FSUE “CS “Zvezdochka”
Nuclear Safety Institute (IBRAE) of the Russian Academy of Sciences

Handbook

Exercise "Arctic-2008"

Severodvinsk,
July 30 – August 1
2008

Moscow
2008

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Abstract

This handbook contains information materials for the specialized tactical exercise "Arctic-2008". The exercise is organized in the framework of cooperation between Russia and the USA in the field of modernization of systems of emergency response to radiation accidents. This exercise is the fourth exercise held in the framework of Russian-American partnership. The previous exercises were held at Bilibino NPP (2002, Bilibino), at FSUE "SSC RF NIIAR" (2003, Dimitrovgrad) and at FSUE "Atomflot" (2005, Murmansk).

The handbook contains the plan of the exercise, the technological scenario of the emergency situation, and short descriptions of FSUE "CS "Zvezdochka", the region of the facility location, and other reference information.

Abbreviations

ARMS — Automated Radiation Monitoring System

ATS — Automatic Telephone Station

CD — Civil Defence

CD&ES — Civil Defence and Emergency Situations

CS — Centre of Shipbuilding

DDNU — Department for Decommissioning of Nuclear Units

DNRS — Department for Nuclear and Radiation Safety

DNS — Decommissioned Nuclear Submarine

DSS NRS MDRF — Department of State Supervision over Nuclear and Radiation Safety of the Ministry of Defence of the Russian Federation

EMERCOM — Ministry of civil defence, emergencies and disaster relief of the Russian Federation

ERT — Emergency Rescue Team

ES — Emergency Situation

ESC — Emergency Situation Commission

FSUE — Federal State Unitary Enterprise

FSUE CS "Zvezdochka" — Federal State Unitary Enterprise "Centre of Shipbuilding "Zvezdochka"

FSUE PA "SEVMASH" — Federal State Unitary Enterprise "Production Association "SEVMASH"

IBRAE RAN — Nuclear Safety Institute of the Russian Academy of Sciences

IPE — Individual Protection equipment

JSC “NIPTB "Onega" — Joint-Stock Company Research and Design Bureau "Onega"

MSCh — Medical Unit

NPP — Nuclear Power Plant

NS — Nuclear Submarine

ODF — On-shore Defueling Facility

PKDP-5 — Floating Radiation Control Station

PSA — Personnel Sanitary Airlock

RCBP — Radiation, Chemical and Biological Protection unit

RCS — Radiation and chemical surveillance

RD No. 58 of FMBA — Regional Department No. 58 of the Federal Medical and Biological Agency

RHF — Radiation-Hazardous Facility

RM — Radiation monitoring

RW — Radioactive waste

SNF — Spent Nuclear Fuel

SRW — Solid Radioactive Waste

SSC RF NIIAR — State Scientific Centre of the Russian Federation “R&D Institute of nuclear reactors”

TCC — Technical Crisis Centre

TSF — Temporary Storage Facility

TUK — Transportation Container

Introduction

US Department of Energy has suggested holding an exercise aimed at training the separate elements of emergency response to emergency situations involved operations with spent nuclear fuel. The exercise is to be conducted basing on the Agreement between the Government of the Russian Federation and the Government of the United States of America, issued on January 14, 1994, "On the cooperation in research on radiation effects for the purpose of minimizing the consequences of radioactive contamination on health and environment". All stakeholders approved the chosen for the exercise venue - the Federal State Unitary Enterprise (FSUE) "Centre of Shipbuilding "Zvezdochka", which is one of the leading facilities involved in NS decommissioning and management of SNF and RW.

The idea was approved by the management of the Department of Shipbuilding of the Federal Industrial Agency of Russia. The corresponding order was issued to hold a tactical exercise on 30 of July – 1 of August 2008. In accordance with the order, the Director General of FSUE "CS "Zvezdochka" V.S.Nikitin was appointed as the head of the exercise.

Representatives of FSUE "CS "Zvezdochka", Nuclear Safety Institute of the Russian Academy of Sciences (IBRAE RAN) prepared and organized the exercise in close contact with the local authorities and the Department of Shipbuilding Industry of Rosprom.

Specific issues of organization, preparation and conduct of the exercise were considered at several meetings, which were used to draw up the program and the plan of the exercise. These documents specify the objectives, goals, main participants, engaged forces and assets, as well as the methods for preparation, organization and conduct of this exercise. Also the roles of the participants at various stages of exercise preparation and conduct were determined.

The scenario of the exercise was prepared by the Nuclear Safety Institute in close contact with the specialists of FSUE"CS "Zvezdochka" on the basis of analysis of the scenarios of design-basis and beyond design-basis accidents at the On-shore SNF defueling facility (ODF). The analysis was carried out in the framework of the Source Control project being implemnted by IBRAE RAN and the US Department of Energy. Fall of a container loaded with SNF during fuel unloading from the decommissioned NS was selected as the initial scenario for the emergency situation.

The current document gives the general plan of the exercise, reference information for the territory of FSUE "CS "Zvezdochka" location, as well as the brief information about the site and the on-shore defueling facility.

The current report was prepared by the specialists of IBRAE RAN and FSUE "CS "Zvezdochka".

The idea of the "Arctic-2008" exercise

Subject of the exercise

Actions of the personnel of FSUE "SC "Zvezdochka" in case of an emergency situation - fall of a reloading container loaded with SNF at the On-shore Defueling Facility (ODF) during unloading SNF from the NS reactor compartment.

Objectives of the exercise

- practicing notification and response procedures in case of a radiation accident caused by a fall of a reloading container on the mooring line;
- testing the emergency plans and decision-making procedures of FSUE "CS "Zvezdochka";
- enhancing interaction of the management, forces and assets in process of mitigation of the consequences of the emergency situation at the federal, branch and local levels.

Tasks of the exercise

- training the procedures of notification at the facility, local and federal levels;
- testing the communication and notification systems;
- transmission of the data on the radiation situation at the location of the accident to the participants of emergency response;
- testing the preparedness of the management, forces and assets to emergency response;
- application of the procedures of situation assessment and forecasting;
- application of the decision-making procedures, including making decisions on protective measures (sheltering, evacuation), and engagement of the counter-emergency plan.
- working out the interaction procedures between the participants of the emergency response;
- informing the public;
- forecasting intermediate and long-term consequences of the accident.

The following elements are to be studied during the exercise

- preparedness of FSUE "CS "Zvezdochka" forces and assets to response and mitigation of emergency situations;
- the time required for deployment of the required forces and assets, organization of interaction and coordination of works;
- timeliness and adequacy of the information exchange at all stages and levels of ES mitigation;
- timeliness and accuracy of the radiation situation forecasts;
- adequacy of the regulatory documents on the response to and mitigation of emergency situations of a given level;
- organization of interaction with the media.

Forces and assets engaged in the exercise

FSUE CS “Zvezdochka”

Management of the exercise

- the General Director of the enterprise;
- Chief Engineer of the enterprise;
- Head of CD department;
- Deputy Head of CD department;
- Head of Radiation, Chemical and Biological Protection (RCBP) unit;
- Deputy Head of RCBP unit;
- Head of medical service;

- Head of Communication and Notification service;
- Head of transport service;
- Head of on-duty dispatcher service;
- Head of public order service;
- analytical team.

Irregular emergency and rescue teams of the Radiation, Chemical and Biological Protection (RCBP) service

- radiation and chemical surveillance (RCS) team:
  - Head of the team - 1 person;
  - three RCS units of 3 persons, 2 "Gazel" vans, two drivers;
- radiation post at the western checkpoint – 2 persons;
- transport decontamination station - 4 persons;
- territory decontamination unit of 4 persons, MAZ-500 truck, one driver;
- personnel sanitary airlock PKDP-5 manned by 6 people.

RCBP equipment (protective suit L-1, filtering gas mask GP-7, individual first aid kits AI-2, radiation surveillance equipment, territory delineation marks, entrenching tools, SRW container, mobile communications).

- on-duty dispatcher service manned by 3 persons.
- ODF personnel (9 persons). (Head, shift supervisor, 3 fitters, 2 dose metering specialists, 2 crane operators).

MSCh-2

- medical assistance team of 3 people;
- one ambulance.

Communications

- facility telephone lines, mobile phone, on-duty dispatcher communication;
- loudspeaker system and radio communications of the coastal facility for SNF unloading.

ESC of Severodvinsk (by simulation)

- unified on-duty dispatcher service;
- Severodvinsk Office of the Main Department of EMERCOM in the Archangelsk Region.

Archangelsk Region (by simulation)

- ESC of the Archangelsk Region;
- CD unit.

Technical Crisis centre (TCC) IBRAE RAN

- operative on-duty expert;
- expert team;
- technical support team.

Observers team

The observers have the following tasks:

- assessment of the actions of the exercise participants;
- assessment of the capabilities and adequacy of the communications and other hardware used in the exercise;
- assessment of the preparation and organization of the exercise.

Special attention in the assessment of the actions of the participants should be paid to the following aspects:

- actions of FSUE "CS "Zvezdochka" on initial notification of the Russian participants of the exercise;

- actions of the team on assessment of the radiological consequences of the accident;
- response of the main Russian organizations and deployment of the Technical Support Centres;
- expert support on justification of the decisions on protective measures;
- coordination of interaction and areas of responsibility of appropriate organizations.

The following organizations will take part in the exercise as observers:

On the Russian side: representatives of the Shipbuilding Industry Department of Rosprom, DNRS of "Rosatom" state corporation, IBRAE RAN, Belomorsk Naval Base, DSS NRS MDRF, RD No. 58 of FMBA, Main Department of EMERCOM in the Archangelsk Region.

The observers also included representatives of foreign organizations – US Department of Energy, emergency response organizations of Sweden, Finland and Norway.

Organization of the exercise

The five stages of the exercise will be held in the territory of FSUE "CS "Zvezdochka" on 30.07 - 01.08.08:

30 of July 2008

Stage 1. Organization of notification and transfer of information about the emergency situation at FSUE "CS "Zvezdochka".

Stage 2. Organization of work of emergency and rescue teams on localization and mitigation of the consequences of the accident at ODF.

31 of July 2008

Stage 3. Organization of handling the damaged reloading container by ODF personnel.

Stage 4. Organization of work of ESC on assessment and mitigation of the consequences of a radiation accident.

1 of August 2008

Stage 5. Debriefing

The actions of the participants are listed in the schedule of the tactical exercise.

Plan of the exercise

The stages of the exercise were separated in time in order to provide the observers with the possibility to assess all the elements and actions of the participants of emergency response.

30.07.08

Stage 1. Organization of notification and transfer of information about the emergency situation at FSUE "CS "Zvezdochka"

10:00-10:20 The bus of the observers team arrives at the ODF.

The Head of the exercise gives a brief description of the On-shore Defueling Facility and the idea of the exercise to the observers

10:20-10:45 During the works on unloading SNF of the DNS reactor, a loaded reloading container fell to the mooring line near the ODF building

- The operator of the portal crane No. 10 reports the rupture of the steel cable of the small hook and the fall of a reloading container with SNF.
- The Head of the unloading works:
  - stops the works, announces "Radiation hazard" condition at the ODF;
  - orders the ODF personnel to put on additional IPE, secure the systems and mechanisms in a safe position, turn ventilation off;
  - orders the dose metering engineer to monitor the radiation situation at ODF using facility ARMS;
  - immediately reports the on-duty dispatcher and the chief engineer about an injured worker of DDNU.

10:45-11:15 The observers team moves to the dispatcher room of the facility

The chief dispatcher gives a brief description of the dispatcher room and the actions of the dispatcher service in case of an emergency situation.

11:15-12:00 Radiation accident at ODF confirmed

- Head of unloading works reports the fall of the container with SNF to the dispatcher of the facility.
- The on-duty dispatcher:
  - Notifies the General Director of the Enterprise and on his orders notifies:
    - management of the enterprise;
    - dispatcher of OJSC NIPTB “Onega”

    Third-party organizations:
    - on-duty specialist of Sudprom;
    - on-duty officer of CD&ES of Severodvinsk;
    - on-duty dispatcher of FSUE "PA "Sevmash"
    - on-duty officer of Belomorsk Naval Base;
    - Head of RD No. 58 of FMBA;
    - Team leader of DSS NRS MDRF;
    - on-duty officer of Rosatom;
    - Archangelsk-Nenetsk office of RHF inspection;
    - BC NRS "Krylov CRDI".
  - Organizes notification of the members of facility ESC and their assembly at the reserve control room:
    - Head of CD department;
    - Deputy Head of CD department;
    - Deputy Chief Engineer - Head of DNRS;
    - Deputy Head of DNRS responsible for RS;
    - Head of MSCh-2:

- Head of ATS section (REC);
- Head of shop 20;
- Head of DDNU;
- Head of public order service;
- Management team

12:00-13:30 Lunch

30.07.08

Stage 2. Organization of work of emergency and rescue teams on localization and mitigation of the consequences of the radiation accident

13:30-14:00 The bus of the observers team arrives at the ODF for inspection of ERT preparedness to the exercise

- Head of the exercise:
  - Informs the observers about the planned actions of emergency and rescue teams on localization and mitigation of the consequences of the radiation accident
  - Announces assembly of the following ERT personnel at the mooring line near PKDP-5:
    - Head of RCBP service;
    - Head of RCS
    - units No.1, 2, 3 of RCS;
    - territory decontamination unit;
    - personnel of transport decontamination station;
    - RM post;
    - medical first aid team.
    - sanitary airlock personnel;
    - vehicles.
  - Carries out inspection of ERT preparedness to the exercise.

14:00-14:30 Organization of radiation surveillance in the vicinity of the fallen container, in the region of South Yagry, in the centre of the facility and in YAGRY settlement.

- The Head of the unloading works:
  - reports the emergency situation to the dispatcher of the facility;
- The dispatcher of the facility notifies the Head of DNRS about the accident.
- Head of DNRS – Head of RCBP gives the following orders:
  - to the Head of RCS team:
    - order the 1st RCS unit to carry out radiation surveillance in the vicinity of the fallen reloading container, identify the character and the possible scale of the accident, delimit the location of the radiation accident with special tape, install radiation hazard signs indicating the gamma-radiation dose rate, and report to the Head of RCS;
    - order the 2nd RCS unit to carry out radiation surveillance in the South Yagry along the approved route and report to the Head of RCS teams;
    - order the 3rd RCS unit to carry out radiation surveillance of the central part of the facility along the approved route and report to the Head of RCS teams;
    - organize a temporary radiation monitoring post at the western checkpoin;
    - evaluate the limit of allowed working time for the personnel inside the hazardous area.
  - Head of the Personnel Sanitary Airlock (PSA) of shop 20 deploys the PSA at PKDP-5.
- The Head of RCS reports the results of radiation surveillance to the Head of RCBP at the reserve control room.
- The Head of PSA of shop 20 reports the deployment of PSA to the Head of RCBP at the reserve control room.
- Head of RCBP reports the results of radiation surveillance to the Head of ESC management team.

14:30-14:45 Evacuation of the injured worker from the accident location

- Head of the unloading works notifies the dispatcher of the facility about the injury to the worker of DDNU.
- The dispatcher of the facility notifies the Head of MSCh-2 about the injured worker at the accident location.
- Head of MSCh-2 orders the ambulance (first aid team) to depart to the accident location and stop at the Controlled access area.
- ODF personnel evacuate the injured worker to the ambulance using stretcher.
- Dose metering specialists of the 1st RCS unit carry out radiation inspection of the skin and clothes of the injured worker and pass the results to the ambulance personnel.
- The medical personnel of the ambulance provide medical aid to the injured worker and evacuate him to CMSCh-58.

14:45-15:30 Organization of mitigation of accident consequences

- Head of RCBP orders the Head of territory decontamination unit to carry out decontamination of the affected territory in the vicinity of the fallen container based on the results of radiation surveillance.
- The head of territory decontamination unit orders:
  - the driver of MAZ-500 to deliver the SRW container to the boundary of controlled access area;
  - together with the head of unloading works orders the crane operator to move the container from the vehicle to the accident spot using the large crane hook;
  - the unit to start decontamination of the territory and the container, stockpiling the RW inside the SRW container;
  - upon the end of decontamination works to move the SRW container back to MAZ-500;
  - the driver of MAZ-500 to deliver the SRW container to the SRW temporary storage pad and proceed to the vehicle decontamination station.
- Head of RCBP reports the results of territory decontamination to the Head of ESC management team.

15:30-16:00 The bus of the observers team proceeds to the transport decontamination station in order to observe the decontamination of MAZ-500 at the vehicle decontamination station

The Head of RCBP orders the Head of transport decontamination station to start the decontamination of MAZ-500. Upon completion of decontamination, perform radiation monitoring of MAZ-500 and the station equipment and then proceed for sanitary treatment to SPA.

16:00- 16:30 Organization of sanitary treatment at sanitary airlock of PDKP-5

- Head of RCBP orders the personnel of the 1st RCS, territory decontamination unit and the personnel of vehicle decontamination station to proceed for sanitary treatment.
- Skipper-mechanic organizes the work of SPA personnel: supply of hot water to the showers, supply of soap and mops, work of "dirty" and "clean" cloakrooms.
- Personnel of the 1st RCS, territory decontamination unit and the personnel of vehicle decontamination station:
  - proceed to SPA (PDKP-5);
  - undergo radiation inspection of skin and clothes under the supervision of dose metering specialist of the 2nd station of PDKP-5. Pack the contaminated clothes in plastic bags and perform sanitary treatment of the skin.
  - undergo radiation inspection of skin under the supervision of dose metering specialist of the 3rd station of PDKP-5;
  - receive clean clothes at shop 22 and leave SPA.

31.07.08

Stage 3. Organization of handling the damaged reloading container by ODF personnel

10:00-12:00 The bus of the observers arrives at the ODF to observe the transportation of the damaged reloading container to ODF, and reloading of SFA from the damaged container to TUK-108/1.

- The Head of unloading works orders the shift supervisor:
  - cover the damaged part of the container with plastic cover in order to reduce the impact on the environment, and transport the container to ODF using the large hook of the crane;
  - use additional IPE during the works.
- The shift supervisor orders to hook the crossarm of the reloading container to the large hook of the crane and place the container to TUK-108/1 loading station with pre-installed guiding device, while observing all of the radiation safety requirements. The large hook of the crane is used to transport the reloading container to ODF and install it on top of the TUK-108/1 guiding device. SFA from the damaged container is reloaded into TUK-108/1. The damaged reloading container is sent to the repair station.
- The dose metering specialists of the on-duty shift perform radiation monitoring of the ODF premises.
- The shift proceeds to the ODF sanitary airlock for sanitary treatment.

12:00-13:30 Lunch

31.07.08

Stage 4. Organization of work of ESC on assessment and mitigation of the consequences of a radiation accident.

13:30-17:00 Organization of work of ESC on assessment and mitigation of the consequences of a radiation accident.

- Members of ESC participating in the tactical exercise:
  - Director General – Head of CD – Head of the exercise
  - Deputy Head of CD;
  - Deputy Head of CD responsible for engineering and technical issues;
  - Deputy Head of CD department;
  - Head of on-duty dispatcher service;
  - Head of Radiation, Chemical and Biological Protection (RCBP) unit;
  - Deputy Head of RCBP unit;
  - Head of medical service;
  - Head of Communication and Notification service;
  - Head of transport service;
  - Head of public order service;
  - Head dispatcher;
  - Management team.
- General Director - the Head of the exercise checks the preparedness of ESC for the exercise.
- The heads of services report to the Head of the tactical exercise about the complement and equipment of the emergency and rescue teams participating in the exercise and their preparedness for the tactical exercise.
- Head of the exercise:
  - Announces the start of the exercise, and gives the input of: "Fall of a reloading container loaded with SNF at the on-shore defueling facility (ODF) during unloading SNF from the NS reactor compartment;
  - Gives instructions to:
    - Deputy Head of CD responsible for engineering and technical issues: stop the works on SNF

unloading, secure the equipment at NS and ODF in a safe position, use the video surveillance system to identify the injured and assess the condition of the reloading container;
- the Head of on-duty dispatcher service to notify the Heads of units of the start of the exercise, about sheltering the personnel inside the buildings and seal the buildings (close windows, doors, shut down ventilation);
- Head of Communication and Notification service: announce the start of the exercise on the plant radio, announce the "Radiation hazard" condition in the South Yagry section of the facility, ensure uninterrupted telephone communication of the reserve control room with the organizations in the town, and the emergency and rescue units participating in the tactical exercise;
- Head of RCBP: start radiation surveillance in the vicinity of the fallen container at ODF, central part of the facility and the Yagry settlement, organize a radiation monitoring post at the western checkpoint and transmit the measurement results to the management team;
- Head of the medical service: - ensure preparedness of the medical first aid team;
- Head of the transport service: stop all vehicles in the territory of the facility, provide the vehicles for the emergency and rescue units in accordance with the resource provision plan, ensure vehicles are available for evacuation of the personnel from South Yagry;
- Head of the public order protection service: restrict access of the vehicles to and from the territory of the facility, restrict access of individuals to the territory of the facility;
- Deputy Head of CD: assure the work of the management team, prepare the draft ESC decisions in accordance with the available information, plot the radiation surveillance data on the map of the South Yagry.

- Actions of the Heads of services:
  - Head of communication and notification service organizes the announcement of the start of the exercise on the plant radio, announces the "Radiation hazard" condition in the South Yagry section of the facility, ensures uninterrupted telephone communication of the reserve control room with the organizations in the town, and the emergency and rescue units participating in the tactical exercise;
  - The Head of RCBP orders the Head of RCS to carry out radiation surveillance in the vicinity of the emergency situation location, in the South Yagry, in the central part of the facility and at the Yagry settlement; receives the radiation surveillance results from the Head of RCS and transfers the received results to the management team. 5.3 Deputy Head of CD responsible for engineering and technical issues: orders the Head of reloading works to stop the works at the ODF, secure the ODF equipment in a safe position, seal the buildings, shut down the ventilation, specifies the information about the injured and inquires preliminary information about the condition of the reloading container.
  - Head of the medical service orders the Head of the medical team to bring an ambulance to the ES location.
  - Head of the public order protection service orders the Head guard to restrict access of personnel to the facility and resctrict access of vehicles to and from the territory of the facility. Exit from the territory is allowed only upon inspection by the dose metering specialists of DNRS at the western checkpoint.
  - Head of the transport service orders the dispatcher of shop 20 to stop all vehicles in the territory of the facility, prohibits parking of the vehicles from the central part of the facility at the garage of South Yagry, provides vehicles for the emergency and rescue teams.6. Head of RCBP transfers the results of radiation monitoring to the management team as soon as they are available.
- The management team plots the results of radiation monitoring on the map of the facility.
- The Head of ESC orders to request assistance in assessment of the accident consequences from TCC IBRAE.
- The management team carries out interaction with TCC IBRAE in accordance with the plan of the exercise, receives the forecast results and prepares a decision about localization and mitiga-

tion of the radiation accident consequences. No evacuation of the personnel from South Yagry is required in accordance with the results of radiation monitoring.

- Deputy Head of CD responsible for engineering and technical issues:
  - reports to the Head of the exercise about an injured worker and takes actions aimed at his evacuation jointly with the Head of the medical service;
  - jointly with the Head of the transport service organizes delivery of a SRW container to the accident location for collection of RW generated in process of decontamination.
- Head of RCBP organizes decontamination of the territory in the vicinity of the accident, collection of RW insiide the SRW container, and transportation of the SRW container to the temporary storage pad
- Head of the transport service sends MAZ-500 to the vehicle decontamination station after completion of territory decontamination and delievery of the SRW container to the storage pad.
- Head of RCBP organizes sanitary treatment of the personnel of surveillance unit, territory decontamination unit, and the personnel of vehicle decontamination station at the sanitary airlock.
- Representative of the local authorities reports the actions on protection of the population taken upon receiving the message about the accident, paying special attention to informing the population. He also reports about the interaction of the authorities with the ESC of the facility.
- The Head of the exercise:
  - announces that the exercise has fulfilled its tasks and is closed;
  - performs debriefing of the exercise.
- Head of the communication and notification service announces the end of the exercise via the plant radio.
- The Head of the exercise summarizes its results after a discussion with the participants.

01.08.08, 10:00-12:00
Stage 5. Debriefing of the tactical exercise

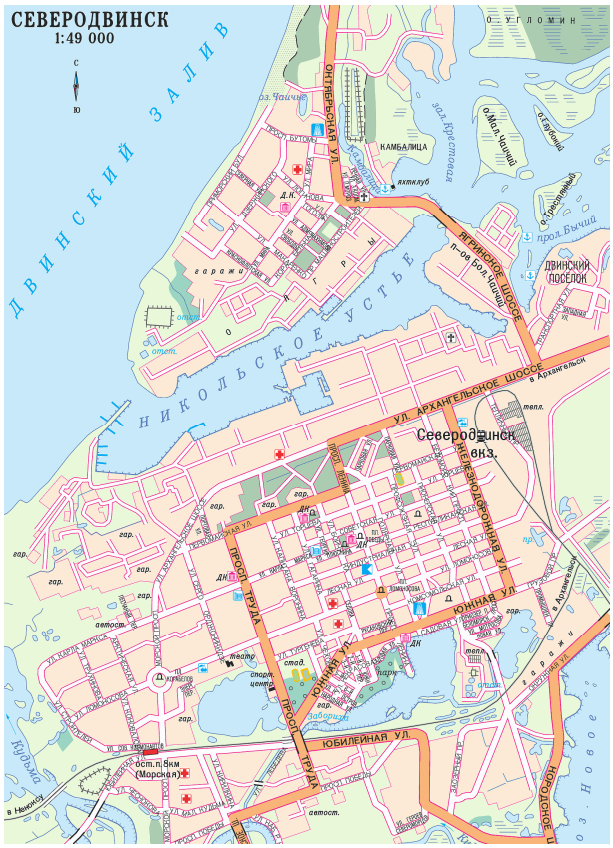
Centre of Shipbuilding "Zvezdochka"

The USSR Council of Ministers issued a Decree about the construction of a State Defence Plant in Nikolskoye Mouth of the Severnaya Dvina River on the Yagry Island in 1946. The facility was initially designed and constructed for refitting naval ships. Its operation was started in 1954. Today "Zvezdochka" is a multi-functional industrial facility.

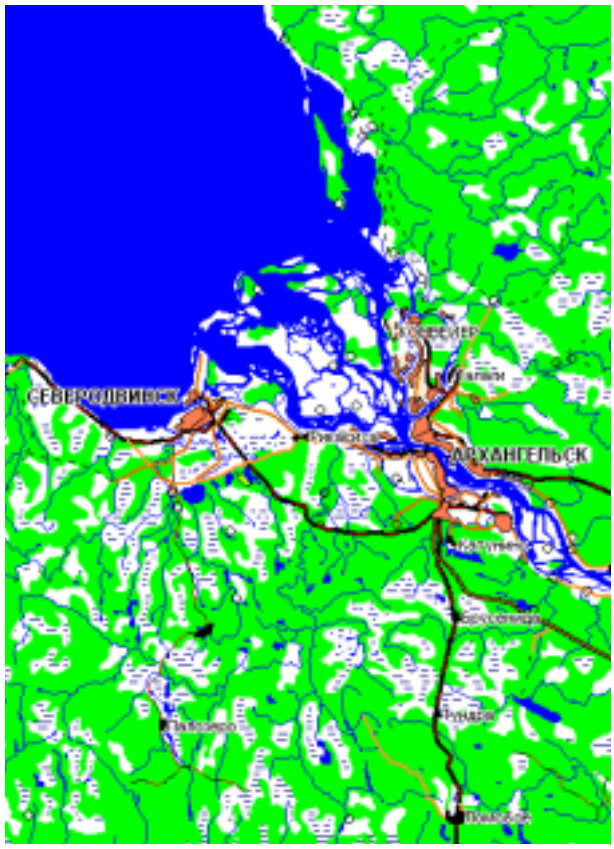
Description of the region of facility location

The facility is located in the town of Severodvinsk on the Yagry Island 35 km to the west of Archangelsk in the delta of Severnaya Dvina River.

Most of the population of Severodvinsk are employed at the major industrial facilities of the ship-building industry, FSUE "CS "Zvezdochka" and FSUE "SevMash". The population of Severodvinsk is 200 thous. people.



Map of Severodvinsk



Fragment of Map of the Archangelsk Region

The activities performed at the facility

The main activities performed at the facility include:

- civil ship building and repair;
- comprehensive decommissioning of the nuclear submarines (NS) and nuclear-powered surface ships (NPSS) retired from Navy;
- production of ship propellers;
- international military and technical cooperation;
- production of ship furniture;
- jewellery and diamonds faceting.

Comprehensive decommissioning of the nuclear submarines (NS) and nuclear-powered surface ships (NPSS) withdrawn from the lists of the Navy

One of the main activities at FSUE "CS "Zvezdochka" is comprehensive decommissioning of the nuclear submarines withdrawn from the lists of the Russian Navy. Modern infrastructure was constructed at FSUE "CS "Zvezdochka" for performing decommissioning of NS and NPSS, as well as processing of the radioactive waste.

The capacity of the facility allows:

- decommissioning of up to 8 NS per year;
- performing 4-6 operations on unloading of spent fuel from the reactors of decommissioned NS annually;
- carrying out management and temporary storage of SNF;
- carrying out management, temporary storage and reprocessing of liquid and solid RW.

The NS decommissioning infrastructure of FSUE "CS "Zvezdochka" includes the following main utilities:

- coastal facility for spent nuclear fuel unloading;
- temporary storage pad for transport containers loaded with SNF;
- utility for temporary storage and reprocessing (conditioning) of liquid and solid RW;
- a section for slipway works, which includes a dry and a floating dock;
- specialized section for mechanical cutting of scrap metal;
- specialized section for gas cutting of scrap metal;
- special section for electrical cable reprocessing.

Transportation of 3-compartment unit

Description the On-shore SNF Defueling Facility of FSUE "EE "Zvezdochka"

Unloading SNF from the NS reactors was the weakest point in resolving the problem of comprehensive NS decommissioning. The fuel from the submarines until recently has been unloaded using the specialized naval floating base, which was launched in 1960. The equipment of the floating base was insufficient to ensure implementation of the approved program of NS decommissioning. The coastal facility for SNF unloading was constructed in 2002 to eliminate this weak point. The construction was supported by the Threat Reduction Agency of the US Department of Defence.

Elements of the on-shore facility for SNF unloading

The coastal facility for SNF unloading includes the following coastal utilities and structures:

1. Section of a special mooring line equipped with a portal crane of 80 t lifting capacity. A decommissioned NS and the floating monitoring and dosimetry station are moored within the operating range of the crane.
2. Building for loading of transport containers, which is located in the immediate vicinity of the special mooring line within the operating range of the portal crane. A trailer route to the building is provided.

Embankment of FSUE "CS "Zvezdochka"

The loading building includes:

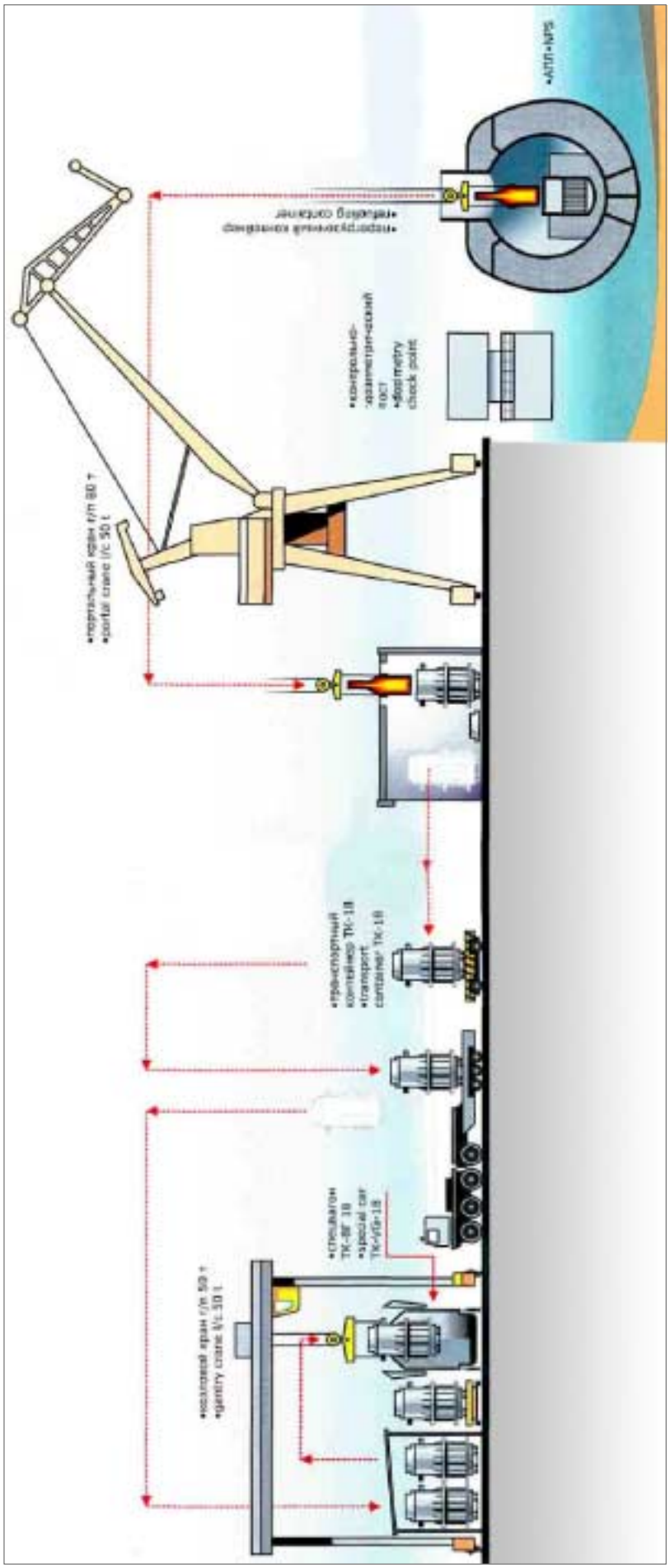
- The container loading section, which has two stations for loading the containers, guiding devices, removable container lids, cross-arms and a bench for testing the conformity of the cases to the technical requirements, including density tests.
- section for storage and preparation of reloading equipment and removable reactor equipment, which is equipped with a bridge crane of 16 tons capacity. The following auxiliary sections are also included in the section: section for deactivation of reloading equipment; section for production of adsorption solutions; section for collection, storage and removal of LRW; ventilation chambers and the control room of SNF unloading.
- an auxiliary building holds the sanitary checkpoint, tank unit for collection and monitoring of shower waters, guardhouse, thermal post, ventilation chambers, etc.

Section of special quay with portal crane of 80 tons lifting capacity

Transport container reloading

Temporary storage facility for transport containers

ODF Building

- 

On-shore SNF Defueling Facility of FSUE "EE "Zvezdochka"

3. Temporary storage pad for transport containers. Section of a railway providing loading of four TK-VG-18 container cars and access routes for trailer are provided for transportation of containers. The pad is equipped with a crane with a 50 tons lifting capacity, which is used to load and unload the containers from the railway cars and the trailer. There is also a checkpoint, security systems, as well as security and fire alarms at the pad.
4. Hold-yard for formation of a special train with a length of 210 m is located in the vicinity of the main railway track in the territory of special facilities and is separated by a fence prior to formation of a special train.

Technological Process of SNF Unloading

The following operations are carried out during unloading of SNF from the NS reactors:

1. The main works performed at the reactor compartment:
   - preparations to opening the reactor compartment and clearing of the opening for SNF unloading from the reactor.
   - preparation to removal of reactor lid, opening the reactor and installation of a guiding device on the reactor connector.
   - mounting of a reloading container onto the guiding device;
   - reloading SFA from the reactor to the reloading container;
   - transportation of the reloading container to the building for transport container loading using the portal crane;
   - conservation of the reactor after fuel unloading.
2. The main works performed at the transport container loading building:
   - installation of an empty transport container on the loading station;
   - opening container, removing the lid;
   - removal of the shrouds from the container, verification of their conformance to the technical requirements and loading the verified shrouds into the container;
   - mounting of a guiding device onto the container;
   - installation of the reloaded container transported by the portal crane from the NS reactor compartment on the guiding device;
   - loading the shrouds of the transport container with SFA;
   - transportation of the reloading container back to the NS reactor compartment using the portal crane;
   - verification of absence of water in the shrouds and plugging the shrouds (once the container is fully loaded);
   - verification of the absence of water in the loaded container;
   - installation of the container lid and verification of airtightness of the container;
   - transportation the loaded container to the railcar using the bridge crane with the capacity of 50 tons;
   - rolling the railcar and the container out of the ODF building;
   - reloading the container to the trailer.

Identification of hazards at *ODF*

A project for analysis of emergency situations risks (Source Control Project) during the works on SNF unloading from the decommissioned submarines has been implemented at FSUE "CS "Zvezdochka" in the framework of cooperation between IBRAE and DOE. The preliminary risk assessment stage was used to study the various initial events and the possible accident evolution scenarios, and to select the most significant ones for further quantitative risk assessment. The following initial events have been selected: loss of power supply during SNF reloading, fire, extreme external impacts, fall of various equipment elements. Thus, the following most significant scenarios were chosen for quantitative risk assessment on the basis of the hazards identified at ODF:

- fall of reloading container loaded with SFA;
- fall of a guiding device onto TK-18 container;
- impact of an aircraft crash on SNF defueling facility.

The event probabilities and appropriate radiation consequences were assessed for these scenarios. Correction measures aimed at reduction of the risk of occurrence of such accidents and minimization of their consequences were also developed.

Risk matrix was used to make recommendations regarding the ranking of correction measures from the point of view of optimization of the resources required for increasing the level of safety at the SNF On-shore Defueling Facility.

Scenario of the exercise

The results of the risk assessment project allowed selecting one of the most significant accidents potentially probable during reloading SNF from the decommissioned NS.

An accident connected with a fall of a reloading container loaded with SNF on the mooring line was selected.

This accident may happen only in case of a simultaneous rupture of two cables used in the lifting crane. Each of the cables will hold the container from falling.

Using the assessments made in the framework of the risk assessment project and taking into account the overall scope of works on reloading of the fuel, the probability of a fall of a container loaded with SFA during its reloading from a NS can be conservatively assessed at the level of $2.5 \cdot 10^{-2}$ year^{-1}.

In process of SNF unloading, the SFA from the decommissioned submarine are transported from the reactor compartment to the transport container loading building inside the reloading container. The reloading container is lifted and transported by a portal crane with a maximum lifting height of 17 m.

When the reloading container holding a single SFA falls onto the pier, the impact deforms the container, leading to loss of airtightness of the fuel elements and release of the radionuclides into the environment.

As the core storage period between the reactor shutdown and unloading of the fuel is at least 18 months and the SNF temperature should have dropped below 100°C, only the fission products contained under the fuel element cladding will be released into the atmosphere. We will conservatively assume that 100% of Kr-85 and I-129, and 1% of Cs-137 and Cs-134 contained under the claddings will be released into the atmosphere. The radionuclide composition of the release with account for the assumptions made is given below in table 1.

Radionuclide composition of the release in case of fall of a reloading container, Bq

Kr-85	I-129	Cs-134	Cs-137
$1.1 \cdot 10^{12}$	$2.0 \cdot 10^{6}$	$1.8 \cdot 10^{9}$	$4.4 \cdot 10^{9}$

Weather conditions

Wind - 210º

Wind speed - 3 m/s

Weather stability category - D (neutral)

Archangelsk Region

Archangelsk Region is located in the North of the European part of Russia. Its coast line with a length of 3 thous. km is washed by cold waters of three Arctic seas: White, Barents and the Kara Seas.

Its area is 587 thous. sq.km. The population of the Archangelsk Region is 1.3 million people, 1 million of them living in urban settlements.

The Region includes the territories of Nenetsk Autonomous District and the islands of Novaya Zemlya and Franz Josef Land.

Since January of 2006 the territory of the Region was divided into 229 municipal districts:

- 7 city districts;
- 19 municipal districts;
- 24 urban settlements;
- 179 rural settlements.

In 1992 the Archangelsk Region and the Nenetsk Autonomous District were proclaimed as subjects of the Russian Federation.

City of Archangelsk, founded by the Tsar Ivan the Terrible on March 5, 1584 in the mouth of Severnaya Dvina is the administrative centre of the Region. The largest cities are: Severodvinsk, Kotlas, Novodvinsk, Koryazhma, Mirny.

The population density is 2.2 people per 1 sq.km. 74.7% of the population are living in the urban settlements and 25.3% in the rural ones. Average age of the population is 37 years. 64.3% of the population are able-bodied.

The territory of the Archangelsk Region is a vast plane slightly sloping towards the White Sea and the Barents Sea, where the planes are broken with hills, which were formed by ancient glaciers.

Landscape

Thick moraine mounds with large number of closed cavities taken up by lakes, and hilly ridges called mountains by the locals (e.g. Letnie Mountains of the Onega Peninsula) are found in the North-West of the Region. A distinctive feature of the South is the Konoshskaya-Nyandomskaya upland with the height of 250 m. The territory in the East of the Region holds North and Middle Timan – low hill ridges made of parallel slopes up to 400 – 450 m high. Vetreny Poyas ridge runs in the West along the Onega Lake. Karst phenomena are widely observed on watershed plains in the West of the Region, where the Paleozoic limestones come closer to the surface. The lowlands are mostly taken by thick sea, glacier and alluvial sediments.

The landscape is influenced by erosion (up to 660 kg of soil per hectare is washed annually in the Severnaya Dvina basin), sea and lake surf, carst processes, making badlands out of the regions near Kuloi and Pinenga, and leading to formation of marshes. Another factor is accumulating activity of the ice cover on rivers and lakes.

Large areas of surface waters and marshes are typical for these lands. Excess water retains in closed cavities, soak the soils and run into the sea via the many rivers. The large river valleys were formed before the ice age, and today the rivers of the Region, including Severnaya Dvina (774 km), Pinega (779 km), Vychegda (1130 km), Mezen (966 km) – are flowing towards the sea through developed valleys. The smaller rivers are mostly less cut into the terrain and near the edges of the plateau have the character of near-mountain fast-flowing streams. The rivers are mostly fed by melting snow, and are flooding in spring. The end of the spring flood is largely delayed due to the forests in

the basins of the rivers. The rivers in the west and in the centre of the Archangelsk Region flow into the White Sea, which greatly affects the nature and economy by soothing the climate and providing fish, sea plants and sea animals.

Archangelsk Region has many lakes. Most of these are located to the west of Onega (Latcha, Kenozero, Kozhozero, Undozero). Mostly they are located in groups near moraine mounds. Such lakes usually do not influence the rivers much. Another frequent features are karst lakes with variable water level.

Ponds

The flora of the Archengelsk Region is characteristic for taiga region. 22.3 million hectares of area are covered by forests. The overall supply of wood is over 2500 million m^3. Most of the forests (80%) are coniferous (pine, firs).

The most frequent woods are firs (65%). Pine forests, driven by the firs to less favorable soils, make up to 20% of the Regions forests. Abies and larch are found in significant quantities only in the east of the region. Deciduous woods (birch, asp) make up about 15% of the forests. Some place in taiga is also taken by marsh and meadow plant systems. The floodlands in the river valleys have high quality.

Forests

The fauna of the Archangelsk Region is typical for taiga areas of the European part of Russia. The frequently found animals include elk, deer, bear, lynx, wolf, fox, squirrel, marten, mink, beaver, musquash, chipmunk, hare; birds include black grouse, capercailye, hazel grouse, titmouse, bullfinch; fish include herring, navaga, smelt, cod, flounder in the sea and pike, perch, burbot, ide, bream, ruff in the rivers. Fox, squirrel, mink, musquash are hunted in the region, but higher priorities are being assigned to breeding foxes, blue foxes and minks.

The seas and ocean strongly affect the climate of the region, which is transient from maritime to continental. The winter is long (up to 250 days) and cold, with low temperatures, in average -26 degrees, and strong winds. The average temperature in summer is about 15 °C.

Coast of Yagry island

The air masses frequently interchange above the Archangelsk Region, leading to quick weather changes and weather instability. The absence of mountain ridges makes the territory easily accessible for Atlantic cyclones and cold arctic air from the north-east. The first ones bring precipitations and cloudy weather and thawing in winter, the latter ones cause frosts and temperature drops. There are a smaller number of cyclones reaching the south-east than the north-west.

Annual precipitation in the forest area ranges from 400 to 540 mm, 200 days per year bringing precipitations. Precipitations fall as weak long snowfalls in the winter and long-term drizzle rains in

the autumn. The high value of the relative humidity is caused in winter and autumn (85-95%) by masses of warm air, and in summer and spring (70-90%) it depends on vaporization over the melting snow, surface waters, forests and marshes and the conditions of prolonged cloudy weather and low temperatures.

A thick snow cover reaching 60-70 cm is formed in the territory of the region in the winter. The snow falls between October 25 and November 10, and the cover melts until April 25 - May 10 (the snow may remain on the White Sea coast until May 20).

The region is rich with minerals. Archangelsk Region has significant proven resources of oil and gas (Nenetsk Autonomous District) and bauxites (Plesetsk District). The only diamond-bearing province in Europe has been discovered in the Archangelsk Region.

The Region has vast supplies of limestone, dolomite, cement resources, gypsum, sands, clay, construction stones, manganese, copper ore, zinc, lead, amber, jewellery agate and other minerals.

Archangelsk Region is the province of forest industry, fishing, ship-building and space industry.

There are over 24 thousand organizations and companies of various industries registered in the territory of the region.

The economic development is based on the more traditional industries, including wood processing and construction industry. Fishing, hunting, diary farming, cattle breeding and linen growing also are of significance.

There is a developed port infrastructure, including the Archangelsk port, which is the northern gate of Russia, ensuring the majority of cargo transport in the region.

Severodvinsk

Severodvinsk is the second largest city in the Archangelsk Region. It is located on the coast of the Whit Sea in 35 km to the west of Archangelsk and has a population of about 200 thousand.

The construction of the city started in 1936, at the same time as the building of the largest shipyard in the country was started. In 1938 the settlement of Sudostroy was renamed as the town of Molotovsk by the Decree of the presidium of RSFSR Supreme Council. On September 12 of 1957, Molotovsk was renamed as Severodvinsk.

During the Great Patriotic War of 1941-1945, it was one of the ports accepting allied convoys with land-lease supplies. During this period, the local port serviced nearly 200 ships, 60 thousands railway cars and about 1 million tons of military cargoes.

Great number of Russian heritage elements are preserved within the territory of the modern city and in its suburbs.

Severodvinsk is a large industrial and scientific centre of the North of Russia. The leading industry of the region is construction and repair of ships, construction of offshore platforms, metal processing and decommissioning of nuclear submarines.

White Sea

During the 30 years since the first launch of a nuclear submarine, Severodvinsk shipwrights delivered about 130 nuclear submarines to the Navy. These include: "Leninsky Komsomol" – USSRs first nuclear powered submarine, "K-162" NS – the fastest titanium-hulled submarine (it reached submerged speed of 83,4 km/h), the largest submerged cruiser "Typhoon", which is included in the Guiness book of records, the deepest-diving submarine, which set a record of diving depth (1000 m).

The Handbook is based on the information materials provided by FSUE “CS “Zvezdochka” and public information resources of the administration of the Archangelsk Region. The photos are by Yu.N. Maksimov.