submarines of the battle core having a large deficit in renewals.

Thus, up to the moment of transition the technical state of AS except for the critical state of a reactor core was characterized as the following:

- a part of the equipment, armature and control panels, including those which are on the security systems, was operated only distantly or manually;
- a part of electric drives had extremely low electrical isolation;
- the control-measuring equipment and the devices of the heat-technical control appeared to be with the overdue check;
- because of the fault the radiation-monitoring system of AS was taken out from operation and etc.

For the towed AS with taken out from operation and warmed installation such technical state of NSTI did not cause any fears. However, as the Navy could not give a sea tug, a sudden order of the commanding of the flotillas to put the both sides of NEI and by their own to cross in the wall of the plant in Severodvinsk was followed. Despite the categorical refusal of the technical service of the division of submarines to input such installation, nevertheless, NEI was put into operation under the threats of punishment from the part of the commanding of the flotillas.

Having taken aboard of AS 1,5 crews, seamen taking large risk planned to stay in the sea during the cross - for 24 hours of the underwater travel. But, having had no time to follow the route of crossing, the operating manager of the Northern Navy commanded to change the route, to arrive in the assigned point of the Barents sea and during about 3 days to participate in the naval training. As a result, the stay of the submarine in the sea lasted about 5 days. During this time on board of AS many terrible incidents took place (fires, flooding of compartments, loss of fresh drinking water, loss of the surface going during strong gale 8 with the threat of eject of a missile carrier on the shore and etc.), including radiation emergency with the pollution of gears and the deck of the whole submarine in separate places up to 300000 rasp/см^2 * per min. The crew knew about it only after coming to the wall of the plant from a factory service of radiation safety, as their internal radiation-controlling system did not work. Not suspecting about radiation danger the submariners, moved along all the compartments of AS, ate, kept the watch at the battle posts and struggled for the ship survival without means of protection. In this emergency nobody died, but the further destiny of these submariners is unknown..., who of them died on the hospital bed? And the only one man – "the little man", who categorically objected (but not up to the end) to putting NEI into operation and going of AS to the place of repair by means of its energy installation, was blamed for this emergency,.

One more example.

In May, 1968 AS "K-27" (the first one in the Navy with the liquid-metal coolant) after recharge of the reactor, went to the sea to carry out the control departure and development of 100 % power. As steam generators of the left side had constant microleakages in the primary circuit, the conditions for appearing of oxides and slugs in the coolant that caused the blockage of active channels and failure of coolant circulations in the reactor, working at 90 % power, were formed. The catastrophe begun quickly: in a few minutes the radiation level in the submarine reached 5 R/h, in the reactor compartment - 1000 R/h, and in the region of steam generators - 1500 R/h, but the permissible dose for a person 15 micR/h. As a result all the crew was overirradiated, and 9 persons died in hospital. AS after this catastrophe was scuttled in 1982 near the New Earth on the depth of 33 m.

The scenario of this catastrophe had been foreseen by the main mechanic of AS before going into the sea, about what he reported to the commanding and made a record in the log-book of the readiness of going into the sea: « BP-5 is not ready to go into the sea ». Long before going into the sea the mechanic had required to spear time for producing temperature regeneration of alloy, but the commanding ignored the mechanic's demand and warning.

All said above directly concerns with the future FNPP, based on the principles of transport NEI. As it has been shown above, the lack of a feedback system of operational experience of transport NEI and low level of « safety culture», result in the most tragically consequences.

Chapter 14. The analysis of violations in the operation of NEI of vessels - prototypes of FNPP

In the materials of the project of FNPP repeatedly as justifying criteria the references to the operational experience of similar power objects are used and practically all substantiations, whether they are substantiations of nuclear, radiation or ecological safety, are substituted by the references to the large and positive operational experience of such installations. And as the direct analogues of a similar energy object in the world practice do not exist, the authors of this book considered it necessary to conduct the estimation of violations in the operation of the vessels - prototypes with similar NEI, used in the civil fleet and the Navy, separately.

And the first thing, that it is necessary to mark, that it is not always possible to judge about the correspondence of the project to the modern normative documents and about the general level of safety of the project in accordance to the presence of the operational experience in the fleet. The secrecy of the history of using of the nuclear energy transport installations of icebreaking and naval fleet and all that is connected with them does not make for the trust of these projects.

The official statistics of violations in the operation of transport nuclear energy installations is "closed", and the data, appearing in the "open" press are similar to those which are in the report of the organization "Greenpeace" - « The problems of the Pacific fleet: radioactive wastes, utilization of nuclear submarines, the accident rate of AS, nuclear fuel safety » (author – D.Hendler) and in the monographies by S.P.Bukan « Following the tracks of underwater catastrophes » and by N.G.Mormul « The underwater catastrophes ». Unfortunately, they can not be referred to the category of the official sources.

And the analyses of those emergencies, the official information about which is available, do not allow to make a certain conclusion that the possible operating of ship reactor installations at industrial NPP will have the extremely positive points.

To be objective the authors of this brochure considered it possible to analyze only those few emergencies and incidents at ship reactors of the icebreaking fleet of USSR / Russia, which have a little more complete official information in the technological publications. The detailed description of some incidents and emergencies is adduced in Appendixes № 2-4 of this brochure.

Except for the incidents at atomic vessels of civil assignment during the period of 40 years of operation of domestic ship atomic energy installations (AEI Navy), according to the official data, seven serious emergencies, accompanied by serious radiological and ecological consequences have taken place (Sharaevsky and oth., 1999). During these emergencies at ship AEI and the liquidation of their consequences, more than 1000 persons have been exposed to overirradiation, and the total radiological consequences of the emergencies at ship reactors are comparable with the similar consequences of irradiation from the Chernobyl catastrophe. According to the informal data (memories of the participants, appeared in press), the total number of radiation emergencies was much larger (Kuznetsov and oth. 2000).

The analysis, carried out according to the violations at NEI of the vessels - prototypes of FNPP, shows that most significant of them concerning safety are the following:

- Leakages of the primary circuit in steam generators, heat exchangers, pipe lines and a cover of the reactor;
- Stop working (jamming) of the emergency protection rods and their spontaneous lowering into the reactor core;
- Stop working of compensatory gratings and their spontaneous lowering into the reactor core before their landing on the mechanical stops;
- Anticipatory thinning of shells of a fuel element;
- Simultaneous operation of emergency protection at NSTI of both sides;
- Frequent failures of KSU TS, distance controls of KG, false operating of EP, only in 1996 the system "Mars" failed 6 times, ionization chambers became unserviceable in the channel of measurement of reactor power, the failure in the pump control circuit of the warming repair;
- Putting out of operation of emergency and reserve diesel - generators.

According to the violations mentioned above concerning the operation of NEI of vessels the weakest link in providing of safety control and the project capacity factor (CF) is the tubal system of steam generators SG – 18 -T, the mean resource of which, known from the operational experience, makes 30-60 thousand hours when the resource, guaranteed by the project, is 90-105 thousand hours with the service life of 20 years (NOTE: the same situation with steam generators is also in stationary atomic engineering, where the total number of failed steam generators reaches the quantity of more than 30 pieces already).

The large difference of the operating time of steam generators before the leakage proves possible several reasons of the leakage, but, unfortunately, anything is not known about them up till now as well as about the correcting measures taken by them.

In tab. 10 the information of the operational organization about leakages of the tubal system of steam generators SG- 18-T at atomic vessels is represented.

Table № 10.

Leakages of the tubal system of steam generators SG- 18-T at atomic vessels (the data of NTC Gosatomnadzor 1992-1998)

year	vessel	number of SG	operating time in hours before leakage

1992	Substitution of steam generators at a/i "Siberia", "Russia", “Arctic”	-	-
1993	"Russia”	SG-7	-
		SG-8	-
	"Siberia"	SG-4	-
1994	"Siberia", leakage in three SG	-	-
	“Russia”	SG-2	-
		SG-7	-
1995	There is no information	-	-
1996	“Arctic”	SG-7	-
1997	“Arctic”	SG-1	-
	“the Soviet Soyuz”	SG-2	46631
		SG-6	48427
	“Sevmorput”	SG-4	-
	“Yamal”	SG-4	34844
1998	“Arctic”	SG-7	-
	“Russia”	SG-5	-
		SG-3	65545
1998	“the Soviet Soyuz”	SG-1	55485
		SG-7	55477
		SG-8	-
	“Taimir”	SG-1L	60794
		SG-1L	61082

Considering these violations, it is possible to imagine two versions of their consequences for FNPP:

- the leaking steam generator managed to be disconnected on water and steam by isolating valves. In this case the functionability of NEI at low power - 75 % Nн is saved, and if there are two leaking steam generators, that is probable, the power of RI will be lowered up to 50 % Nн. The deterioration of radiation situation will be localized, the radiation emergency will be prevented;
- the leaking steam generator did not manage to be disconnected by isolating valves. In this case radioactivity will be spread outwards the shells into the turbine compartment and, probably, into other adjacent compartments, and the level of radiation emergency will depend not so much on the quantity of poured primary circuit water into the secondary circuit, but on the radioactivity of the primary circuit, that is on the state of the reactor core. This fact in the report about the substantiation of safety was not taken into account (at the end of the company of the reactor $A_{ud} = 10^{-2}$ Ku/kg).

To eliminate the consequences of emergency, RI is taken out from operation. After disactivating of the contaminated rooms the repair of isolating valves and damping of leaking pipes of steam generators is carried out, and this requires a lot of time. NOTE: in 1998 under conditions of the plant RTC "Atomflot" the repair of a steam generator SG - 4 at the atomic lighter carrier "Sevmorput" took 4,5 months, and the repair of steam generators № 7,8 at the icebreaker « the Soviet Soyuz » - 6 months. The period of repair of steam generators under conditions of the Pevek base can appear to be even more considerable.

According to the operational experience of ship and submarine NEI, the violations in the operation of a steam turbine installation and the electrical power system are known to occur quite often. They do not influence NEI safety, but require it to be taken out from operation during the period of repair. For example, leakage of steam pipes in the undisconnected sections. In this case such violations, caused by the idle time of FNPP during the time of elimination of leakage in steam pipes will reduce capacity factor and, that is very important, will magnify thermalcyclical load on output and input of power modes of RI, that, in turn, can result in lowering of the project resource and the service life of shells of the fuel element and other elements of RI.

Unfortunately, in the project materials one cannot find the preoccupation of a projector of FNPP with the above-stated problems, which, all means, the operating organization will face, because of a weak infrastructure in the place of constructing FNPP and its remoteness from Inc.C "ММП" and the maintenance base, difficulties with delivery of the equipment, renewals and experts to it in case of carrying out the maintenance activities in the parking area.

Taking into account the data mentioned above it should assume, that the project CF 0,63 and, especially, 0,8 (in a base mode) will not be certainly executed.

It is possible to assert, that technically safe NEI is a necessary, but not sufficient condition of providing the safety control of a vessel as a whole. Such factors, as the conditions of allocation of FNPP with the supplying infrastructure, the possibility of highly qualified support for the operating staff of station from the part of the specialists of the projectors' supervision in case of emergency, external influences and the navigational incidents, and, at last, a human factor are capable to have a decisive influence on the safety of FNPP even if there is a technically safe NEI. As the practice shows the non-standard development of emergencies result in serious radiation consequences for a crew, the population and the environment. This fact is often proved by the operational experience of NEI of vessels and atomic submarines. Nevertheless, describing the project and out-project emergencies the projector of NSTI included only a technical aspect of safety control without adding errors of the operating staff as the beginning events of possible failures during the control of emergencies. The safety of NEI during external influences with different initial states of FNPP: collision in the port at the wall or during traveling by sea, beaching, fires and explosions, scuttling and splashing down FNPP also is not taken into account.

So, in the project of FNPP the simplified consideration of so-called "project" and "out-project" emergencies, as a matter of fact, is brought to the analysis of incidents, in which the limits and conditions of safe operation have not been broken, and this has prevented developing the incident into emergency.

In this case an advertising character of the descriptions of project and out-project emergencies and also the references to the positive operational experience of ship NEI are not to the point.

The operational experience of the prototypes NEI has shown anticipatory dehermetising of shells of the fuel element (before burnup of fuel energy supply) on separate fuel assembly. At the standard of 2,5 million MWt/h the burnup was only 1 million MWt/h.

The integrity of shells of the fuel element during the retracted guaranteed life is known to depend on a number of factors, the main ones are the following:

- thermalcycling during changing the power of RI, enforced outputs from operation, the operation of emergency protection of a reactor;
- radiation clod increasing fragility of the material of shells of the fuel element, depending from the burnup of the energy supply of a reactor core;
- accumulation of fission products raising the pressure under the shell of the fuel element;
- the quality of a water regime of the 1 and 2 circuits;
- the quality of materials and the technology of production of fuel assembly.

The main disadvantage of the control of the quality of fuel assembly at ship NEI is the lack of the resistance control of metal and hermeticity of shells of the fuel element during recharging the reactor core and constant control of hermeticity of the fuel element in the operation period according to the analogy of control of hermeticity of shells (CHS) of the fuel assembly at NPP. For the project of FNPP such control system is not provided.

According to the operational experience there are frequent leakages of the first circuit before the yield of the safe life in the tubal systems of steam generators, in the heat exchangers, pipe lines, in the cover of a reactor and the racks of actuators of SCP on it.

The main reason of such situation is the lack of methods of a non-destructive control of the 1-st circuit during the operation period when conducting the inspection of the 1-st circuit and searches of microleakages in the pipe lines and the equipment of the 1-st circuit. The system of a remote control of integrity of metal of the main equipment in the project of FNPP (according to the analogue at NPP with WWER-1000, SK-187) also is stipulated.

The main disadvantages of a protective shell are:
- the lack of control of hydrogen content – the powerful catalyst of explosion and fire generated by radiolysis in the melted reactor core. At the same time the way of deleting of “a fulminic mixture» from the protective shell (PS) during emergency with a gap of the reactor circuit and melting of a reactor core is not provided;
- in the materials there are no substantiations of resistance and gas-density of PS during maximum project emergency (MPE) with a gap not only in the pipe line of the 1-st circuit, but also the steam pipe of steam generators in the boundaries of PS. According to the operational experience of NEI of vessels it is known, that the requirements on resistance and gas-density were groundlessly underestimated.

The main disadvantages in the estimation of functionability of physical barriers of NEI safety are:
- lack of information permitting to conduct the objective analysis of reliability level and safety of physical barriers;
- lack of practice of a deep analysis of separate violations in the operation of NEI because of technical complexity during investigation of the basic reasons of emergency;
- lack of information about taken correcting measures and their fulfilment;
- lack of practice of installing “model - witnesses" for detection of the real state of crucial point from the point of view of strength of clusters of the RI equipment and the pipe lines of the 1-st circuit, diagnosing of the technical condition and forecasting the actual safe life of the elements of RI.

In the present system of the state supervision on ship NEI the pointed out above remarks and problems, following from them, are not taken into account and can not be taken into account, as there is no unified systemforming doctrine of safety reflecting the contemporary state of the mechanism of taking the regulating measures from the party of Gosatomnadzor of Russia on the whole range of questions concerned with NEI safety of a transportable kind, in which basis the effective and stable system of feedback in the operational experience should lie.

Besides, it is necessary to mark, that, unfortunately, Gosatomnadzor of Russia, as the body of the state supervision and regulation is under Minatom’s thumb in the part of allocation (duplicating) of especially nuclear - and radiation - dangerous objects in the territory of Russia and by doing this it roughly breaks its direct duties assigned to it by the Government. For example, STC of Gosatomnadzor of Russia in its « Experts' Report on the safety of allocation of nuclear heat low-power plant on the basis of floating energy unit of the project 20870 with the reactor installations KLT-40C in Pevek» did not noticed or did not want to notice the uncorrespondence of a nuclear reactor of RI КЛТ-40С to the requirement of item 4.4 of Appendix to RNS RI NP - 89 and a number of obvious mismatches to the requirements of ND of the input system of a liquid absorber inserted into SCP of RED and etc. It is possible, they did not reveal some other mismatches to the key requirements of ND, at any rate, on the nuclear safety in the project of FNPP. In this connection it is pity, that the poor skill level of the experts of STC of

nuclear and radiation safety, and, maybe, of Gosatomnadzor of Russia is as a whole combined now with starting Minatom to put in practice constructing of more dangerous NPP. This happens because of lack of precise unified state requirements of safety control for each object of atomic energy using as a whole (of separate systems and units as well as to the main and auxiliary equipment).

CONCLUSION AND RECOMENDATIONS

As a matter of fact Minatom began the construction of floating NPP by openly breaking the Constitution and laws « About the environmental protection » (1991), « About the ecological expertise » (1995) and « About nuclear energy using» (1995) and with wide use of funds from the federal budget.

The construction of floating NPP is planned by Minatom on the basis of ship nuclear reactor installations КLT-40C. Their history of operation has always been secret, including owing to radiation emergencies on them. One this circumstance let us assert, that these reactor installations are unacceptably dangerous.

The economic grounds of the construction of floating NPP are doubtful, as it does not take into account much necessary expenditure. Registering these expenditures the construction of FNPP can not be profitable or, at all events, it will be much more expensive, than in case of providing the suggested regions with other energy sources.

The construction and using of FNPP are connected with large ecological risks, underestimated by atomic engineers. The analysis of possible effect of FNPP on the environment is made with large principled disadvantages and can not be recognized as satisfactory one.

The beginning of Minatom to put into practice the construction of more dangerous NPP happens without precise unified state requirements of safety control for each type of object of nuclear energy using as a whole, of its systems and units, the main and auxiliary equipment. Such situation especially causes fears under conditions of liquidation of the structures that used to execute the supervision of safety of the project design developments in Gosatomnadzor of Russia. With their abolition the possibility of estimation of the main project solutions is lost from the point of view of their conformity to the requirements of safety in the field of nuclear energy using already at the earliest stages of creation of the project (now the estimation of the project is being made only at the stage of obtaining the license for constructing the object in Gosatomnadzor of Russia). The combination of the present situation in Gosatomnadzor of Russia with the interest of Minatom in constructing many dangerous NPP and with lack of necessary completeness and sufficiency of the package of ND on safety for transportable kind of NEI for Russia, in our opinion, is not permissible.

Support of the plans of allocation of FNPP by the regional authorities of the Chukotsky and Taimir (Dolgano-Nenetsky) autonomous areas, and also the Arkhangelsk area (Severodvinsk) is transparently connected with their desire to receive funds from the federal budget for social-economic development of these regions with the help of Minatom. At the same time the authority of the regions does not imagine perils and negative consequences of the operation of FNPP, which are incommensurable with the momentary profit from them.

The plans of Minatom concerning the proliferation of floating NPP in other countries of the world are extremely dangerous from the positions of non-proliferation of mass destruction weapons. Highly enriched uranium of weapon quality contained in two reactors of floating NPP and in the storehouse of fresh fuel assembly is enough for manufacturing of tens of nuclear bombs. Appearing of this uranium in the countries that seek to become members of the nuclear club, will save them of necessity of creation of their own uranium industry (of extraction, enrichment of uranium). It will make nuclear weapon practically easy of access, that will change all the geopolitical picture of the modern world.

Minatom's activities concerning creation of floating NPP have one more access of the Russian atomic engineering to the overseas market as a long-term target. These plans of Minatom about the organization of proliferation of floating NPP worldwide on the basis of leasing are doubtful not only from economic and geopolitical, but also from the moral-ethical points of view. Minatom produces the electric power at FNPP, sells it to a country, then returns all radioactive waste, all spent fuel to the territory of Russia and accepts all superunprofitable obligations of the further waste management, including ultimate disposal of radioactive waste. The profit for Minatom - today, expenditures of the budgetary funds for radioactive waste treatment- tomorrow, and radioactive waste for the Russians - forever!

We pay attention of Gosatomnadzor of Russia to its connivance at implementation of Minatom's plane concerning the construction of FNPP.

We pay attention of the Government of the Russian Federation, authorities and public organizations of St.-Petersburg to the appearing of a serious risk of emergencies, concerned with the construction and industrial tests of FNPP in the territory of the city (at JSC « the Baltic plants »).

We pay attention of the General prosecutor's office of Russia to obviously breaking the Constitution and lots of laws of the Russian Federation during the organization of the construction of FNPP by Minatom of Russia and we demand to provide bringing active laws of nuclear energy using, ND of NPP into line with the Constitution of the Russian Federation and to return Minatom's activity to the constitutional field of the Russian Federation.

We pay international intergovernmental and public organizations' attention to the approaching, new danger concerned with the uncontrolled proliferation of spallating material in connection with Minatom's plans of organization of leasing of FNPP.

We call for the public and governments of all countries of the world, first of all, Arctic countries (the USA, Canada, Norway, Denmark, Finland, Sweden, Germany, Japan), - still it is not too late! - to state against these dangerous intentions, and those countries, with which Minatom of Russia have already negotiated on FNPP (Indonesia, the Philippines, Chile, Argentina, China) - should refuse from their implementation.

APPENDIX 1

THE ATOMIC ENERGY MINISTRY
OF THE RUSSIAN FEDERATION
The state company
“Russian state concern
producing electrical and heat
energy at nuclear plants”
The concern "ROSENERGOATOM"

The mail address:
101000. Moscow, mailbox 912
AT 207457 FLUENCE tel. 239-24-22
04.12.2000 № 27-10/3036
For № 005 - 47 dated back 20.10.2000.
141 dated back 19.10.2000.

With regard to the appeal to the International Social - ecological Union (ISEU) about granting of preproject and project documentation on the construction of CNTS SP on the basis of FEU with RI KLT-40C in Pevek for carrying out the public ecological expertise I am reporting:

In 2000 a group of the members of ISEU issued the book « Floating NPP of Russia: A Threat to the Arctic, World Ocean and Non-Proliferation Treaty », in which the authors (V.M.Kuznetsov, A.V.Yablokov, V.M.Desyatov, A.M.Nikitin, I.V.Feropontov) not being familiar with all complete set of the project documentation, claim about serious violations in the project of CNTS SP on the basis of FEU with RI КЛТ-40С and breaking the Laws of the Russian Federation.

The book mentioned above shows, that even before familiarizing with the materials of the project in ISEU, the extremely negative, tendentious and subjective approach to the idea of creation of CNTS SP as well as to the materials of the particular project was developed.

So apparent bias of some members of the commission gives all basis to consider the work of the public ecological expertise on the project of CNTS SP in Pevek of the Chukotsky autonomous area to be meaningless and beforehand predetermined on the conclusions.

Besides, the transmission of the project to the commission in any case has lack of common sense because of full absence of perspectives of solvent demand of electrical and heat energy in the Chaun region of the Chukotsky autonomous area.

The concern "freezes" the project and asks the commission to search for necessary for the Chaun region types of generating powers and sources of finance for their implementation on their own.

Yours faithfully,
The Executive Director
U.Y.Yakovlev

Ex. Kuzin 962-92-69

APPENDIX 2

Some emergencies and incidents on the ship reactors of The Icebreaking fleet of the USSR / RUSSIA (V.M.Kuznetsov, 2000)

In February, 1965 during planned repair works on the reactor № 2 of the atomic icebreaker “Lenin" there was an emergency. As a result of an error made by operators of NSTI, the reactor core was left without water for some time, that caused partial damage approximately 60 % of fuel assembly (FA). During the each channel reloading only 94 FA was managed to unload. The rest 125 FA appeared not to be extricated from the reactor core. This part of SNF was unloaded together with screen assembly and was placed into the special container, which was filled by hardening mixture on the basis of futurol and then has been stored under coastal conditions about for 2 years.

In August, 1967 the reactor compartment with NSTI OK-150 and its own hermetic bulkheads was sunk directly from a side of the icebreaker "Lenin" through the bottom in the shallow-water bay of Tsivolka in the northern part of the New Earth archipelago on the depth of 40 - 50 m. Before sinking of the compartment SNF was unloaded from reactors, and their primary circuits were washed, drained and hermetically sealed. According to the data of the Central design bureau "Iceberg", before sinking the reactors were filled by hardening mixture on the basis of futurol. The container with 125 spent FA, filled with futurol, was transferred from the shore, placed inside a special pontoon and sunk. By the moment of emergency the reactors and ship nuclear - dangerous installation had operated about 25000 hours.

November 11, 1988 at a/i "Russia" the event which developed into a nuclear - dangerous situation took place. The icebreaker was at the mooring line RTP "Atomflot". As a result of mishandlings of the staff the reactor remained without cooling for 4 minutes. There was the operation of emergency protection.

In 1992 at atomic vessels 12 cases of operation of emergency protection (EP) and 7 cases of emergency descent of power were recorded, 68 % of them were caused by error operations of the staff of NSTI.

The main technological disadvantage influenced the nuclear and radiation safety is low reliability of:

- the element base of a complex control system (CCS) "Sever" of the atomic icebreaker "Taimir" and the lighter carrier "Sevmorput", resulting in taking out of operation of sections of automatics, control and protection systems;
- steam generators (production of 18-T). For this reason the icebreaker "Siberia" is put in repair for replacement of steam generators, the reactor installations of atomic icebreakers "Russia" and "Arctic" have been used with limitation of power (75 % of established one).

In 1993 there were the following operational incidents:

- leakage of a tubal system of SG- 7 of NSTI-1 and SG- 8 of NSTI-2 a/i "Russia";
- leakage of a tubal system of SG-4 of NSTI-2 a/i "Siberia";
- reaching of the up limit of activity of a coolant STI-1 a/i "Arctic";
- operation of EP on NSTI of both sides of a/i « Sovietsky Soyuz » according to a signal « Pressure (min) » by switching of current supply;
- on January 25, 1993 excess of the contents of radioactive gases was recorded in a reactor compartment of a/i "Arctic”. The icebreaker was in the Karsk sea. Leakage of one of the holes in the cover of a reactor became the source of increase of radioactivity. Despite the noticed leakage, the reactor was working with the same power for 3 more days. During the incident, according to the ship's log, there was an emission of short-lived isotopes with the general activity of 55 GBk (1,5 Ku).

In 1994 in the vessels with NSTI the following operational incidents took place:

- operation of EP according to a false signal in a/ lighter carrier "Sevmorput";

- loss of leakage of a tubal system of SG (structural - technological defect) in a/i "Russia" and "Siberia";
- failure of a remote control system of a steam pressure regulator of a warming condenser in the a/ lighter carrier "Sevmorput";
- operation of EP according to a signal « Stop PB » during checking StartUp of working water pumps of automatics owing to aging of rubber-technical devices, lock and control valves PTP and incorrect set-up of these devices in the a/ lighter carrier "Sevmorput";
- operation of EP during carrying out regulated checks of channels of passing of EP signals owing to fault of one of modules of a system "Mars" because of imperfection of the scheme in the a/ lighter carrier "Sevmorput".

In 1995 in the atomic icebreakers there were two operations of emergency protection and one emergency break. Besides, in the icebreakers 20 operational incidents, from them owing to failures of technical equipment - 15, to fault of staff - 4, for the obscure reason - 1 were recorded.

On the whole, failure of technical means happened because of violation of seals of steam and water valves and appearance of leakages in pipelines.

Mishandlings of the staff are connected with unqualified preparation of systems for operation (three cases) and errors during mounting systems at the moment of maintenance (one case).

In 1996 in the vessels with NSTI the following incidents happened:

- in the a/i "Arctic" on the 22-th of February a gas thinness of a primary circuit system of STI-1, which was developed further into a small leak (70 l/ h), was detected;
- in the a/ lighter carrier "Sevmorput" on March 11 during parking under the load with power of 22 % the protection (EP) of a nuclear reactor was worked during putting the system "Almak" into operation and etching vapour because of falling of the vapour pressure;
- in the floating technical base (FTB) "Lotta", February 17, during loading a protective cover into the container ТК-18 there was it’s jamming. At the attempt of its return into the base container there was a breakaway of a rope of the winch of the container. The base container is substituted, the protective cover is put into the storehouse of FTB.

In 1997 in the vessels with NSTI the following incidents took place:

- three leakages of SG: October 2, in the a/i “Yamal" - gas thinness of SG - 4, March 15, in the a/i « Sovietsky Soyuz » - a small leak of SG - 2, November 2, in the a/i "Arctic" – a small leak of SG - 1;
- from six operations of emergency protection of the reactor five of them happened in the a/i "Arctic";
- March 12, during unloading spent fuel assembly (SFA) from the storehouse of FTB "Imandra" a radiation incident - local radiological contamination of a watched zone of the floating technical base "Imandra" took place.

In 1998 at the objects of Mintrans of Russia 21 operational incidents were registered. They are classified according to RD 31.20.42-93 (ЭП-6 - 10, ЭП-5 - 6 incidents , ЭП-4 - 2 incidents, ЭП-3- 2 incidents, EP-2 - 1 incident).

Here are three incidents - with operation EP:

- A/lighter carrier "Sevmorput", 26.03.98 – the operation of EP of a reactor according to a signal « Reduction of the period of doubling reactor power ». The limits and conditions of safe operation were not broken;
- a/i "Russia", 03.03.98 - operation of EP of reactor 2 according to a signal « Reduction of consumption of feedwater » owing to opening a throttle valve at 100 %, that was caused by a latent defect in the mounting of the rack of STI. Radiational situation and the parameters of STI remained within the limits of the norm;

- a/i "Arctic", 31.12.98 - while setting a throttle valve from automatic control to remote one unauthorized closing of a throttle valve took place, that resulted in operation of EP according to a signal « Loss of feedwater consumption ».

In 1999 in the vessels with NSTI there were 14 operational incidents, 4 from them with operating of emergency protection: 3 - in the atomic icebreaker "Russia" (January, 1999) and 1 - in the atomic icebreaker "Taimir" (June, 1999):

- 23.01.99 a/i "Russia", NSTI - 2. During putting on МКУ of reactor 2 there was a spasmodic change of the readings of current starting equipment (SE), that resulted in operating EP-1. The reason is the oxidation of contacts in the circuit of SE.
- 29.01.99 a/i "Russia", NSTI - 2. Reactor power 12 %. As a result of lowering a water-level in the deaerator below the permissible level (1700 mm), failure of operation of turbo feed pumps 1 and 2 the operation of emergency protection of the reactor according to a signal « Stop PB » took place. The reason is the imperfection of water- level measurement system in the deaerator, poor control of the operation of level measurement system in the deaerator by the experts of KePeA. The limits of the normal operation are not broken.
- 31.01.99 a/i "Russia", NSTI - 1. Reactor power 15 %. On eliminating the violation «Disappearance of current at output of ИК - 7 » the emergency protection of the reactor worked . The reason is the rest electric charge on the electrodes of a chamber.
- 03.06.99 a/i "Taimir". Reactor power 17 %. EP-1 worked because of a false signal of lowering of a reactor period. The control parameters of NSTI did not fall outside the limits of the normal operation.
- 12.01.99 a/lighter carrier "Sevmorput". During putting out and warming of NSTI the increase of gas activity in the expansion tank of the third circuit was found out. As a result of search of leakage the thinness of a cooler of the primary circuit pump was detected. The cooler was dissected away by the second stop reinforcement on the third circuit.
- 11.01.99 a/i "Vaigach". Reactor power 50 %. The converter of a system "Sever" was out of operation. The unstable readings of the device were registered. The reason is failure of electrolytic condensers in the scheme of a module.
- 29.01.99 a/i "Russia", NSTI - 1. Reactor power 15 %. Because of violation of hermeticity of a tubal system of SG - 7 there was the increase of vapour activity behind SG. The steam generator is switched off by the second stop reinforcement on the secondary circuit.
- 17.02.99 a/i "Vaigach". Reactor power 50 %. As a result of failure of electrolytic capacitors in the scheme of the module UcFR of the device PA there was a light up of a signal « Fault of PA ». The functions of automatic control of compensatory group on temperature were kept.
- 18.02.99 a/i "Vaigach". Reactor power 75 %. As a result of failure in the electrolytic scheme of the module CHM-1 of the device PA there was a light up of a signal « Fault of PA ». The reason is the failure of condensers in circuit 27 B.
- 15.03.99 a/i « Sovietsky Soyuz », NSTI - 1. Reactor power 80 %. Because of violation of hermeticity of a tubal system of SG - 1 there was the increase of vapour activity behind SG. The steam generator is switched off by the second stop reinforcement on a secondary circuit.
- 01.08.99 a/i "Vaigach". Reactor power 90 %. Failure of an autoswitch of power supply of АПП-15 of a system VR 1-2 (the system “Veter", an operator console, the switch of modes "light" - "dark"). Failure of the switch did not influence the modes of usage of NSTI, nuclear and radiation safety.
- 02.08.99 a/i "Vaigach". Reactor power 91 %. Failure of a module of galvanic separation) МГР-7 of the system "«DOMATIC" (disappearance of the readings "P/1к" of the second channel). Failure of the switch did not influence the modes of usage of NSTI, nuclear and radiation safety.
- 08.10.99 GUP DBZ "Star". At the pier on the depth of 15 m the control-dosimetric point (the vessel "Uranus") was sunk. Earlier it was used for collecting and temporary storage of decontamination waters of low level of radioactivity and then it was taken out from operation.

During 2000 there were 18 operational incidents, from them 3 with the operation of emergency protection:

- 03.01.2000. a/i "Russia", NSTI № 2, reactor power - 13 %. On checking the voltage output of supply units of racks of backup IZK “ Pole - C" there was a false signal of recompression in a primary circuit and, therefore, the operation of emergency protection of the reactor.

- 29.01.2000. a/i "Taimir". Reactor power - 32 %. There was the operation of EP. The reason is the oscillation of voltage in the electrical circuits; during switching on the second turbogenerator there was the operation of protection of supply units, from which the cards of one floor of processing stations « the emergency message » are supplied with voltage. The protection worked at all 26 supply units. The equipment controlled by the system "«DAMATIK" remained without control, that resulted in operating EP.

- 21.04.2000.a/i "Vaigach". Reactor power - 65 %. Owing to spontaneous closing of the shut-off valve BTG-2 there was an automatic switching-off of the generator device BTG-2, the board RS2 was de-energized. Analyzing the incident it was found out, that the closing of the shut-off valve of the turbine was caused by false operation of one of the relay assembly in schemes 3,474,7631,65,2621,40962, ZL, 115, participating in passing an influence signal on the shut-off valve provoked by vibration, that at the moment of switching-off of BTG was rather considerable.

- 18.05.2000. a/i "Arctic". NSTI № 2. The reactor was stopped by all nominal absorbers. On testing SG – 2, in two day after putting them into the storage ammonia was found in the water. On spectrometring the test of water the isotopes Xe-133, I-131, Cs-134 were detected. The steam generator is removed from wet storage, is switched - off on water and vapour by stop reinforcement. During repairing, the leak of a handset of section 8 was found.

APPENDIX 3

Incidents and emergencies in atomic submarine fleet of USSR / RUSSIA.

During the forty years operational period of domestic ship nuclear energy installations (NEI) twelve nuclear and more 100 radiation emergencies have taken place. A nuclear emergency is such kind of emergency that concerned with the damage of fuel elements exceeding the established limits of safe operation, and/or irradiation of staff exceeding the permissible level for normal operation, caused by:

- violation of control and managing of a chain nuclear reaction of fission in the reactor core;
- creation of a critical mass during reload, transportation and storage of fuel elements;
- violation of heat elimination from fuel elements (GRS -88/97).

A radiation emergency is losing the control of an ionizing radiation source caused by equipment malfunction, mishandlings of staff, natural disasters or other reasons, which could result or have resulted in irradiation of people above established norms or radiological contamination of the environment (NRS-99).

All emergencies were accompanied by serious radiological and ecological consequences. During emergencies on ship NEI and liquidation of their consequences more than 1000 persons were exposed to exceeding irradiation. The total radiological consequences of emergencies on naval reactors are comparable with the nearest consequences of irradiation from the Chernobyl catastrophe (Sharapaevsky and oth., 1999).

Some nuclear and radiation emergencies having taken place in domestic atomic submarines in 1960-2000.

(Int. Herald Tribune, 1989; Gagarinsky and oth., 1994; Grach, 1994; Nilsen, Bermer, 1994; Osipenko and oth., 1994; Zubko, 1995; Handler, 1995; Nilsen and oth., 1996; Calendar..., 1996; Kucher and oth., 1996; Pavlov, 1997, 1999; Nilsen, Kudrik, 1998; Y.Nikitin, 1998; Mormul, 1999; Putnik, 1999; Sharaevsky and oth., 1999; Dolgodvorov, 2000; from A.V.Yablokov. 2000, tab. 5 with additions, V.M.Kuznetsov and others, 2001)

Date	**Region**	**Atomic submarine**	**Description of emergency**
October *13, 1960	The Barents sea	"November", (K-8), project 627	Radiation emergency. Emission of radioactive products as a result of a gap in a steam generator. Overirradiation of 13 persons
July *4, 1961	Atlantic	"Hotel", (K - 19), project 658	Nuclear emergency. Overirradiation of 138 persons (8 persons died). Substitution of a reactor compartment
1962	The Arctic	"November", (K - 52), project 627A	Radiation emergency. Emission of radioactive products as a result of a leakage in a steam generator. Overirradiation of the crew
1962	The Arctic	"November", (K - 14), project 627A	Radiation emergency. The destruction of emergency protection in the reactors of both sides entailed serious radiation consequences. Substitution of a reactor compartment

July, 1962	The Arctic	"November", (K-3), project 627, "Leninsky Komsomol"	Radiation emergency. Dehermeticity of fuel elements entailed serious radiation consequences, as a result of which a reactor compartment was compelled to be substituted
April 10, 1963	The North Atlantic	"Hotel "- 2, (K - 19), project 658	Emergency of a reactor. Death of 8 persons
1963	The Pacific ocean	(K - 151), project 659	leakage of the third circuit. Overirradiation of the crew
November 1964	Severodvinsk	"November", (K - 11), project 627A	Radiation emergency. Dehermeticity of fuel elements
1965	The Arctic	"Hotel "- 2, (K - 33), project 658	radiation emergency. Dehermeticity of fuel elements
February *12 1965	Severodvinsk	"November", (K - 11), project 627	Nuclear emergency. Unauthorized operation of a reactor on power, emission of radioactive products. Overirradiation of the crew (for more details see Appendix 4)
1965	The Arctic	"November", (K-5), project 627	Radiation emergency. Dehermeticity of fuel elements entailed serious radiation consequences, as a result of which a reactor compartment was compelled to be substituted
1966	The Barents sea	"November", (K-8), project 627	Radiation emergency. Leakage of steam generators
1968	The Arctic	"Hotel "- 2, (K - 33), project 658	Radiation emergency. Dehermeticity of fuel elements
1968	PON (the Pacific ocean navy)	(K - 175), project 675	Radiation emergency. Dehermeticity of fuel elements
May 24, 1968	The Barents sea	"November", (K - 27), project 645	Nuclear emergency as a result of failure of an automatic power regulator. Emission of radioactive gas from a gas system. Overirradiation of all crew (147 persons, from them 44 persons died). For more details see Appendix 4.
August 27, 1968	Severodvinsk	"Yankees", (K - 140), project 667a	Nuclear emergency. Unauthorized operation of a reactor on power. Overirradiation of crew (for more details see Appendix 4)
March 21, 1969	The Arctic	"November", (K - 42) project 627	Emergency of NEI owing to salting of the second circuit
1969	The North Navy	K-166, project 675	Gas thinness of fuel elements
January 19, 1970	Gorky, the "Krasnoe Sormovo" plant	"Charley", (K-320), project 670	Nuclear emergency. Unauthorized start of a reactor. Death of four, overirradiation of several hundreds of people, radiation pollution of the plant. (for more details see Appendix 4)

April 10-12, 1970	Bay of Biscay	"November", (K-8)	A fire in the compartments of AS. The wreck of the submarine.
1975	The Pacific ocean	(K-23), project 675	Emergency of SGI
1975	The North Atlantic	(K-172), project 675	leakage of a primary circuit
1975	The Barents and the White seas	K- 253	Radiation emergency - violation of hermeticity of fuel elements. Irradiation of the crew. (for more details see Appendix 4)
1977	The Pacific ocean	(K- 56), project 675	Emergency of SGI. Dehermeticity of a reactor
*Июль 1979	The Pacific ocean	(K - 116), project 675	Nuclear emergency. Leakage of a coolant on the cover of a reactor. Dehermeticity and melting of a reactor core, overirradiation of 38 persons
1979	The northern Navy	(K - 90), project 675	Leakage of SGI
April 14-15, 1980	The Pacific ocean	(K - 45), project 659	Leakage of a primary circuit
November 30, 1980	Severodvinsk	"Anchar", (K - 222), project 661	Nuclear emergency. Unauthorized start of a reactor to work on power. Emission of radioactive substances. Overirradiation of staff
1981	The Pacific ocean	(K - 66) project 659	Leakage of a primary circuit
April 8, 1982	The Barents sea	”Alpha", (K - 123), project 705	Nuclear emergency. A gap of a primary circuit. Emission of 2 tons of a liquid-metal coolant into the reactor compartment
August 11 1983	The Pacific ocean	(K - 94), project 675	Leakage of a primary circuit
March 21, 1984	The Pacific ocean	(K - 94), project 675	Leakage of a primary circuit
March 26 1984	Base	(K - 184), project 675	Emergency of SGI
April, 1984	The Barents sea	"Charley", (K - 508), project 670M	Radiation emergency. Leakage of a steam generator
September 24 1984	The northern Navy	(K - 47), project 675	Emergency of SGI. Leakage of the third circuit
1985	The Barents sea	"Victor", (K - 367), project 671	Emergency in the emergency protection system of a reactor
August 10	The bay of	"Victor-1", (K- 431),	Nuclear emergency. Melting of a

1985	Chazhma	project 675	reactor core. Explosion. Overirradiation of 100 people, death of 10. Radiological contamination of close water areas and territory
September 29, 1985	The Pacific ocean	“Echo-2”, (K-175) project 675	Nuclear emergency. Dehermeticity of reactor cores. Overirradiation of the crew
November, 1986	The Kamran bight	(K - 175), project 675	Emission of liquid RW and radioactive aerosols. Radiation pollution the close territory
1986	The Pacific ocean	(K - 59), project 659	Radiation emergency. Leakage of SGI
1986	The Pacific ocean	"Hotel", (K - 55), project 658	Radiation emergency. Leakage of SGI
November, 1986	Base at PON	“Echo "- 2", (K - 175), project 675	Radiation emergency. Emission of LRW and aerosols into the environment
June 15,16-26, 1989	the Barents sea	“Echo "- 2", (K - 192, the former K - 172) project 675	Leakage of a primary circuit of the reactor portside. Leakage of a primary circuit of the reactor starboard. Nuclear emergency. Emergency of NEI with melting of a reactor core. Overirradiation of the crew. Pollution of the ocean and the atmosphere with iodum - 131
January, 1991	PON	(K - 94), project 675	Emergencies of SGI of both sides
January 28, 1998	West Litsa	Victor-3, project 671PTM	A gap of a gas circuit of NEI. Five persons suffered, one person died
2.08.2000	The Barents sea	Oscar-II K - 148 (Kursk)	The wreck of the submarine. 118 persons died.

APPENDIX 4

Emergency at AS in the bight of Chazhma (the Primorye area) in 1985. (edited by S.Baranovsky, V.Samosuk, 1999)

August 10, 1985 at AS K- 431, project 675, ref. № 175, situated at pier №2 of the ship repair plant of Navy in the Primorye area (the bight of Chazhma, settlement "Shkotovo-22"), during recharging the reactor cores owing to the violation of the requirements of nuclear safety and the technology of undermining of the cover of a reactor there was an uncontrolled spontaneous chain reaction of uranium nucleus fission of the reactor port side. At the same time a radioactive train was formed whose axis crossed the Danube peninsula in the northwest direction and went out to the sea at the coast of the Ussuriysky bay. The expansion of the train in the peninsula constituted 5,5 km (further emission of aerosolic particles happened on the surface of a water area up to 30 km from the place of emission).

As a result of emergency, the center of radiological contamination of the water area bottom of the bight of Chazhma was formed. The area of intensive radiological contamination was concentrated in the region of emergency and in the limits of MED > 240 micR/h takes the area about 100000 м². In the central part of the center MED is 20 - 40 mR/h (maximum 117 mR/h as of 1992). Under the influence of flows the radiological contamination was being gradually transferred in the direction of going out from the bight of Chazhma. The radioactivity of bottom sediments is stipulated mainly by cobalt - 60 (96 - 99 %) and partially by cesium - 137.

The radiological contamination of the water area of the bight of Chazhma has taken place in its southeast part. The area of maximum pollution of bottom of the bight has constituted 0,08 - 0,1 km² (in the limits of MED the gamma-radiation > 240 micR/h). The movement of the pollution of bottom sediments from the emergency zone in the direction of the Western pass of the bay of Arrows has been watched. The pollution of the water area of the eastern part the Ussuriysky bay with the radius of 3 - 5 km away from the place of the emission of the coast radioactive track has created the excess of MED of the gamma-radiation over the background within the limits of 1 - 8 micR/h.

The watched tendency of moving of radiological contamination in the natural layer and its dispersion along the bottom of the bight of Chazhma has not resulted in serious ecological consequences, as the general activity of radionuclides in the bottom sediments is rather insignificant (about 5 Кu), and the leading radionuclide has been cobalt - 60 with a half-life of 5,26 years.

In the course of emergency and during the liquidation of its consequences 290 (according to other data - 260) people were exposed to exceeding irradiation. At the moment of the emergency 10 persons died of injuries. The hard radiation sickness was developed for 10 persons, the radiation reaction was marked for 39 persons.

APPENDIX 5

The brief analysis of ecological conditions in the Far North of Russia (V.M.Kuznetsov and oth., 2000).

The Arctic region of Russia due to its geographical and sociological features is endangered by the radiological pollution to the greater degree and the degree of this dander is permanently increasing. In many respects it is connected with a great number of military objects on nuclear-weapon tests and nuclear naval bases in the region. Now separate territories of the Arctic of Russia are referred to the ecologically unfavorable ones. So special attention should be paid to the radiation situation, which on the Kola peninsula and in other areas of the Arctic threatens to become disastrous.

The following sources of potential danger of radiological pollution of the environment can be pointed out:

- nuclear energy installations among which the Kola and Bilibino power nuclear plants;
- atomic icebreaking fleet;
- Northern fleet equipped with submarines and ships with nuclear energy installations and carrying nuclear weapons;
- ship repairing and shipbuilding plants of civil and military type;
- nuclear-weapon tests in the New Earth;
- underground nuclear explosions with the “peace" purposes;
- companies engaging in recycling and utilization of radioactive wastes and written off submarines;
- places of burial of radioactive waste;
- sunk atomic ships;
- consequences of radioactive rainfalls after the emergency at the Chernobyl NPP.

The companies are necessary to add to this list the operation of which also has an unfavorable influence on the radiationsituation in the region, as the radioactive products of their operation come on the northern rivers into the seas of the Arctic. They include such plants as the Siberian chemical plant located in the region of Tomsk, the industrial association "Mayak" in the Southern Ural and the Krasnoyarsk mining-chemical plant near Krasnoyarsk.

The Murmansk surpasses all other areas and countries area in quantity of nuclear reactors per person of the population. The facilities using different nuclear technologies are widespread here. Among the civil facilities , first of all, it is the Kola nuclear power plant having four energy units with light-water reactors under pressure of a type WWER-440 of single electrical power 440 MWt (however, two of them are coming to the end of their safe life), and also the construction of the Kola NPP-2 with the power of 640x2 MWt is in schedule. Different radioisotope devices of technological control are used at 58 plants and offices of the area the. In Murmansk at RTP "Atomflot" 9 vessels (8 icebreakers and 1 lighter carrier) with 13 light-water reactors under pressure are based.

The main quantity of nuclear facilities is connected with the military forces. The Northern fleet has (according to the press) on the arms 123 nuclear vessels, onboard which there are 235 nuclear reactors in total. The main bases are located in the Kola bay and along the coast of the Kola peninsula.

Extraction and processing of natural - radioactive raw material (loparit, bedellit, perovskit) are conducted by the Lovozersky and Kovdorsky mining-enriching plants in the Kola peninsula. The contents of radioactive substances in ore, intermediates and finished products is near the low level of an activity interval , requiring special organization, and radiation monitoring.

The radioactive wastes (RW) created by the operation of NPP and vessels with nuclear energy installations (NEI), are stored for long-termed storage in special facilities at NPP and at the plants maintaining ship NEI located in the territory or near these plants.

The modern nuclear electric power plants and NEI of atomic submarines are the most widespread and the probable source of pollution of the environment. In the Kola peninsula there are five places for utilizing nuclear waste. Nuclear wastes with 200 NEI of the Northern fleet and plants of their service are being utilized in the military bases along the Kola peninsula and near Severodvinsk in the Arkhangelsk area. The spent fuel of the Kola NPP is stored at the station, and then is transferred to PC "Mayak" for recycling. Low-active wastes from civil companies are stored 30 kilometers away from Murmansks. In the Kola bay the Murmansk marine shipping company executes temporary storage of radioactive wastes in five vessels. To sink solid and to drain liquid RW in the Kara and Barents seas the shipping company used the vessels "Lepse", "Volodarsky" and "Serebryanka" up to 1986. Separate sites for drainning low-active and liquid RW were near the coast of the Kola peninsula. Until 1985 a great number of RW was sunk in the Kara sea and in the bays of the New Earth archipelago. Nowadays RW is being utilized in the Murmansk, Arkhangelsk areas and in some other places located in Siberia. The vessels "Lotta", "Serebryanka", "Lepse", "Volodarsky" and "Imandra" used for storage of radioactive wastes and spent fuel are situated in the Kola bay only two kilometers away from dwelling houses. The whole civil atomic icebreaking fleet of Russia also is maintained in Murmansk. Onboard the icebreakers there were fires several times.

As a result of using military and civil atomic fleet based in the Murmansk and Arkhangelsk areas up to thousand cubic meters solid and 5000 м3 of liquid radioactive wastes annually appear. The share of highly active wastes makes no more than 5 - 7 %, and practically there are no wastes with transuranium elements. Approximately 85 % of all volume of wastes appear at the ship repairing plants . The indicated level of nuclear wastes has been the same for the last twenty years.

The source of deterioration of radiological conditions in the Arctic region of Russia is also the conducted surface and underwater nuclear-weapon tests on the shelf of the Barents and Kara seas. Thus the main anxiety is brought by a nuclear testing area in the New Earth, where 132 nuclear explosions have been already carried out , from which 86 explosions - in the atmosphere and 8 - in the Barents and Kara seas.

The history of the New Earth military tests is divided into two stages. The first stage (from 1954 till 1963) is characterized by powerful nuclear explosions in the atmosphere at the altitude of 3-10 km, and also above the water and underwater in the depthes up to 100 - 200 m. Here the most powerful in the world practice explosions in 58 megatons (30.10.61) and in 30 megatons (5.08.62) were made. In general the power of explosions was about one megaton. Still in 1958, 1961 and 1962 not less than 30 explosions annually, and sometimes 7 - 8 monthly were conducted in the atmosphere. Some powerful bombs (20 - 25 megatons) were blown up in the coastal area to the west and the east from the Matochkin Shar channel. In the second half of 1961 and 1962 a series of nuclear explosions in the sea were made.

After the beginning of ground tests the considerable rainfalls of radioactive substances in the Murmansk area, Komi ASSR and in other regions and settlements of the North were recorded. In the region of the New Earth the icebreaking ships repeatedly came to the regions with exceeding background radiation, which was the result of a nuclear explosion, when a part of gases on the cracks reached the atmosphere and then was spread at large distances. During air nuclear explosions the considerable quantity of radionuclides which structure differs from the structure of radioactive wastes of nuclear production was found in the atmosphere and on the surface of the ocean. Basically, they are fission products, some part of non-fissile nuclear fuel, the products of activation of air, water, ground, biota fission by neutrons.

It is considered, that during land nuclear explosions with the power of 1 Mt a radioactive track of several hundred kilometers is created. At the same time up to 80 % of the created radioactive dust settle. At the moment of nuclear explosions or catastrophes at NPP the radiation levels at the expense of concentration of radionuclides, especially short-lived, considerably exceed so-called average monthly and average annual levels. Some part of pollution falls out not far from the place of testing. Some part of long-lived isotopes stays in the low layer of the atmosphere (troposphere) and is transferred by jets of he wind at large distances, gradually falling down on the sea and on the land.

The overwhelming part of radioactive fall-out has fallen down in the Northern hemisphere, where the majority of tests has been conducted. Those people, who were near the proving ground, have received, in a result, considerable radiation doses. Reindeer-breeders and fishermen in the sea in the Far North have received a radiation dose from cesium - 137, 100 - 1000 times exceeding the mean dose per person for the rest of the population.

The radionuclides, falling out of the atmosphere, are gradually stored in the soil-vegetative coverage. In the course of accumulation of nuclides there is their radioactive decay, migration deep into the soil and partial washoff by the surface waters into the rivers, lakes and seas. The important researches of a specific chain « lichen - deer - person » in the regions of Far North of Russia have been conducted by a group of the Leningrad scientists. They were studying the contents and dynamics of lead - 210, polonium - 210, cesium - 137 and strontium-90 in different lichens, venison, the organism of people. In 1965-1966 years in the Murmansk and Arkhangelsk areas, the Republic of Komi, in Taimir and Chukotka the contents of cesium - 137 in the organism of reindeer-breeders was 5 times more than in 1986, and in comparison with the inhabitants of the south of Russia - ten hundred times more. The specific activity of strontium -90 in reindeer-breeders' bone tissue many times (up to 60 times) exceeds similar values for the people irrelevant with reindeer-breeding. The dose of internal irradiation at the expense of cesium - 137 for the native born population makes the main share of the artificial irradiation. The very high death rate of the native born population in many respects is connected with cancer tumour of the bowels and lungs.

The pollution of the seas by radionuclides with different kinds of RW burial is rather powerful. Many sea organisms are capable to store radioactive substances in themselves, even if they are of a very low concentration. It is necessary to note, that some radionuclides of lead - 210 and polonium - 210, get into an organism with food. They are concentrated in fish and shellfishes, so people eating a lot of fish and other seafood can receive rather large doses of internal irradiation.

From the end of the 50s till 1992 the wastes with the total activity of 2,5 million Curie, including 15 reactors and a screen assembly of an atomic submarine and 3 reactors and a screen assembly of the atomic icebreaker "Lenin" were sunk by the Soviet Union in the Northern seas. Thirteen reactors of them are from emergency AS (6 of them with unloaded nuclear fuel), and also 3 reactors and a screen assembly with the partially unloaded fuel of the icebreaker "Lenin" were sunk at the New Earth.

The Bilibino central nuclear thermal system (CNTS) has been built in Chukotka.

At the station 4 units EGP-6 (graphite channel reactors of the early period) work. The 1-st and the 2-nd units were put into operation in 1974, 3 units - in 1975, 4 units - in 1976. The station works according to the sliding schedule in order to cover electrical and heating needs of the region.

The Billibino CNTS has been projected according to the block principle. All four reactors are placed in one reactor compartment. The outside walls of a reactor hall are made of aluminium panels. In connection with the lack of concrete walls during reloading of fuel channels a container way is used. With the help of the special protective container the fuel channels are unloaded in the storehouse located directly in the reactor hall.

The uranium-graphite reactor of the Billibino CNTS is of a channel type with tubular fuel elements made of stainless steel.

At the Billibino CNTS a single-circuit thermal scheme is applied.

The design of fuel elements and the channels of the reactor, according to their creators' idea, should prevent radionuclides created in uranium fuel from putting into the water of the primary circuit and to customers. However the designers haven't taken into account the possibility of tritium diffusion through the walls of fuel elements made of stainless steel, into the water of the primary circuit and further, that is why it is sated with radioactive tritium water. Through the shell of fuel elements made of stainless steel, up to 80 % of tritium get into. An imperfect design of the reactor of the Billibino CNTS, the numerous water leakage from the primary circuit have resulted that the region of this station is contaminated not only by strontium-90 and cesium - 137, but also tritium water , which is close to usual water on its properties, it is easily actuated in biogeochemical cycles and influences the biosphere negatively.

The waters of a zone of defrosting of frozen layers formed under the first-order objects of the Billibino CNTS, contain tritium in concentration from 156 TU (industrial ground) up to 1719 TU (slit N 16), that is comparable on the order of magnitude with the global concentration of tritium produced in the 50-s as a result of explosions of hydrogenous bombs. For comparison: the maximum concentration of tritium in the atmospheric falls above Great Britain formed during thermonuclear weapon testings, were watched in 1963 and reached up to 2000 - 4000 TU (TE – a tritium unit creating 7,2 of decay per a minute in a litre of water). It is impossible to explain storm tritium concentrations in the area of the Billibino CNTS by natural reasons, as in similar rocks of the northern Yakutia (upper reaches of the Yana) the contents of tritium in the waters of the seasonal-thawed surface grounds does not exceed 2 TU. According to the conclusion of the scientists of the Moscow University named after M.V.Lomonosov and the experts from the institute "VSEGINGEO" it is possible to explain such large concentration of tritium only by outflows from the services lines on the industrial ground of the first-order of the Billibino CNTS.

The majority of the equipment has reached or is going to reach the safe life on the energy units of the Billibino CNTS. The energy units do not conform the requirements of the rules and the norms on safety and finishing them up in accordance with the indicated requirements is impossible.

The main problems of providing CNTS with the safety control are the following:

- the electric equipment of control and protection systems of reactors has already worked out the established safe life several times, the element base is morally obsolete, the part of completing units is taken out of production at this time and it is not delivered to CNTS;
- there is a considerable recession of experienced and well-qualified staff. It is connected with problems of the wage;
- we may notice the decreasing of a skill level of staff, that is directly concerned with providing of nuclear safety (the operating staff, the staff of the laboratory SCP).

The description of the most serious incidents having taken place at this CNTS is adduced below:

- in 1991 at the station there was an emergency with mass breakage of down-take pipes of a drum of the separator.
- 20.09.91. V.Y.Lipskus, the senior foreman of the shop of the centralized maintenance (SCM), organized the exportation from maintenance-assembly workshops located in the zone of strict operating conditions, radioactive wastes (RW) in the storehouse of solid and liquid wastes. During the exportation the bucket with wastes fell out from the loader, so there was pollution of the territory of NPP;
- 10.07.91 as a result of exportation of liquid highly active radioactive wastes to the storehouse there was leakage of RW. So not only the territory of NPP and the vehicle on transportation were appeared to be contaminated but also the territory of the main administrative body. The repair staff and the staff of the departments of labour protection and safety precautions attempted to make a secret of this incident, that worsened the radiation conditions at NPP. The materials about 4 persons are

handed to the investigation agencies. This incident was qualified by the third level according to the international scale INES;

- 19 workers had an exceeded control level of irradiation (3 bur) in 1997 at NPP.

Great fears are caused by the problem of a nuclear safety degree of the Bilibino NPP. Some extracts from the reports of State committee on the environmental protection of the Chukotsky autonomous area (Goscomchukotecology) for 1995 and 1996 are given below.

«...The first stage of BNPP put into operation in 1974, is being exploited now with deviations from the operational sanitary regulations on 63 points. The effective life of the power plant finishes in 2000. More than 510 tons of spent fuel and 685 cubic metres of liquid wastes have accumulated at the power plant.

In view of such situation we cannot exclude the probability of emergencies the Bilibino NPP during next 10 - 15 years. Thus the emergencies can be of radiational, non-radiational and mixed type.

There is the tendency of increasing of irradiation dose of the staff, there are some tags of reduction of efficiency of clearing filtering systems of the plant. The greatest levels of radionuclides have been detected in the samples of soil and lichen, selected in the direction of a torch of air emissions in the territory situated close to BNPP. The similar picture is also watched in the bottom sediments during the drain of sewer waters from the industrial ground of NPP. The registered pollutions by radionuclides around NPP are obviously of a tracer character and indicate lowering of efficiency of clearing and filtering systems... »

In 1992 the institute "Atomenergoproject" developed the project of modernization of the power plant. The project was not established, and the modernization of NPP, because of lack of means, was not carried out too. In the opinion of the experts, the safety of the plant causes serious fears. The following measures are necessary to be taken: the urgent reconstruction of the main clusters and the refinement of clearing systems of the plant with finishing of nuclear safety up to a necessary level. According to the statement of the Chukotsky regional headquarters of civil protection, in case of emergency the pollution of the territory of over 1300 square kilometers and irradiation of 100 thousand inhabitants of Russia is possible. Taking into account a slow development of a biological turnover of substances in ecosystems of Chukotka, to liquidate consequences of catastrophe is practically impossible.

In 1995 the monitoring researches of general radiation situation of the area were conducted by the Pevek and Kolyma territorial authorities on hydrometeorology and monitoring of the environment. The monitoring observations showed that, as a whole, in Chukotka the radiation level was not dangerous and did not exceed radioactivity rates in comparison with 1994. In the same year the St.-Petersburg research institute conducted radiation researches and sampling in the Chaun and Bilibino regions. Exceeding of the permissible norms was not detected, the contents of radionuclides in organisms of the researched people was not found. However, it was established, that concentration of cesium - 137 in plants of the Bilibino region 2 – 4 times, and concentration strontium-90 - twice exceeded the contents of these radioisotopes in the similar tests of the Chaun region. It is also necessary to notice, that the contents of strontium-90 in bones of the inhabitants of the area who lead a traditional way of life, 5 - 6 times more than the average russian person has, and the annual effective equivalent radiation dose accounts for 0,5 bur/y at the average rate of this area - 0,4 bur/y. It, first of all, is explained by concentration of radioactive substances in the trophic chain "reindeer moss-deer-man" and a slow process of removing of radioactive strontium from the osteal tissue of the organism of a person.

The radiological contamination of the territory of the Chukotsky autonomous area has several sources. The main source of an exceeded level of radiological contamination of the territory is the consequences of nuclear-weapon tests on the testing grounds of the New Earth in the 50-60-s. The western winds of the arctic cyclones transferred radioactive wastes and appeared the reason of pollution of Chukotka by radionuclides, especially of its northern coast. The concentration of radioactive substances in rainfalls was rather low, but even minor quantities of radioactive substances have a property to be accumulated in the soil cover, and, therefore, to increase in plants, especially in tundra lichens, and to be a genetic and medical threat to health of a person (in the 1960-s abrupt worsening of health of the population, especially of reindeer-breeders was noticed).

The second source of the radiological contamination of the territory of Chukotka is the Bilibino nuclear power plant.

The third and the most actual source of the radiological contamination is RIHPG (radioisotope heat power generators). About 60 % of all ionizing radiation sources in Chukotka are subjected to exportation outside of its territory and burial in the way of radioactive waste, as their safe life ran out a long time ago. The most dangerous and powerful RIHPG in the number of 85 items and the total decay-activity - 5,64 мKu are under the jurisdiction of the Providensk hydrobase of the Hydrographic company of the Marine Fleet Department of Russian Federation. The hydrobase owing to different reasons does not control the conditions of its most RIHPG, the radiation power sources are spread along the whole arctic coast, including sites of the sea up to the Northern marine ways. Contrary to the law of Russia on radiation safety, the access of outsiders to many of RIHPG is not limited. So, for example, not far from the settlement called Malaya Baranikha there is a power generating installation consisting of three RIHPG, and thus, the population of this settlement is subjected to a constant to threat of irradiation. For the emergency atomic irradiation the failed installations are dangerous not only for a man and animals, but for land and marine territories.

Since the 1940 – 50-s till now the territory of extraction and processing of uranium ores in the settlements Western and Northern (the Chaun region) hasn't been recultivated. The concentration of radioisotopes of radon in the storehouses of the mine hundreds times exceeds the background rates.

Making a certain grand total of the analysis of the ecological conditions of Far North of Russia, it is possible to make the following conclusion:

- in Far North of Russian Federation there is an extremely unfavorable radiological situation caused by the effect of 182 nuclear energy installations, which are being used nowadays , and 133 reactors which safe life has run out. The extra radiation load on the nature of these regions can turn out for it as serious consequences.

APPENDIX 6

Conclusions and recommendations of the summary conclusion of the united public ecological expertise of the project documentation « the Substantiation of the investments of nuclear heat low-power plant on the basis of a floating energy unit of project 20870 with the reactor installations КЛТ-40С in Pevek », (Kuznetsov V.M. (chairman), Smirnov G.P., Kuznetsova H.E., Kolton I.B., Simonov Y.Y., Shramchenko A.D., Kokurin., Matushevsky G.V., Kabatchenko I.M., Ovsyannikov N.G., 2000)

1. The development and implementation of the project of FNPP break article 48, i.3 of the law of RSFSR « About the environment protection » (1991), prohibiting « to place, to project and to build nuclear plants near large basins of the federal importance ».

2. During the preparation of the project of floating NPP none of the state ecological expertise was conducted, and also the documentation for carrying out of the public ecological expertise was not represented, in spite of the appropriate inquiries from public organizations. So articles 28 and 30 of the Federal law « About nuclear energy using » (1995) and articles 11, 27, 30 of the Federal law « About the ecological expertise » (1995) have been broken.

3. As the offered place of basing of FNPP is in the zone of liability of Russia on a number of international and intergovernmental agreements in the field of protection and use of natural resources, the question concerning the implementation of the project should be co-ordinated with the appropriate both-sided commissions.

4. In the considered project documentation there is no sufficient economic evaluation of the project, its advantage in comparison with other alternative solutions of the energy problem of the region is not substantiated. Because of lack of the data it is impossible to judge about the economic expediency of the project. However, if the cost of FNPP in Pevek, indicated in the project, (more than 300 million US dollars disregarding a lot of expenditures) do not change greatly, the project will be hardly paid back.

5. The project documentation introduced to the expertise contains a lot of defects and weak points from the point of view of operation safety control of FNPP near Pevek. Many technical, technological and organizing-methodical solutions are not worked out enough and do not correspond to the requirements of the normative documents on providing of safe operation of nuclear facilities.

6. It is necessary to develop criteria and norms on nuclear, radiation safety and ecological safety for floating NPP including the requirements to conditions of their allocation. Modify the whole volume of the project documentation according to the results of development.

7. It is necessary to correct all the technological parameters of FNPP concerning the actual safe life of the main equipment of floating NPP.

8. It is necessary to develop and to introduce in the project methods of a non-destructive control of the first circuit in the operation period, and also during carrying out the audit of the first circuit in searches of microleakages in pipe lines and in the equipment of the first circuit.

9. The materials about OVOS do not correspond to the majority of the requirements « Regulations concerning the estimation of the effect of proposed economic or other activity on the environment in the Russian Federation » (2000). The alternative variants, including refusal from activity are not considered. The choice of the suggested variant is not proved. The possible effects of FNPP on the environment and their consequences are not considered to the full volume. On the basis of the repre-

sented materials on OVOS it is impossible to judge about admissibility of the effect of FNPP on the environment.

10. In the experts' opinion the unconsidered or underestimated in the materials on OVOS effect of FNPP on the environment even in the nominal mode of operation can result in serious negative consequences presenting threat to the people and the nature of the Arctic Region. In case of emergency with the emission of radioactivity out of the vessel vast territories will be subjected to radioactive contamination.

11. Taking into account the mentioned above disadvantages of the considered project documentation from the point of view of safety control, and also the possibility of serious negative consequences of the effect of the projected facility on the environment, the commission considers the implementation of the construction of FNPP in Pevek to be inadmissible.

12. In connection with the great ecological danger of the project of allocation of FNPP near Pevek the commission of experts recommends to consider the possibility of using other, ecologically less dangerous energy sources (heat power engineering on coal, petroleum, gas; the wind energy; reconstruction of present powers; energy protective technologies and etc.) for heat energy supply of the Chaun region ChAA.

APPENDIX 7

List of used abbreviations

EP	emergency protection
EB	emergency break
HSNP	heat supply nuclear plant
RCCE	radiation conditions control equipment
CNTS	central nuclear thermal system
NHPP	nuclear heat power plant
AS	atomic submarine
LWPR	light-water power reactor
GAN RF	Gosatomnadzor of the Russian Federation
BUT	closed territorial derivation
LRW	liquid radioactive waste
IAAE	International agency of atomic energy
SRIET	Scientific-research institute of Energy technology, Moscow
MSR	the main sanitary regulations of operation with radioactive sources of MSR - 72/87
SF	spent fuel
SFEA	spent fuel element assembly
FEU	Floating energy unit
PRWB	place of radioactive waste burial
FNPP	floating nuclear power plant
RNS	rules of nuclear safety
RW	radioactive waste
RI	reactor installation
CPS	control and protection system
FA	fuel assembly
SRW	solid radioactive wastes
NEI	nuclear energy installation
NSGI	nuclear steam-generating installation

Literature

Adamov Y.O. (editor). The white book of nuclear power engineering. M., 1998. P.269.

Baranovsky S.I., Samosuk V.N., (ed.). Radiation heritage of the cold war. M., 1999. The Russian Green Cross. P.375.

Bukan P. Following the tracks ofunderwater catastrophes. M., 1992. Publ. « the Order of masters «Rus », p.230.

Bulatov V. Radioactive Russia. Publ. Novosibirsk, 1996. P.272.
The bulletin « Nuclear safety », № 15 - 16, 1998.

Veksler L.M., Preobrazhenskaya L.B. Nuclear low-power plants can provide power supply of the remote regions of Russia // Bul. № 5-6. 1995, p. 3 (6.

Foreign economic relations of Russia in the field of nuclear power engineering (1996) // Bul. ZOIPAE, № 4 (5. 1996. p. 28 -31.

The declaration about intentions of the construction of nuclear thermal power plant on the basis of a floating energy unit with reactor installations KLT-40C in Pevek, the Chaun region of the Chukotka autonomous area, JSC « Low power engineering », agreed with the authorities of the Chukotka autonomous area and established by "Rosenergoatom". M., 1996. p.23

Dolgodvorov B. A secret dose // "Labour", № 19, February 2, p. 1-2.

The task to develop the substantiations of the investments of the construction of nuclear heat low-power plant(NHLPP MM) on the basis of floating energy unit (FEU) with reactor installations КЛТ-40C in Dudinki, the Taimir (Dolgano-Nenetsky) autonomous area. "Rosenergoatom". 01.08.98, p. 17

The conclusion of the central jury of the competition of the projects of nuclear low-power plants (1994), Nuclear Society. M., 1994. 42 pages.

The conclusion № 99-04 dated back 17.03.99. Federal administration of biomedical and extreme problems at the Ministry of Health of Russia.

The conclusion 399-15 dated back 15.10.99 of the Center of State sanitary-epidemic inspectorate in the Chukotsky autonomous area.

The conclusion of an independent commission of experts of Control on business GO and CHS of the Chukotsky autonomous area.

The engineering report « The organization of the local ecological monitoring of the period of construction and operation of NHPP MM in the region of Pevek of “Ecological-analytical center”.

Kozlov A.S., Paszhenko S.E., Eremenko S.I., Baklanov A.M., Malishkin S.B., Olekhnovich E.S., Ivaszhenko S.A. Research of a dispersible structure of aerosol and the concentration of small gas admixture in the moderate and arctic air masses // » Optics of the atmosphere and the ocean ». T. 10, № 6, 1997. p. 673 - 680.

Konovalov B. Submarines prolong the life of NPP // » the Evening Moscow », 26.08.98. p. 6.

The brief reference about scientific-technological and economic principles of creation of floating nuclear power plants of the new generation on the basis of floating energy units with a reactor installation such as KLT-40C. V.N. Mikhaylov's letter, ref. № 01-1467 dated back 04.04.97.

Kuznetsov V.M. State radiation, the International Chernobyl Fund of safety. M., 1994. p. 61

Kuznetsov V. A great number of questions concerning « low atom » // "Today", 06.06.96. p. 5.

Kuznetsov V.M. Radiation incidents on the civil atomic fleet of Russia // Bul. « Nuclear safety », № 31, 1999. p. 6.

Kuznetsov V.M. (a) Experiment, threating catastrophe to come // "the Independent newspaper", № 84 (2146), dated back 11.05.2000. p. 5.

Kuznetsov V.M. (b) the Russian atomic engineering. Yesterday, today, tomorrow. A view of an independent expert. », M., 2000. Publ. « Vote - press », 285 p.

Kuznetsov V.M. (c) Nuclear experiment. What the new project of Minatom threatens to Russia. //Version, December 5-11, 2000. p. 5

Kuznetsov V.M. (d) The perspectives of floating NPP//Bul. ZOI, № 1, 2000, p. 23.

Kuznetsov V. M., Smirnov G.P., Kuznetsova E.E., Kolton I.B., Simonov Y.Y., Shramchenko A.D., Kokurin Y.S., Matushevsky G.V., Kabatchenko I.M., Ovsyanikov N.G. .. (2000) « The public ecological expertise of project materials of nuclear heat low-power plant on the basis of floating energy unit of the project 20870 with reactor installations KLT-40C in Pevek », MCoES, Moscow - Anadir, 2000, the manuscript, p. 80

Kuznetsov V.M., the report « The Analysis of safety of nuclear plants located in the territory of the Russian Federation for the period from 01.01.91 till 31.12.2000 », M, Russian Green Cross, 2001, the manuscript, p. 48.

Kurkin B.A. Burden of "peace" atom. M., 1989. Publ. « Molodaya Gvardiya », p. 272.

Kucher V.A., Manuylov Y.V., Novosyelov S.A., Semyenov V.P., Shmakov R.A. (1996) Submarines of Russia. Nuclear. The first generation. A history of creation and use. 1952 - 1996. The scientific - historical reference. V. IV, chapter 1. S-Pb, 1996. p.234.

Lebedev O. The agreement on cooperation of Russia and Indonesia in the field of atomic engineering using in the peace purposes should have been signed in the first half of 1998, Yevgeniy Reshetnikov reported // RIA - Hot line dated back 29.11.97.

Legasov V.A., Kuzmin I.I., Chernoplektov A.N. The effect of power engineering on the climate // USSR. Physics and the ocean atmosphere. Volume 20, № 11. 1984. pages 1089 - 1103.

Margulis U.Y. Atomic energy and radiation safety. "Energoatomuzdat". M., 1988. .279 p.

V.Marinina, V.Dotsenko. 90 years of construction of submarines in Russia. The magazine « Military parade », 1994, p. 14

The materials on the estimation of the effect of construction and using of NHPP MM on the environmental in the region of Pevek. Volume 1. The present condition of the environment of the area of allocation of NHPP MM. Book 1. JSC « Low power engineering »

The materials on the estimation of the effect of construction and using of NHPP MM on the environmental in the region of Pevek. Volume 1. The present condition of the environment of the area of allocation of NHPP MM. Book 2. JSC « Low power engineering »

The materials on the estimation of the effect of construction and using of NHPP MM on the environmental in the region of Pevek. Volume 1. The present condition of the environment of the area of allocation of NHPP MM. Book 3. JSC « Low power engineering »

The materials on the estimation of the effect of construction and using of NHPP MM on the environmental in the region of Pevek. Volume 2. The estimation of the effect of construction and using of NHPP MM on the environmental in the region of Pevek. (Stage -« the Substantiation of the investments ») Book 4. JSC « Low power engineering »

Mitenkov F.M., Vostokov V.S., Drozhkin V.N., Samoylov O.B. The economic efficiency of a low-power NPP// Bul. ZOIPAE, № 7-8. 1994. p. 49 - 50.

Mikhaylov V.N. A brief reference about the technological and economic principles of creation of floating nuclear power plants of a new generation on the basis of floating energy unit with a reactor installation such as КЛТ-40С. The letter № 01-1467 dated back 04.04.97.

Mormul N.G. Catastrophes under the water (Wreck of submarines in the epoch of cold war). Murmansk, 1999. 572 p.

The opinion of State committee on the environmental protection the Chukotsky autonomous area, Goskomchukotecologiya.

Nikitin Y.A. Cold depthes. S-Pb , 1998. 235 p.

Nilsen T, Bemer N. Sources of radiological contamination in the Murmansk and Arkhangelsk areas // the Report of the association "Belluna", №1. 1994.Publ. J. Nordahl, Oslo. p. 149

Nilsen T., Kudrik I., Nikitin A. The Northern fleet. A potential risk of radiological contamination of the region // the Report of the association "Belluna", № 2. 1996. Publ. J. Nordahl, Oslo, 168 p.

About fixing duties of the participants of the project of creation of nuclear plants with RI such as КЛТ-40. Order № 523 dated back November 29, 1995 on the Ministry of Atomic engineering of the Russian Federation. p. 2

Orlova A.I. Radioactivity and ecology. The report of the center of public information on atomic energy, № 10. 1994. p.54 (76.

Osipenko L., Zhiltsov L., Mormul N. The atomic underwater epopee. Feats, failures, catastrophe. Publ. "Borges". M., 1994. p. 403

The report on the substantiation of safety and estimation of the efficiency of the investments (the substantiation of allocation). Volume 1.The general description of a plant. NHPP 1. ПАС. 008-01 JSC « Low power engineering »

The report on the substantiation of safety and estimation of the efficiency of the investments (the substantiation of allocation). Volume 2. The main principals of providing of safety control of NHPP. Book 1. NHPP 1. ПАС. 008-01 JSC «Low power engineering»

The report on the substantiation of safety and estimation of the efficiency of the investments (the substantiation of allocation). Volume 2. The main principals of providing of safety control of NHPP. Book 2. (Part 1) NHPP 1. ПАС. 008-01 JSC «Low power engineering »

The report on the substantiation of safety and estimation of the efficiency of the investments (the substantiation of allocation). Volume 2. The main principals of providing of safety control of NHPP. Book 2. (Part 2) NHPP 1. ПАС. 008-01 JSC «Low power engineering »

The report on the substantiation of safety and estimation of the efficiency of the investments (the substantiation of allocation). Volume 2. The main principals of providing of safety control of NHPP. Book 3. NHPP 1.ПАС. 008-01 JSC«Low power engineering »

The report on the substantiation of safety and estimation of the efficiency of the investments (the substantiation of allocation). Volume 2. The main principals of providing of safety control of NHPP. Book 4. NHPP 1.ПАС. 008-01 JSC «Low power engineering »

The description of the place of the construction NHPP LP. An explanatory memo.
Part 1. The initial positions. NHPP 1. ПАС 011-01 JSC « Low power engineering »
The description of the place of the construction NHPP LP. An explanatory memo.
Part 2. The description of the project. NHPP 1. ПАС 011-01 JSC “Low power engineering”
The description of the place of the construction NHPP LP. An explanatory memo.
Part 3. The brief items of information about the considered sites. NHPP 1. ПАС 011-01 JSC “Low power engineering”
The description of the place of the construction NHPP LP. An explanatory memo.
Part 4. Selection and the brief description of the recommended site. NHPP 1. ПАС 011-01 JSC “Low power engineering”
The description of the place of the construction NHPP LP. An explanatory memo.
Part 5. The brief characteristic of NHPP LP. NHPP 1. ПАС 011-01 JSC “Low power engineering”

The reports on the activity of the federal supervision of Russia on nuclear and radiation safety in 1992-1999.

Pashenko S.E., Sabelfeld K.K. The atmospheric and technical aerosol. Publ. "Science". Novosibirsk, 1993. 310 p.

Pinchuk D. Five new energy units for NPP will be built in Russia in the nearest years. ITAR-TASS. S-Pb , 01.03.99.

The decree of Government of the Russian Federation « About the establishing of an atomic engineering development program of the Russian Federation for the period of 1998-2005 till 2010 »

Dated back 21.03.98 № 815.

The program of engineering researches and investigations. NHPP 1. . PAS 011-01 JSC “Low power engineering”

The project of a Federal purpose-oriented programme « Socio-economic development of the Taimir (Dolgano-Nenetsky) area for 1998-2005 », Dudinka - Moscow, 1998 p. 235

The letter of the Headquarters of the ecological control and meteorologic provision of the nature protection activity at the Ministry of Nature of Russia. Ref. № 290/11 dated back 12.11.98.
Sivintsev Y., Kiknadze O. Radioecological danger of ship nuclear reactors sunk in the Arctic Region // The bulletin of the center of the public information on atomic energy, № 1 (297), 26.01.99 p. 3

The agreement of the materials of the substantiation of the investments in construction and using of NHPP in the region of Pevek № 01-02/301 dated back 13.07.99 The central authority on fish economy expertise and normative of protection and reproduction of fish reserves and amortization (ZUREN) of the State Committee of the Russian Federation on fishery.

Subbotin V.I. Speculations on atomic engineering. S-Pb ., 1996 195 p.

Feshbakh M., Frendy-junior A. Ecocide in the USSR. M. 309 p.

The petition for intentions of construction of nuclear thermal power station on the basis of a floating energy unit with the reactor installations KLT-40 C in the region of Dudinki, JSC “ Low power engineering “, agreed with Minatom, Rosenergoatom, the governor of the Taimir autonomous area and the Russian Academy of Science « Norilsk nickel », 13.11.97, 47 p.

Handler G. Problems of the Pacific Navy: radioactive wastes, utilization of nuclear submarines, the accident rate of AS, safety of nuclear fuel // the Report of Greenpeace. 1995, p. 62.

Chupakhin A. ITAR-TASS the Unified tape of news dated back 07.10.99. Berlin

Sharaevsky Y.G., Belikov A.D., Lisovsky I.V., Petrov O.I. Radiological and ecological consequences of emergencies of ship nuclear energy installations. The marine digest, № 7. 1999. p. 52-58.

The experts' report on the safety of allocation of nuclear heat low-power plant on the basis of a floating energy unit of project 20870 with reactor installations KLT-40C in Pevek № ДНП-5-68-99 dated back 09.09.99. Science-technological center on nuclear and radiation safety (STC NRS) of Gosatomnadzor of Russia.

Yablokov A.V. Nuclear mythology. Ecologist’s notes about the nuclear industry. Publ. "Science". M., 270 p.

Yablokov A.V. About the ecological expenditures in the project of the budget of the Russian Federation for 1999 // « Green world », № 2. 1999. p. 6-7.

Bergman R., Baklanov A. Radioactive sourses of main radiological concern in the Kola-Barents region. Swedish Council for Planning and Cooperation of Research, Stockholm. 1998. 11 p.

Grosman K. Cover Up: What you are not supposed to know about Nuclear Power. The Permanent Press N.Y. 1980. 306 p.

Vexler L., Panov Y. Russian floats APWS-40 idea. Nuclear Engineering. December. 1994. p.40-41.

Green Cross is a non-for-profit environmental organization founded in April 1993 in Kyoto. Today, Green Cross has 26 national affiliates on 5 continents; international headquarters are in Geneva. Guiding principles of Green Cross are:

- Co-operation instead of confrontation as an approach to solve environmental challenges;
- Mediation between stakeholder groups;
- Facilitation of solutions integrating ecological, social and economical aspects;
- Transformation of societal values in regard to environment and sustainability;
- Implementation of Agenda 21;
- Combination of global thinking with local action through 26 national organizations and their local chapters.