Exercise Assessing Consequences and Responding to Radiation Emergency in the North-West Region of Russia

<<Arctic – 2014>>
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In 1996, after several years of cooperation and scientific strategy development, Canada, the Kingdom of Denmark, Finland, Iceland, Norway, Russia, Sweden, and the United States established the Arctic Council to provide a systematic approach to handling issues affecting the Arctic region. The Arctic Council was created with four working groups assigned to undertake specific areas of work. The Emergency Prevention, Preparedness and Response (EPPR) Working Group was formed to deal with the prevention, preparedness and response to environmental emergencies in the Arctic. EPPR focuses primarily on prevention and preparedness strategies for radionuclides and oil and gas transportation and extraction. The goal of the EPPR Working Group is to contribute to the protection of the Arctic environment from the threat or impact that may result for an accidental release of pollutants or radionuclides.

In 2001, EPPR partnered with the Nuclear Safety Institute of the Russian Academy of Sciences (IBRAE RAN) to prepare and conduct drills and exercises focusing on radiological emergency scenarios in the Arctic. Since that time many drills as well as the Arctic series of large scale exercises have been planned and carried out by EPPR. The exercises and drills have been designed to validate planning and preparedness activities developed by the EPPR Working Group and validate plans and procedures developed by individual countries and international organizations, such as the International Atomic Energy Agency and World Health Organization. The exercises incorporate advances and improvements in radiation detection technology (some sponsored by EPPR), modeling, public communications, and response and management capabilities at the facility, local, national regional and international levels. Lessons learned from each exercise are identified and implemented for continuous improvement. Additionally, EPPR reviews the results of the exercises and identifies projects which EPPR can undertake to improve overall response capabilities. The EPPR Working Group also observed each exercise of the Arctic series to ensure improvement of radiological emergency management systems among Arctic states. EPPR Working Group members and Arctic Council Observers have the opportunity to experience the exercise on site which greatly expands national, regional and international understanding of the systems in place to address radiological emergencies in the Arctic.

The latest large scale exercise in the series is the Arctic 2014 exercise conducted in June 2014. The exercise scenario involved an event on a nuclear powered icebreaker in northwest Russia. The Arctic 2014 exercise focused on assessing consequences and response to the radiation emergency. The main tasks for this exercise were related to communications, patient treatment of radiological exposure, and protection of workers and the public. Communication activities included obtaining and coordinating scientific and technical support information, alerting and informing authorities at the facility, local, national, regional and international levels and interfacing with the public and media. Many types of communication systems were used, including video conferencing, and interactions with mass media were also tested. Technical information was produced to inform decision making, including source term, dose burden to the public, protective measures, and meteorological data. Information was gathered to develop press releases and respond to journalists’ questions as a part of the communication processes being tested. As with all drills and exercises, there were positive practices as well as items identified where improvements could be made. Recommendations for improvements were developed and are included as a part of the Arctic 2014 final report. In addition, the Arctic 2014 exercise incorporated outcomes identified from the Arctic 2012 exercise where communications were identified as an area needing additional effort. This exercise and the lessons learned will be reviewed by the EPPR Working Group as a part of activities related to future exercise development and the ongoing development of Arctic Council products and work.

The EPPR Working Group, IBRAE RAN, and other Arctic Council working group activities continue to support protection of the Arctic environment, in part through the ongoing series of EPPR exercises. Continued international cooperation and coordination provides the opportunity to experience a test of the emergency management system in place to respond to a radiological emergency. Lessons identified from Arctic 2014 will be taken into account in the planning for future exercises. Exercising is a critical element in the process of developing, testing and maintaining effective emergency response capabilities in and among the Arctic countries.
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<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>A.I. Burnazyan FMBC</td>
<td>Russian State Research Center A.I. Burnazyan Federal Medical Biophysical Center</td>
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<tr>
<td>ARMS</td>
<td>Automated Radiation Monitoring System</td>
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<tr>
<td>CDP</td>
<td>Central Dosimetry Post</td>
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<tr>
<td>CDS</td>
<td>Civil Defense Structure</td>
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<tr>
<td>CERT</td>
<td>Contingency Emergency Rescue Teams</td>
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<tr>
<td>CMCU</td>
<td>Central Medical Care Unit</td>
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<tr>
<td>CSMC</td>
<td>Crisis Situation Management Center</td>
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<tr>
<td>CSTS</td>
<td>Centre for Scientific and Technical Support</td>
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<td>DNRS</td>
<td>Department of Nuclear and Radiation Safety</td>
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<tr>
<td>EC</td>
<td>Emergency Commission</td>
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<tr>
<td>ECCS</td>
<td>Emergency Core Cooling System</td>
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<tr>
<td>EM</td>
<td>Environmental Monitoring</td>
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<tr>
<td>EMERCOM of Russia</td>
<td>The Ministry of the Russian Federation for Civil Defense, Emergencies and Elimination of Consequences of Natural Disasters</td>
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<tr>
<td>EMRDC of A.I. Burnazyan FMBC</td>
<td>Emergency Medical Radiation-Dosimetry Center of A.I. Burnazyan Federal Medical Biophysical Center</td>
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<tr>
<td>EROUA</td>
<td>Emergency-Rescue and Other Urgent Activities</td>
</tr>
<tr>
<td>ERT</td>
<td>Emergency Rescue Team</td>
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<tr>
<td>ES</td>
<td>Emergency Situation</td>
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<tr>
<td>ETC SPb</td>
<td>Emergency Technical Center of Rosatom, St. Petersburg, Russia</td>
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<tr>
<td>FE</td>
<td>Fuel Element</td>
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<tr>
<td>FMBA</td>
<td>Federal Medico-Biological Agency</td>
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<tr>
<td>FP</td>
<td>Fission Products</td>
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<tr>
<td>FSUE</td>
<td>Federal State Unitary Enterprise</td>
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<tr>
<td>GD</td>
<td>General Directorate</td>
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<tr>
<td>HA</td>
<td>HydroAccumulators</td>
</tr>
<tr>
<td>HTS</td>
<td>Highly Toxic Substances</td>
</tr>
<tr>
<td>IBRAE RAN</td>
<td>Nuclear Safety Institute of the Russian Academy of Sciences</td>
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<tr>
<td>ICE</td>
<td>Information Component of the Exercise</td>
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<td>IDDS</td>
<td>Integrated Duty-and-Dispatch Service</td>
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<tr>
<td>Acronym</td>
<td>Full Form</td>
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<tr>
<td>IRD</td>
<td>Inter-Regional Department</td>
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<tr>
<td>MCU</td>
<td>Medical Care Unit</td>
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<tr>
<td>Murmansk HM &amp; EM</td>
<td>Murmansk Department for Hydro-Meteorology and Environmental Monitoring</td>
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<tr>
<td>Murmansk Region EPP and FS</td>
<td>Murmansk Region Department for Civil Defense, Emergency Protection of Population and Fire Safety</td>
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<tr>
<td>NEITA</td>
<td>North-European Interregional Territorial Administration</td>
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<tr>
<td>NPI</td>
<td>Nuclear Power Installation</td>
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<tr>
<td>NRHF</td>
<td>Nuclear- and Radiation-Hazardous Facility</td>
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<tr>
<td>NRS</td>
<td>Nuclear and Radiation Safety</td>
</tr>
<tr>
<td>ODO</td>
<td>Operational Duty Officer</td>
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<tr>
<td>OLM</td>
<td>On-line message</td>
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<tr>
<td>PCP</td>
<td>Primary Coolant Pump</td>
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<tr>
<td>PPE</td>
<td>Personal Protective Equipment</td>
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<tr>
<td>RI</td>
<td>Reactor Installation</td>
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<tr>
<td>RM</td>
<td>Radiation Monitoring</td>
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<tr>
<td>RMS</td>
<td>Radiation Monitoring System</td>
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<tr>
<td>ROSATOM’s SCC</td>
<td>Situation Crisis Center of ROSATOM</td>
</tr>
<tr>
<td>RSS</td>
<td>Radiation Safety Standards</td>
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<tr>
<td>SG</td>
<td>Steam Generator</td>
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<tr>
<td>SMS</td>
<td>Short Messaging Service</td>
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<td>VC</td>
<td>VideoConferencing</td>
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INTRODUCTION

The ‘ARCTIC-14’ exercise was held on June 23-24, 2014 at the site of the Federal State Unitary Enterprise ‘ATOMFLOT’ (FSUE ATOMFLOT) within the framework of the Agreement between the Government of the Russian Federation and the Government of the United States of America of 14.01.94 ‘On Cooperation in Research on Radiation Effects to the Purpose of Minimizing the Consequences of Radioactive Contamination on Health and the Environment’ and was agreed with the leaders of ROSATOM.

FSUE ATOMFLOT is a part of State Corporation ROSATOM, and its mission is to support operation and technical maintenance of nuclear icebreakers and nuclear maintenance ships.

The exercise was prepared by ATOMFLOT and Nuclear Safety Institute of the Russian Academy of Sciences (IBRAE RAN).

Specific issues of the exercise organization, preparing and holding were addressed at several meetings wherein basic documents and the time schedule of the exercise were established. The developed basic documents defined the exercise goals, objectives, key actors, involved forces and resources, and also the methods of its preparation, organization and holding. The functions of the exercise actors at various stages of preparation and holding were determined as well.

The responsible executing partners of ATOMFLOT and IBRAE RAN jointly developed and agreed a hypothetical emergency scenario at a nuclear icebreaker.
1 Concept of ‘ARCTIC-2014’ Exercise

1.1 Objectives

- Verifying readiness of the facility personnel activities on containing the accident and eliminating its consequences at the site;
- Practicing actions of emergency-response players on the protection of workers, the public and the environment; and
- Verifying the procedures of information exchange and interactions between emergency-response players.

1.2 Main Tasks

- Practicing warning and response procedures at the facility level and also at local and federal levels.
- Verification of communication and warning systems.
- Training procedures of the situation assessment and forecast by emergency-response players.
- Practicing decision-making procedures and practical actions on protection of workers and the public including enactment of emergency plans.
- Practicing medical scenario of the exercise.
- Training the public and media information procedures.

1.3 Key Actors

‘ROSATOM’ State Corporation:
FSUE ATOMFLOT;
- Experts of the Nuclear and Radiation Safety Department (DNRS);
- Rosatom’s Situation Crisis Center (SCC);
- Emergency Technical Center of Rosatom in St. Petersburg (ETC SPb).

FMBA of Russia:
- A.I. Burnazyan Federal Medical Biophysical Center (FMBC);
- South Urals Biophysics Institute;
- Research Institute of Industrial and Marine Medicine;
Northwest Regional Medical & Radiation Monitoring Emergency Center;
Central Medical Care Unit (CMCU) No 120;
Inter-Regional Department (IRD) No 120;
Medical Care Unit (MCU) No 2 of CMCU No 120.

**Murmansk Region:**
Murmansk Region Department for Civil Defense, Emergency Protection of
Population and Fire Safety;
General Directorate of EMERCOM of Russia for Murmansk region;
- Murmansk Department for Hydro-Meteorology and Environmental
  Monitoring (Murmansk HM & EM Department).

**Centers of Scientific & Technical Support (CSTS):**
- CSTS of IBRAE RAN;
- Emergency Medical Radiation Dosimetry Center (EMRDC) of A.I. Burnazyan
  FMBC, FMBA.

### 1.4 Basic Provisions

A) The exercise included elements of special tactical exercises that enabled
training of practical actions of emergency-response workers and also elements of
headquarters exercises.

B) During the exercise the following practical actions of the personnel were
worked out:

- rendering assistance to the victims of the accident;
- primary measurements of the radiation situation parameters;
- assembly of emergency-rescue team of the facility; and
- warning and transfer of information about the emergency by the facility duty
  officer.

C) Elements of headquarters exercises included practicing activities of the facility-
level emergency commission on:

- providing a shelter to the facility personnel not involved in the emergency
  operations;
- adjusting contaminated locations *in situ*, at the facility site and in the near zone
  outside it;
– arranging a special sanitary and access-control regime at the accident location within the facility site;
– conducting initial activities to contain the accident;
– examination of emergency icebreaker; and
– involvement of additional forces and resources to provide technical and expert support of emergency activities.

D) To provide scientific and technical support for decision-making, centers of scientific and technical support (IBRAE RAN, EMRDC) were informed about the fact of the accident. To enable interactions of the exercise players, all types of communications, including video conferencing, were used. Such a system enabled the participants' work in a single information space at all stages of the exercise including the preparatory stages and the summing up stage. As a result of the joint work, the source term was estimated, dose burden to the public was assessed and protection measures were developed.

E) The following issues were also trained during the exercise:
– assessment of the radiological consequences of the accident for the population;
– measures to bring the emergency icebreaker to a safe condition; and
– practicing a ‘medical scenario’ of the exercise.

F) Considerable importance was given to interactions with the Murmansk HM & EM Department, which upon receiving the data about the incident:
– checked the operation of the Murmansk Automated Radiation Monitoring System (ARMS);
– transferred hydrometeorological stations to a more frequent monitoring mode; and
– upon request, provided data on the meteorological situation at the icebreaker location area.

G) During the exercise much attention was also paid to interactions with mass media. To provide such interactions, special centers are being established at crisis centers of various agencies and also at nuclear facility operating enterprises. The purpose of practicing the public information procedures is to improve practical skills in interactions with mass media and readiness to repel ‘information attacks’ in a case of emergency, as well as training interactions of expert support teams with each other and with the facility
press center when preparing information messages to mass media about a conventional accident.

H) During the exercise various technical elements of the Murmansk region emergency response system were used. Most attention was paid to simulation of the data of the Murmansk region ARMS and the data of mobile radiometric laboratories.

1.5 Scenario of Conventional Emergency

Within the framework of the ‘ARCTIC-2014’ exercise at FSUE ATOMFLOT site a scenario of incident caused by external impact on icebreaker moored at berth was selected. Such an impact brought to depressurization of the primary circuit with loss of coolant and damage of the core of one icebreaker’s reactor.

1.6 Main Stages of the Exercise

1) Warning and transfer of information about emergency at FSUE ATOMFLOT.

2) Organization of the work of managing authorities and Emergency Rescue Teams (ERT) on elimination of the occurred beyond-design-basis accident at Nuclear Power Installation (NPI) and its implications.

3) Providing interactions between FSUE ATOMFLOT and regional authorities in responding to the conventional radiation accident.
2 General Progression of Conventional Emergency Situation

‘H’ + 0 — external impact to icebreaker initiating an emergency at Reactor Installation no 1 (RI-1);

‘H’ + 3-5 s — rapid drop of pressure and coolant level in pressurizer of the primary circuit. An increase of readings of the Radiation Monitoring System (RMS)’s detection unit begins indicating a leak from the primary circuit to the sub-unit space;

‘H’ + 3-5 s — in response to a signal of pressure decrease in the primary circuit pressurizer, the RI emergency protection system is actuated (core, $P_{\text{min}}$), and the RI is transferred to the cooldown mode via the use of the primary circuit cleaning and cooldown system;

‘H’ + 20-30 s — with further pressure decrease primary circuit circulation pumps are stopped, and localizing fittings in pipes of the cleaning system are closed;

‘H’ + 100 s — on pressure decrease in the reactor, water ingress from HydroAccumulators (HA) of the Emergency Core Cooling System (ECCS) starts;

‘H’ + 200 s — warning setpoint is actuated indicating an increase of radioactive substance concentration in air within the containment above 8.5E+4 Bq/m³ due to coolant release from the primary coolant. Almost immediately, the emergency setpoint is actuated indicating an increase of radionuclide concentration in air inside the containment above 6.7E+6 Bq/m³;

‘H’ + 10 min — active outflow of steam-water mixture from the primary circuit, but the level of coolant above the core is yet kept at the height of pressurizer inlet nozzle due to loss-of-coolant compensation through water supply to the gap from HAs. Simultaneously, primary circuit parameters (pressure and temperature) decrease due to excess of the flow rate of steam leak from the reactor over that of steam generated by decay heat of the core;

‘H’ + 12 min — coolant outflow with large flow rate results in coolant boiling in the reactor downcomer and its steaming. Next, the level of coolant in the reactor downcomer increases due to steam leaks from the downcomer via ‘small’ openings;

‘H’ + 15 min — the level of coolant above the core decreases below the pressurizer inlet nozzle resulting in the onset of steam outflow from the RI;
‘H’ + 20 min — readings of gamma-level detection units in the control room increase. The emergency setpoint 200 μSv/h is actuated, next readings increase further to 600 μSv/h and continue to grow;

‘H’ + 40 min — a request is forwarded to ROSATOM’s SCC to assess possible development of the occurred emergency situation and its potential radiological implications. The SCC transmits this request to CSTS of IBRAE RAN;

‘H’ + 1 h 12 min — until then heat removal power in Steam Generator (SG) is insignificant due to the lack of flow over the primary circuit. Heat removal from the reactor in the steam-condensation mode is limited by the presence of a gas emitted from coolant during temperature decrease in the course of cooling down. In addition, low power of SG at this phase is due to the process of SG filling over the secondary circuit;

‘H’ + 1 h 20 min — a response is received from IBRAE RAN containing preliminary estimates of possible development of the occurred emergency (up to depressurization of a part of fuel elements) and potential radiation consequences of such an accident;

‘H’ + 1 h 40 min — exhaustion of water in HAs; start of coolant level decrease above the core; transition to steam outflow from the reactor;

‘H’ + 2 h 24 min — the level of coolant decreases to the upper edge of the core. Thus, under the considered emergency scenario the reserve time before the core unwatering is at least 2.4 hours;

‘H’ + 2 h 25 min — due to a short-time unwatering of the core the temperature of some Fuel Elements (FE) reaches a critical level. This results in volume swelling of a part of FEs followed by their depressurization and development of local through defects of small size and cracks in claddings with partial release of radioactive gases and some volatile radionuclides;

‘H’ + 2 h 28 min — a release of Fission Products (FP) from FEs to coolant begins followed by radioactive substance transfer over the primary circuit and release to rooms of the containment;

‘H’ + 2 h 30 min — in the control room pressure increase up to a critical value is recorded, and the emergency valve is actuated. Via the mainmast steam-air mixture is released to the atmosphere;
‘H’ + 2 h 31 min — several external sensors of the facility-level ARMS at FSUE ATOMFLOT site are actuated. Maximum dose rates reach 92 μSv/h. A sensor of the regional-level ARMS at ATOMFLOT’s administrative building is also actuated — 17 μSv/h (Fig.1);

Fig.1 – Simulation of readings of regional ARMS sensor

‘H’ + 2 h 32 min — readings of gamma detection units in the control room reach 44 mSv/h. In some work rooms and living rooms readings of gamma detection units also increased - up to 1-15 μSv/h. The highest sensor readings of the naval RMS are recorded in the room within the area of radiation monitoring — 12 mSv/h;

‘H’ + 2 h 33 min — the containment spray system is put into operation in the control room that has resulted in a decrease of pressure of steam-air mixture;

‘H’ + 2 h 36 min — analysis of time variations of the facility ARMS’s sensor readings shows that the radioactive cloud is moving NNE and after about 4 minutes it reaches the sensor near the ‘Lepse’ mast;

‘H’ + 2 h 37 min — analysis of time variations of the facility ARMS’s sensor readings demonstrates that the radioactive cloud moving NNE mainly consists of radioactive noble gases. This is due to the fact that after the cloud passage sensor readings are sharply reduced and exceed only slightly the pre-accident values - e.g. at the location of ‘Amec 3’ sensor;
Fig. 2 – Simulation of readings of regional ARMS sensor installed at ATOMFLOT’s administrative building within the first 6 minutes after accidental release of radioactive substances

‘H’ + 2 h 39 min — the personnel managed to run the system of emergency core quenching using water of the secondary circuit. The temperature of FE claddings dropped below the critical value that stopped the process of their further depressurization;

‘H’ + 2 h 42 min — a dosimetrist technician, who conducted radiation monitoring including contamination of surfaces, has been injured and is unable to leave the rooms himself. To evacuate him from the contaminated area, an emergency team is formed. Overexposure of this person is possible due to his quite long staying in a room with elevated radiation levels;

‘H’ + 2 h 45 min — a request is sent to ROSATOM’s SCC (with a copy to CSTS IBRAE RAN) to assess the integral activity of the occurred radiation release based on the data of sensors of the facility ARMS as well as the related radiation consequences;

‘H’ + 2 h 50 min — the facility ARMS’s sensors show that the radioactive cloud has left the facility site. Levels of external gamma dose rate increased only slightly, but the presence of local areas with increased radiation levels at the facility site is also possible;

‘H’ + 2 h 58 min — a sensor of the regional ARMS is actuated in Roslyakovo but the recorded dose-rate increase is very small and only 3 times higher compared to the natural radiation background that poses no hazard to the population;
‘H’ + 3 h 10 min — a response is received from IBRAE RAN with preliminary estimates of the integral activity of radioactive release based on the data of sensors of the facility-level ARMS (Fig. 3) as well as of the related radiation consequences (Fig. 4). From these estimates an important conclusion is reached: outside the ATOMFLOT site the possibility of the population exposure dose excess above 1 mSv is expected nowhere;

‘H’ + 3 h 25 min — a radiation survey of the contaminated zone of the facility begins with the aim of contouring an area with gamma dose rate of 1 μSv/h. Decontamination of the contaminated area will be carried out later.

Fig.3 – Preliminary estimate of integral activity of the occurred emergency release of radioactive substances based on the data of sensors of the facility-level ARMS, CSTS of IBRAE RAN

Fig. 4. Revised estimate of the radiation consequences of the nuclear icebreaker accident, CSTS IBRAE RAN
### Operational Messages on Violations in Operation of Ships with NPI and Radiation Sources

#### No 1

**8h:04 min  June, 23**

<table>
<thead>
<tr>
<th>.</th>
<th>Ship name</th>
<th>‘The Soviet Union’</th>
</tr>
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<tbody>
<tr>
<td>.</td>
<td>Ship location (coordinates)</td>
<td>Pier No 3</td>
</tr>
<tr>
<td>.</td>
<td>Time of violation occurrence (Y, M, D, H, M)</td>
<td>2014, June, 23, 8:00 a.m.</td>
</tr>
<tr>
<td>.</td>
<td>Condition of RI or radiation source before the violation</td>
<td>Standard, no violation</td>
</tr>
<tr>
<td>.</td>
<td>Condition of RI or radiation source at the message transfer instant</td>
<td>An emergency at reactor installation RU-1</td>
</tr>
<tr>
<td>.</td>
<td>Radiation situation on board</td>
<td>Unknown</td>
</tr>
<tr>
<td>.</td>
<td>Type of violation</td>
<td>Unknown</td>
</tr>
<tr>
<td>.</td>
<td>Estimated causes of violation</td>
<td>An external impact on ‘The Soviet Union’ icebreaker</td>
</tr>
<tr>
<td>.</td>
<td>Measures taken to eliminate the violation</td>
<td>Actuation of RI emergency protection</td>
</tr>
<tr>
<td>0.</td>
<td>Need for additional technical means and organizational measures to assist in elimination of accident, incident and their consequences</td>
<td>TBD</td>
</tr>
<tr>
<td>1.</td>
<td>Title and full name of the person who sent the message</td>
<td>GOLENOK Alexander Fedorovich, Dispatcher of FSUE ATOMFLOT</td>
</tr>
</tbody>
</table>
REQUEST TO ROSATOM’s SCC

I ask you to assess possible development of the occurred emergency situation and its potential radiological implications.

8h:41min  June, 23

Chairman of FSUE AROMFLOT’s Emergency Commission  Kashka M.M.
Based on information available in IBRAE RAN’s databases on radionuclide composition in the core of OK-900A reactors and technology data about the dynamics of the accident, IBRAE RAN’s experts performed preliminary estimates of potential release of noble gases, I-131 and Cs-137 in a case that adequate cooling of the reactor core is not achieved.

Radionuclide composition of potential release to the atmosphere:

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Activity, Bq</th>
</tr>
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<tbody>
<tr>
<td>Cs-137</td>
<td>1.80E+12</td>
</tr>
<tr>
<td>I-131 (aerosol)</td>
<td>2.10E+13</td>
</tr>
<tr>
<td>Kr-88</td>
<td>6.50E+13</td>
</tr>
<tr>
<td>Xe-133</td>
<td>2.70E+14</td>
</tr>
</tbody>
</table>

Executor (name, signature) Aron D.V.
Time and date of the form sending (Moscow time) 9h:5min June, 23, 2014
Results of Radiation Situation Estimate at the Accident Location

CSTS IBRAE RAN
Name of CTS providing information

FSUE ATOMFLOT
Location of emergency-response exercise

Meteo

<table>
<thead>
<tr>
<th>Wind</th>
<th>Direction 0°</th>
<th>Atm. Precip.</th>
<th>Stability class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>□ Yes □ No</td>
<td>□ A, □ B, □ C, □ D, □ E, □ F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>No atmospheric precipitations</td>
</tr>
</tbody>
</table>

Characterization of the area towards the wind direction

Roughness (z₀) 0.1 m

A conservative Calculation without Accurate Wind-direction Data!

Predicted doses over the first 10 days after the accident, mSv

<table>
<thead>
<tr>
<th>Distance from the object, km</th>
<th>Dose to the thyroid</th>
<th>The whole body dose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adults</td>
<td>Children</td>
</tr>
<tr>
<td>1</td>
<td>3.9</td>
<td>8.9</td>
</tr>
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<td>2</td>
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<td>7.4</td>
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<td>2.3</td>
</tr>
<tr>
<td>8</td>
<td>8.7E-1</td>
<td>2.0</td>
</tr>
<tr>
<td>9</td>
<td>7.4E-1</td>
<td>1.7</td>
</tr>
<tr>
<td>10</td>
<td>6.3E-1</td>
<td>1.4</td>
</tr>
<tr>
<td>12</td>
<td>5.2E-1</td>
<td>1.2</td>
</tr>
<tr>
<td>14</td>
<td>4.2E-1</td>
<td>9.5E-1</td>
</tr>
<tr>
<td>16</td>
<td>3.3E-1</td>
<td>7.5E-1</td>
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<td>18</td>
<td>2.7E-1</td>
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</tr>
<tr>
<td>20</td>
<td>2.3E-1</td>
<td>5.2E-1</td>
</tr>
<tr>
<td>22</td>
<td>1.9E-1</td>
<td>4.4E-1</td>
</tr>
<tr>
<td>24</td>
<td>1.6E-1</td>
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<td>28</td>
<td>1.1E-1</td>
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</tr>
<tr>
<td>30</td>
<td>7.3E-2</td>
<td>1.7E-1</td>
</tr>
</tbody>
</table>

Even in such a case no population protection measures would be required in accordance with RSS-99/2009!

Executor (name, signature) Aron D.V.
Time and date of the form sending (Moscow time) 9h:10 min June, 23, 2014
**EXERCISE!!! EXERCISE!!! EXERCISE!!! EXERCISE!!!**

Additional message
on contingency (emergency) situation

9h:16 min  June, 23

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Enterprise</td>
<td>FSUE ATOMFLOT</td>
</tr>
<tr>
<td>2.</td>
<td>Facility (industry), where the violation occurred</td>
<td>‘The Soviet Union’ nuclear icebreaker</td>
</tr>
<tr>
<td>3.</td>
<td>Time and date of violation (local time / Moscow time)</td>
<td>June 23, 8-00/8-00</td>
</tr>
<tr>
<td>4.</td>
<td>Falls under the criteria of information about emergency situation?</td>
<td>Yes</td>
</tr>
<tr>
<td>5.</td>
<td>Events class:</td>
<td>-</td>
</tr>
<tr>
<td>6.</td>
<td>Preliminary classification according to categories and account of violations in nuclear power facility operation</td>
<td>P1</td>
</tr>
<tr>
<td>7.</td>
<td>Rating of event according to the INES scale</td>
<td>2</td>
</tr>
<tr>
<td>8.</td>
<td>Condition of the facility (power unit, reactor, industry, production line, special cargo, etc.) before violation:</td>
<td>Normal operation</td>
</tr>
<tr>
<td>9.</td>
<td>Brief description of the origin, development and localization (elimination) of violation; its supposed causes and development; deviations from safety limits and conditions, if any.</td>
<td>Rapid drop of pressure and coolant level in pressurizer of the primary circuit. An increase of readings of the icebreaker’s RMS detection unit indicating a leak from the primary circuit to the sub-unit space. Actuation of the RI emergency protection system.</td>
</tr>
<tr>
<td>10.</td>
<td>Name and basic data of the damaged main equipment</td>
<td>RI No 1</td>
</tr>
<tr>
<td>11.</td>
<td>Status of this facility and other potentially hazardous facilities at the site (other reactors, industry, production line, special cargo, etc.) by the message transfer time</td>
<td>Other facilities and installations at FSUE ATOMFLOT are in normal operating conditions</td>
</tr>
<tr>
<td>12.</td>
<td>Radiation, chemical, environmental and other implications of violation (according to the data of monitoring devices and laboratory measurements and other data)</td>
<td>Actuation of sensors of the icebreaker’s RM system</td>
</tr>
<tr>
<td>13.</td>
<td>Number of victims / of them fatal (full name, age, position, years of experience)</td>
<td>Unknown</td>
</tr>
<tr>
<td>14.</td>
<td>Need for immediate assistance of experts and facility-level EC (expert and resource support)</td>
<td>Yes</td>
</tr>
<tr>
<td>15.</td>
<td>Information on countermeasures already taken and being implemented</td>
<td>-</td>
</tr>
<tr>
<td>16.</td>
<td>Title, name and signature (for a message sent by fax) of official, who prepared and transmitted the message</td>
<td>GOLENOK Alexander Fedorovich, Dispatcher of FSUE ATOMFLOT</td>
</tr>
</tbody>
</table>
INFORMATION (REPORT)  
ABOUT THREAT (FORECAST) OF EMERGENCY SITUATION

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Type of conventional emergency</td>
</tr>
<tr>
<td></td>
<td>Radiation incident on a nuclear icebreaker moored at a pier of FSUE ATOMFLOT; loss of coolant of the primary circuit of RI No 1 due to external impact</td>
</tr>
<tr>
<td>02</td>
<td>Conventional area (facility) of emergency</td>
</tr>
<tr>
<td></td>
<td>Nuclear icebreaker ‘The Soviet Union’</td>
</tr>
<tr>
<td>03</td>
<td>Administrative location of the area (facility) of conventional emergency</td>
</tr>
<tr>
<td></td>
<td>Site of FSUE ATOMFLOT, State Corporation ‘Rosatom’</td>
</tr>
<tr>
<td>04</td>
<td>Forecast of the time of occurrence and extent of conventional emergency</td>
</tr>
<tr>
<td></td>
<td>By convention, 8:00 of June 23, a local incident on board of the icebreaker</td>
</tr>
<tr>
<td>05</td>
<td>Proposed measures to avoid the ES development (on reducing potential implications and damage)</td>
</tr>
<tr>
<td></td>
<td>Actuation of the RI emergency protection, closing of localizing fittings on pipes of the cleaning system, water ingress from HA of the emergency core cooling system</td>
</tr>
<tr>
<td>06</td>
<td>Organization that made a forecast or other forecast sources</td>
</tr>
<tr>
<td></td>
<td>FSUE ATOMFLOT</td>
</tr>
<tr>
<td>07</td>
<td>Additional text information</td>
</tr>
<tr>
<td></td>
<td>Rapid drop of pressure and coolant level in pressurizer of the primary circuit has occurred. An increase of readings of the icebreaker’s RMS detection unit begins indicating a leak from the primary circuit to the sub-unit space. Actuation of the RI emergency protection system. Primary circuit circulation pumps stopped, and localizing fittings in pipes of the cleaning system closed. Water ingress from HA of the ECCS starts. Active outflow of steam-water mixture from the primary circuit followed by boiling of coolant in the reactor downcomer area. Start of steam outflow from RI. The temperature of some FEs reached a critical value that resulted in FE swelling, depressurization and release of radioactive gases and volatile radionuclides. Start of FP release from FEs to coolant followed by their transfer over the primary circuit and release to the containment. Actuation of AS-1 emergency valve. Via the mainmast steam-air mixture is released to the atmosphere.</td>
</tr>
</tbody>
</table>

Chairman of FSUE AROMFLOT’s Emergency Commission   Kashka M.M.
Data of FSUE ATOMFLOT’s Facility-level ARMS
Organization providing information – Radiation Safety and Environmental Monitoring Service at FSUE ATOMFLOT

Dose rates on the facility ARMS sensors, μSv/h

<table>
<thead>
<tr>
<th>Time from the survey start</th>
<th>RKT</th>
<th>VKH</th>
<th>Amec_1</th>
<th>Amec_2</th>
<th>Amec_3</th>
<th>Amec_4</th>
<th>Amec_5</th>
<th>Amec_6</th>
<th>Building_5</th>
<th>Lepse</th>
<th>Lepse Mast</th>
<th>Admin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00:07 (release)</td>
<td>42.1</td>
<td>11.5</td>
<td>16.0</td>
<td>22.0</td>
<td>29.5</td>
<td>46.2</td>
<td>92.4</td>
<td>207.8</td>
<td>9.3</td>
<td>0.2</td>
<td>0.2</td>
<td>13.8</td>
</tr>
<tr>
<td>0:01:05</td>
<td>63.9</td>
<td>19.9</td>
<td>33.2</td>
<td>47.2</td>
<td>66.8</td>
<td>115.9</td>
<td>258.9</td>
<td>589.2</td>
<td>17.9</td>
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<td>0.3</td>
<td>7.4</td>
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<tr>
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<td>35.3</td>
<td>79.4</td>
<td>120.7</td>
<td>185.7</td>
<td>361.5</td>
<td>699.2</td>
<td>637.7</td>
<td>38.0</td>
<td>0.3</td>
<td>0.4</td>
<td>4.2</td>
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<tr>
<td>0:03:00</td>
<td>65.3</td>
<td>58.9</td>
<td>229.9</td>
<td>384.7</td>
<td>617.4</td>
<td>924.7</td>
<td>585.2</td>
<td>239.7</td>
<td>92.5</td>
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<td>0.5</td>
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<td>0:03:58</td>
<td>43.7</td>
<td>81.8</td>
<td>696.7</td>
<td>1006.9</td>
<td>1157.9</td>
<td>636.8</td>
<td>206.2</td>
<td>88.2</td>
<td>267.6</td>
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<td>0.6</td>
<td>1.6</td>
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<tr>
<td>0:04:55</td>
<td>32.3</td>
<td>115.3</td>
<td>1368.9</td>
<td>1253.5</td>
<td>715.0</td>
<td>255.3</td>
<td>93.7</td>
<td>44.2</td>
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<td>0.8</td>
<td>1.2</td>
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<tr>
<td>0:05:53</td>
<td>26.3</td>
<td>165.3</td>
<td>825.6</td>
<td>421.2</td>
<td>226.0</td>
<td>106.8</td>
<td>48.7</td>
<td>25.2</td>
<td>1218.5</td>
<td>1.0</td>
<td>1.3</td>
<td>0.9</td>
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<tr>
<td>0:06:50</td>
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<td>153.4</td>
<td>215.7</td>
<td>126.2</td>
<td>81.0</td>
<td>45.3</td>
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<td>14.2</td>
<td>195.7</td>
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<td>3.4</td>
<td>0.5</td>
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<tr>
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<td>95.8</td>
<td>70.7</td>
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<td>2.0</td>
<td>0.6</td>
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<tr>
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<td>16.0</td>
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<td>60.7</td>
<td>4.2</td>
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<td>0.4</td>
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<tr>
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<td>11.1</td>
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<td>0.8</td>
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<td>0.2</td>
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<td>6.6</td>
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<td>0.1</td>
</tr>
</tbody>
</table>

Executor (name, signature)               Nenagliadov S.D.
Time and date of the form sending: 11:00 a. m. June 23
REFINED ESTIMATE OF THE RELEASE OF RADIOACTIVE SUBSTANCES TO THE ATMOSPHERE

CSTS IBRAE RAN
NAME OF CTS PROVIDING INFORMATION

FSUE ATOMFLOT
LOCATION OF EMERGENCY-RESPONSE EXERCISE

Based on the data of sensors of the facility ARMS provided by Rosatom and methods of restoring the radionuclide composition of the release to the atmosphere, a refined estimate of the release of radioactive substances to the atmosphere was carried out by CSTS of IBRAE RAN.

Radionuclide composition of the release to the atmosphere

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Activity, Bq</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cs-137</td>
<td>1,00E+11</td>
</tr>
<tr>
<td>I-131</td>
<td>1,10E+12</td>
</tr>
<tr>
<td>Kr-88</td>
<td>3,10E+12</td>
</tr>
<tr>
<td>Xe-133</td>
<td>1,30E+13</td>
</tr>
</tbody>
</table>

The refined estimate of the release is 20 times lower than initial estimate.

The release parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective height of release</td>
<td>30 meters</td>
</tr>
<tr>
<td>Release duration</td>
<td>Instant</td>
</tr>
</tbody>
</table>

Executor (name, signature) Aron D.V.
Time and date of the form sending (Moscow time): 11:25 a.m. June 23, 2014
Results of Radiation Survey at FSUE ATOMFLOT’s Site
Organization providing information – Radiation Safety and Environmental Monitoring Service (RS & EM Service) at FSUE ATOMFLOT

The results of radiation survey near Pier No 8 of FSUE ATOMFLOT’s site are presented below. The survey was carried out by two radiation survey teams for the purpose of contouring the contaminated area with dose rates above 1 μSv/h (in the circle center - the number of measurement points, beside – the dose rate value, μSv/h). Yellow color indicates the border of the area with isoline of 1 μSv/h.

Executor (name, signature)                        Nenagliadov S.D.
Time and date of the form sending:   11:30 a.m.
### Scenario-based estimates of radioactive contamination density
in nodes of the computational grid after accidental release of radioactive substances, MBq/m²

<table>
<thead>
<tr>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<th>22</th>
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</thead>
<tbody>
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<td>0.25</td>
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<td>0.38</td>
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<td>0.23</td>
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<tr>
<td>3</td>
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<td>0.30</td>
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<td>0.29</td>
<td>0.33</td>
<td>0.45</td>
<td>0.53</td>
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<td>0.72</td>
<td>0.83</td>
<td>0.90</td>
<td>0.94</td>
<td>0.92</td>
<td>0.84</td>
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<td>0.31</td>
<td>0.27</td>
<td>0.25</td>
</tr>
<tr>
<td>5</td>
<td>0.23</td>
<td>0.28</td>
<td>0.32</td>
<td>0.37</td>
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<td>1.3</td>
<td>1.5</td>
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### Scenario-based estimates of gamma dose rates at 1 m height
from the land surface in nodes of the computational grid after accidental release, μSv/h

Head of RS & EM Service of FSUE ATOMFLOT

Nenagliadov S.D.

Time and date of the form sending: 11:30 a.m.
EXERCISE!!!  EXERCISE!!!  EXERCISE!!!  EXERCISE!!!

RESULTS OF *IN SITU* ESTIMATE OF THE RADIATION SITUATION

**CSTS IBRAE RAN**

**NAME OF CTS PROVIDING INFORMATION**

**FSUE ATOMFLOT**

**LOCATION OF EMERGENCY-RESPONSE EXERCISE**

**Meteo**

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<th>Wind Direction</th>
<th>Atm. Prec.</th>
<th>Stability class</th>
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<tbody>
<tr>
<td>247.5°</td>
<td>☐ Yes</td>
<td>☐ No</td>
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No atmospheric precipitations

**Characterization of the area towards the wind direction**

| Roughness ($z_o$) | 0.1 m |

**Predicted doses over the first 10 days after the accident, mSv**

<table>
<thead>
<tr>
<th>Distance from the object, km</th>
<th>Dose to the thyroid Adults</th>
<th>Dose to the thyroid Children</th>
<th>The whole body dose</th>
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</table>

In accordance with RSS-99/2009, no population protection measures are required!

The event class on the INES scale: ☐ 0, ☐ 1, ☒ 2, ☐ 3, ☐ 4, ☐ 5, ☐ 6, ☐ 7.

Executor (name, signature)       Aron D.V.

Time and date of the form sending (Moscow time):   June 23, 2014
Predicted total effective dose over 10 days for children of 1-2 years, mSv

Inhalation dose to the thyroid for children of 1-2 years, mSv
Minutes of the Meeting  
of FSUE ATOMFLOT’s Emergency Commission  

No 1 of 23.06.2014  Murmansk city

Chairman:
First Deputy General Director - Chief Engineer, Chairman of EC  Kashka M.M.
Secretary: Korotkov V.M.

Attendees:
Members of the Commission for Prevention and Elimination of Emergency Situations and Fire Safety (hereinafter the Emergency Commission) - 13 persons.

AGENDA:
“On Elimination of Implications of Emergency Situation at ‘The Soviet Union’ Nuclear Icebreaker”

Opening speech on the agenda was made by Kashka M.M., First Deputy General Director, Chief Engineer and Chairman of EC at 8-40 MSK:

“Due to an external impact, at 8:00 a.m. of June 23, 2014 an off-normal situation has occurred on ‘The Soviet Union’ nuclear icebreaker moored at berth of FSUE ATOMFLOT that has resulted in loss of coolant of the primary circuit of RI No 1 and possible development of a potentially hazardous radiation incident.

Currently, work is underway to restore heat removal from the damaged RI in order to prevent depressurization of FEs. In accordance with the acting procedure, primary notification of organizations and agencies has been carried out, and the ATOMFLOT’s Facility Warning and Emergency Response System (FWERS) has been transferred to the ‘high alert’ state”.

In order to stabilize the situation and ensure radiation and technology safety at FSUE Atomflot, the EC has decided the following:

1.1. Carry out a preliminary notification of Murmansk-city IDDS by phone on possible warning of city residents in the near future about the need of sheltering indoors and not be outdoors within the next few hours. Prior to start the warning procedure, a
special FSUE ATOMFLOT’s notice is necessary to avoid social tension in the city. Responsible person: Gerasimovich A.M.; deadline – 8:41 MSK.

1.2. Notify and gather urgently the members of ATOMFLOT’s CERT.

Command captains of the neighboring ships to prepare emergency ship consignments to assist the emergency icebreaker. Responsible person: Ivanov D.V.; deadline – 8:45 MSK.

1.3. Draw up and forward a request to ROSATOM’s SCC to assess possible development of the occurred emergency situation and its potential radiation consequences. Responsible persons: Gerasimovich A.M. and Golenok A.F.; deadline – 8:55 MSK.

1.4. Heads of ATOMFLOT’s structural units are to limit the number of personnel and the duration of staying near the emergency icebreaker. Deadline – 10:00 MSK.

1.5. Prepare shielding structures and shelters in buildings at the enterprise site. Responsible person: Sheykin E.V.; deadline – 9:30 MSK.

1.6. Prepare a draft of the primary press release about the contingency situation at ‘The Soviet Union’ nuclear icebreaker. Responsible person: Ananieva E.V., deadline – 9:45 MSK.

1.7. To prevent possible internal exposure of the thyroid gland in a case of emergency radiation release, carry out iodine prophylaxis for the enterprise workers involved in emergency activities and the crews of icebreakers moored at berth. Responsible persons: Oreshko A.N., Ivanov D.V. and Mizerniuk V.N., deadline – 9:50 MSK.

1.9. Prepare the following report to ROSATOM’s SCC: according to expert estimates, even in a case of conservative development of events - taking into account the current processes at the damaged RI with potential risk of a radiation release to the atmosphere - the predicted population exposure doses would not exceed 1 mSv. Responsible person: Nenagliadov S.D.; deadline – 10:00 MSK.

1.10. Transfer medical services of the enterprise to the ‘high alert’ mode to be ready for possible admission of persons with mechanical injuries and possible radiation exposure. Responsible person: Mizerniuk V.N.; deadline – 10:10 MSK.
At 10:30 MSK M.M. Kashka, First Deputy General Director, Chief Engineer and Chairman of AROMFLOT’s Emergency Commission makes an urgent report:

“During the last few minutes the situation on ‘The Soviet Union’ nuclear icebreaker worsened dramatically. Due to a rapid decrease of pressure and coolant level in the RI, the temperature of some FEs reached a critical value that resulted in FE swelling and depressurization and a consequent release of radioactive gases and volatile radionuclides out of FE claddings. The emergency valve AS-1 was actuated and steam-air mixture was released from the control room via the mainmast to the atmosphere. Thus the situation has degenerated into a ‘radiation incident’.

To minimize and eliminate the emergency consequences for ATOMFLOT’s personnel and the site, the EC has decided the following:

2.1. Put into action ‘The Plan of Actions at FSUE ATOMFLOT for the prevention and elimination of emergency situations during peacetime’. Responsible person: Ruksha V.V.; deadline – 10:40 MSK.

2.2. In connection with information received about a victim on the icebreaker with the risk of overexposure, provide his evacuation from the icebreaker, necessary medical assistance and radiation exposure control.

Responsible person: Oreshko A.N.; deadline – 10:40 MSK.

2.3. Provide movement of ATOMFLOT’s personnel not involved in emergency activities beyond the enterprise’s entrance, in shielding structures or on PD-0002 floating dock depending on their location at the ATOMFLOT’s site. Responsible person: Popovich S.D.; deadline – 10:55 MSK.

2.4. Prepare forms 1ES-4ES and forward them to the relevant agencies and organizations in accordance with the established procedure. Responsible person: Gerasimovish A.M.; deadline – 12:05 MSK.

2.5. Based on analysis of the facility-level ARMS, identify potential locations of increased radioactive contamination and conduct their radiation survey. Responsible person: Nenagliadov S.D.; deadline – 10:40 MSK.

2.6. Establish the regime of sanitary-and-access control at the accident location within ATOMFLOT’s site. Responsible person: Nenagliadov S.D.; deadline – 12:00 MSK.
2.7. Move ATOMFLOT’s personnel from shelters and shielding structures beyond the enterprise site. Responsible person: Sheykin E.V.; deadline – 12:00 MSK.

2.8. Estimate potential consequences of emergency radiation release to the atmosphere for personnel, population and the site and determine the possibility of further operation of the enterprise structures. Responsible persons: Nenagliadov S.D. and Kashka M.M.; deadline – 14:00 MSK.

2.9. Develop a plan and begin the accident containment and elimination of its consequences Responsible person: Kashka M.M.; deadline – 16:00 MSK.

3. The Emergency Commission's conclusions:

3.1. Despite the release of a certain amount of radioactive substances to the atmosphere, the occurred radiation incident at ‘The Soviet Union’ nuclear icebreaker has had a facility-level scale and has produced no radioactive contamination beyond the enterprise site.

3.2. The injured person was provided with necessary medical aid, and negligible levels of his exposure were confirmed. At the moment, the health of the victim is not in danger.

3.3. Generally, the occurred radiation incident has not affected operation of the enterprise’s structural units, except for the emergency icebreaker.

3.4. According to the data of radiation survey at the damaged icebreaker, no radioactive contamination of its non-residential, residential and process rooms has occurred.

3.5. Radiation monitoring data for the city of Murmansk and the Murmansk region have revealed no radioactive contamination either. According to the Russian radiation safety standards in force, no population protection measures are required.

4. The control over implementation of the above decisions of FSUE ATOMFLOT’s Emergency Commission I reserve for myself.

Chairman of FSUE AROMFLOT’s Emergency Commission

Kashka M.M.
A.1 Information Component of the Exercise (ICE)

A.1.1 Goals, Objectives and Actors

To perform an ‘information attack’ on the press service, journalists of Murmansk-city were invited. Their mission also included preparation of several news items upon acquaintance with press releases drawn up by ICE participants.

It is worthy of notice that during major exercises at ROSATOM’s enterprises local journalists are generally invited only to cover the event in question in local media. Performing an ‘information attack’ by local journalists during the ATOMFLOT’s exercise has become possible thanks to open position of ATOMFLOT’s leadership and support by ROSATOM’s Communications Department.

Three Murmansk journalists participated in the ICE: two of the ‘Murman’ State TV-Radio Company and one online journalist of ‘Bellona-Murmansk’ regional public organization.

The exercise managers set the following tasks to ICE participants:

Press Service of Russian EMERCOM’s General Directorate (GD) in the Murmansk region:

− draw up press releases by four introductory messages (operational messages received by IDDS duty officer) in accordance with agency regulations with the possibility of using the contacts provided by such regulations with operational services of the GD involved in the exercise; and
− answer questions of journalists related to the content of official press releases (in keeping with the exercise scenario).

Press Secretary of Murmansk-city Administration:

− draw up press releases and/or a text of Murmansk-city Mayor’s appeal to the city inhabitants based on four introductory messages (operational messages received by IDDS duty officer) within the time limits corresponding to past experience of the city administration participation in informing residents about an ES; and
− answer journalists’ questions.

ATOMFLOT’s Press Service:
draw up press releases by three introductory messages (texts of the EC decisions) and coordinate them with the EC Chairman; and

answer journalists’ questions.

Journalists:

prepare news items for their editions based on obtained official press releases; and

upon reading these press releases, ask questions for understanding/clarification of the situation to the relevant press services.

As the ICE of such a level was held in the Murmansk region for the first time with the participation of local journalists, a preliminary meeting for the registered ICE participants was organized in roundtable format three days before the exercise (on 20.06.2014). The seminar was organized by specialists of IBRAE RAN (Melikhova E.M., Barkhudarova I.E. and Byrkina E.M.)

The seminar’s program covered the following subjects:

1. Availability of approved official duties by each ICE participant when declaring an ES.

2. Knowledge by the ICE participants of the competence/responsibility area of their agency and other agencies when informing the public about an ES at Nuclear- and Radiation-Hazardous Facilities (NRHF);
   - Knowledge of agency regulations for drawing up first press releases upon declaring an ES at NRHF and the time of their coordination with other agencies;
   - Availability of approved templates of first press releases in case of an ES at NRHF;
   - Knowledge of the likely magnitude of emergency consequences at NRHF in the Murmansk region;

3. Discussion of:
   - issues of confidence (between the authorized organizations; the level of public confidence in official sources and the media);
   - attitude of local media (vs national media) in case of a local/regional ES; and
   - features of perception by the public of radiation hazards.
A ‘blitz test’ on writing press releases about ES was held at the end of the seminar. The participants were given two introductory items on a local-accident scenario at one of FSUE ATOMFLOT’s nuclear icebreakers and were asked to write the first and the second press releases about the incident on behalf of their organization.

The roundtable meeting lasted more than five hours (from 14:00 till 19:15 p.m.). Based on its results, the tasks for some ICE participants were specified or expanded:

**Press Secretary of Murmansk-city Administration (clarification):**

- based on four introductory messages (operational messages received by IDDS duty officer) and EMERCOM’s and ATOMFLOT’s press releases, draw up Murmansk-city Mayor’s appeal to inhabitants of the city within the time limits corresponding to past experience of informing the city residents about an ES.

**Press service of ATOMFLOT (supplements):**

- obtain the EC Chairman’s permission/clearance for one of the press officers to use the EC protocol for drawing up press releases;
- clarify the order of actions of two press officers following the announcement of evacuation of the enterprise personnel from the EC chairman; and
- approve the list of ATOMFLOT’s speakers authorized to provide explanations to journalists during the acute accident phase at the EC Chairman.

**Journalists (a supplement):**

- upon reading official press releases, ask questions to ATOMFLOT’s speakers and experts (IBRAE, FMBA) for understanding and clarification of the situation (within the scenario framework).

As experts were invited: -participants of the ‘medical part’ of the exercise from FMBA; and –an expert of IBRAE RAN, i.e. organization that, in accordance with the exercise scenario, estimated population exposure doses and recommended no use of population protection measures.

**A.1.2 ICE Holding - 23.06.2014**

The ICE was held on June 23, 2014 from 8:00 a.m. to 13:30 p.m. in the small conference hall at ATOMFLOT’s site and was attended by 14 people:

Table A 1 – Participants of the ICE of 23.06.2014
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<tr>
<th>Company</th>
<th>Position</th>
<th>Name</th>
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<tr>
<td>Press Service of FSUE ATOMFLOT</td>
<td>Head</td>
<td>Ekaterina ANANYEVA</td>
</tr>
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<td></td>
<td>Key Specialist</td>
<td>Evgeny SVIRIDOV</td>
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<td>Russian EMERCOM’s General Directorate (GD) in the Murmansk region</td>
<td>Deputy Head of the Press Service</td>
<td>Tatiana ABRAMOVA</td>
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<td>Murmansk-city Administration</td>
<td>Acting Deputy Head of Department of Information Analysis and Interaction with the Media</td>
<td>Maria POGADAEVA</td>
</tr>
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<td>‘Murman’ State TV-Radio Company</td>
<td>Radio Journalist</td>
<td>Pavel KONDRATIEV</td>
</tr>
<tr>
<td>‘Murman’ State TV-Radio Company</td>
<td>TV Journalist</td>
<td>Ilya KOMLEV</td>
</tr>
<tr>
<td>FSUE ATOMFLOT</td>
<td>Chairman of the EC, Chief Engineer</td>
<td>Mustafa KASHKA</td>
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<tr>
<td>CSTS of IBRAE RAN</td>
<td>Deputy Director, Expert (radiation protection, dosimetry)</td>
<td>Rafael ARUTYUNYAN</td>
</tr>
<tr>
<td>FMBA of Russia</td>
<td>Dep. Head of Gossanepidnadzor Office – Head of Radiation Safety Supervision Department</td>
<td>Nadezhda POTSYPAPUN</td>
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<td>Gennady FROLOV</td>
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<td>Elena MELIKHOVA</td>
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<td>Ekaterina BYRKINA</td>
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</table>

Introductory messages were distributed to the participants at the actual time of the exercise. That is in keeping with the scenario the icebreaker’s external impact occurred at 8:00 a.m. and already at 8:15 a.m. journalists received the first introductory message (several posts in social networks about the events at ATOMFLOT) and started calling the ATOMFLOT’s Press Service and the Russian EMERCOM’s GD in the Murmansk region (hereinafter EMERCOM).

Over 5.5 hours of the exercise 10 official communications were drawn up (EMERCOM – 5; ATOMFLOT – 4; Murmansk-city Administration – 1). Press officers
responded to about 30 calls of journalists. Journalists drew up five news reports - for
daytime TV news and the online edition: www.bellona.ru. Texts of press releases and
news items are presented Appendix A 2.

The exercise observers who were placed in the next hall were provided with
information on the process of informing the public through the media within the exercise
framework.

Upon termination of the ICE, all participants of the roundtable discussion and the
ICE received special certificates from IBRAE RAN.

A photo report about the roundtable discussion (20.03.2014) and the ICE
(23.03.2014) is presented in Appendix A 3.

A.1.3 ICE Outcomes

Readiness of authorized institutions to adequate public information through the
media was assessed by organization of the informing process and also by the criteria that
the information provided to the public must meet: timeliness, reliability, clarity,
usefulness and consistency (inter-agency) of the data provided in press releases.

A.1.3.1 Public Information through the Media

For EMERCOM’s press services, information of the public through the media is
everyday practice. Accordingly, they have clear procedures for obtaining information
from operational duty officers, tried and tested templates of press releases and clichés,
approved procedures for coordination of prepared texts and their distribution in the media
(distribution via web subscription).

During the exercise, all administrative issues associated with the task of information
by the ATOMFLOT's press service were promptly resolved thanks to the EC Chairman’s
assistance. One of the press officers was allowed to participate in the EC work that
enabled him to rely on the minutes of the EC meetings and coordinate promptly the
prepared texts with the EC Chairman. A second officer was engaged in distribution of
press releases to the media and also answered questions of journalists (by phone). After
the announcement of ATOMFLOT’s personnel evacuation from the site, the issue of
continuing the press service operation was also resolved in a prompt way by the EC
Chairman. With no approved templates and practical skills in drawing up press releases
about an ES, the ATOMFLOT’s press service managed to prepare quickly short clear texts that reflected the essence of actual situation at the enterprise.

Because under the exercise scenario the Murmansk-city’s EC was not assembled, the city Administration’s press center prepared only one message (at X+ 3 h) on behalf of the Mayor that confirmed information provided by EMERCOM and ATOMFLOT on no hazard to the population of the city.

Atomflot issued press releases following EC meetings where key accident-progression events were discussed. Such an approach is justified when attention of the media focuses on a specific event, and every press release from the emergency site becomes a ‘pretext’ for breaking news release. But in the scenario under consideration the situation was different.

In the opinion of ‘Murman’ TV-Radio Company journalists, early press releases by EMERCOM and ATOMFLOT gave no reasons for airing breaking news. In such a situation, drawing up ATOMFLOT’s press releases with consideration for the schedule of issuing local TV and radio news and information already made public by EMERCOM (according to its regulations) would have been more appropriate.

The city administration information message was issued with consideration for the daily news release time.

A.1.3.2 Timeliness

Press releases prepared by EMERCOM, ATOMFLOT and the city administration met the requirements of the interagency instruction.\(^1\)

On-line information about the event was received by duty officer of CSMS EMERCOM’s GD at 8:15 (Time ‘H’). The first EMERCOM’s press release was drawn up at H+20 min., the second one at H+45 min., the third one at H+1 h 15 min., the fourth and the fifth ones at H+2 h and H+3 h, respectively.

ATOMFLOT’s press releases were issued (conventionally) at: H+40 min, H+2 h, H+ 2 h:50 min and H+4 h.

\(^1\) Interagency Instruction (Minutes No 5 of 19.12.2006): “On Interactions of Federal Executive Authorities and Other Stakeholders when Informing the Public through the Media about Predicted and Occurred Emergencies of Wide Publicity, Progress in their Elimination and Measures Taken to Ensure Life Support of the Population” approved by the decision of the Government Commission on the Prevention and Elimination of Emergency Situations and Fire Safety.
The head of the city of Murmansk made an appeal to the population (conventionally) after 3.5 hours following receipt of the first on-line information about an emergency at ATOMFLOT’s site.

Thus, all official reports were made available to the media in a timely manner.

A.1.3.3 Accuracy, Clarity and Usefulness

Information contained in all press releases was accurate, and no one tried to hide the occurred potentially hazardous event or distort the data.

All EMERCOM’s press releases and the text of the Mayor address were comprehensible (at a level of 12 year-old schoolboy).

The first two (of four) ATOMFLOT’s press releases used special technical language (e.g. loss/depressurization of coolant of RI primary circuit, emergency protection of RI), but that was not crucial for understanding of general meaning of the communications.

It is worthy of note that the EC Chairman, who was permanently cited in ATOMFLOT’s press releases, did not use too many numerical data about the radiation situation but provided its qualitative assessment (e.g. “According to the data of radiation survey at the damaged icebreaker, no radioactive contamination of its non-residential, residential and process rooms has occurred”).

The sentence “The radiation background at ‘The Soviet Union’ nuclear icebreaker and outside it does not exceed maximum permissible limits” (ATOMFLOT-10:10) is not entirely correct, because the background radiation is not standardized.

The reported information of all press releases concerned the occurred potentially hazardous situation and in that sense they were quite useful.

A.1.3.4 Interagency Coordination

There were no apparent contradictions between the messages of different agencies, but EMERCOM and ATOMFLOT used different approaches to inform the public about a potentially hazardous situation.

EMERCOM in its early press release avoids direct references to the radioactive nature of the threat and does not mention a release of radioactivity, the ‘radiation’ term being only used in a reassuring way: “…no radioactive contamination has occurred”, “the radiation background does not exceed maximum permissible limits” and “the radiation value does not exceed the level of natural radiation background”. By contrast,
ATOMFLOT in its very first message mentions the possibility of “initiating a potentially hazardous radiation event” and next reports about a radioactive release of facility scale.

The approach of both organizations may be criticized.

Generally, EMERCOM is more trusted than operating organizations. But in its communications, EMERCOM does not clearly disclose the nature of possible hazard to the public. However the population will easily understand from the context that the risk is associated with radiation (EMERCOM reports about the radiation background) and that the situation is serious (the ‘threat of life’ is mentioned, and EMERCOM calls the population to remain calm and opens a ‘hotline’). Such vagueness may cause people’s worst fears until the panic.

Journalists are clearly lacking EMERCOM’s press releases to draw up news reports, and they combine them with ATOMFLOT’s press releases.

Indeed, an enterprise where an incident/accident has recently occurred has low credibility: it is believed that in all cases such enterprise will diminish any risk. Consequently, if ATOMFLOT reports about a facility-scale release, the public may think it much more serious than reported. In addition, EMERCOM in its reports does not refer to ATOMFLOT’s representatives that might have given more weight to their words.

The lack of inter-agency coordination when providing information to the media does not necessarily leads to problems. According to the scenario, the accident is localized within 3 hours, the radiation situation in Murmansk-city has not changed and the radiation background increase in Roslyakovo-settlement is minor. If until the end of the day all official sources unanimously spoke about the absence of hazard, public concern most likely would quickly come to naught. But under different circumstances inter-agency non-coordination may significantly amplify public concern.

During the ICE, the subject of preparedness for responding to public concerns was addressed only in passing. Journalists asked about three dozen questions to press services about clarification of the situation at the emergency enterprise. Some of them are cited below:

1. Is there destruction of the reactor?
2. Reactor core melting – is it possible?
3. Are there injured people?
4. Is there a leak of radioactive substances?
5. What is the radiation situation at the facility?

6. Is it possible to get comments of ATOMFLOT’s expert on the situation?

7. Is there a threat to ATOMFLOT’s personnel?

8. What is being done to eliminate the accident?

9. What could be implications for the city?

Press service responses to journalists’ questions have demonstrated that:

• EMERCOM redirects all questions of ‘radiation nature’ to ATOMFLOT;
• specialists of EMERCOM’s ‘hotline’ have no templates of responses on radiation protection issues / redirection of questions about radiation hazards; and
• ATOMFLOT’s press service has no templates for redirecting questions going beyond the scope of its responsibilities.

A.1.4 Conclusions

Based on the ICE outcomes, the following conclusions may be reached:

1. During major emergency-response exercises at ROSATOM’s enterprises it is for the first time that an ICE with full involvement of press services of key authorized structures and the participation of local journalists was held, in line with the practice of developed nuclear countries. The involvement of local journalists, including a ‘Bellona’ representative, was justified. That enabled creating more realistic (stress) conditions for press officers and making a number of recommendations for ATOMFLOT on drawing up press releases (see below). News reports prepared by journalists were used to assess the ICE results.

2. The ICE demonstrated readiness of EMERCOM and ATOMFLOT to inform the public through the media under the played accident scenario (no radiation risk to the public).

3. In general, information provided to the media by press services of EMERCOM and ATOMFLOT met the criteria of timeliness, reliability, understandability and usefulness, but at the same time it did not satisfy the inter-agency coordination criterion. In the ‘no risk’ case, this is a drawback that is not critical. But in a more difficult situation (e.g. population exposure doses in the range between levels A and B) this may create serious problems for the population.
Though readiness of press services for responding public concerns was not assessed, it was established that EMERCOM redirected all questions involving radiation hazards to the operating organization which, however, had no authority, forces and resources to carry out an extensive public-explanatory campaign.

A.1.5 Recommendations

1. It is recommended to EMERCOM’s GD for the Murmansk region to organize elaboration and to the Murmansk region Government, Murmansk-city Administration and FSUE ATOMFLOT to participate in elaboration - at a level of regional subsystem of the Integrated State System for Prevention and Elimination of Emergencies – of the issue of powers of authorities and other stakeholders on clarification of radiation-hazard matters to the public.

2. It would be appropriate for FSUE ATOMFLOT to consider – under scheduled activities of the EC – the work of its press service in a case of operation violation or an emergency situation at the enterprise including:

- introducing the press service’s Head in the EC and in the mailing list of operational information;
- developing procedures (internal regulations) for preparation, approval and distribution of press releases;
- organizing the work of other press officers (workplace, time of work, meals, communication, responsibilities, etc.);
- nominations for speakers working with the press service during an emergency; and
- elaboration of templates for redirecting questions going beyond the scope of responsibilities of the enterprise.

3. Development of guidelines for ICE preparation and carrying out at NRHF, taking into account the lessons learned, is advisable for organizers of such exercises.

A.2 Press Releases and News Items

A.2.1 Press Releases of EMERCOM GD for the Murmansk Region
Press release No 1
8:35 a.m.

Today, 23.06.2014, at 08:15 a.m. the Operational Duty Officer (ODO) of the Crisis Situation Management Center (CSMC) of EMERCOM GD for the Murmansk Region received information from FSUE ATOMFLOT (Murmansk) about a damage at ‘The Soviet Union’ nuclear icebreaker occurred at 08:01 a.m. due to an external impact. The situation is controlled by the governor of the Murmansk region. Further details are to be clarified.

(The information is agreed with the Murmansk region Government).

Press release No 2
An Incident at ‘The Soviet Union’ nuclear icebreaker – refined information
09:00 a.m.

Currently, work is underway to prevent the development of an off-normal situation at ‘The Soviet Union’ icebreaker that was damaged due to an external impact.

An operational team of CSMC of EMERCOM GD for the Murmansk Region is forwarded to the place of the incident.

The Commission for Emergency Situations and Fire Safety (EC) of the Murmansk region Government began its work.

At the moment, the radiation situation at FSUE ATOMFLOT’s site is normal, and there is no threat for the population of Murmansk-city.

The cause of the incident is under investigation.

(The information is agreed with the Murmansk region Government).

Press release No 3
A ‘Hotline’ is Open in the Murmansk Region
09:30 a.m.

Work on elimination of off-normal situation at ‘The Soviet Union’ icebreaker that was damaged due to an external impact continues. The Government of the Murmansk
region has established an operational headquarters to coordinate the activities of public authorities and related organizations of the Murmansk region.

EMERCOM’s GD for the Murmansk Region is keeping the situation under control.

Real-time monitoring of the radiation situation in the Murmansk region is conducted.

At the moment, the radiation situation is normal. Sensors of ARMS in Leninsky district of Murmansk-city and at ATOMFLOT’s office building show the radiation background of 0.08-0.12 μSv/h.

We ask the residents and guests of the regional center and the nearest settlements to keep calm.

For more information, please call the ‘hotlines’:

- psychological support (EMERCOM’s GD for the Murmansk Region): +7 (152) 39-**-**; and
- assistance in organizational matters (the Murmansk region Government): +7 (152) 48-**-**.

(The information is agreed with the Murmansk region Government).

Press release No 4
An Incident at ‘The Soviet Union’ nuclear icebreaker – refined information
10:15 a.m.

According to FSUE ATOMFLOT’s data, work at ‘The Soviet Union’ nuclear icebreaker continues.

We recall that today, June 23, 2014, at 08:00 a.m. an off-normal situation occurred at the icebreaker due to an external impact that resulted in loss of coolant of the primary circuit of RI No 1. The RI emergency protection was actuated. There are no victims and injured persons resulting from the contingency.

Read more at ATOMFLOT’s official website ..... (press release of Rosatomflot’s Communications Office)

The ‘hotlines’ are open:

- psychological support (EMERCOM’s GD for the Murmansk region): +7 (152) 39-**-**; and
Press release No 5

The radiation background in Murmansk-city and in Murmansk region does not exceed natural values

11:10 a.m.

Work on elimination of a radiation incident at ‘The Soviet Union’ nuclear icebreaker continues. EMERCOM’s GD for the Murmansk region is keeping the situation under control. Real-time monitoring of the radiation situation in the Murmansk region is conducted. According to the radiation monitoring data, no radiation contamination has occurred at the territory of Murmansk-city and the Murmansk region. The radiation background beyond FSUE ATOMFLOT’s site does not exceed maximum permissible limits. ARMS sensors in Leninsky district of Murmansk-city show that the radiation background does not exceed natural values and equals 0.08-0.12 μSv/h, in Roslyakovo-settlement – 0.36 μSv/h.

Read more at ATOMFLOT’s official website ..... (press release of Rosatomflot’s Communications Office).

A.2.2 Press release of Murmansk-city Administration

Press center of Murmansk-city Administration.

Release on the EC operation results.

The radiation situation in Murmansk-city is normal!

The EC has established no threat to inhabitants of Murmansk-city.

Today, a radiation incident occurred at the at ‘The Soviet Union’ nuclear icebreaker that resulted in loss of coolant of the primary circuit of RI No 1. Consequently, a release of radioactive gases and volatile radionuclides occurred. The incident is confined within the nuclear icebreaker’s area.

The occurred emergency situation was localized by the enterprise forces. According to a statement of M.M. Kashka, the Chairman of ATOMFLOT’s EC, no radioactive contamination of the icebreaker’s non-residential, residential and process rooms has
occurred. According to experts of IBRAE RAN, the health of inhabitants of Murmansk-
city is not in danger.

The radiation background was checked by independent experts, and they also
established that the radiation situation beyond the enterprise site does not exceed
maximum permissible limits. In Roslyakovo, the radiation background is slightly higher
within the permissible limits that also present no hazard to the settlement residents. No
population protection measures are required.

In the course of the accident one dosimetrist technician was injured and was
provided with necessary medical assistance. Other persons involved in the accident-
confinement activities were not affected and are under medical supervision.

Real-time monitoring of the situation is underway.

A.2.3 TV Air of ‘Murman’ State Company

09:16 a.m.

An emergency situation at ATOMFLOT. Today, at 8:00 a.m. an accident occurred
at ‘The Soviet Union’ nuclear icebreaker due to an external impact that resulted in loss of
coolant of the primary circuit of RI No 1. The RI emergency protection was actuated.
According to ATOMFLOT’s press service, work is underway to restore heat removal.
ATOMFLOT asserts that there is no threat to Murmansk-city population. Meanwhile, it
is known about victims among ATOMFLOT’s personnel.

According to EMERCOM’s report, at present the radiation situation at FSUE
ATOMFLOT’s site is normal.

10:08 a.m.

Some details about the emergency at ATOMFLOT became known. According to
the Deputy General Director of the enterprise, the on-board emergency protection
systems and equipment cope with the situation. There is no depressurization of the core,
and there is no environmental threat either. The level of radiation on the icebreaker
allows the personnel to remain on-board. M. Kasha reported on no victims at the
enterprise, though an earlier official ATOMFLOT’s press release said that ‘the number of
victims is to be ascertained’.

According to forecast of ATOMFLOT’s Deputy General Director, to restore heat
removal of the damaged reactor, 3 to 4 hours are required. We recall that today, at
08:00 a.m., an accident occurred at ‘The Soviet Union’ nuclear icebreaker due to an external impact that resulted in loss of coolant of the primary circuit of RI No 1. The RI emergency protection was actuated. Work is underway to restore heat removal. According to EMERCOM’s report, there is currently no threat to Murmansk-city population. Weather conditions are also favorable. The wind is blowing in the opposite direction from the city.

A.2.4 The Bellona Foundation: [www.bellona.ru](http://www.bellona.ru)

9:20 a.m.

An Off-normal Situation at a Nuclear Icebreaker

MURMANSK – Today, at 08:00 a.m. ‘The Soviet Union’ nuclear icebreaker was damaged due to an external impact that resulted in a damage of RI of the first reactor but the reactor vessel was not affected. The RI was stopped by emergency protection systems.

Mustafa Kashka, ATOMFLOT’s Chief Engineer, heads the EC; the situation is under control of the Governor.

Currently, the following ships are at berths of FSUE ATOMFLOT: icebreakers ‘The Soviet Union’ with the crew on board, ‘Yamal’ and ‘Russia’ and also ‘The Sevmorput’ lighter carrier.

Preliminarily, ATOMFLOT rejects a terrorist-attack version.

Experts clarify the level of the situation hazard.

‘The Soviet Union’ nuclear icebreaker was commissioned in….

A Radiation Release at Nuclear Icebreaker’s Naval Base

12:45 a.m.

MURMANSK – Due to depressurization of the primary circuit of a reactor at ‘The Soviet Union’ nuclear icebreaker, radioactive substances were released to the atmosphere. There are victims among the crew.

As already reported by ‘Bellona’, today, at 08:00 a.m. ‘The Soviet Union’ nuclear icebreaker was damaged due to an external impact that resulted in loss of coolant of the primary circuit of RI. The RI was stopped by emergency protection systems.
Within two hours the crew of the icebreaker tried to restore heat removal from the damaged RI to prevent depressurization of FEs.

However after 2.5 hours a release of “some amount of radioactive substances has occurred within the enterprise territory that has produced no radioactive contamination beyond ATOMFLOT’s site”, - as is stated in an official press release of the enterprise.

According to Chief Engineer Mustafa Kashka, who heads the EC, if the leak persists, this may lead to the inability of using the reactor in the future.

According to Alexander Nikitin, the chairman of Bellona (St. Petersburg), this is certainly a severe accident at RI, and the consequences would largely depend on the actions of the crew. The situation also depends on what capacity and how long the reactor has been in operation so far. However the fact that the icebreaker is at its naval base generally simplifies the situation.

According to recent reports, during the incident a dosimetrist technician was injured; he was hospitalized with minor levels of exposure. Currently, his health is not in danger.

According to EMERCOM’s data, there is currently no threat to the life of the public. The radiation situation in Murmansk is normal.

Recall that ‘The Soviet Union’ nuclear icebreaker was built in 1989. In 2007 it was withdrawn from service and for seven years stayed at the pier pending dismantling. However, in 2013 ‘Russia’ nuclear icebreaker was taken out of service and, consequently, a decision was made to restore ‘The Soviet Union’ icebreaker.

According to Andrei Smirnov, ATOMFLOT’s Deputy Director General for Fleet Operation, the cost of repairs and refueling was at least one billion rubles. During the restoration, the RI resource was increased up to 150 thousand hours. This is enough for about 8 years of continuous operation. The icebreaker will mainly operate in the Kara Sea and the Ob basin.

Currently, the following ships are at berths of FSUE ATOMFLOT: icebreakers ‘The Soviet Union’ with the crew on board, ‘Yamal’ and ‘Russia’ and also ‘The Sevmorput’ lighter carrier.
A.3. A Photo Report

Fig. A 5 - A roundtable of 20.06.2014

Fig. A 6 - Pavel Kondratiev (correspondent of ‘Murman’ TV) and Ekaterina Ananyeva (ATOMFLOT’s press secretary)
Fig. A7 - Maria Pogadaeva (Press Service of Murmansk-city Administration, on the left), and Tatiana Abramova (Russian EMERCOM’s GD in the Murmansk region, on the right)

Fig. A 8 – An explanation on introductory messages to representatives of EMERCOM and the city administration
Fig. A 9 - E. Ananieva (ATOMFLOT’s press secretary) is speaking with M. Kashka, the EC chairman, after the announcement of evacuation of the personnel
Fig. A 10 - Press releases and news reports drawn up by 10:30 am

Fig. A 11 - Anna Kireeva is writing news on the website: www.bellona.ru
Fig. A 12 - The first ATOMFLOT’s press release is obtained

Fig. A 13 - Rafael Arutyunyan, expert of IBRAE RAN, is answering questions on radiation risk
Fig. A 14 - Elena Melikhova (IBRAE RAN) and Tatiana Abramova (EMERCOM’s GD) are reporting the main results of the ICE to the exercise observers.

Fig. A 15 - Tatiana Abramova (EMERCOM’s GD) is reading one of her press releases to the exercise observers.
Fig. A 15 - Awarding the exercise certificates
APPENDIX B

“Development of a Medical Scenario for ARCTIC-2014 Exercise and Elaboration of Recommendations on Carrying out Medical and Protective Measures for Workers and the Public in Case of a Radiation Accident Based on the Exercise Results”
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
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<tr>
<td>A.I. Burnazyan</td>
<td>Russian State Research Center A.I. Burnazyan Federal Medical Biophysical Center</td>
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<tr>
<td>AIL</td>
<td>Annual Intake Limit</td>
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<td>ARMS</td>
<td>Automated Radiation Monitoring System</td>
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<td>ARS</td>
<td>Acute Radiation Sickness</td>
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<td>CMCU</td>
<td>Central Medical Care Unit</td>
</tr>
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<td>EC</td>
<td>Commission on prevention and elimination of Emergencies and fire safety</td>
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<tr>
<td>EMRDC</td>
<td>Emergency Medical Radiation-Dosimetry Center</td>
</tr>
<tr>
<td>EROUA</td>
<td>Emergency-Rescue and Other Urgent Activities</td>
</tr>
<tr>
<td>FE</td>
<td>Fuel Element</td>
</tr>
<tr>
<td>FMBA</td>
<td>Federal Medico-Biological Agency</td>
</tr>
<tr>
<td>FSUE</td>
<td>Federal State Unitary Enterprise</td>
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<tr>
<td>HEC</td>
<td>Hygiene and Epidemiology Centre</td>
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<tr>
<td>IBRAE RAN</td>
<td>Nuclear Safety Institute of the Russian Academy of Sciences</td>
</tr>
<tr>
<td>UCES</td>
<td>Unified Commission for prevention and elimination of Emergency Situations and fire safety</td>
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<tr>
<td>IRD</td>
<td>Inter-Regional Department</td>
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<tr>
<td>MCU</td>
<td>Medical Care Unit</td>
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<tr>
<td>MRML</td>
<td>Mobile Radiation-Monitoring Laboratory</td>
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<tr>
<td>NIIPMM</td>
<td>Research Institute of Industrial and Marine Medicine</td>
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<tr>
<td>NPI</td>
<td>Nuclear Power Installation</td>
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<tr>
<td>NREMRDC</td>
<td>Northwest Regional Emergency Medical Radiation-Dosimetry Center</td>
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<tr>
<td>PIE</td>
<td>Planned Increased Exposure</td>
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<td>PPE</td>
<td>Personal Protective Equipment</td>
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<tr>
<td>REMRDC</td>
<td>Regional Emergency Medical Radiation-Dosimetry Center</td>
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<tr>
<td>RSS</td>
<td>Radiation Safety Standards</td>
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<tr>
<td>TSC</td>
<td>Technical Support Center</td>
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B.1 MEDICAL SCENARIO FOR ‘ARCTIC-2014’ EXERCISE

B.1.1. General Concept of the Medical Scenario

To achieve general objectives of ‘ARCTIC-2014’ exercise and detail the implementation of medical, sanitary and hygienic measures, a medical scenario and an action plan of FMBA institutions (Appendix 1) serving FSUR Atomflot was developed.

The developed medical scenario provides for training of actions FMBA institutions’ personnel when:
- receiving notifications from FSUE ATOMFLOT;
- organizing steps of emergency assistance to affected persons during pre-hospital period;
- a need arises for psychological support of personnel involved in Emergency-Rescue and Other Urgent Activities (EROUA);
- emerging threats to personnel and persons involved to be subjected to an excessive impact due to accidental exposure and during EROUA; and
- conducting field measurements of the radiation situation on the terrain.

B.1.2. Possible Models for Occurrence of Health Care Implications

The scenario of ‘ARCTIC-2014’ exercise provides for the emergence of medical-and-sanitary consequences of the serviced enterprise (FSUE ATOMFLOT). A list of possible consequences (models) with varying degrees of probability for the used general scenario is given below.

For a part of probable models for the occurrence of medical-and-sanitary consequences, various actions of medical units at stages of medical assistance and carrying out urgent sanitary and preventive measures are planned.

To analyze and evaluate the probability of eventual consequences of a radiation accident, the following models are considered:
- a few cases of acute traumatic injuries among witnesses of initial phases of accidents or an external impact – mechanical trauma, burns, poisoning by combustion products and toxic substances (are probable; during the exercise are not actually practiced);
- a few cases of acute psychotic reactions among witnesses of initial phases of accidents or an external impact – stupor, agitation, acute motor stimulation and others (are probable; during the exercise are not actually practiced);

- a few cases of acute traumatic injuries among the personnel – mechanical trauma, burns, poisoning by combustion products and toxic substances. The medical scenario uses the model of a mechanical injury of one person’s limb resulting from a fall with locking of his foot by a metal structure within a room with adverse radiation environment;

- cases of stress reactions and/or signs of exhaustion of the central nervous system among personnel involved in EROUA. According to the medical scenario, there is a group of persons (6 people) of the number of personnel needing assistance of psychologists and other rehabilitation measures following EROUA;

- contamination of the involved personnel’s working clothes and skin by radioactive substances above established levels that are hazardous to life and health with likelihood of developing local radiation injuries (for the present technical scenario this is extremely unlikely; during the exercise is not practiced);

- contamination of the involved personnel’s working clothes and skin by radioactive substances above established levels that are not hazardous to life and health. According to the scenario, a group of persons who carried out EROUA is sent to perform sanitary treatment and change of clothes at the sanitary pass of the enterprise (on board);

- a few cases of external exposure of personnel at doses leading to clinical manifestations of Acute Radiation Sickness (ARS) – above 1-2 Sv (extremely unlikely; during the exercise is not practiced);

- cases of external exposure at potentially hazardous doses exceeding the dose limit for personnel, including the level of Planned Increased Exposure (PIE), but without clinical manifestations and the likelihood of ARS – 200-1000 mSv (extremely unlikely; during the exercise is not practiced);

- cases of external exposure at doses exceeding the dose limit for personnel but below the PIE level – 20-200 mSv. According to the scenario, the victim with a limb injury is in the room with adverse radiation conditions for 50 minutes (the predicted dose is 20-40 mSv);

- cases of external exposure of personnel and/or cases of internal exposure at doses that do not exceed the dose limit for personnel – below 20 mSv, below AIL_{pers} (are probable; during the exercise is not practiced);

- cases of external and/or internal exposure and surface contamination of skin by radioactive substances above the established limits (intervention levels) for persons of the general public (extremely unlikely; during the exercise is not practiced);
- radioactive contamination of the water area, water sources and foodstuffs (extremely unlikely; during the exercise is not practiced); and
- intake of radioactive substances in the air of process rooms and a release to the environment (air) followed by the generation of contaminated territories due to depositions.

According to the scenario, notification of adjacent territories and monitoring of radiation situation parameters \emph{in situ} by FMBA’s Mobile Radiation-Monitoring Laboratories (MRML) are practiced, and radiation doses to the population as a result of external exposure and possible intake of radioactive substances inside are estimated.

**B.1.3. Reflex Stage: Early Notifications, ‘Automatic’ Actions**

The medical scenario assumes a consistent and dynamic occurrence of events at the enterprise during which a flow of information of different content and credibility is formed from:
- victims seeking medical help from affecting factors during a radiation accident;
- warnings and alarms of the shift manager and the head of the enterprise’s EC including the radiation situation data; and
- messages of regional and federal media.

The medical scenario provides for simulating the work of medical personnel of: Central Medical Care Unit No 120 (CMCU-120); a branch of MCU No 2 (MCU-2); Inter-Regional Department No 120 (IRD-120) and Center for Hygiene and Epidemiology No 120 (CHE-120) of FMBA at sequential receipt of information (calls, signals, notifications) from witnesses of the incident, the duty-and-dispatcher service and the enterprise’s EC, when:
- the facility workers are seeking medical care, and medical workers are notified about the victims needing assistance at the enterprise site;
- signal of the local alarm system sounds ‘\emph{Attention to all}’;
- communicating the mode of high alert and emergency at the enterprise; and
- the radiation situation is worsened, and a state of radiation emergency at the enterprise and on the adjacent territory is declared.

Within the exercise framework (under the medical scenario) the incoming and outgoing information messages and reflex actions are practiced (executed).

\emph{Duty paramedic} of the ship informs the Chief of MCU-2 at different time intervals about:
- the occurred external impact on the nuclear icebreaker based on the fact of its observation (H+100 s);
- the availability of a group of persons among witnesses of the occurred external impact being in a reactive (psychological stress) state (H+15 min);
- the need to assist the victim with a ‘locked’ limb (H+2h:40 min);
- makes a request for a counseling (recommendations) about the possibility and the order of work of medical personnel for rendering emergency medical care in accordance with vital indications under adverse radiation conditions (external exposure dose rate 25 mSv/h) (H+2h:45min);
- start and end of the rescue operation and the beginning of the victim transportation to the post of medical care and evacuation;
- sending a group of persons who participated in the EROUA to provide psychological support.

Reflex actions of the Head of medical institution of FMBA include:
- decision-making, in accordance with the relevant information received from medical staff of medical stations, ambulance stations and other sources about victims, on organizing steps of medical care (Head of CMCU-120 and MCU-2 of FMBA);
- declaration of ‘high alert’ and an ‘emergency situation’ for medical personnel upon receiving the relevant notification of ATOMFLOT’s EC;
- bringing departments of medical institutions on ‘high alert’ and ‘emergency’ modes;
- informing the ODO of FMBA, Regional Emergency Medical Radiation-Dosimetry Centers (REMRDC) of FMBA – EMRDC, NREMRDC and other emergency-responders in accordance with the emergency plane and the notification procedure.

B.1.4. Reflex Stage: Emergency Actions to Assist Victims;

Protective Measures

B.1.4.1. Medical & Sanitary Unit on Medical-station Basis

The enterprise’s medical station is successively transferred to the modes of ‘high alert’ and ‘emergency’, and communication with the Unified Commission for Prevention and Elimination of Emergency Situations and Fire Safety (UCES) of FMBA is established.

Medical personnel with first-aid kits move to the shelter to set a temporary medical-care station, where the ship’s workers not involved in EROUA and watchkeeping are sheltered. Here, medical personnel conduct iodine prophylaxis of the sheltered persons in accordance with the directions of the ship’s captain and by agreement about holding such protective measure with UCES of FMBA. Potassium iodide tablets of 0.125 mg are also given to medical personnel.

Information is received about a victim: one of his limbs is ‘locked’ by a metal structure (H+2h:40 min). According to a witness, the victim is bleeding and has pain. Gamma dose rate in
the room where the injured person is ‘locked’ reaches 20 mSv/h. Assistance is required of: - technical staff to release the injured limb; and -medical personnel to perform antishock measures and prophylaxis of prolonged-compression syndrome.

B.1.4.2. UCES FMBA Servicing FSUE ATOMFLOT

Upon receiving notification on bringing the enterprise systems on high alert and information from medical assistant of the medical station, the head of MCU-2 prepares and sends a reinforced ambulance team to the facility. The team’s place of arrival and deployment is determined by the ATOMFLOT’s Radiation Safety Service and agreed with IRD No 120 and Hygiene & Epidemiology Center No 120 of FMBA.

At the announcement of ‘Emergency Situation’ signal and introducing the ‘Radiation Emergency’ regime, the UCES FMBA is assembled. In accordance with incoming information about the emergency:

- victim-assistance stations are prepared;
- necessary material and human resources are involved including solution of the task of radiation monitoring at FMBA enterprises and at its responsibility area;
- decisions on protective measures with regard to medical personnel are taken;
- recommendations for EC of FSUE ATOMFLOT on population protection are developed;
- prescriptions to ATOMFLOT’s EC for sanitary, hygienic and anti-epidemic actions on serviced sites and territories are prepared;
- permanent communication with units involved in EROUA is maintained;
- ODO FMBA, REMRDC (EMRDC, NREMRC) are informed, and requests for needed assistance are generated; and
- work of a team of experts in radiation medicine & hygiene on UCES FMBA basis is organized.

The above actions are practiced in reality (in keeping with the medical scenario, during the exercise over 50 various documents are to be developed and transferred). The following sites for visits of Observers are established:

- a station of the reinforced ambulance team operation (an assortment station);
- a station of psychological-support team operation on polyclinic’s basis;
- a work area of the team of experts on UCES FMBA basis; and
- a work post of MRML NREMRC (NIIPMM FMBA) that arrived at the emergency area for reinforcement purposes.
B.1.4.3. Reinforced Ambulance Team

The reinforced ambulance team operates at the victim’s assortment station located within a ‘buffer area’\(^2\) at the outer boundary of the accident area where excessive impact of radiation factors on personnel is possible. In case of many victims this station is as much as possible approached to the accident area. In case of only individual victims, no station is deployed but only an ambulance team arrives to a location determined from the radiation-situation parameters. The injured person is transferred to the ambulance team of MSU-2 (Murmansk-city).

The above actions of the exercise’s plan are really practiced. According to the medical scenario, the victim-transfer procedure is performed in the presence of a team of Observers. In job descriptions of the ambulance team members the possibility of their participation in rescue operations in case of a radiation accident should be indicated. Given the condition of the victim (severe), he is immediately sent to the relevant department of CMCU-120 of FMBA of Russia (the town of Snezhnogorsk).

B.1.4.4. Team of Psychological Support

According to the medical scenario, at the station of psychological-support team on FMBA polyclinic’s basis a variety of necessary activities are provided for different teams involved in the response activities:

- for a team of rescuers sent to conduct EROUA a short training is conducted and their psychological status is evaluated to identify contra-indications to the work in emergency conditions (planned conventionally);
- for persons with a reactive state caused by observation of the occurred external impact psycho-corrective actions are conducted (planned conventionally); and
- for a team of rescuers that participated in EROUA psychological support procedures of rehabilitation nature are performed (conducted really, in the presence of Observers, upon completion of the key activities of the exercise).

B.1.4.5. Expert Support Teams

According to the medical scenario, the work of expert teams of NREMRDC (St. Petersburg) and EMRDC (Moscow) is organized to provide expert support.

The team of NREMRDC (4 experts) performing routine work in the Murmansk region, comes to strengthen MCU-120 and HEC-120 FMBA upon receiving a request for assistance and orders of FMBA’s management bodies.

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\(^2\) Handbook of Rescuer, Rosenergoatom, State Corporation Rosatom, Moscow 2013.
The team of EMRDC (4 experts) operates remotely in VC mode (a dedicated videoconference channel of ROSENERGOATOM and access to the FTP server of ROSATOM’s SCC).

The work of expert groups on analysis of the radiation situation and making recommendations to the enterprise’s EC, UCES FMBA and the regulatory authority (IRD-120 FMBA) on dose assessment and protective measures is demonstrated to Observers.

The above actions of the exercise’s plan are practiced in reality.

B.1.4.6. Mobile Radiation-Monitoring Laboratories

Two Mobile Radiation-Monitoring Laboratories (MRML) of HEC-120 and NREMRDC FMBA are given the task of UCES FMBA to monitor the radiation situation on the following route: Lobov str. - Heroev Severomortsev str. - Eastern bypass road - Roslykovo - Severomorsk as well as in Murmansk-city on the route from FSUE ATOMFLOT with entering the road in the direction in Snezhnogorsk (MRML of HEC-120). This action is organized in reality. The data are transferred to UCES FMBA, EC of FSUE ATOMFLOT and expert teams. At the end of the exercise, MRML come to ATOMFLOT’s entrance and demonstrate the results of real measurements and capabilities of the laboratory equipment to the exercise Observers.

B.1.5. Intermediate Phase of the Accident

The operation of FMBA institutions and management bodies 48 hours after the onset of a radiation emergency provides for the involvement of additional health units of the federal level. Victims with symptoms for transfer to specialized (radiological) clinic on the basis of A.I. Burnazyan FMBC (Moscow) are prepared for transfer using special aviation. Additional personnel and resources to carry out continuous environmental monitoring are involved. A specialized (radiological) rapid-response team of A.I. Burnazyan FMBC is arrived and deployed in treatment facilities where victims may be sent.

Within the medical scenario, these activities are not provided for.
B.2 RECOMMENDATIONS ON MEDICAL AND PROTECTIVE MEASURES FOR PERSONNEL AND POPULATION IN CASE OF A RADIATION ACCIDENT (BASED ON THE RESULTS OF ‘ARCTIC-2014’ EXERCISE)

This section focuses on the results of operation (functioning) of FMBA institutions in the course of the exercise under both the ‘general’ and the ‘medical’ scenarios and on recommendations for medical and protective measures with regard to workers and the public.

According to the plan, the following FMBA’s institutions participated in the exercise:
- MCU-2, Murmansk-city;
- CMCU-120, Snezhnogorsk, Murmansk region;
- IRD-120, Snezhnogorsk, Murmansk region;
- HEC-120, Snezhnogorsk, Murmansk region;
- NREMRDC (NIIPMM), St. Petersburg; and
- EMRDC (A.I. Burnazyan FMBC), Moscow.

B.2.1. A Brief Description of the Radiological Scenario of the Exercise

According to the radiological part of the exercise, after initiation of the accident (H+200 s) the concentration of radioactive substances in the air within the reactor containment due to release of coolant from the primary circuit system exceeded $8.5 \times 10^4$ Bq/m$^3$. At the time H+20 min gamma levels in the control room reached 600 $\mu$Sv/h and continued to increase. Later on (H+2h:25 min) the temperature of some FEs reached a critical value due to short-time unwatering of the core that resulted in depressurization of some FEs with partial release of radioactive gases and certain volatile radionuclides. Fission products were issued from FEs to coolant with subsequent transfer of radioactive substances over primary circuit and release to rooms of the containment. Due to pressure increase up to a critical value and actuation of the emergency valve (H+2h:30 min) steam-gas-air mixture was released from the control room via the mainmast to the atmosphere. Several outer sensors of the facility-level ARMS at ATOMFLOT’s site were actuated (H+2hg:31 min), maximum dose rates being 92 $\mu$Sv/h. On the nuclear icebreaker, gamma-detection units discovered increased dose rates: in the control room – up to 44 mSv/h, and in working and living spaces – up to 1-15 $\mu$Sv/h.

Beyond the controlled area, actuation of a sensor of the regional ARMS in Roslyakovo-settlement was recorded (H+2h:58 min). The observed dose rate increase was minor: it only
exceeded the natural radiation background by a factor of 3. On the territory of Murmansk-city (28 measurement points) gamma dose rates did not exceed 0.14 μSv/h.

B.2.2. Activities of FMBA Institutions during the Exercise

Initial information about the emergency situation was transferred to FMBA institutions in accordance with the notification scheme: MCU-2 (H+200 s), CMCU-120 (H+3 min), IRD-120 (H+3 min), HEC-120 (H+10 min), NREMRDC (H+12 min) and EMRDC (H+12 min).

Notification of the institutions’ personnel on setting high-alert and emergency-operation modes was trained (successively), and preparations for implementing measures to ensure radiation safety of patients and medical staff, as well as the institutions’ operation under radioactive contamination and admission of injured/affected persons were carried out (conventionally).

B.2.2.1. MCU-2

MCU-2 was prepared to receive victims with contamination, and the contingency emergency medical unit was gathered and brought to readiness. Arrangements for setting a sanitary-admission regime were carried out (conventionally).

On MCU-2 basis, a reinforced ambulance team was formed (a doctor, a paramedic, and a medic driver) to assist the victim (a dosimetrist technician) evacuated from the ship and transfer him to hospital. The ambulance team directed to the accident site was informed about the occurred radiation accident and doses which they may get. Before arrival of the team to the accident site, the ATOMFLOT’s radiation safety service - upon agreement with UCES FMBA and taking into account the radiation situation parameters - selected the route of the ambulance car driving, identified the area for receiving the victim and determined their maximum possible operation time. Following dose control, initial medical checkup and emergency medical actions, the victim was moved to the car’s stretcher covered with a film to prevent contamination of the ambulance car.

This procedure was trained in the presence of the exercise Observers.

Next, the victim was immediately forwarded to the relevant department of CMCU-120 FMBA. Before transporting the victim to medical institution, the procedure of drawing up the accompanying medical documentation was practiced. When transporting the victim having a radioactive contamination, the requirements on radiation safety and protection of accompanying medical personnel were observed.
B.2.2.2. Unified (Regional) Commission for Prevention and Elimination of Emergency Situations of FMBA (UCES FMBA)

Following the announcement of the ‘Emergency Situation’ signal and setting the emergency regime, gathering of UCES FMBA (chaired by the head of MCU-120) was declared and its operation was organized to coordinate the activities of FMBA’s institutions on medical and sanitary maintenance. It included representatives of FMBA regional institutions (MCU-2, CMCU-120, IRD-120 and HEC-120). UCES FMBA worked in close collaboration with FSUE ATOMFLOT’s EC and REMRDC FMBA (EMRDC and NREMRDC) which carried out the function of expert-analytical support.

Also, specialists of UCES FMBA performed the functions of the state sanitary-and-epidemiological supervision (control) over compliance with the radiation safety requirements during EROUA and population protection measures and drawing up the relevant prescriptions.

During the exercise, UCES prepared reports to the FMBA on medical-and-sanitary consequences of the occurred emergency and recommendations on protection of workers and the population in keeping with departmental formats.

B.2.2.3. HEC-120

On assignment of UCES FMBA, HEC-120 specialists performed measurements of the radiation situation parameters within the controlled area and the surveillance area of FSUE ATOMFLOT. Their results show no excess of gamma dose rates above the control levels (Table B 1).

Measurements were performed using MRML. The results of measurements were transferred to UCES FMBA, ATOMFLOT’s EC and expert teams’ specialists.

Table B.1 – Results of dose rate measurements in ATOMFLOT’s controlled area and surveillance area

<table>
<thead>
<tr>
<th>Measurement location</th>
<th>Exposure dose rate, μSv/h</th>
<th>Control level, μSv/h</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Average</td>
</tr>
<tr>
<td>Nearest settlement to the accident site (Murmansk-city) - 14 measurement points</td>
<td>0.10</td>
<td>0.13</td>
</tr>
<tr>
<td>A section of the road from ATOMFLOT’s site to residential buildings in Murmansk-city - 14 measurement points</td>
<td>0.10</td>
<td>0.11</td>
</tr>
</tbody>
</table>
B.2.2.4. Work of Expert-Support Groups

In accordance with the medical scenario, several groups of expert-and-analytical support of FMBA emergency centers participated in the exercise: EMRDC (A.I. Burnazyan FMBC) and NREMRCDC (NIIPMM).

Four experts of NREMRCDC (a radiologist, a physician-hygienist, a radiation-safety expert and a physicist-dosimetrist) worked on basis of UCES FMBA servicing FSUE ATOMFLOT. In their work, experts used the latest information from ATOMFLOT’s EC and the teams of environmental monitoring. Information and analytical data provided by the SCC of Rosatom were also accessible to the expert group (via EMRDC in Moscow based on the relevant information-transfer agreement).

Using MRML, NREMRCDC experts conducted monitoring of the radiation situation on the route: Lobov str. - Heroev Severomortsev str. - Eastern bypass road - Roslykovo - Severomorsk. The data of measurements were transferred to UCES FMBA and ATOMFLOT’s EC.

Four experts of EMRDC provided expert-and-analytical support remotely (via a dedicated VC channel).

Experts of EMRDC performed calculations and estimates of the radiation situation parameters at FSUE ATOMFLOT’s site and in the area adjacent to the emergency release location and dose calculations to workers and the public; they also formulated recommendations on medical and protective measures and presented them to UCES FMBA and ATOMFLOT’s EC. The results of predictive estimates of the radiation situation and recommendations on protection of workers and the public made by EMRDC were sufficiently consistent with those of IBRAE’s expert group. Information receipt and processing was carried out within the framework of established regulations with the use of modern communication systems, software and analytical tools.

B.2.2.5. Psychological Assistance

Establishment of a ‘self-restoration’ system for workers involved in EROUA, and their protection from the effects of emotional stress and professional ‘burnout’ is one of the priorities when organizing psychological help during operations on elimination of emergency situations and their consequences.
Under the exercise, various procedures of rendering psychological assistance to rescuers involved in EROUA were worked through with the participation of a FMBC’s psychologist. A practical training with the participation of 6 rescuers was held where techniques of emergency psychological aid and self-help were practiced with the aim of rapid recovery from fatigue and exhaustion, sleep disturbances, and excessive degree of mental-and-emotional stress and anxiety.

B.2.3. Recommendations on Carrying out Medical Actions

According to the scenario, during the accident a dosimetrist technician, who conducted radiation monitoring on the icebreaker, received mechanical injury to his left lower limb (H+2h:40 min) and was unable himself to leave a room with elevated radiation levels (dose rate up to 20 mSv/h).

It was decided to send the medical station’s paramedic, a dosimetrist and technical experts to the injured person’s location for emergency medical treatment.

Before and during release of the injured limb a variety of urgent medical and sanitary measures was carried out with the victim such as: anesthesia by drugs, cooling the injury, bandaging and immobilization of the affected limb (Fig. B 1). The total time spent to medical procedures made up 12 min. The dose rate at the victim location area reached 20 mSv/h. According to the results of personal dose control, the dose received by the paramedic did not exceed the recommended value and was 4.8 mSv. After completing all procedures, the paramedic left the area with high gamma dose rates.
After leaving the contaminated area, the patient was partially sanitized at the sanitary treatment post (shower room on the ship). Before his partial sanitary treatment the level of surface contamination of individual sections of clothing and exposed skin (hands, neck) was up to 10 000 β-particle/cm²·min (the dose rate at 10-cm distance from the surface of contaminated clothing and skin – up to 1 μSv/h). After completion of partial sanitary treatment the level of contamination of the skin decreased to 1000 β-particle/cm²·min (the dose rate at 10-cm distance – to 0.5 μSv/h). The above actions were carried out in accordance with the instruction for providing medical care to victims of radiation accidents developed on the basis of recommendations of “The Protocols of Medical Staff Operation when Providing Medical Aid to Victims of Radiation Accidents” (2004) and “The Guidelines for the Implementation of Medical, Sanitary and Hygienic Measures during Radiation Accidents” (2005).

Before the start of the victim evacuation and transportation from the ship, the duty-dispatching service of MCU-2 of FMBA was informed about the time of planned leaving the emergency facility, and the need for arrival of an ambulance car with a team prepared for transportation of the victim with contaminated clothes and skin was agreed.
B.2.4. Recommendations for the Protection of Personnel

In these recommendations, the term ‘personnel’ refers to: the nuclear icebreaker’s crew, workers involved in EROUA and medical staff.

Based on the radiation situation data on the icebreaker and at the ATOMFLOT’s site and on other operational information, specialists of UCES FMBA with expert support of REMRDC (EMRDC and NREMRDC) developed recommendations for the protection of personnel:

A. Sheltering the personnel not involved in watchkeeping and EROUA.

This standard protective measure allows significantly reducing the personnel exposure dose.

B. Taking into account high expected probability of iodine isotopes presence in the radioactive release (at the time of H+2h:30 min), conducting iodine prophylaxis to all workers at the ATOMFLOT’s site. The preparation of potassium iodide should be taken once in a dose of 125 mg (1 tablet). In this specific case of personnel protection, the very fact of expected significant release of nuclear fuel FPs containing aerosols should be used as a criterion for decision-making on iodine prophylaxis rather than dose levels in the thyroid. The fact that the maximum effect of iodine prophylaxis is achieved when taking the drug 6 hours or less before iodine radioisotope intake should be accounted for. Taking the drug 6 hours after inhalation intake leads to a 2-fold reduction in the efficiency, and after 24 hours to almost complete lack of the protective effect.

C. EROUA should be planned from the condition of non-exceedance of the main dose limit dose to workers (20 mSv) in accordance with the RSS-99/2009.

Based on the radiation survey data obtained from FSUE ATOMFLOT and CSTS IBRAE RAN by H+3h:00 min, a team of EMRDC’s experts using ‘EASYRAD’ specialized software performed dose rate interpolations and generated a map of the radiation situation at the enterprise site (Fig. B 2). The figure shows localized areas of radioactive contamination with maximum dose rates of 10 μSv/h within the enterprise site.
The dependence of effective doses on the time of personnel staying *in situ* taking into account dose rate decrease was determined (Fig. B 3). As established, the planned individual personnel exposure doses over 10 days of EROUA (without regard to the mode of staying, around the clock) will not exceed 1.6 mSv. The admission of personnel to PIE is not required.

Medical staff (including ambulance teams) may stay in the given territory for 5 days. Under these conditions, the dose limit for the public – 1 mSv - is not exceeded.

EROUA are to be conducted in personal protective equipment and under conditions of constant dose control. To ensure safety of works, the established regime regulating the permissible time of personnel staying in the contaminated area must be observed.

Coordinating decisions of ATOMFLOT’s EC and UCES FMBA regarding the number of EROUA participants and the time (duration) of their execution is recommended. Within the contaminated area smoking, eating and drinking is prohibited.
D. Recommendations for the Protection of Medical Personnel when Providing Assistance to the Victim

When assisting victims of a radiation accident, measures should be taken to minimize the exposure of medical staff being under conditions of excess exposure to radiation factors (dose rate up to 20 mSv/h). In accordance with the RSS-99/2009, exposure doses of medical personnel, when providing assistance to victims, should not exceed 5 mSv/year.

Upon agreement with UCES FMBA, the following recommendations were developed: -limit staying of medical staff under high radiation levels up to 15 minutes (based on non-excess of the dose of 5 mSv); and -provide medical staff with direct-reading personal dosimeters with sound indicators of cumulative dose of 5 mSv; skin PPE made of elastron; latex gloves; waterproof shoes; respirators; and safety helmets (hard hats and facial visors).

Dose levels for medical staff of various categories, at which the radiation safety requirements of the SRS-99/2009 with no significant restrictions on the ability of rendering medical aid to the victims are met, are presented in Table B 2 (without consideration for introductory messages of the scenario).
## Table B.2 - Medical staff exposure limits

<table>
<thead>
<tr>
<th>Dose limits, exposure conditions</th>
<th>Personnel</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. 1 mSv during participation in emergency operations (but not more than 5 mSv in the current calendar year)</td>
<td>Staff of departments of medical care units</td>
<td>Medical assistance to the victims</td>
</tr>
<tr>
<td>Max. 5 mSv during participation in emergency operations (but not more than 5 mSv in the current calendar year)</td>
<td>Staff of medical teams (ambulance teams)</td>
<td>Primary medical and sanitary assistance</td>
</tr>
<tr>
<td>Max. 50 mSv/year</td>
<td>Medical staff of ‘A’ category due to possible excess of radiation dose of 5 mSv/year</td>
<td>Participation in rescue operations. Emergency medical care</td>
</tr>
<tr>
<td>Max. 100 mSv/year</td>
<td>Medical staff of ‘A’ category with admission for PIE, involved in EROUA and having a ‘rescuer’ status</td>
<td>Medical assistance <em>in situ</em> to the victims of radiation accidents for health reasons</td>
</tr>
</tbody>
</table>

### E. Recommendations on Ensuring Radiation Safety Requirements when Transporting Victims with Radiation Exposure to Hospital

Transportation of a victim with radiation exposure by ambulance car may cause radiation effects on medical personnel and accompanying persons. In accordance with the RSS-99/2009, exposure doses to the medical staff having contact with people involved in a radiation accident, shall not exceed 5 mSv / year.

In keeping with the given medical scenario, after partial sanitary treatment the contamination level of open skin areas of the victim equaled 1000 β-particle/cm²·min (dose rate at a distance of 10 cm – up to 0.5 μSv/h). These contamination levels pose no significant risk to the health of medical personnel and do not restrict (impede) the implementation of necessary medical-assistance actions. Nevertheless, the ambulance team accompanying the victim (assisting the victim during transportation) should use protective clothing, respiratory PPE ( respirators), latex gloves and personal dosimeters.
To prevent the spread of radioactive contamination, equipping the ambulance car with plastic (film) covering of the floor, seats and victim-transportation devices as well as with leakproof containers (bags) for collection and temporary storage of radioactive waste (bandages, medical instruments) is recommended.

As a general rule, in case of a radiation accident victims are transported to medical facility in a special and duly equipped medical transport (ambulance cars). Dose control and decontamination of transport vehicles (if necessary) is organized at a special assortment area.

If effective decontamination of vehicles and equipment is impossible, victims are moved to a ‘clean’ ambulance transport (ambulance cares) and are transported to hospital.

Permissible values the gamma dose rates and surface contamination of ambulance cars depending on their use are given in Table B 3.

Table B.3 – Permissible use of ambulance cars at different levels of radioactive contamination

<table>
<thead>
<tr>
<th>Permissible use of ambulance cars</th>
<th>Gamma dose rate at 10-cm distance from the outer surface of the car, μSv/h</th>
<th>Gamma dose rate at 10-cm distance from the inner surface of the car, μSv/h</th>
<th>Contamination of inner surfaces of the car, β-particle/(cm²·min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaving the assortment area and transportation of victims to MCU is allowed.</td>
<td>max 10</td>
<td>max 5</td>
<td>max 100</td>
</tr>
<tr>
<td>Transportation of victims from the location of radiation accident to the assortment area is allowed.</td>
<td>up to 100</td>
<td>up to 10</td>
<td>up to 1000</td>
</tr>
<tr>
<td>Transportation of victims is only allowed in case of need for emergency medical care (during 1-2 hours).</td>
<td>up to 1000</td>
<td>up to 100</td>
<td>up to 10000</td>
</tr>
<tr>
<td>Using the car outside the radiation accident area is prohibited.</td>
<td>above 1000</td>
<td>above 100</td>
<td>above 10000</td>
</tr>
</tbody>
</table>

At dose rates of 1 mSv/h at 10-cm distance from any point of the victim’s body and skin-contamination levels up to 20 β particl./cm² min, no special conditions of victims’ accommodation and sanitary regime in hospitals are required.
B.2.5. Recommendations on Population Protection

Based on information on radionuclide composition in the core of OK-900A reactors, technology data about the dynamics of emergency situation development and readings of the facility-level ARMS, experts of CSTS IBRAE RAN estimated the composition of occurred radioactive release to the atmosphere (Table B 4).

Table B.4 – Radionuclide composition and the atmospheric release parameters

<table>
<thead>
<tr>
<th>Radionuclide composition</th>
<th>Activity, Bq</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cs-137</td>
<td>1.00E+11</td>
</tr>
<tr>
<td>I-131</td>
<td>1.10E+12</td>
</tr>
<tr>
<td>Kr-88</td>
<td>3.10E+12</td>
</tr>
<tr>
<td>Xe-133</td>
<td>1.30E+13</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters of atmospheric release</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective height of release</td>
</tr>
<tr>
<td>Release duration</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weather conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind direction</td>
</tr>
<tr>
<td>Wind speed</td>
</tr>
<tr>
<td>Atmospheric precipitations</td>
</tr>
<tr>
<td>Stability class</td>
</tr>
</tbody>
</table>

Using the above data, a team of EMRDC experts estimated the radiation situation in situ and calculated exposure doses over first 10 days following the accident to elaborate recommendations on the protection of population in the adjacent areas (Table B 5).

Table B.5 – Predicted dose over first 10 days following the accident, mGy

<table>
<thead>
<tr>
<th>Distance, km</th>
<th>Thyroid dose</th>
<th>Whole body dose</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>adults</td>
<td>children</td>
</tr>
<tr>
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<td>1.90</td>
<td>4.30</td>
</tr>
<tr>
<td>2</td>
<td>0.70</td>
<td>1.50</td>
</tr>
<tr>
<td>3</td>
<td>0.37</td>
<td>0.80</td>
</tr>
<tr>
<td>4</td>
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<td>0.51</td>
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<tr>
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<tr>
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<tr>
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<tr>
<td>8</td>
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<tr>
<td>10</td>
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<td>0.13</td>
</tr>
<tr>
<td>12</td>
<td>0.05</td>
<td>0.10</td>
</tr>
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</table>
The calculations of predicted doses over the first 10 days following the accident showed that no emergency population protection measures (sheltering, iodine prophylaxis, evacuation) are required in accordance with the RSS-99/2009 criteria. The release is radiologically equivalent to 5.1 TBq of $^{131}$I. The event class on the INES scale is 2.

According to EMRDC estimates, no population exposure doses above 1 mSv are expected beyond the ATOMFLOT’s site.

**CONCLUSIONS**

In the course of the ‘ARCTIC-2014’ exercise, the preparedness was checked and practical skills were worked through on medical-and-sanitary support when eliminating the consequences of a conventional radiation accident at a ship’s NPI. During the exercise, the work of FMBA’s medical institutions was organized and conducted in accordance with the current medical-and-sanitary plans.

In general, the demonstrated capabilities of FMBA’s medical institutions servicing FSUE ATOMFLOT (MCU-2, CMCU-120) enable a phased treatment of victims in the prescribed extent during the pre-hospital period and at a stage of qualified medical care, as well as necessary evacuation actions. Arrangements for the provision of pre-hospital care by a paramedic team of ATOMFLOT’s medical station were successfully implemented, and coordinated actions of medical personnel and rescue units, when providing emergency assistance to the victim, were worked through.

During the exercise information interactions of FMBA institutions with ATOMFLOT’s EC, technical-support centers and other emergency-response actors were practiced. Specialists of FMBA institutions provided expert and analytical support on the organization and holding of radiation-hygienic and protective measures, on planning of
Rescue and recovery operations, on the use of PPE and establishing individual dose control.

Expert groups (EMRDC and NREMRDC) made predictive estimates of potential radiation and health consequences and elaborated recommendations on protection of workers and the public - mostly, using the calculated source term parameters and meteorological data.

However, in case of such-type radiation accidents (at naval NPI), when timely information about the source term parameters, its radionuclide composition and other data needed for correct estimates of individual exposure doses may be lacking, instrumental assessment of the radiation situation as well as decision-making procedures, taking into account the operating values, are important. Given large uncertainties in estimates during the initial phase of a radiation accident, such an approach is deemed justified and conservative.

Table B.6 shows the operating values and the corresponding levels of radiation hazard used when making decisions on urgent medical-and-sanitary actions regarding the population. For a preliminary assessment of the level of radiation hazard during a nuclear reactor accident, gamma dose rate measured at 1-m distance from the ground is taken as the operating value. Note that dose rate decrease due to radioactive decay of short-lived fission products is the key parameter to be taken into consideration when estimating the value of this operating parameter. Therefore, to provide a reasonably conservative estimate, the condition of dose rate measurement at 3-km distance from the source term during passage of the cloud or in the next 1-4 hours following the release is taken.

Radionuclide composition of the release is taken on the basis of design documentation dealing with scenarios of beyond-design-basis accidents at NPPs with VVER and RBMK-type reactors. Also, melting of NPI reactor core with FP release to the environment with no separation in NPP’s containment systems (undiminished release) is anticipated. The conditions of atmospheric scattering are also taken conservatively as the most unfavorable ones.

The estimated gamma dose rates take into account:

- external exposure from the radioactive cloud and depositions; and

- thyroid exposure of children and adults due to inhalation of radioactive iodine during radioactive cloud passage (without secondary resuspension).
Exposure doses due to consumption by the population of local agricultural products and water from open sources are not considered.

The values of gamma dose rate on the thyroid gland of children and adults are established to evaluate the efficiency of iodine prophylaxis or the content of radioactive iodine in the thyroid gland in a case when this protective measure was not carried out. The levels of radiation hazard are estimated based on the absorbed-dose values to the thyroid gland and equal 250, 50 and 10 mGy for the first, second and third levels of radiation hazard, respectively.

Approximate dose rate values during individual EROUA conducted by personnel of emergency-rescue units are presented in Table B.7. The level of radiation hazard and the corresponding gamma dose rate value are determined by dose criteria (Table B.8) and the time needed to carry out this type of work or an individual operation.

Operating values and the corresponding levels of radiation hazard used when implementing protective measures for personnel are given in Table B.9.

Taking account of uncertainties in radionuclide composition of radioactive contamination, the basic dose limit of 500 mSv to the skin of A-category personnel at 10 μSv/h dose rate measured 10-cm distance from open areas of the skin and clothing could be achieved within a few working shifts. This operating value is intended for operational control and assortment of workers by the level of contamination of their clothing, PPE and skin.
APPENDIX B

A Photo Report

Fig. B.1 - The Director-General Ruksha V.V. is making a presentation on FSUE ATOMFLOT
Fig. B.2 – Dr. Pavlovsky O.A. and Mr. Darbinyan O.E., Atomflot’s Deputy Director-General for Technical Operation of the Fleet, comment the course of ‘ARCTIC-2014’ exercise to Russian and foreign observers
Fig. B.3 – Discussing the exercise progress
Fig. B.4 – Work of press services
Fig. B.5 – Radiation survey and contouring the contaminated area near the Pier No 8
Fig. B.6 – Rendering first aid and evacuation of the victim

Fig. B.7 – Work of ATOMFLOT’s Emergency Commission (EC) and the Dispatch Team
Fig. B.8 – End of the exercise; a photo of the exercise participants