

**FEDERAL ENVIRONMENTAL, INDUSTRIAL AND  
NUCLEAR SUPERVISION SERVICE OF RUSSIA**

**DECREE No. 13**

**dated December 27, 2006**

**ON APPROVAL AND PUTTING INTO EFFECT FEDERAL CODES AND  
REGULATIONS IN THE FIELD OF THE USE OF ATOMIC ENERGY  
“REQUIREMENTS FOR PLANNING OF ACTIONS AND PROTECTION OF  
EMPLOYEES (PERSONNEL) DURING RADIATION  
ACCIDENT AT A NUCLEAR INSTALLATION OF A SHIP AND (OR) OTHER  
WATER CRAFT ”**

The Federal Environmental, Industrial and Nuclear Supervision Service decrees:

Approve and validate from June 1, 2007 the attached federal codes and regulations in the field of atomic energy use "Requirements for Planning of Actions and Protection of Employees (Personnel) during Radiation Accident at a Nuclear Installation Ship and (or) other Water Craft " (NP-079-06).

Head  
K.B. Pulikovsky

Approved by  
the Decree  
of the Federal Environmental, Industrial and Nuclear  
Supervision  
Service  
as of December 27, 2006 No. 13

Effective  
since June 1, 2007

**FEDERAL CODES AND REGULATIONS  
IN THE FIELD OF ATOMIC ENERGY USE**

**REQUIREMENTS  
FOR PLANNING OF ACTIONS AND PROTECTION  
OF EMPLOYEES (PERSONNEL) DURING RADIATION ACCIDENTS  
AT A SHIP AND (OR) WATER CRAFT NUCLEAR INSTALLATION**

**NP-079-06**

This regulatory document "Requirements for Planning of Actions and Protection of Employees (Personnel) during Radiation Accident at a Nuclear Installation of a Ship and (or) other Water Craft " sets forth the requirements for planning the actions aimed at activities and protection of employees (personnel) during radiation accidents at nuclear installation of a ship and (or) some other water craft.

The preparation and implementation of the plans of employees (personnel) protection during radiation accident at a nuclear installation of a ship and (or) other water craft, rendering assistance by the Operating Organization, port, by other water crafts, is the fifth level of the system of defence-in-depth organization and engineered features during operation of a nuclear installation of a ship or some other water craft .

The document makes use of the terms and definitions specified in the legislation and regulatory documents valid in the field of the use of atomic energy.

First issued <\*>.

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The document is developed based upon the international conventions "Convention on Early Notification of a Nuclear Accident", "Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency", International Code for the safe

management and operation of ships and for pollution prevention (International Safety Management (ISM) Code), Federal law "On the Use of Atomic Energy", Federal law "On Radiation Safety of Population", decrees of the Russian Federation Government "Regulations On Unified State System of Emergency Prevention and Liquidation", "Provisions on Cooperation of Emergency Rescue Services of Ministries, Agencies and Organizations in the Sea and Water Basins of Russia" as well as the Rules on Radiation Safety of Sea Ports when Called by Ships Carrying Nuclear Installation or Radiation Sources or when such Ships Stay in the Port.

The comments and proposals of the Federal Environmental, Industrial and Nuclear Supervision Service, Federal Agency of Sea and River Transport of the Ministry of Transport of Russia, Russian Maritime Register of Shipping, RSC "Kurchatov Institute", North-European Interregional Territorial Office for Nuclear and Radiation Safety Supervision of the Federal Environmental, Industrial and Nuclear Supervision Service, FSUE "Experimental Design Machine Building Bureau named after I.I. Afrikantov", TsKB "Aisberg" JSC, Murmansk Maritime Shipping Company" were taken into consideration during development of the document.

The regulatory document has been subject to legal peer review at the Ministry of Justice of the Russian Federation (letter ref. N 01/1115-AB of February 12, 2007).

## 1. PURPOSE AND SCOPE OF APPLICATION

1.1. This regulatory document "Requirements for Planning of Actions and Protection of Employees (Personnel) during Radiation Accident at a Nuclear Installation of a Ship and (or) other Water Craft " sets forth the requirements for the planning of actions aimed at protection of employees (personnel) during radiation accidents and release of ionizing radiation and (or) radioactive substances beyond the physical safety barriers during operation of the nuclear installation of a ship and (or) some other water craft in the sea and (or) in the port.

1.2. These Rules set forth the requirements for:

- for the process of development of Action Plans and Employees (Personnel) Protection Plans in case of radiation accidents at a nuclear installation of a ship and (or) other water craft, for agreement and approval of such Plans;

- for organization and technical measures to be taken by the ship Employees (Personnel) (hereinafter referred as personnel), Operating Organization in order to maintain constant preparedness for implementation of the Action Plans aimed at protection of personnel under radiation accident at the nuclear installation of a ship and (or) other water craft (referred to as ship hereinafter), when the ship is in the sea and (or) in a port (referred to as Ship Action Plan in the sea and (or) Ship Action Plan in the port – Ship Action Plans hereinafter);

- for the updating and revision of Ship Action Plans.

1.3. These Rules apply to the planning by the atomic energy use management bodies, Operating Organization, nuclear installation-equipped ship personnel, organizations which perform the work and render services in the field of the use of atomic energy as well as by the individuals temporary present at a ship, of activities related to employees (personnel) actions and protection during a radiation accident.

1.4. These Rules apply to the operating nuclear installations of the ships and (or) other water crafts, including floating units with nuclear power plants, and those being decommissioned.

## 2. GENERAL PROVISIONS

2.1. The Operating Organization plans and ensures preparedness for taking actions and protection of personnel during radiation accidents at ship nuclear installations. Preparedness of personnel to take actions in case a radiation accident occurs shall be a part of the safety management system valid at the Operating Organization.

2.2. To ensure preparedness for personnel protection under radiation accidents at a ship nuclear installation the Operating Organization shall develop model ship action plans when in the sea and (or) in the port for the ship personnel to follow when developing the Ship Action Plans at each individual ship taking into consideration the specific features of the ship nuclear installation.

2.3. Each ship develops the Ship Action Plans based upon the model action plan, agree it with the Operating Organization and the ship captain approves it.

2.4. To formulate the unified general organizational and technical approaches towards development of Ship Action Plans and towards ship personnel training to get ready to take actions in radiation hazard conditions the Operating Organization, involving other organizations as necessary, shall develop the manual on maintaining ship survivability under design and beyond design basis accidents.

2.5. The manual on maintaining ship survivability under design and beyond design basis accidents shall establish:

- main targets of struggle for survivability of the nuclear installation and the ship as a whole under radiation accident conditions;

- methods of notification of the ship and of the external organizations about the radiation accident;

- methods of bringing nuclear installation into safe mode;

- targets of personnel activities aimed at radiation accident localization;

- methods of struggle for survivability of the ship under a radiation accident meeting the priority measures of personnel safety;

- recovery methods of recovery of the physical safety barriers and nuclear facility operability .

2.6. The ship commanding personnel and heads of ship services perform the functions of coordination body of vessel-level unified state system of emergency situation prevention and liquidation, vessel commission, planning and management of ship personnel actions aimed at prevention, during threat of occurrence and during an emergency including during radiation accidents at the nuclear installation.

2.7. The results of the analysis of the nuclear installation design basis and beyond design basis accidents, their probable sequence assessment, assessment of radiation accident consequences including the results that describe the severest radiation consequence obtained during design development and from the nuclear installation operation experience shall be taken into consideration when developing the Ship Action Plans.

2.8. For each ship in the sea and (or) in a port the following shall be developed:

- Ship Action Plans;
- personnel action plans under accident situations;
- ship schedules effective upon the signal “Radiation Hazard”;
- schemes of radiation accident annunciation.

2.9. The Ship Action Plan shall establish the top priority actions as well as the measures to be taken by all personnel of the ship in case of nuclear installation operational occurrences presenting radiation hazard. The format of Ship Action Plans is established by the Operating Organization.

2.10. At the Operating Organization’s and on ships the individuals responsible for overall and actual management of actions of planning and assurance of preparedness of the personnel to act and of personnel protection under radiation accident at the nuclear installation shall be appointed by the administrative documents, their specific duties and the procedure of replacement of such individuals shall be specified in such documents.

2.11. The Operating Organization develops, within its competence, the regulations on the procedure of ship personnel selection, training, work permit granting, certification, refreshment training, qualification upgrading and maintaining, which establish the arrangement of functioning of the system of ship crew recruiting and crew member qualification maintaining at the required level.

2.12. The Operating Organization shall maintain the completeness of the crew of a ship equipped with the nuclear installation loaded with nuclear fuel at the level that enables fulfilling of all personnel protection actions and implementation of Ship Action Plans.

2.13. For perfection of personnel actions under a radiation accident the Operating Organization shall develop the programs and methods of training, drills and exercise at ship nuclear installations, monitor the quality of their implementation. The frequency of drills and exercise (scheduled and unscheduled) shall ensure maintaining the personnel preparedness for actions to be taken during radiation accidents at the specified level.

2.14. The commanders of drills and exercise aimed at improvement of practical skills of personnel under the conditions of radiation accidents carried out at a ship in the

sea and (or) in the port, individually and (or) in cooperation with the ship personnel shall register performing of activities, recording the results achieved, in relevant documents.

2.15. The following shall be ensured for the officials to implement the Ship Action Plans:

- study and performance by the personnel of the duties imposed upon them;
- locate as specified the individual protection means (including spare ones), individual medical first aid kits with antiradiation medicines and instructions on their administration, dose and radiation metering devices with the operation range conforming with the maximum radiation consequences of an accident;
- sound state of the main and redundant engineered features of systems (elements) important for nuclear installation and communication system safety;
- keeping record of all persons present on the ship;
- determination of rooms for the personnel who has been exposed to radiation;
- prediction of possible enhanced exposure of personnel who maintain the nuclear installation and who may be involved in implementation of emergency activities.

2.16. The Ship Action Plan in the port shall be coordinated with the Action Plan aimed at protection of port personnel and other individuals present on the territory of the port and in its water area (referred to as Port Action Plan hereinafter), in regard to notification about the accident, frequency of providing subsequent information on the state of nuclear installation and the ship, coordination of activities during implementation of joint actions of radiation accident liquidation.

The state of the ship nuclear installation shall comply with the requirements of the document which establishes the radiation safety regulations for the sea ports when they are called by the ships with nuclear installations and radiation sources.

2.17. To render assistance and prompt taking measures of radiation accident and its consequences liquidation at the ship nuclear installation the capacities and means of the below shall be engaged (if necessary):

- the Operating Organization;
- the sea rescue service of the Federal marine and river transport agency organization;

- the professional emergency rescue detachments of Rosatom in conformity with the plans of interfaces during liquidation (localization) of radiation accidents at a ship and (or) other water craft nuclear installation.

2.18. The Operating Organization shall provide to the captain of a ship with the nuclear installation suffering an accident the information on sending of emergency rescue detachments to the ship, their composition and leaders, identification signs of delivery means.

2.19. The leaders of emergency rescue detachments and emergency rescue services, who arrive at the ship with nuclear installation suffering an accident, participate in radiation accident or its consequences liquidation coordinating its activities with the captain of the ship in conformity with the document that defines the interfaces with the organizations rendering service under emergencies.

### 3. REQUIREMENTS FOR CONTENTS

The Ship Action Plans shall be based upon the input data describing the ship and nuclear installation preparedness to ensure safe operation of engineered features and shall contain the following sections:

- input data;
- measures and actions aimed at personnel protection during radiation accidents at a ship nuclear installation;
- specific features of Ship Action Plan in a port.

#### 3.1. Input data

3.1.1 The information that defines the below shall be used as input data:

- availability within the crew of sufficient number of personnel maintaining nuclear installation, who have the permits to perform the work in the field of the use of atomic energy;
- technical state of nuclear installation normal operation systems (elements) and safety systems (elements), state of working media inventory, individual protection means, radiation and dose monitoring means, medical provisions, compliance of analysis of the



nuclear installation circuits working medium with the requirements of operation documents;

- the results of performed scheduled visual inspections and repairs of nuclear installation systems (elements), including physical safety barriers;

- the results of comprehensive and functional inspection of nuclear installation systems (elements) and elimination of the violations revealed;

- guarantee the continuous monitoring and recording of parameters and operation conditions of nuclear installations in conformity with the requirements of operation documents;

- the time of arrival of the personnel at the working places upon the alarm signal "Radiation Hazard";

- data on the ship radiation monitoring system, including:

- on instrumentation support of the measurements of radioactive aerosol and gas concentrations as well as of gamma and neutron flux in conformity with the ship cartogram;

- on feasibility of individual dose monitoring under normal and emergency conditions of nuclear installation operation.

3.1.2 The data on radiation situation at the ship shall be entered into the operation documents, including:

- data on radiation situation in the controlled and monitored area rooms;

- data on the measurements taken under nuclear installation normal operation, results of computed evaluations under design and beyond design accidents;

- data on predictions of the design basis and beyond design basis accident consequences including the results of computed assessment of radiation situation in case of an accident leading to the severest radiation consequences;

- on the sequences considered in the nuclear installation design, radiation accident analyses and upon the nuclear installation operation experience, with indication of:

- the design quantity of coming radionuclides;

- duration of radioactive substances coming;

- calculated levels of radioactive contamination of room surfaces;

- evaluation of individual occupation effective (equivalent) doses;
- evaluation of the number of persons who may require medical assistance;
- on evaluation of radiation situation variation at the ship and in the water area of the ship depending upon weather conditions.

3.2. Activities and actions aimed at protection of personnel under radiation accident at nuclear installation of ship in the sea;

The section shall contain the organizational and technical measures and actions of protection of personnel under radiation accident at nuclear installation, sequence of actions during works under the conditions of radiation accidents and shall consist of the below subsections wherein the information on the following shall be provided:

3.2.1. Identification of emergency state of nuclear installation of the ship.

The following shall be provided:

- process of identification of emergency state of the nuclear installation by the crew personnel on duty and of possible radiation consequences;
- the pattern of reports of the personnel on violations of nuclear installation safe operation limits and conditions;
- actions on recovery of nuclear installation normal operation, identification of possible causes, nature and location of radiation accident;
- the conditions under which the reactor plant is immediately brought into subcritical state.

3.2.2 The conditions of initiation of alarm signal “Radiation hazard” at the ship

The following shall be specified:

- the values of exceeding the limit radiation level in the rooms and circuits of the nuclear installation upon reaching of which the decision to initiate alarm “Radiation Hazard” on ship is taken;
- violations of nuclear installation safe operation limits and (or) conditions, in case of which the installation shall be brought into subcritical state and cooling down mode;
- the list of ship officials authorized to issue order to initiate the alarm “Radiation Hazard” on the ship.

### 3.2.3 Notification about the radiation accident at the ship nuclear installation.

The following shall be provided:

- the procedure of ship personnel notification;
- the lists of officials who make decision on notification of external organizations and persons responsible for notification and control of implementation;
- the list of organizations to be notified and the diagram of their notification with indication of the numbers of the persons to be called and the communication channels to be used for notification and the methods of message receipt acknowledgment;
- data on urgent notification of organizations by the communication facilities (main and standby ones) and on stable communication with the ship;
- data on the international signals of radiation accident raised on the ship.

Information provided in the message about the radiation accident at the ship nuclear installation shall be sufficient to evaluate the ship nuclear installation and ship state and the number of the injured persons (if any).

### 3.2.4 Ship Safety Assessment

The following shall be specified

- the methods of ship safety assessment in case of loss (limitation) of travel due to accident at the nuclear installation;
- the conditions requiring further operation of the nuclear installation suffering an accident to ensure ship safety depending upon actual situation;
- the methods of assessment of ship controllability using redundant and emergency propulsion means and evaluation of operation time of standby and emergency power sources based upon organic fuel inventory;
- the methods of evaluation of the ship-common safety systems (elements) need in power including water removal means, habitability and personnel life support features.

### 3.2.5. Nuclear Installation Bringing into Safe Mode.

The following shall be described:

- emergency situations, limit parameter values when the reactor is immediately brought into subcritical mode, and report is submitted to the main command post;

- actions aimed at bringing the nuclear installation into the cooling down mode (emergency cooling down, if necessary) from the central control post or from the emergency cooling down post;

- the actions performed by the personnel in case the algorithm of automatic engineered features switchover to bring the nuclear installation to the cooling down (emergency cooling down) mode is violated, the variants of assurance of heat removal from the reactor core;

- methods of determination of reactor subcriticality in case some reactivity compensating rods stick in some intermediate positions over the core height;

- methods of lowering the reactivity compensating rods into the bottommost positions and maintaining the reactor subcritical;

- methods of maintaining the makeup (flush) water inventory.

#### 3.2.6. Radiation Accident Localization.

The methods of physical safety barriers state evaluation shall be specified, including:

- direct and indirect methods of physical safety barriers state evaluation;

- methods of physical safety barrier violation detection and its localization;

- the methods of evaluation of the state of engineered features of keeping and maintaining efficiency of the physical safety barriers.

#### 3.2.7. Assurance of Ship Personnel Radiation Safety.

The following shall be described:

- arrangement and technical rigging of ship radiation situation monitoring;

- the process of identification of the contaminated rooms and the number of personnel in them, their life support and evacuation;

- arrangement of planning (in conformity with the valid legislation) of the enhanced exposure of personnel involved in the actions aimed and radiation accident liquidation;

- the process of administration of the medicines from the individual antiradiation first aid kits;

- the procedure of recruiting, identification of equipping and training of emergency team and group personnel for general and radiation reconnaissance and for performing work in the radiation accident area;

- arrangement of personnel evacuation and determination of the escape routes from the radiation accident area;

- arrangement of radiation examination of the personnel evacuated from the radiation accident area;

- the process of monitoring and accounting of individual exposure doses of the personnel engaged in the activities aimed at radiation accident localization and its consequence liquidation;

- the procedure of the use of the individual protection and personal hygiene means;

- monitoring of contamination of the individual protection means, clothes and skin at the places of coming out of radiation accident area, as well as of collection of the contaminated protection means and clothes and safe temporary storage;

- assessment by express-methods of the quantity of radionuclides entering inside the organism of the personnel exposed to radiation, detection of the persons to be subject to additional examination by biophysical methods and spectrometric analysis of the body;

- arrangement of sanitary treatment of the personnel, place and procedure of such treatment, special treatment in case of damage of skin and mucous tunics, deployment of additional sanitary locks (if necessary).

### 3.2.8. Radiation and general situation reconnaissance in the accident area.

The following shall be specified

- the composition of radiation and general situation reconnaissance groups and their equipment;

- the procedure of instructions, formulation of the tasks of personnel rescue, visual inspection of actual state of the reactor plant system (element) state, preparation and putting into effect of the reactor plant systems (elements), measurements of radiation situation parameters as well as the procedure of entering the radiation accident area to perform the tasks, stay in that area and leaving it;

- arrangement of forming of rescue teams, radiation and general situation reconnaissance groups and sanitary team (group) out of the members of the emergency party to render medical assistance to the personnel evacuated from the radiation accident area;

- the process of sanitary treatment and decontamination of the personnel and rescue team members brought out of the radiation accident area;

- the process of treatment and generalization of the radiation accident area visual inspection results, of the actual measurements of the characteristics of radiation situation in the radiation accident area taken by the radiation and general situation reconnaissance teams to submit the information to the main command post.

#### 3.2.9. Medical assistance to the injured persons.

The following shall be specified:

- the locations of medical posts to render assistance;

- furnishing of the medical aid posts with property, medical means, medicines, including individual antirad medical first aid kits, stable iodine medicines, other antirad medicines;

- the procedure of iodine prophylactics and administration of antirad medicines;

- the procedure of rendering first medical aid to the injured persons and their sorting out;

- the procedure of evacuation of the injured persons (if any);

- the process of urgent hospitalization of personnel who have been subject to individual dose above 1 Sv;

- the process of sending to medical examination of the personnel who have received individual doses 5 times as high as the limit dose specified by the radiation safety standards;

- the procedure of providing information on the results of medical examination of the ship personnel and rendering urgent medical aid to the top managers of the Operating Organization and to the managers of the organizations (if necessary) cooperating in performing the emergency actions;

- arrangement and performing the examinations of food and potable water.

### 3.2.10 Evaluation of the nuclear installation emergency state.

The methods of evaluation of the technical state of the nuclear installation suffering an accident after it is brought into the safe mode shall be described, taking into consideration:

- the refined data on the results of radiation and general situation reconnaissance in the radiation accident area;
  - technical state of the systems (elements) of nuclear installation, including:
    - physical safety barriers;
    - safety-related (control, protective, localizing and support) systems (elements) of the nuclear installation;
- the analysis of process fluids inventory state.

3.2.11. Evaluation of possibility of recovery of the nuclear installation operability after radiation accident.

It is necessary to provide the evaluation of the possibility:

- partial decontamination of rooms and equipment for periodical maintenance of systems (elements) of nuclear installation;
- operation of nuclear installation systems (elements) after elimination of the accident causes, recovery of normal operation limits and conditions, including by means of reduction in redundancy and nuclear installation operation power level.

### 3.3 Peculiarities of the Ship Action Plan in the port.

3.1.3 The requirements specified by port administration for arrangement of notification about an accident at a ship nuclear installation, cooperation with port emergency team and towage of the ship with the nuclear installation suffering an accident to a remote berth (if necessary) shall be taken into consideration in the Ship Action Plan in the port. Cooperation of port personnel with the ship with nuclear installation suffering an accident, engagement of organizations and ministries in liquidation of radiation accidents takes place in conformity with the Port Action Plan.

3.3.2 The requirements of the Ship Action Plan in the port set forth for the actions aimed at the ship personnel protection and liquidation of radiation accident at a nuclear

installation are similar to the requirements for the actions performed at the nuclear installation suffering an accident when the ship is in the sea, as described in item 3.2.1 - 3.2.11.

3.3.3 The Ship Action Plan in the port shall stipulate:

- the procedure of the use of communication means and notification system (connection of the ship to public telephone network, with the port telephone exchange; direct communication line to the port administration; application of radiotelephone means);

- permanent presence onboard of the ship captain or his replacement and the specified number of personnel to implement the emergency actions in case of radiation accidents;

- preparedness for ensuring the towage and the route of the ship with the nuclear installation suffering an accident to a remote berth, as well as the list of water crafts which may perform such towage;

- the list of emergency parties, location of their gathering and equipping;

- assessment of radiation situation at the ship and at the adjacent port territory, establishing of radiation monitoring if the radiation situation aggravates;

- evacuation routes of the ship personnel not participating in the post-accident actions;

- measures of radiation monitoring and rendering medical aid to the ship personnel and port personnel who have been exposed to radiation effects, measures of their sanitary treatment;

- the procedure of the use of shore-based fire extinguishing facilities and implementation of other anti-accident measures including power supply from the shore;

- providing information on any fire onboard to the port fire brigades, on the fire fighting measures taken together with port fire fighting detachments and notification of the port fire fighting brigades participating in fire liquidation (when such fire occurs) of the radiation hazard;



- ship guarding (taking into consideration the local conditions), by port or other local guards (if necessary) preventing the possibility of uncontrolled access to the ship of unauthorized persons;

- determination of technical and organizational measures of ship protection from external effects.

3.3.4 The scheme of notification of port administration about the radiation accident, developed at the ship, shall be agreed with the port administration.

3.3.5 The events, actions of the personnel and orders during radiation accidents at a ship nuclear installation shall be recorded in the sea logs as at the central control room so at the ship main command post by the installed engineered features of recording.

3.3.6 Before accident investigation by the special commission the ship captain shall approve the technical report on the accident.

3.3.7 To define the classification of the radiation accident at the ship nuclear installation and develop recommendations on its liquidation the accident final identification shall be implemented by the commission appointed by the authority of the management of atomic energy use in compliance with the jurisdiction the ship is subject to and the Federal Atomic Energy Agency within the time periods specified by the mentioned authorities, notifying at the same time the state body regulating safety of the use of atomic energy.

#### 4. SHIP ACTION PLAN UPDATING AND REVISION

4.1. A person responsible for Ship Action Plan updating and revision and support of its continuous conformity with the tasks performed by the ship and the ship crew composition shall be officially appointed at the ship equipped with a nuclear installation.

4.2. The Ship Action Plan shall be revised not less than once each five years. They shall be revised during putting into effect the regulatory documents that introduce changes into the emergency planning at the federal and ministry and Operating Organization levels, the practice of use of the ship equipped with nuclear installation, changes in the notification system, technical state and performances of the ship, personnel experience enhancement, names of official persons.

4.3. Frequently changing information contained in the Ship Action Plan (the crew, telephone numbers etc.) shall be updated with the established frequency.

4.4. The Operating Organization controls the regularity of Ship Action Plans updating and revision.

4.5. During the work of getting ready for decommissioning of ship nuclear installation the Ship Action Plans are compiled and approved before the nuclear installation is brought into safe mode from the viewpoint of nuclear and radiation hazard.