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1/ MINISTRY OF NUCLEAR POWER OF THE USSR
60TH ANNIVERSARY OF THE SOVIET UNION NUCLEAR POWER PLANT AT ROVNO

OPERATIONAL RULES FOR UNIT NO. 3 OF THE ROVNO NUCLEAR POWER PLANT

Approved by the Chief Engineer of the Rovno Nuclear Power Plant, Ye. A. Andreev, on November 11, 1988

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[Trans: The numbers in the margins indicate the pagination of the foreign text]

9/ BASIC DEFINITIONS

Preparing a power unit for startup is a combination of steps and operations to repair, check, and test the systems of a nuclear power plant performed for the purpose of bringing their characteristics up to design standards.

A power unit is cold when its systems and equipment conform to the following conditions:

1) the reactor plant is sealed;
2) the reactor is subcritical and the control rods of the safety system of all groups are in the extreme lower position. The content of the liquid absorber (boric acid) in the water of the primary circuit is determined by the reactivity of the reactor core and is equal to the standing concentration for the assumed (two or three year) run of the reactor fuel (National Standard 95 962-82);
3) the average temperature of the heat transfer agent in the primary circulation circuit and the metal of the equipment is no greater than 70C and pressure in the primary circuit is no greater than 15 kilogram force per square centimeter;
4) the temperature of the metal of the body of the turbine in the area of the steam admission pipes is no greater than 80C.

A power unit is hot when its systems and equipment conform to the following conditions:

A brief shutdown is a shutdown (disconnection) of a power plant due to errors by operators or the false or true operation of safety and interlock systems which does not cause damage to the primary equipment for the time needed to determine the causes of the shutdown and correct deficiencies (no more than three days).

An emergency shutdown is a shutdown caused by the operation of the scram system or operational safety systems which make the reactor hot or cold.

False operation of the scram or operational safety systems is operation due to malfunctions of the components of their electrical circuits when the equipment and systems of the power unit are operating normally.

10/ Startup of a unit is a combination of operations which makes it possible to connect the turbogenerator to the power grid and then bring the load up to a specific level.

Power operation of a unit is its prolonged operation at a specific power level determined by the characteristics of its equipment.

Shutdown of a unit is a condition where:

1) the turbogenerator is disconnected from the power grid;
2) the unit is switched to either hot or cold.

Cooling is a combination of operations on systems and equipment which make the reactor cold.

Readiness for operation is a condition of a system (equipment) when no additional operations other than those called for by the design are required to activate the system and make it fulfill its functional purpose.

The startup range is a range of anticipated critical contents of boric acid in the water of the primary circulation circuit for a given nuclear steam generation plant condition equal to 1 gram per kilogram and reckoned in the direction of values higher than its nominal critical content.

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INTRODUCTION

The rules were written in light of the requirements of:

1. general principles of ensuring the safety of nuclear power plants in design, construction, and operation (General Safety Principles 82).

2. nuclear safety rules for nuclear power plants (Nuclear Safety Rules 04-7, Moscow, Atomizdat, 1977, 2d edition).

3. operational rules for electric power plants and grids (13th edition, Moscow, Energiya, 1977);

4. Rules for the design and safe operation of the equipment of nuclear power plants and pilot and research reactors and installations (Moscow, Energoizdat, 1984);

5. Radiation safety standards (Radiation Safety Standard 76, Moscow, Energoizdat, 1981);

6. Basic health rules for handling radioactive materials and other sources of ionizing radiations (Basic Health Rules 72(80), Moscow, Energoizdat, 1981);

7. Health rules for designing and operating nuclear power plants (Health Rules for Nuclear Power Plants 79, Moscow, Energoizdat, 1981);

8. National Standard 95 962-82. The Heat Transfer Agent of the Primary Circuit of a VVER-1000 Nuclear Reactor. Quality Requirements. Ways of Maintaining Quality;

9. 8.05-Pr-2298. Water and Chemical Condition Standards for the Secondary Loop of Nuclear Power Plants With Water Moderated Water Cooled Power Reactors. Requirements for the Quality of the Working Medium and Ways of Maintaining and Monitoring It. National Standard 37-769-85;

10. Rules (Provisional) for Testing the Equipment of the Safety Systems of Nuclear Power Plants with VVER-1000 Reactors (V-320), Moscow, 1985;

11. Rules (Provisional) for Testing the Equipment of the Safety Systems of Nuclear Power Plants with VVER-1000 Reactors (V-320), Moscow, 1985;

12. Materials of the Designs of the Power Units of Power Plants with VVER-1000 Reactors, Including the Materials of Nuclear Steam Generator Designs (V-320).

Administrative and technical personnel and the personnel of the sections, departments, and services of nuclear power plants are obligated to meet these requirements.

12/ Changes to the rules must be submitted in writing and then approved by the organizations which took part in formulating the Standard Rules (TVR-1000-1) and then approved by the Main Administration for Water Cooled Water Moderated Reactor Nuclear Power Plants of the Ministry of Nuclear Power.

This document does not concern design accidents or damage control. This information is provided by the Damage Control Manual.

The document does not concern specific routine operations, which are the subject of the operations manuals for the systems and equipment of the power unit.

The provisions of the rules place emphasis on certain requirements of the operations manuals written by the designers of the equipment and nuclear steam generators and the requirements of the general contractor. In writing operations manuals one must take into account all the requirements of the operations manuals written by the designers of the equipment and systems and the manufacturers.

All operations on equipment and systems must be performed in accordance with the requirements of operations manuals.

These rules were written on the basis of Standard Rules TVR-1000-1.

13/ ## 1. GENERAL REACTOR OPERATION PRINCIPLES

1.1. After fuel recharging or repairs or a shutdown lasting for more than three days, a power unit should be started up under the supervision of the plant's chief engineer. Otherwise the unit should be started up under the supervision of the shift supervisor in accordance with guidelines written on the basis of design specifications and the requirements of this document and the results of tests of the basic normal and emergency conditions of the power unit.

1.2. The shift supervisor is responsible for overall immediate supervision of connections between the power unit and general plant systems and for communications with the duty controllers of the controller services (the central control service, regional electrical administration, or consolidated control agency).

1.4. A list of equipment indicating the persons assigned to maintain it should be approved by the director of the power plant, while a list of equipment indicating the persons responsible for controlling it should be approved by the chief engineer of the regional electrical administration.

1.5. No matter what condition the unit is in, there should be an operator present at every work station of the unit's control panel who is authorized to control the systems in question.

1.6. A list of hazardous operations and conditions should be put together and approved by the chief engineer of the plant. Operations manuals should provide complete information on the conduct of operations and describe organizational procedures for the safety of these operations.

1.7. Operations not described in this document and hazardous operations not included in the approved list and the startup of a unit after its basic equipment has been overhauled should be conducted on the basis of programs coordinated with the scientific director, chief designer, and manufacturer of this equipment and approved by the chief engineer of the plant.

1.8. The appropriate duty and operations manuals and instructions should be used to determine the functions and duties involved in maintaining systems, equipment, and rooms and the operational procedure and the schedule for monitoring parameters in the operation of individual systems and equipment in the process of maintaining the unit's operation.

14/ 1.9. A list of systems and equipment where switchings must be carried out according to special switching instructions which indicate the sequence of operations and safety measures and a list of rooms and equipment which should be locked up should be put together and approved by the plant's chief engineer.

1.10. If the alarm system goes off or unforeseen deviations occur in the process of making a planned change in the condition of the unit, operators should temporarily halt this change (if necessary returning the unit to normal condition) and determine and correct the cause of the deviations and continue the operations they have begun only after this has been done.

1.11. Prior to prestartup operator tests of basic systems and equipment, the heads of the departments responsible for maintaining and repairing them should make entries in the appropriate log ("Power Unit Instructions) after the maintenance has been completed indicating that all maintenance has been completed and the equipment and svstems are ready for testing.

1.12. In recharging the reactor fuel a fuel recharging certificate should be written up and a cartogram of the fuel charge and cartogram indicating the location of used fuel in the cooling pond should be appended to the certificate.

1.13. Section personnel should test the systems and equipment and make them ready for startup under the supervision of section shift supervisors. The completion of these operations should be indicated by entries in the appropriate logs, including the power unit's shift supervisor's operations log.

The unit shift supervisor is obliged to organize and conduct a test of the unit's safety and interlock systems (a list of the systems to be tested in the event of a shutdown lasting no more than 7 days is given in the appendix) and check to see that the system as a whole is functioning properly using the appropriate personnel at his disposal. The results of the test should be certified (using a certificate of acceptance of the unit's safety system from the maintenance department) and recorded in the "Safety System Test Log."

1.14. After system and equipment tests and checks have been completed, the unit shift supervisor must inform the plant's chief engineer that the unit is ready for startup, and afterwards the chief engineer should authorize the shift supervisor in writing (by making an entry in the "Unit Instructions") to start up the unit, indicating the maximum permissible reactor power level.

15, 1.15. The unit shift supervisor should inform the plant shift supervisor that he has been authorized to start up the reactor and give a written order (in the operations logs of the reactor and turbine sections).

1.16. If a unit has been shut down for a short period of time and there was no damaged equipment or rebuilding involved, a the unit may be brought up to full power after authorization in writing by the shift supervisor of the plant with an entry (in the appropriate form) in the unit shift supervisor's operations log.

1.17. If damage to equipment or system components which make it impossible to start up a unit is discovered after a shutdown, the unit may be started up again only upon receipt of written authorization from the chief engineer of the plant (in the "Unit Instructions") after a commission appointed by him has investigated the causes of the shutdown and after all defects and damage have been repaired.

1.18. The plant shift supervisor is responsible for authorizing any planned change in the power of the unit or a planned shutdown but first must receive the appropriate authorization from control agencies (the central control agency of the regional electrical administration).

1.19. The operations involved in reducing the power and shutting down the unit are performed by operators after they have received written authorization from the unit shift supervisor.

1.20. If an accident situation which threatens nuclear safety should occur, the operator of the reactor is obliged to shut down the reactor on his own (switch it to subcritical) if further operation would threaten the safety of the unit and the power plant as a whole.

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2. PREPARING THE POWER UNIT FOR STARTUP

Prior to startup, entries should be made in the Unit Instructions to reflect the changes in the equipment made following the established procedure and should include instructions for the operators on operational procedure on the basis of these changes.

Operational records at operator work stations should be revised in accordance with these changes prior to startup.

2.1. The condition of normally operating systems and equipment prior to startup.

2.1.1. The nuclear steam generator is cold.
2.1.2. The condition of the main electrical connections and plant auxiliaries and auxiliary power supply systems and equipment should meet the following requirements:

- the eq[illegible]ent for outputting power to the power grid (the systems [illegible] buses, outdoor distribution system, autotransformer) should be energized;

- the unit transformers and main auxiliary power transformers should be put under auxiliary load;

- the 6 KV high voltage backup supply sections should be supplied from the backup auxiliary transformers, and the circuit breakers of the backup leads of these sections should be set for emergency backup activation;

- all the low voltage (0.4 KV) auxiliary power sections should be supplied by the main leads. A backup transformer may be substituted for no more than one main transformer (6/0.4 KV) in each group of sections if authorized by the chief engineer of the plant;

- reliable power should be provided for the unit control panels from the main and backup auxiliary power sections and power must be transmitted to the backup control panel and local control panels of the unit.

- one must check alarm settings and circuits and the sound and light alarms of the unit control panel and backup control panel should be in good working order. One should check the backup control panel to make sure that it can monitor and control the equipment of the power unit properly.

2.1.4. The main and backup lighting in the rooms of the power unit should be checked and turned on.

2.1.5. Intercom and telephone communications with the rooms and workplaces of the unit should be checked and be in good working order.

2.1.6. The auxiliary steam supply of the unit should be in operation. One should make sure that steam can be delivered from its sources (a common line connecting the unit to other units and/or the startup-backup boiler) to all loads in the required amount with the appropriate characteristics.

17/ 2.1.7. The water supply system for noncritical loads (group C) and the circulation water supply system should be operating properly and should be able to deliver the nominal flow of water to loads. The water temperature should be nominal.

The unit's heat release system (cooling towers or cooling pond, spray pond) should be in working order as indicated in the design.

2.1.8. The high and low pressure nitrogen dispensing system should be ready for operation. The nitrogen receivers should contain the proper amount of nitrogen at the nominal operating pressure. The quality of the nitrogen should meet the requirements of standards (State Standard 9293-74, grade 1).

2.1.9. The ventilation systems and cooling systems should be activated as called for by the design.

2.1.10. The dosimetric monitoring system should be activated as called for by the design. The alarms of this system should be checked.

2.1.11. The special plumbing of the reactor section and the special facility and the drainage system of the turbine sections should be serviceable. The sump water tank of the special plumbing of the reactor section and drainage tanks and sumps of the machine room should be prepared to take in drainage.

2.1.12. The automatic process control system of the unit (including the reactor monitoring system, control computer system, standardized set of hardware, and automatic control system) should be fully activated.

2.1.13. The pulse lines of the instrumentation should be purged. The instruments should be tested and turned on. The characteristics of the power unit should be fully monitored, measured, and recorded at the unit control panel, backup control panel, and local control panels.

2.1.14. The valves and their control circuits should be checked; valves which have undergone repairs (inspections) for electrical or mechanical problems should be tested for leaks. Unit safety valves should be adjusted and tested as called for by unit inspection and testing schedules. Safety valves which have been repaired should be adjusted on a stand prior to installation or tested in place.

2.1.15. The equipment and systems of the special facility's special water treatment units should meet the following requirements:

- the sump water treatment unit, the holding tank water treatment unit, the steam generator purge water treatment unit, and the boric acid regeneration unit (Treatment Units 3, 4, 5, and 6) should be prepared for operation to the extent which will make it possible to start up the reactor. The filters of these units should be regenerated if necessary;

- at least half of the control tanks of the special water treatment units should be emptied and prepared to take in fluid;

/18 - there should be a supply of appropriate reagents at the reagent storage facility of the special facility sufficient to enable the continuous operation of the unit at nominal power for one month.

2.1.16. The necessary supply of distillate (at least 500 cubic meters) should be prepared for the makeup tanks of the primary circuit. The distillate system pumps should be prepared for operation. Distillate quality should conform to standards (National Standard 95 962-82).

2.1.17. The mixers for preparing a boric acid solution and the system for delivering this solution to loads should be ready for operation.

2.1.18. A supply of boron containing water (at least 150 cubic meters) should be prepared in every purified boric concentrate tank. Water quality should conform to standards (National Standar. 95 962-82).

2.1.19. Free space (at least 500 cubic meters) should be left in the tanks for taking in the discharged waters of the primary circuit.

2.1.20. The process circuit system should be in operation. Process circuit water should be delivered with a nominal flow to all the loads of the reactor section. The level of distillate in the respirator tank of the system should be nominal as indicated by a level gauge. Water quality should confotm to standards. Water temperature should be in the nominal range.

2.1.21. The special gas treatment and gas blowoff system should be operating nominally.

2.1.22. The primary circuit organized leak system should be ready for operation. The gas blowers of the special gas treatment system should be used to establish the nominal underpressure in the organized leak tank. The level in the tank should be minimal for normal operation.

2.1.23. The pressure compensation system should be ready for operation. The electric heaters of the pressure compensator should be serviceable.

The bubbling tank should be filled with water to the nominal level (1700 millimeters). The integrity of its split membranes should be checked. Water temperature should lie within the established range (20 to 60C). Water quality should conform to standards (8.05-Pr-2298). The level maintenance and bubbling tank blowoff systems should be ready for operation. The water level in the pressure compensator should be 11600-11700 millimeters.

2.1.24. The reactor section oil supply system should be serviceable. The emergency oil drain tank and tank for draining oil from the cases should be emptied and prepared to take on dirty oil.

The necessary supply of oil should be prepared for every oil tank for the makeup units. Every tank of the main circulation circuit's oil supply system should be provided the required supply of oil.

19/ Oil quality should conform to standards (State Standards 9972-74, State Standard 32-74, or Specifications 1084-80).

2.1.25. The makeup purge system should be ready for operation and all (three) makeup pumps should be ready.

The makeup deaerator of the primary circuit should be filled with boric water to the nominal level and the boron concentration should be equal to boron concentration in the circuit.

The boron control deaerator should be emptied.

2.1.26. The sample preparation system should be ready for operation. The primary circuit water automatic radiation monitoring system should be turned on. Samples should be taken by hand in accordance with the established schedule.

2.1.27. Special water treatment unit 2 should be ready for operation. The newly regenerated filters of the unit should be activated prior to warming up the nuclear steam generator.

2.1.28. The reactor and primary circulation circuit should be ready for operation and should meet the following requirements:

- reactor fuel recharging operations should be completed, the reactor core charge should be checked to see if it conforms to the approved cartogram of the fuel charge, one should see that information on the neutron and physical characteristics of the reactor are available, and this information should include, in particular, the results of calculations of the burnup reactivity margin, the efficiency of the control rods of the control and safety system, and the levels of static and dynamic Xe-135 and Sm-149 poisoning.

- the reactor should be made subcritical by filling it with a solution of boric acid with a concentration determined for the assumed duration of the run of the fuel charge (12 grams per kilogram).

- all the actuators of the control and safety system should be linked to their control rods. A dynamometer should be used to check the connection of the rod of a control actuator to the absorber element assembly, and one should check to see that the connection is firm by moving the rod of the holder.

- all the low pressure piping of the auxiliary systems of the nuclear steam generator should be reliably disconnected by means of their cutoff valves from the high pressure piping, with the exception of the systems for emergency gas removal from the primary circuit, draining the loops, and removing air from the separate circuits of the main circulation pump, the electric actuators of valves in this position should be deenergized, and the manual backups should be removed. The unit shift supervisor is responsible for checking the disconnection. The reliability of disconnection should be checked every shift by means of the alarms on the unit control panel and the condition of the control cabinets. The cabinets which contain the automatic systems and knife switches for taking power from the power and control switches after the systems and switches have been put in a position which deenergizes the electric actuators should be
20/ locked and sealed.

- The equipment of the nuclear steam generator should be assembled and sealed, the reactor should be assembled and sealed, water with a temperature of 20 to 60 degrees and a quality which meets standards (National Standard 95 962-82) which has been inspected for deaeration should be added to the primary circulation circuit, and the boron content of the added water should be no lower than that in the primary circulation circuit and the pressure of the primary circuit should be no lower than 5 kilograms per square centimeter.

Adding water to (filling) the primary circulation circuit is prohibited when the reactor is cool if the water temperature differs by more than 30C from the temperature of the metal of the body of the reactor, the primary circulation piping, the primary circulation pump, or the steam generator;

- the bypass water treatment unit (treatment unit 1) of the primary circuit should be ready for operation;

- the neutron flux of the reactor should be monitored by means of the neutron flux monitoring equipment in the source range. The channels of the information system should be purged and filled with nitrogen with a nominal pressure of 1.0 to 1.5 kilogram force per square centimeter and the valves for delivering and removing nitrogen from the channels should be closed;

- the energy release and temperature monitoring channel connectors should be electrically connected to the [Trans: the abbreviation used in this case, VRK, is not indicated in the list of abbreviations given at the beginning of the document or defined in any available reference materials] equipment;

- the system for monitoring leaks in the joints of the equipment of the primary circuit should be operational, and there should be no pressure in the space between the gaskets of these joints;

- the serviceability of the electrical portion of the reactor's control system should be checked in accordance with operations manuals and an entry should be made in the appropriate log indicating that the reactor is ready to be brought up to power and this entry should be signed by the head of the thermal automatic control and monitoring department.

The unit shift supervisor is responsible for meeting the requirements of this subsection. The results of check(s) performed on the instructions of the unit shift supervisor should be indicated in his operations log.

2.1.29. All the primary circulation pumps should be ready for operation.

Process circuit cooling water and sealing water must be delivered to the primary circulation pumps not used in starting up the unit.

2.1.30. The primary circuit rooms (according to the approved list) should be inspected to see that no persons or combustible and explosive objects are in them. After the end of the inspection these rooms should be sealed and closed. The interlocks for opening (or closing) the main and emergency pressurized locks should be activated.

The results of the inspection should be entered in the unit duty supervisor's operations log and the inspection should be made by the unit duty supervisor.

2.1.31. The systems for monitoring the level in the steam generator and monitoring the moisture content of the steam line in back of the steam generator should be activated. The operation of the level gauges of the steam generator should be checked by comparing the readings of different level gauges. If the readings of level gauges of the same kind differ by more than 21/ 30 millimeters on one steam generator, then the KUP-1000 system should be used to check to see that the level measuring system is operating properly.

Every steam generator should be filled with water through the secondary circuit to a specific level (3700 millimeters). Water quality should conform to standards (8.05-Pr-2298). The filling of the steam generators should be completed prior to the start of leak tests of the primary circuit.

The system for monitoring leaks in the joints of the steam generators on the primary and secondary circuits should be operational, and there should be no pressure in the space between gaskets of these joints.

2.1.32. The operation and correctness of the settings of the safeties and interlocks of the systems and equipment of the unit should be checked in accordance with the settings diagram.

The safeties and interlocks must be fully tested by acting on the actuators and emergency backup activation devices of the equipment with the backup activated prior to every startup if the unit and equipment have been down for 7 days or more. If actuation operations cannot be tested due to the condition of a unit (actuator), the safety system should be checked without acting on the unit (actuator).

Systematic testing of the safety and interlock systems and the emergency backup activator is the responsibility of the personnel on duty in the reactor section, turbine section, chemical section, thermal control and measurement section, and the electrical section under the supervision of the section shift supervisor depending on what equipment they are responsible for and the results should be entered in the unit shift supervisor's operations log.

2.1.33. The safety systems of the power unit should be activated. The devices for activating the safety systems and the devices included in the safety system (except for the recording devices) should be closed and sealed.

2.1.34. The condition of other systems which do not directly affect the readiness of the unit for startup and the operation of the unit is determined by the need to use them and operations manuals.

21/ 2.2. The Condition of the Safety System Prior to Startup

2.2.1. The emergency power supply system of the power unit should be tested and meet the following requirements:

- the 6 and 0.4 kilovolt sections for supplying the loads of the first and second categories of reliability and the direct current panel should be powered by the primary leads from the auxiliary power transformer;

- all the diesel generators should be ready for operation and automatic startup should be checked. It should take them no
22/ longer than 15 seconds to reach rated speed.

The automatic system for starting up and gradually connecting the load of a diesel generator should be ready for operation.

The oil and fuel service tanks of the diesel generators should be filled to the nominal level (each should contain 10 tons each). Each tank in the intermediate storage facility should be given a supply of fuel in accordance with VSNTP-80 [Trans: VSNTP-80 is evidently some sort of regulation not listed in the abbreviations given at the beginning of the document or any available references] sufficient to ensure continuous operation of the diesel generators for two days.

The quality of fuel and oil should meet manufacturer's standards.

- the storage batteries and continuous power supply unit should be operational.

2.2.2. The neutron flux monitoring equipment and electrical equipment of the control and safety system should be systematically inspected.

- the reactor power regulation and limitation device and the automatic power regulation device;

- the devices for controlling and monitoring the positions of the control rods of the control and safety system and the devices for supplying electrical power to the system;

- the devices for generating emergency safety and preventive safety signals.

2.2.3. The active subsystem of the reactor core emergency cooling system should be tested and ready for operation.

The boric acid solution emergency supply tank should be filled with boron containing water with a temperature of 20 to 60 C and a level no less than nominal (3100 mm; 500 cubic meters).

Water quality should conform to standards (National Standard 95 962-82).

Three of the four hydroaccumulator tanks of the passive subsystem of the reactor core emergency cooling system should be ready for operation and disconnected from the primary circulation circuit. The other tank should be ready for tests involving pouring a boric acid solution into the reactor.

2.2.4. The system for emergency addition of a high pressure boric acid solution to the primary circulation circuit should be tested and operational. Each tank should contain the nominal supply of a concentrated boric acid solution (15 cubic meters) with a temperature of 20 to 60C. Water quality should conform to standards (National Standard 95 962-82).

2.2.5. The system for protecting the equipment of the primary and secondary circuits from overpressure should be operational. The pulse safety device of the pressure compensator of the safety valve of the reactor core emergency cooling system, the pulse safety device of the steam generator, and the fast acting reducers for discharging steam into the atmosphere and into the turbine condensers should be serviceable.

2.2.6. The localizing (cutoff) valves and their pneumatic and electric actuators and control circuits should be tested and in operating position. The air supply system for the pneumatic actuators should be operational. All three high pressure compressor units should be serviceable.

The compressed air receivers should contain an operational supply of air with the nominal pressure and temperature.

23/ 2.2.7. The sprinkler system should be tested and ready for operation. Each reagent solution tank of the system should contain no less than the amount of boron containing water and chemical reagent stipulated by the design (6 cubic meters).

The quality of the solution of the tanks and in the operation of the sprinkler system should conform to standards (National Standard 95 962-82).

2.2.8. The system for emergency delivery of feed water to the steam generators should be tested and operational.

Each tank of the system should contain no less than the amount of desalinated water stipulated by the design. Water quality should conform to standards (8.05-Pr-2298). The level in each tank should be at least 5500 millimeters.

2.2.9. The fast acting cutoff valve should be serviceable.

2.2.10. The water supply system for critical users (group A) should be operational and deliver the nominal flow to the users.

The water level in the group A water tank should be 4200 millimeters (volume of 80 cubic meters).

2.2.11. All three active channels of the emergency cooling system should be ready for operation and one channel should be in operation for the purpose of handling residual energy releases.

2.2.12. The containment vessel should be tested for leaks with specific excess pressure characteristics (0.7 kilogram force per square centimeter) inside the vessel. The test results should conform to standards ("Standard Guidelines for the Operation of the Accident Containment System of a Nuclear Power Plant with VVER-1000 Power Units). Leak tests should be conducted once every four years and after each abnormal leak in the sealing circuit (cutting into the backup tunnels, and so forth).

Local tests of the cutoff valves on the systems for maintaining underpressure and the special plumbing of the containment vessel should be conducted prior to testing the containment vessel for leaks.

The sealing circuit should be tested by evacuating it by means of the exhaust ventilation system prior to each startup after every shutdown involving repairs of components of the sealing circuit, but at least once every year.

2.2.13. The tilt of the reactor section should be checked on a regular basis (at least once every four years). If the tilt is greater than 1:10,000, the Chief Designer and General Designer are responsible for deciding whether operation may continue.

24/ During operation there should be regular inspections of the stress-strain state of the containment vessel, the prestress system for the containment vessel, and the anchors, compound, and reinforcing wire for the purpose of determining their integrity and making sure that there is no corrosion and the condition of the anticorrosion coating of the sealing lining (if damage is present it should be corrected). If deviations from requirements are found as a result of these inspections the General Designer is responsible for deciding whether operation may continue.

25/ 3. STARTING UP THE POWER UNIT

3.1. Switching the Unit to "Hot"

The power unit may be started up only if the provisions of points 1.14 and 1.15 and Chapter 2 are followed.

3.1.1. Warming up the Nuclear Steam Generator

3.1.1.1. The purge-makeup system of the primary circuit is activated. Makeup water is delivered to the seals of the primary circulation pumps and to maintain the water level in the pressure compensator using the standard procedure.

3.1.1.2. Nitrogen should be delivered to the pressure compensator prior to starting the warmup of the primary circulation pump. The water level in the pressure compensator should be at the upper limit (11600-11700 millimeters) with the proper nitrogen pressure for warmup (approximately 20 to 25 kilogram force per square centimeter) in the gas blanket of the pressure compensator. Nitrogen quality should conform to standards (State Standard 9293-74, grade 1).

3.1.3.3. Hydraulic leak tests of the primary circulation circuit and steam generator should be conducted in accordance with the operations manual. Tests should be conducted every time a leak occurs in the equipment of the primary circulation circuit.

The pressure indicated in the operations manual (250 kilogram force per square centimeter) and a special procedure should be used to conduct hydraulic strength tests of the primary circulation circuit at least once every four years.

3.1.1.4. The minimum temperature of the heat transfer agent of the primary circulation circuit in hydraulic strength and leak tests should be no lower than the temperatures indicated in the operations manual depending on service time (see Table 2 of the Appendix).

In the process of raising pressure in hydraulic tests at any time in the operation period the temperature of the heat transfer agent should not exceed the upper limit indicated in the operations manual (120C).

3.1.1.5. The primary circulation circuit should be warmed up by running the primary circulation pump and the residual heat release of the reactor core. The primary circulation pump should be started up in accordance with the requirements of point 3.1.1.12.

3.1.1.6. The equipment of the primary circulation pump should be checked for leaks with the appropriate pressure levels above the reactor core (35, 100, 160, and 200 kilogram force per square centimeter).

If a leak is discovered at any stage of the hydraulic tests, repairing this leak requires cooling the nuclear steam generator to the temperature indicated in the design and reducing pressure in the circuit to atmospheric pressure.

3.1.1.7. Pressure in the primary circulation circuit should be raised above the limit pressure of 35 kilogram force per square centimeter only after the metal of the reactor vessel and equipment of the nuclear steam generation plant has been warmed up to the hydraulic testing temperature. The rate of change....[Trans: bottom line on pg 25 of original illegible]

26/ 3.1.1.8. The joints in the steam generators of the secondary circuit should be tested for leaks after the hydraulic tests of the primary circulation circuit. The temperatures of the metal of the components of the steam generator (at least 70C) should conform to the operations manual, depending on operating time and pressure in the secondary circuit (88 kilogram force per square centimeter). Pressure in the primary circuit should not exceed 3 kilogram force per square centimeter.

3.1.1.9. In hydraulic tests of the primary circulation circuit and steam generators in the secondary circuit, pressure in the primary circuit should vary over a range so that there is an always an acceptable margin (10C) between the temperature of the heat transfer agent and the saturation point at the actual pressure in the primary circulation circuit.

3.1.1.10. At the hydraulic testing temperature there should be a trial activation of the mechanisms of the emergency reactor core cooling system using a gradual start from the diesel generators once the pressure in the primary circuit reaches 160 kilograms per square centimeter after the hydraulic tests.

If this activation is unsuccessful, the test should be repeated after malfunctions have been corrected.

3.1.1.11. Each hydroaccumulator tank of the passive subsystem of the core emergency cooling system should be subjected to a test involving pouring a boric acid solution into the reactor on an alternating basis once every four years with a pressure of 30 to 35 kilogram force per square centimeter in the primary circuit.

3.1.1.12. The primary circulation circuit should be activated and operated in the process of warming up the primary circuit with a pressure of at least 20 kilogram force per square centimeter above the reactor core and a water temperature in the primary circulation circuit no greater than 150C.

In startup, cooling, and power operation of the nuclear steam generator, one should make sure that air is reliably removed from the separate circuit of each primary circulation pump and the circulation of water on this circuit.

When the primary circulation pump is in operation pressure in the in the primary circuit should be no lower than the stipulated level for a given heat transfer agent temperature in the cold strands of the loops of the primary circulation circuit (see the appendix "Graph of Minimum Pressure Above the Reactor Core at Which the Primary Circulation Pump May be Activated as a Function of Temperature in the Cold Strands of the Loops of the Primary Circulation Circuit").

3.1.1.13. In warming up the nuclear steam generator the water and chemical conditions of the primary circuit should be adjusted with the primary circulation pumps operating and with the water temperature in the proper range. Nitrogen concentration should be no higher than 20 milligrams per kilogram.

3.1.1.14. The equipment of the nuclear steam generator should be warmed up no faster than 20C per hour.

One may warm up the metal of the pressure compensator at a faster rate after a steam blanket has been generated in the pressure compensator but no faster than permitted by the operations manual (30C per hour).

27/ 3.1.1.15. One may reduce the water level in the steam generator to the nominal level after the water temperature in the steam generator has risen to a level in the established range (100 to 120C) if there is boiling in the steam generator.

3.1.1.16. Once the pressure above the reactor core has reached a stipulated level (more than 65 kilogram force per square centimeter) the hydroaccumulator tanks of the core emergency cooling system should be connected to the circuit.

3.1.1.17. Prior to bringing the reactor up to nominal power the temperature monitoring system of the reactor should be checked. This check should follow the instructions of the intrareactor monitoring system operations manual.

3.1.1.18. The pulse safety devices of the pressure compensator should be tested in the process of warming up the nuclear steam generation plant.

3.1.1.19. If the pressure level in each steam generator is at a stipulated level (10 kilogram force per square centimeter), one may bleed steam from these steam generators to heat the equipment and piping of the power unit if the nuclear steam generation plant is warmed up at the proper rate and if the steam generators are continuously replenished with feed water (from the auxiliary feed pump).

The difference between the water temperature in a steam generator and the temperature of the feed water should be no greater than 120C.

The feed water piping should be heated, and stagnant cold water should be removed through the drains or the air valves of the feed piping.

3.1.2. Bringing the reactor to a critical level and the minimum controlled power level.

3.1.2.1. The reactor of the power unit should be brought up to the minimum controlled power level from a subcritical state after the reactor fuel has been recharged and after the reactor has been shut down for more than three days in the presence of a responsible representative of the Department of Nuclear Safety and Reliability (duty physicist).

The senior reactor control engineer is responsible for calculating the content of boric acid in the water of the primary circulation circuit and the startup position of the control rods of the control and safety system and enter the results in the operations log after they have been checked by representatives of the Department of Nuclear Safety and Reliability.

3.1.2.2. The reactor may be brought up to power from a subcritical state after it has been shut down for less than three days without a representative of the Department of Nuclear Safety and Reliability present and the calculation results should be checked by the reactor section shift supervisor.

3.1.2.3. The reactor may be brought up to a critical level if the following conditions are met:

- the requirements of section 2 and the preceding points of this section are met;

28/ - the nitrogen blanket of the pressure compensator is replaced with a steam blanket;

- The water level in the pressure compensator is the nominal level for a given temperature and automatic maintenance of this level;

- the steam passage of the safety valve of the pressure compensator is no higher than the stipulated level (250 kilograms per hour);

- all the hydroaccumulator tanks of the emergency core cooling system have been connected to the reactor;

- the water temperature in the primary circulation circuit is no lower than 230C;

- pressure above the reactor core is no lower than 70 kilogram force per square centimeter;

- the source range, intermediate range, and power range neutron flux metering ionization chambers are set in working position;

- calculations have been made for the critical state of the reactor core in accordance with point 3.1.2.1;

- the actuators of the control and safety system control rods may be moved if pressure above the reactor core lies in the range indicated by the control and safety system operations manual (50 to 160 kilogram force per square centimeter);

- the boric acid content in the water of the primary circuit is no lower than a minimum level which will ensure a reactor subcriticality of at least 0.02 after the control rods have been raised.

3.1.2.4. Any time that a reactor is switched from a subcritical state to power operation, the reactor section shift supervisor must be present at the unit control panel and supervise the actions of the senior reactor control engineer until a switch is made to an automatic power maintenance mode.

3.1.2.5. A reactor may be brought up to critical and to the minimum controlled power level after written authorization has been given by the unit shift supervisor in the operations log of the senior reactor control engineer and the following procedure should be followed:

- all the control rods of the control and safety system should be removed from the reactor core in order of ascending group numbers, with the exception of the control rods used to ensure negative heat transfer agent temperature reactivity coefficients. The groups that are removed should be raised in steps of 35 centimeters (by transmitting a control signal to the actuators of the rods for 18 seconds) with an interval of one minute between steps with a stable controlled neutron flux level.

If in the process of raising the control rods any instrument of any set of the neutron flux monitoring equipment indicates that it has taken less than 60 seconds for neutron power to rise, one should immediately stop raising the group and continue to raise it only after it takes at least 60 seconds for neutron power to rise.

If there is a violation of the logical sequence of transmission of motion to the control rod groups, bringing the reactor to a critical level is prohibited.

A working group of control rods should be raised to the stipulated height of 140 centimeters if.....[Trans: bottom line
29/ of page 28 illegible] If the reactivity coefficient is positive at the beginning of a fuel cycle the startup position of a working group or the group preceding it should be determined so as to ensure the required heat transfer temperature reactivity

coefficient (-0.001%/C) and the unit should be started up in accordance with the "Supplement" to these r 'es.

- the reactor should be brought to the minimum controlled power level by means of reducing the concentration of boric acid in the water of the primary circuit with a flow rate of no more than 10 tons per hour in the startup period. Samples should be taken at least once every 30 minutes for determining and monitoring the boric acid content in addition to continuous monitoring. After the reactor has been brought up to the m imum controlled power level the linkage of the control rods should be checked. This check should be made by lowering the control rods 35 to 70 centimeters from the upper position. Linkage is determined by the change in reactivity or neutron flux.

3.1.2.6. It is prohibited to perform simultaneously any combination of operations involved in removing the control rods from the reactor core, lowering the content of boric acid in the water of the primary circuit, or changing the water temperature in the primary circuit so as to lower its density in the startup period.

3.1.2.7. During the time that the reactor is brought to critical and to the minimum controlled power level it should take at least 60 seconds for reactor power to increase.

3.1.2.8. The following operations are prohibited while bringing the reactor to critical:

- any repairs on equipment or in control and safety system and neutron flux monitoring equipment circuits;

- any operations which may lead to an unplanned change in temperature in the primary circulation circuit;

- activation or deactivation of a primary circulation pump (depending on the sign of the water temperature reactivity coefficient);

- periodically replenish the steam generator by the primary feeder in the startup period and until power is sufficient for the unit's auxiliaries (10% of nominal);

- transfer boric acid from the primary circuit with a flow greater than indicated by the rules (10 tons per hour) during the startup period;

- sharply reduce pressure in a steam generator;

- rapidly raise a group of control rods;

- activate the filters of special water treatment unit No. 2 during startup;

- perform any other operations which may lead to an unanticipated change in the reactivity of the reactor core.

30/ 3.1.2.9. The senior reactor control engineer is obliged to inform the reactor section shift supervisor that the minimum controlled power level has been reached and make an entry in his operations log.

The position of the control rods of all the groups and the boric acid content in the water of the primary circuit and the basic characteristics of this circuit must be recorded in the operations logs of the senior reactor control engineer and unit shift supervisor.

3.1.3. Raising Reactor Power Above the Minimum Controlled Level

3.1.3.1. Raising reactor power above the minimum controlled level is prohibited if the conditions and operations listed in this section are not met and performed.

3.1.3.2. The serviceability of all automatic power controller channels should be checked once reactor power is in the unit's auxiliary power range (10% of nominal). The check should be made by moving the control rods up and down a specific distance (within a 35 centimeter zone) by means of the individual control system. The automatic power regulator should maintain a specific power.

After the check is completed the control rods must be returned to their initial positions and the automatic power regulator left in an automatic mode.

3.1.3.3. Reactor power should be raised to nominal automatically in a way so that upon a reduction in the boric acid content in the primary circuit the control rods of the working group are always in a position which will optimize the energy release field and the effectiveness of the scram system and ensure negative heat transfer agent temperature reactivity coefficients. (The control region 140 to 300 centimeters in size for the working group should be maintained by adjusting the boric acid concentration in the water of the primary circuit).

One may raise the power of the reactor by means of remote control with the primary controllers of the power unit operating automatically. The unit's automatic controllers should be activated in accordance with the operations manuals for individual systems and equipment. Reactor power should be built up in accordance with the restrictions listed in Table 1 of the Appendix.

3.1.3.4. Once the reactor has reached the power level indicated by the operations manual (10% of nominal), the neutron flux monitoring equipment should be calibrated on the basis of the results of calculations of thermal power perfomred on the basis of process characteristic readings.

3.1.3.5. The following requirements should be met in raising reactor power and in subsequent operation of the unit:

- one must monitor the tightness of the joints of the nuclear steam generation plant on the primary and secondary circuits and monitor process characteristics;

- one must use the radiation safety monitoring equipment to continuously check the fuel element cans for leaks on the basis of specific total gamma activity and neutron flux density;

31/ - the isotope composition of the media of the primary and secondary circuits should be periodically checked by means of radiochemical analysis of samples in accordance with special rules;

- one must monitor discharges of radioactive gases into the ventilation stack of the power unit, discharges of radioactive nucleides with liquid wastes, and monitor the specific activity of air in attended and unattended areas of the reactor section, the levels of which should not exceed established values and standards.

3.1.3.6. Prior to starting up the turbine, the thermal power of the reactor may be increased (to 40% of nominal) with discharge of steam through the fast acting reducer for discharging steam into the turbine condensers.

3.1.3.7. The feed turbopump should be started up either by providing auxiliary power to the unit from startup-backup boiler (common plant line) or at the maximum possible reactor power which can be provided by two auxiliary feed pumps. The load regulator is used to start up the feed turbopump.

3.1.3.8. The turboset may be connected to the grid, if:

- the steam generator is supplied by the feed turbopump;

- the electrical subsystem of the turbine regulation system is in operation;

- steam pressure in the primary circulation circuit is equal to nominal;

- the total flow of fresh steam through the fast acting reducer for discharging steam into the turbine condensers is sufficient for the turbine to take on the specific load;

3.1.3.9. Continuous purging from each steam generator with a flow as high as 7.5 tons per hour and periodic purging with a standard flow of 30 tons per hour through the steam generator's purge water treatment unit (special water treatment unit No. 5) (8.05-Pr-2298) should be provided to maintain proper water conditions in the steam generator.

When a steam generator is started up after coming out of mothballs the purging of this generator should be at least 15 tons per hour for a period of time after startup whose duration is determined by the results of chemical analyses and the quality requirements indicated in 8.05-Pr-2298 must be met.

31/ 3.2. Starting up a Hot Power Unit

3.2.1. If repairs have been made on the systems and equipment of a power unit when it is shut down, after the completion of the repairs the systems and equipment should be tested and brought into the condition defined in section 2 on the basis of the following characteristics:

- the reactor is critical or is in auxiliary power operation;

- all the primary circulation pumps planned for startup, at least two, are operational;

- the pressure regulator of the primary circuit is operational and pressure above the reactor core is 160 kilogram force per square centimeter;

32/ - the water temperature in the primary circuit is equal to or greater than 260C;

- the water level in the pressure compensator is equivalent to its level for a given average temperature of the water of the primary circuit;

- the primary circuit's purging and makeup system is operational;

- the bypass water treatment unit of the primary circuit (special water treatment unit No. 1) has been turned on;

- the fast cutoff valves of all the steam generators are open, and the level in each steam generator is nominal, and steam is bled for the auxiliaries of the power unit. If necessary excess steam should be discharged into the turbine condensers by means of the fast acting reducers for discharging steam into the turbine condensers;

- the turbine plant is ready for operation, and the temperature of the metal of the body of the turbine in the area of the steam inlets of the high pressure cylinder is equal to or greater than the level which defines a hot turbine. The rotor of the turbine should be rotated by means of turning the shaft. The rotor hydraulic lift system should be operational. The vacuum in the turbine condensers should be no worse than the startup level determined by the operations manual.

- feed water should be delivered to the steam generator by means of the auxiliary feed pump or feed turbopump. Feed pumps which are not in operation should be ready for operation;

- auxiliary supplies for the power unit may be provided by steam by means of delivering it by means of the auxiliary fast acting reducer from the common plant line (startup-backup boiler or other power units).

3.2.2. In the event that the unit is shut down due to the operation of the scram system, the causes of its operation should be determined and corrected;

3.2.3. During a short-term shutdown caused by operator errors or the operation of the safeties (scram system), one is not allowed to make any switchings in the process and electrical circuits which could lead to a change in the condition of these systems prior to shut down except for technically necessary switchings.

3.2.4. If a reactor is subcritical, it should be brought up to a critical level and the minimal controlled power level in accordance with subsection 3.1.2.

3.2.5. One should conform to subsection 3.1.3. in raising the power of the unit above the minimum controlled level.

33/ ## 4. POWER OPERATION OF A POWER UNIT

4.1. General Requirements for the Operation of a Power Unit

4.1.1. Power operation of the unit should involve the use of the unit's automatic process control system (including the control computer system, the reactor monitoring system, and the automatic control system).

Power may be maintained and changed by means of remote control in accordance with the requirements of the operations manuals published by the designers of the nuclear steam generation plant and equipment of the unit.

4.1.2. During power operation of the reactor the control rods of the working group should be in a control zone which eliminates the effect of positive temperature reactivity coefficients and is adequate to ensure the effectiveness of the scram system.

When the control rods of the working group are moved to the upper or lower boundary of a specific control range one must alter the boric acid content in the water of the primary circuit in order to enable the return of the control rods of this group to the control zone.

The position of every control rod with respect to any other control rod of this group should not differ from that indicated by the operations manual (70 millimeters).

4.1.3. Whenever a steam generator is in power operation the temperature of the feed water at the inlet of the generator should be no less than 164C.

4.1.4. The safety system should be checked and tested during the operation of the unit.

4.1.5. The steam generator may be operated for a limited period of time of no more than 72 hours if there is a leak in just one of the gaskets, the first or second, in the flange joint of the hatch of the header of the primary circuit and then the hatch must be resealed. The leak line should be open, and pressure in the space between gaskets should be no greater than 20 kilogram force per square centimeter.

If there is a leak in just the first gasket, pressure in the space between gaskets may be raised to the working pressure of the primary circuit. If there is a leak in just the second gasket, pressure in this space may be raised to the working pressure of the secondary circuit.

Operating the steam generator when both gaskets of the hatch of the primary circuit are leaking is prohibited (determined by the presence of pressure in the space between gaskets and an increase in the activity of the steam generator's purge water).

Pressure in the space between gaskets should be checked on a monthly basis and the results of the check should be entered in the senior reactor control engineer's log.

34/ 4.1.6. A steam generator may be operated until the next scheduled maintenance if only the inside gasket in the flange joint of the hatch of the secondary circuit is leaking if the following requirements are met:

- the valves on the line for monitoring leaks in the space between gaskets should be open and the line should be tight over its entire length;

- pressure in the space between gaskets should be equivalent to actual pressure in the secondary circuit, and pressure in the space between gaskets should be checked at least once every shift and the results should be entered in the senior reactor control engineer's log.

A steam generator may be operated with both gaskets in the flange joint of the hatches of the secondary circuit leaking for a period of no more than 72 hours after a leak has been detected (the presence of pressure in the space between gaskets, the presence of moisture in the moisture separator lines for constant monitoring of gas activity in the box of the steam generator) as long as one meets the requirements of point 5.1.3.

A steam generator may be operated for no more than two days if the pH of the feed water is too low. If it proves to be impossible to bring the pH up to the proper level in twenty four hours, the unit should be shut down.

4.1.7. During power operation of the unit all work on equipment and systems should be carried out in accordance with the operations manuals of the designers of the equipment. If malfunctioning safety channels are discovered the channel should be repaired and the malfunction corrected. The channel should be submitted for repairs in accordance with point 4.2.2.16, items 8 and 9.

4.1.8. During any kind of reactor operation the power level, reactor core energy release coefficients, and primary circuit characteristics should be maintained in accordance with the requirements of the "Table of Permissible Conditions" and operations manuals.

4.1.9. In the process of operating the nuclear steam generator plant one should record the number of loading cycles of the plant and its components in normal and abnormal operation and the number of cycles of emergency conditions, which are limited by the design (see the "List of Conditions Incorporated in the

Design of the Nuclear Steam Generator Plant" in the appendix). The cycles should be recorded by the Department of Nuclear Safety and Reliability and the information should be provided if necessary to interested parties according to the established procedure.

The operation of a nuclear steam generation plant with equipment whose life has expired (in terms of cycles) is strictly prohibited.

4.1.10. During power operation of a unit operators are required to:

- inspect and service equipment to the extent....[Trans: bottom line of page 34 in the original illegible]

35/ - make sure that estimates of the reactor's thermal and neutron pow r based on the readings of the instruments (displays) of the neutron flux monitoring equipment and intrareactor monitoring system agree;

- in the event of a planned change in reactor power change the settings of the overpower safety system;

- maintain operational supplies of the media and materials which enable the operation of the unit and make sure they are of the requisite quality and conform to subsections 2.1 and 2.2;

- work the actuators of the control rods up and down every day. The actuators should be worked up and down individually within a single 35 centimeter zone.

35/ 4.2. The Condition of Power Unit Systems and Equipment in Power Operation

4.2.1. The condition of power unit safety systems

4.2.1.1. All channels of every nonoperating safety system of the unit should be kept operational, and in the process:

- the fast acting valves on the pipelines of the passive portion of the reactor core emergency cooling system should be open, their electrical circuits should be wired, and the interlock to close these valves upon a reduction in the level of the hydroaccumulator tanks of the core emergency cooling system should be operational

- all three channels of the water supply system for category A loads should be operational, and a nominal flow of water should be maintained in each channel;

- the condition of the emergency power supply system of the power unit is determined by the requirements of point 2.2.1. All the storage batteries of the system should be trickle charged from their rectifier devices.

4.2.1.2. The neutron flux monitoring equipment should be fully operational, along with the control rod group and individual control system, the signal shapers for the nuclear steam generator plant's scram system, the safety systems' control devices, and power regulating and limiting device when the unit is operating at more than 50% nominal power.

4.2.1.3. The controls which operate on the safety systems should be operational.

4.2.1.4. The process safeties and interlocks should be operational, and the automatic control system, control computer system, and reactor monitoring system should be in operation.

4.2.1.5. One channel of the safety system may be taken off line for repairs for no more than two shifts if the other two channels are activated while the channel is under repair.

4.2.1.6. Only one channel of the power control and regulating system may be taken off line for repairs if reactor power is no more than 50% of nominal.

36/ 4.2.1.7. One pulse safety device of the pressure compensator may be taken off line for repairs, if reactor power is no more than 50% of nominal, for a period up to a scheduled reactor shutdown.

4.2.1.8. One fast acting reducer for discharging steam into the turbine condensers or two of the same reducers may be taken off line for repairs if reactor power is no greater than the levels indicated in point 5.1.5. item 7.

4.2.1.9. One steam generator pulse safety device may be taken off line for repairs only if it is on a primary circulation circuit loop with an idle primary circulation pump.

4.2.1.10. Taking any of the channels of the passive subsystem of the core emergency cooling system for repairs is prohibited.

4.2.1.11. The safety system, its individual components, and its devices should be periodically inspected for the purpose of determining if they are functioning properly and to see if they meet the requirements of "Rules for Testing and Checking the Safety Systems of Nuclear Power Plants with VVER-1000 Reactors."

The schedule for testing safety system channels by means of starting up the diesel generators should be determined on the basis of the actual condition of the equipment, but these tests should be conducted at least once a month (one channel every ten days) under the condition that repairs have not been made inside the safety system's channels in the aforementioned period. If any repair work related to the functional serviceability of the safety system has been done and every time the power unit is started up, the safety system must be checked.

The inspection should include:

1. A check of the electrical circuits and interlocks of the scram system, the preventive safety system, and the core emergency cooling system with respect to the signals used for a gradual start.

2. When the mechanisms are activated by the diesel generator one must check:

2.1. the condition of the mechanisms and valves which should take the positions indicated by the design;

2.3. the activation and operation of the inhibits used to turn off the mechanisms and change the design condition of the valves;

2.3. the serviceability of the alarm system;

2.4. one must make sure that the control computer system knows and has recorded the fact that the safety system has been activated;

3. When the safety system is started up from the diesel generators, the head valves of the sprinkler pumps should be closed. The valves should be inspected in accordance with the aforementioned schedule and to the aforementioned extent after the appropriate safety system channels are tested.

4. The serviceability of the cutoff (containment) valves should be checked prior to starting up the unit.

5. A check of the closing of the cutoff valves on the purge line of the primary circuit......[Trans: bottom line of pg 36 of the original illegible]

37/ 4.2.1.12. Any malfunctions discovered in tests of the safety system should be immediately corrected and afterwards the safety system should be retested.

4.2.1.13. The safety system should be tested under the overall supervision of the unit shift supervisor and under the immediate supervision of the shift supervisor of the department responsible for the maintenance of this safety system only after authorization has been received from the power plant shift supervisor. The test results should be entered in the approved operations records (in the logs of the shift supervisors of the appropriate departments and in the "Safety System Test Log").

4.2.2. The condition of systems for normal operation

4.2.2.1. The backup steam lines (the auxiliary steam lines from the startup-backup boiler to the cutoff valve and from the auxiliary fast acting reducer to the moisture separator) should always be warmed up and ready for operation.

4.2.2.2. All the systems of buses of the outdoor distribution system and autotransformers of the backup auxiliary transformer set should be live.

Overhead power lines should be live to the extent necessary for outputting power from the plant to the power grid. The automatic safety devices should be operational.

The electrical auxiliaries of the unit should be powered from the auxiliary transformers.

4.2.2.3. The automatic process control system should be used to control the power plant. The automatic control system, control computer system [Trans: here follow three abbreviations in the parentheses which are not given in the list of abbreviations or any other available reference], and the reactor monitoring system.

4.2.2.4. The automatic power regulator operating in combination with the electrical subsystem of the turbine regulation system should be used to maintain and change the power of the unit. The operation of the automatic power regulator and electrical subsystem of the turbine regulation system is automatically coordinated.

Unit power may be maintained and changed by means of remote control in accordance with the requirements of the operations manuals of the designers of the nuclear steam generation plant and the equipment of the power unit.

4.2.2.5. At least two primary circulation pumps must be employed to circulate water in the primary circuit. Special water treatment unit 1 should be in operation.

The purge-makeup system of the primary circuit should be in operation as indicated by the design. Under any operating conditions if makeup stops the operators should immediately stop the purging of the primary circuit.

4.2.2.6. The gas content in the water of the primary circuit should be no higher than the permissible for current parameters as indicated in National Standard 95.962-82 when the primary circulation pumps are in operation.

Water and chemical conditions in the primary circuit should be maintained in accordance with established standards (National Standard 95.962-82).

4.2.2.7. The holding pond should be constantly purged as indicated by the design. The hydrogen content in the gas blanket of the holding pond should not exceed the standard level (2% by volume).

38/ 4.2.2.8. The boric acid content in the makeup water should be equivalent to its current content in the water of the primary circuit.

4.2.2.9. The boron regulating deaerator should be ready for operation.

4.2.2.10. The following should be operational as indicated in the design:

1. the process water supply for category B users.
2. the process circuit system.
3. the sample taking system.

4.2.2.11. At least two steam generators should be in operation. Feed water quality indicators should be maintained within standard limits by means of constantly purging each steam generator with a flow within a stipulated range (the purge flow is determined on the basis of chemical analysis results) and providing 100% purification of the turbine condensate by means of the unit desalinator (605-Pr-2298).

Steam generator purge water should be delivered to the filters of the purge water treatment unit (special water treatment unit No. 5). One strand of unit No. 5 should be in operation, while the backup strand should be ready for operation and the filters of this strand should be regenerated.

4.2.2.12. All the general exchange and special process ventilation systems, air conditioner, and [Trans: here follows an abbreviation not indicated in the list or any other available reference] should be operational.

4.2.2.13. The turbogenerator should be in operation at a specific power level. The high and low pressure regeneration systems of the turbine plant should be activated in accordance with the requirements of condition charts.

The nuclear steam generation plant may be operated for prolonged periods with the high pressure heater shut off under the condition that the temperature of the steam generator's feed water is maintained no lower than a temperature (164C) appropriate for the power of the turboplant.

The operation of the feed turbopump should be appropriate for the operation of the turbogenerator.

4.2.2.14. The condition of the other systems and equipment for normal power unit operation is determined by subsection 2.2 and the appropriate equipment designer operations manuals.

4.2.2.15. All the backup equipment of the power unit should be kept ready for operation.

4.2.2.16. The following systems and equipment for normal operation may be taken off line for repairs:

- any of the system of buses of the outdoor distribution system if the connections are switched to systems of buses still in operation;

- the switch of any overhead power line if the bypass circuit breaker is substituted for it;

- the switch....[Trans: last line of page 38 in original illegible]

39/ - the voltage transformer if the safety and measurement circuits can be powered by a transformer still in operation;

- the voltage coupling autotransformer if unit power is reduced to 70% of nominal;

- one switch of any primary or backup lead in any 6 kilovolt high voltage section is this section is powered from a backup or primary switch respectively;

- one transformer of the 6/0.4 kilovolt sections in combination with the circuit breakers of the leads if power is provided to the appropriate sections from the backup transformers or via the section circuit breakers;

- one channel of a safety consisting of three (four) independent channels of one set which generate safety signals on the basis of the "2 out of 3" ("2 out of 4") principle. In the process prior to taking it off line for repairs the scram system should be switched to a condition appropriate for the operation of this safety on the given channel;

One of the two sets of the scram system of the reactor which generate safety signals on the basis of the "2 out of 3" principle may be taken off line for a limited amount of time (no more than 24 hours). In the process the set taken off line for repairs should be switched to a "test" mode.

- the channels of safeties or interlocks of the primary equipment designed on the basis of the "one out of one" principle if the protected equipment is taken off line for repairs;

- the electrical subsystem of the turbine regulation system if the turbine is switched to the hydraulic regulation system. Any change in power is prohibited when the hydraulic regulation system is in operation. One may change power at planned rates when the automatic power regulator, fast acting reducer for discharging steam into the turbine condensers, generator excitation booster, and the primary controllers of the booster are in operation;

- measurement channels which do not take part in generating safety and interlock signals when it is possible to monitor the condition of the equipment either directly or indirectly on the basis of the monitoring channels still in operation;

- the computer hardware of the reactor monitoring system if the intrareactor monitoring equipment is still operational and reactor power is no higher than the stipulated level.

- when there is no temperature monitoring at the output of the reactor core the reactor may be operated for no more than the stipulated period and then reactor power must be reduced to the minimum controlled level.

The time that one set of intrareactor monitoring equipment may be taken off line for repairs is limited (see the requirements of point 3.3 of the Appendix);

- the automatic power regulator if reactor power is no higher than 90% of nominal;

- the information subsystem of the control computer system for no more than 1 hour if the condition of the power unit can be reliably monitored by means of the displays of the intrareactor monitoring system and neutron flux monitoring equipment....[Trans: bottom line of page 39 in original missing]

- the computer subsystem of the control computer system. Any set of hardware may be taken off line for repairs if the sets still in operation are capable of keeping the control computer system fully functional;

- one makeup aggregate of the purge-makeup system of the primary circuit (if a defect is discovered);

- one pump and one heat exchanger of the process circuit (if a defect is discovered);

- one channel of the hydrogen combustion system and one gas blower;

- one channel of the special gas treatment system;

- one channel of the holding pond water cooling system;

- one channel each of special water treatment units No. 2, No. 3, No. 5, and No. 6;

- one fan each of the ventilation systems for maintaining the necessary underpressure in the containment vessel, cooling the rooms of the oil systems, the primary circulation pumps, cooling the rooms of the makeup aggregates, cooling the tunnels in the bottom and vessel of the containment area, cooling the rooms of the reactor control and safety system board, and the instrument and control and safety system panel rooms;

- one fan each of the air conditioning systems for the rooms of the unit control panel, backup control panel, and control computer system.

4.2.2.17. If taking any systems, devices, or equipment for normal operation off line for repairs means that the unit will operate without a backup for the period of repair, this is permitted only after written authorization has been received from the chief engineer of the plant.

4.2.2.18. When the unit is in power operation one should check to see that its systems and equipment can be operated from the backup control panel on a monthly basis;

4.2.2.19. The possibility of controlling power unit equipment from the backup control panel should be checked by means of trial activation (deactivation) of the equipment from the backup panel after this equipment has been tested from the unit control panel in accordance with approved test schedules.

4.2.2.20. Prior to performing operations on the backup control panel one should also (if enough time is available) check the serviceability of the alarm system and the power supply and serviceability of the instrumentation, including the neutron flux monitoring equipment of the backup control panel.

All malfunctions should be corrected immediately after they are discovered.

4.2.2.21. One should check the operation of a neutron flux monitoring equipment set by moving the backup control panel's set of detectors only upon receipt of special authorization from the chief engineer of the plant (deputy chief engineer).

4.2.2.22. The results of the tests described in 4.2.2.19-4.2.2.21 should be entered in the appropriate logs and other standard records.

41/ 4.2.2.23. It is prohibited to:

- perform the operations indicated in 4.2.2.19-4.2.2.21 when the unit is not operating stably;

- enter the backup control panel room without permission from the unit shift supervisor;

- control power unit equipment from the backup control panel during normal operation with the exception of when the backup panel is tested.

4.2.2.24. If conditions which would normally activate the core emergency cooling system should arise and the automatic mechanisms of the system fail to operate, the operator must activate them manually.

4.3. The Basic Characteristics of a Unit in Operation

4.3.1. When the unit is in power operation process characteristics should lie within the ranges stipulated by the design and the operations manuals of the designers of the equipment and the systems, and the table of permissible conditions.

4.3.2. A mixed ammonia-potassium water supply with boric acid should be used in the primary circuit.

Primary circuit water quality should conform to established standards (National Standard 95.962-82).

4.3.3. The content of boric acid in the primary circuit water should be determined on the basis of the reactor's reactivity margin.

4.3.4. A permissible hydrogen content should be ensured by maintaining an equilibrial concentration of ammonia in the primary circuit whose quality meets directive requirements (State Standard 6221-75, grade A).

4.3.5. The quality of the boric acid used should conform to directive requirements (State Standard 9656-75, "chemically pure," or State Standard 18704-78, grade A).

4.3.6. In adding boric acid to the primary circuit or when the chloride life of the filters has expired, a temporary (no more than 24 hours) increase in the chloride content of this water is permissible (up to 0.15 milligrams per kilogram).

The total duration of operation with such elevated chloride contents should not exceed five days over the course of a year (National Standard 95.962-82).

Under normal operating conditions it is prohibited to take special water treatment unit No. 1 out of operation when the pressure differential on the sorbent trap is no higher than 5 kilogram force per square centimeter, and if this pressure differential is higher, one must take an appropriate strand of the unit out of operation and shut off the primary circulation pump of this strand.

42/ 4.3.7. Hydrazine-hydrate in a quantity of 20 to 30 milligrams per kilogram of solution should be added to all solutions added to the primary circuit without preliminary deaeration when the reactor is in operation (National Standard 95.962-82).

4.3.8. The quality of the feed water at the inlet of a steam generator and the purge water of the steam generator and the quality of turbine condensate (downstream of the unit desalinator) should be no lower than standard levels (8.05-Pr-2298).

4.3.9. Deterioration of the quality of steam generator feed water and purge water and turbine condensate with respect to specific electroconductivity and the content of oxygen, oils, and heavy petroleum products of as high as 50% by comparison with the standard levels is permissible for a certain period (the first three days) after a turbogenerator has been connected to the grid. In addition a limited increase in the content of iron and copper compounds in the feed water is permissible (8.05-Pr-2298).

4.3.10. For a limited period after a turbogenerator has been connected to the grid (first two days), the content of free hydrazine hydrate in the feed water of the steam generator should be no lower than 0.5 milligrams per kilogram (8.05-Pr-2298).

4.3.11. The total flow rate of continuous and periodic purge water should be no lower than 15 tons per hour for a limited period (first three days) after the turbogenerator has been connected to the grid. In the process the flow of periodic purge water for this steam generator should be no less than that indicated by the design (7.5 tons per hour) and periodic purging should be carried out for at least two hours per day (8.05-Pr-2298).

4.3.12. Periodic purging of a steam generator may be carried out only on an alternating basis, that is, the total flow of purge water from a steam generator should be at least as high as the flow of constant purging for three steam generators and periodic purging for one steam generator.

4.3.13. If the chloride content in the purge water is too high (8.05-Pr-2298), periodic purging time should be no longer than required for normal cooling of the power unit (10 hours).

4.3.14. The total specific activity of radionucleides in primary circuit water should be no higher than 10^{-1} curies per liter.

4.3.15. The specific activity of steam generator purge water should be no higher than 1.10^{-8} curies per liter or 3.7 times 10^{2} becquerels per liter.

4.3.16. The average daily permissible discharge of radioactive gases.....[Trans: bottom line of pg 42 in original missing]

43/ 4.3.17. Annual discharges of radionucleides into bodies of water should conform to approved standards.

4.3.18. Annual discharges of radionucleides with liquid wastes and the specific radioactivity of air in attended and semiattended rooms and the level of contamination of the surfaces in them should not exceed the levels determined by their control (working) levels.

The control (working) levels of the aforementioned standards must be approved according to the established procedure and as a rule should not exceed permissible levels.

4.3.19. When radioactive water is discharged into household, industrial, and storm sewage, the specific radioactivity of the discharges, including with respect to radionucleides, should not exceed established standards.

43/ 4.4. Turning Off One Primary Circulation Pump out of Three (Four) Operating Pumps.
Connecting One Primary Circulation Pump to Two (Three) Operating Pumps

4.4.1. Prior to turning off one primary circulation pump, the power of the unit should be reduced to a level no greater than that appropriate for the pumps still in operation.

4.4.2. After turning off a pump, the power safety settings should be changed to fit the reactor's new power level.

4.4.3. It is permissible to cut off the feed water and purge water of the steam generator of a loop with an idle primary circulation pump and cut off its steam if written authorization is received from the chief engineer of the plant under the condition that the valve of the fast acting reducer for discharging steam into the atmosphere is switched to remote control.

4.4.4. In connecting one primary circulation pump to two or three operating pumps:

- reactor power should be reduced to an appropriate level (20% to 30% respectively) from nominal;

- the condition of the other systems and equipment should meet the requirements of subsection 4.2.

4.4.5. After a pump has been connected and the unit's parameters have been stabilized, reactor power may be increased to a level appropriate to the new number of operating primary circulation pumps, taking the requirements of point 4.1.1 into account, and the settings of the safeties of the nuclear steam generation plant should be changed to fit the new power level.

44/ 4.4.6. One may start and stop primary circulation pumps by means of remote control when the controllers of the unit are operating in an automatic mode.

4.5. Shutting Off (Connecting) the High Pressure Heater

4.5.1. Prior to shutting off a high pressure heater the automatic power regulator must be switched to a constant neutron power maintenance mode.

4.5.2. One should cut off the steam to a high pressure heater in a way such that the rate of change of the temperature of the feed water downstream of the heater will not exceed a permissible level (55C per hour).

4.5.3. After a high pressure heater has been cut off, reactor power may be increased until the power unit recovers its initial electrical load but no higher than the authorized level.

4.5.4. In connecting a high pressure heater one must meet the requirements of point 4.5.2. with the automatic power regulator operating in a constant neutron power maintenance mode.

The rate of change of pressure in the bodies of high pressure heaters when they are connected should not exceed 0.6 kilogram force per square centimeter per minute).

4.5.5. After steam and water have been allowed to flow to a high pressure heater and the parameters of the nuclear steam generation plant have been stabilized, the power of the unit may, if necessary, raised to a permissible level.

4.6. Shutting Off a Feed Turbopump

4.6.1. When shutting off an operating feed turbopump, the power of the unit should be reduced to 50% of nominal. After power has stabilized at this level it may be raised to a power level determined for each specific unit in the process of startup and adjustment.

4.6.2. When a unit operatin at a power of 350 megawatts is shut down, one feed turbopump should be switched to a recirculation mode after taking it off automatic control.

45/ 5. DISRUPTIONS OF NORMAL OPERATING CONDITIONS LEADING TO SHUTDOWN OF THE PRIMARY EQUIPMENT OF THE UNIT OR A REDUCTION IN ITS POWER

5.1. Shutting Down the Reactor or Reducing its Power

5.1.1. The reactor should be immediately shut down by the operators by pressing the switch of any of the scram system sets on the unit control panel or backup control panel if:

1) any scram signal has been generated and a safety has not operated (the unit should be switched to "hot" until the problem is corrected);

2) two channels of all three neutron flux monitoring equipment sets are not monitoring neutron power (the unit should be switched to hot until the problem is corrected);

3) two channels of all three neutron flux monitoring equipment sets are not monitoring power buildup time (the unit should be switched to hot until the problem is corrected);

4) the monitors for pressure in the primary and secondary circuits, water temperature at the outlet of the reactor core, the water level in the pressure compensator, the water level in the steam generator of any loop with operating primary circulation pumps, the pressure differential at any primary circulation pump when the unit is operating with two operating primary circulation pumps, and the pressure differential at the reactor core are fully down (the reactor should be switched to cold until the problem is corrected);

5) malfunctions in the control rod control circuits which keep its scram system from operating are discovered (the reactor should be switched to hot until the problem is corrected);

6) a control circuit malfunction causes a group of control rods to move uncontrollably up (the reactor should be switched to hot until the problem is corrected);

7) two or more control rods drop unexpectedly in the reactor core (the reactor should be switched to hot until the problem is corrected);

8) a fire on the unit control panel, a fire in the rooms, or an emergency which poses a threat to the integrity of the primary equipment and a threat to nuclear safety and plant safety (the reactor should be switched to cold until the causes and effects are eliminated);

9) both feed turbopumps have gone off and cannot be reactivated in a timely manner, or if the level in a steam generator drops to more than 350 mm below nominal, or if the makeup water for a steam generator is not getting to it and cannot be restored (the

reactor should be switched to hot until the problem is corrected);

10) there is an abrupt (radical) increase in the radioactivity of the purge water of a steam generator (the reactor should be switched to cold until the problem is corrected);

11) there is a leak in the primary or secondary circuit which causes one of the characteristics of the atmosphere under the containment vessel to exceed the following levels: pressure (1.2 kilogram force per square centimeter, absolute), temperature....[Trans: bottom line on page 45 in original missing]

46/ 5.1.2. Power should be reduced to the minimum controlled level by the operators if:

1) preventive safety circuits are unserviceable, preventing the transmission of safety signals and the operation of preventive safeties (until the problem is corrected);

2) one control rod of the fifth, ninth, or tenth group cannot be controlled and it is more than 100 centimeters above the bottom of the reactor core or two or more control rods less than 100 centimeters above the bottom of the reactor core cannot be controlled (until problem corrected);

3) monitoring of the position of more than one control rod has been lost (until the malfunction is corrected);

4) one control rod less than 100 centimeters above the bottom of the core cannot be controlled and monitoring of the position of another control rod has been lost (until the malfunction is corrected);

5) malfunctions which keep the operation of the control and safety system's preventive safety 1 and prevencive safety 2 are discovered;

6) the unit desalinator has shut down and cannot be restored to normal operation within 10 hours when chloride and sodium concentrations in steam generator purge water are three times higher than permissible or within twenty four hours when the pH level is too low in steam generator feed water.

5.1.3. The reactor should be shut down and the unit switched to cold if:

1) there is a leak in the primary circuit with a flow of more than 0.2 tons per hour and the location of the leak cannot be found or there is a leak with a flow of more than 2 tons per hour whose location is known;

2) total specific activity in the water of the primary circulation circuit is greater than 1.10^{-1} curies per liter or 3.7 times 10^{9} becquerels per liter;

3) the specific activity of the purge water of any steam generator has increased to the upper limit (1.10^{-8} curies per liter or 2.7 times 10^{2} becquerels per liter), has continued to increase, and cannot be reduced without shutting down the reactor (one may not use periodic purging of the steam generator to correct deviations from purge water radioactivity standards);

4) two independent monitoring channels indicate that discharges of radioactive noble gases into the atmosphere are too high while the operation of the ventilation system and gas blower system has remained the same (500 curies per hour);

5) the gas and aerosol activity of the air in attended rooms has increased above permissible levels (10^{-6} curies per liter, 1976 Radiation Safety Standards) and it cannot be reduced without shutting down the reactor;

6) more than one channel of any safety system is malfunctioning, there is a leak from any emergency boron supply tank or from any hydroaccumulator tank of the core emergency cooling system, or if it is impossible to take a safety system off line for repairs within the stipulated time (up to two shifts), or if the requirements of section 2.2 with respect to......[Trans: bottom line of page 46 in original missing) are violated.

47/ 7) more than one pulse safety device of the pressure compensator is malfunctioning;

8) all the pulse safety devices of one steam generator are malfunctioning;

9) more than two fast acting reducers for discharging steam into the turbine condensers or more than one fast acting reducer for discharging steam into the atmosphere are malfunctioning;

10) malfunctions are discovered in the proce[illegible] circuit system which prevent normal cooling of the loads;

11) requirements for the operation of the reactor and steam generator in any loop of the primary circulation circuit when there are leaks in the gaskets in the flange joints of the main reactor joint and the primary and secondary circuit hatches of the steam generator are not met;

12) the chloride content in steam generator purge water has gone above 1.5 milligrams per kilogram or has steadily exceeded 0.5 milligrams per kilogram for ten hours. After the unit has been shut down the causes should be corrected and the steam generator should be flushed with desalinated water. A steam generator should not be allowed to operate with an excessive chloride

content in the purge water of up to 1.5 mg/kg for more than 120 hours per year;

13) not enough water is being provided to cool the control and safety system actuators (27700 cubic meters per hour) or the concrete of the reactor shaft (18000 cubic meters per hour);

14) there is a fire at the backup control panel;

15) the information subsystem of the control computer goes down and cannot be reactivated within five hours. The unit may be operated with no reduction in power for up to one hour if the information subsystem fails, but if it is not restored within an hour unit power must be reduced to 70% of nominal;

16) more than one makeup pump set is malfunctioning.

5.1.4. The reactor should be shut down (the unit switched to hot until the problem is corrected) and the boron concentration should be stabilized if:

1) malfunctions which disrupt the proper sequence of motion for groups of control rods and lead to upward movement of certain control rods apart from the entire group or to the simultaneous movement of a more acceptable number (two groups) at any level in the reactor core or other malfunctions which require shutdown of the reactor in accordance with the operations manual for its control and safety system are discovered;

2) movement is not automatically transmitted between groups of control rods in the proper sequence either when removing them from the core or lowering them into the core.

5.1.5. Reactor power should be reduced by operators to the levels indicated below if:

1) one control rod of any group located less than 100 centimeters from the bottom of the reactor core cannot be controlled (90% of nominal);

2) the position of one control rod of any group cannot be monitored (90% of nominal);

3) the automatic power regulator has gone off or malfunctions which keep it from....[Trans: bottom line of page 47 in original
48/ missing]...are discovered;

4) the power regulating and limiting device has gone off or malfunctions are discovered which keep it from functioning normally (no higher than 50% of nominal);

5) one pulse safety device of the steam generator of any loop with operating primary circulation pumps is malfunctioned (the loop must be shut off);

6) one pulse safety device of the pressure compensator is malfunctioning (50% of nominal) (for a period of up to 24 hours and then unit must be switched to cold);

7) one fast acting reducer for discharging steam into the turbine condensers (90%), two (50%), three or more (one fast acting reducer for discharging steam into the atmosphere) (the power unit should be switched to cold);

8) all pressure differential monitors on any operating primary circulation pump are malfunctioning (75% of nominal when four pumps are in operation or 50% when three pumps are operating);

9) Any operating primary circulation pump malfunctions which require shutting it off are discovered (see the table of permissible conditions);

10) the basic monitored characteristics of the unit have exceeded permissible deviations in normal operation according to the table of permissible conditions (until permissible parameters are restored);

11) reactor monitoring system malfunctions are discovered (monitoring temperature at the outlet of the reactor core or monitoring energy release distribution) (50% of nominal for up to three days, subsequently the unit must be switched to hot) (see point 3.3 of the Appendix);

5.1.6. In the event that atmospheric characteristics in the rooms (temperature, pressure, density, radioactivity, moisture content) keep varying and get close to the maximum permissible levels indicated in the manufacturers' (suppliers') specifications and operations manuals for the equipment, valves, instruments, and other items installed in the rooms, the operators must take steps to stabilize these variable characteristics.

If just one characteristic should reach the limit, the unit must be switched to cold.

49/ 6. HANDLING ACCIDENTS AND DISRUPTIONS OF NORMAL OPERATION

6.1. General Measures and Procedures

6.1.1. In the event that an emergency should arise at the power unit, the operators of the unit headed by the power plant shit supervisor are obliged to take all possible steps to restore safe operation.

Operators must monitor and support the operation of the scram (preventive safety) system, safety systems, and safety devices, and the operation of the interlocks designed to control the hazardous afteraffects of nuclear steam generation plant equipment failures.

6.1.2. The plant shift supervisor is obligated to inform the director of the plant, the chief engineer, and the deputy chief engineer of any emergency situation.

6.1.3. In the event of disruptions in normal operation, the operators of a unit headed by the plant shift supervisor are obliged to:

1) quickly and correctly determine the reasons for the disruption of normal operation on the basis of the readings of displays, instruments, and alarms, on the basis of recordings of variations of characteristics on the control computer system's printers and printouts, and also on the basis of messages from operators at work stations;

2) make sure that the safeties and interlocks of the power unit's systems and equipment are operating correctly. In the event that certain safeties and interlocks fail to operate they are obligated to switch to others either by remote control or manually;

3) use intercom and online communications to announce disruptions in normal operation to all operators at the unit and inform the chief engineer, deputy chief engineer, and telephone operator on the basis of a list approved by the plant director.

4) set up continuous monitoring of the radiation situation in the attended rooms of the power plant and monitoring of the discharge of radioactive isotopes into the environment.

6.1.4. Intervention in the operation of automatic controls, safeties, and interlocks is prohibited, except in the case of malfunctions.

6.1.5. In the process of handling disruptions of normal operation at a power unit the operators headed by the power plant shift supervisor are obliged to:

1) prevent any uncontrollable rise in the reactor's power;

2) provide reliable cooling for the reactor core;

3) avoid any uncalled-for shutoff of operating primary circulation pumps or feed turbopumps (auxiliary feed pumps);

4) make sure that the unit's deaerator-feeder units are operating reliably;

50/ ....[TRANS: PAGE 50 MISSING FROM THE ORIGINAL]

51/ 6.1.13. In the event of a break in a steam line operators must arrange for the delivery of boron to the primary circuit from the high pressure pumps and boron sprinkler pumps.

6.2. Accelerated cooling of the nuclear steam generation plant.

6.2.1. The nuclear steam generation plant may be subjected to accelerated cooling at a rate of no more than that indicated by the design (60C per hour) after an emergency shutdown of the reactor by the scram system or operators pressing the scram switch in the event that leaks from the primary circuit can be compensated for, including leaks of water from the primary circuit into the secondary circuit.

Accelerated cooling must be carried out with the primary circulation pumps operating.

52/ ## 7. SHUTTING DOWN THE POWER UNIT

7.1. The power unit should be shut down using the electrical portion of the turbine regulation system and the automatic control system with the automatic power regulator operating in a secondary circuit pressure maintenance mode.

7.2. Every purified boron concentrate tank should contain a total irreducible water supply of 150 cubic meters with a boric acid concentration of 40 grams per kilogram.

The condition of the boron containing solution tanks should conform to design requirements (free space of at least 400 cubic meters).

7.3. The power of the unit should be reduced by means of changing the turbogenerator power setting on the turbogenerator regulation electrical subsystem panel in a way such that:

- the rate of reduction of reactor power is no greater than the stipulated rate of 3% of nominal per minute;

- the water level in the pressure compensator is kept equal to corresponding reactor power levels;

- steam pressure in the steam generator is within stipulated limits (60 to 64 kilogram force per square centimeter);

It is permitted to reduce the power of the unit by means of remote control of the turbine synchronizer to alter its power setting.

7.4. The containment vessel may be unsealed in the process of a planned shutdown of the power unit after pressure in the primary circuit has been reduced to the proper level (no more than 5 kilogram force per square centimeter).

7.5. The turbine should be shut down in accordance with the requirements of its operations manual.

7.6. If the power unit is to be kept hot after it is shut down, reactor power should be reduced to the level of auxiliary power or minimum controlled power.

7.7. When a reactor is shut down for scheduled maintenance and fuel recharging, the nuclear steam generation plant should be switched to cold and the reactor should be made subcritical by means of increasing the content of boric acid in the water of the primary circuit to a level no lower than that established for the given reactor fuel charge (12 grams per kilogram).

7.8. Once the reactor has reached a certain subcritical level, one may leave no less than two primary circulation pumps in operation, and afterwards one must lower all the control rods all the way to the bottom of the reactor core.

7.9. After the reactor has been shut down the pulse safety devices of the steam generators should be tested and they should be tested prior to cooling of the nuclear steam generation plant.

53/ 7.10. It is prohibited to start cooling the nuclear steam generation plant if the content of boric acid in the water of the primary circulation circuit is less than that required to ensure a subcritical level of 0.05 with the control rods lowered (boric acid concentration in the primary circuit of at least 12 grams per kilogram).

7.11. The nuclear steam generation plant should be cooled to the temperature level indicated by the design once the steam generators are filled with water on the secondary circuit to a specific level of 3750 + 3850 mm and the pressure compensator is filled to a level of 11700 millimeters. One should follow the nuclear steam generation plant's designers' manual in filling the steam generators with water.

7.12. In cooling the nuclear steam generation plant one should also make sure that the primary circuit steam generator headers and reactor roof are cooled.

The rate of cooling of the nuclear steam generation plant should not exceed 30C per hour.

For every steam generator body and the body of the pressure compensator the difference between the temperature of the metal and the lower part of the body should not exceed 50C.

The difference between the temperature of the feed water and the temperature of the water in a steam generator should not exceed 120C.

When the primary circuit is cooled and its temperature has reached 200C, flow through special water treatment unit No. 1 on each strand should be reduced to 20 tons per hour (in order to avoid the entrainment of corrosion products) and at the same time the flow of purge water through the primary circuit should be increased to the maximum permissible level (60 tons per hour).

7.13. If the pressure compensator does not have a nitrogen blanket, the primary circulation circuit should be cooled so that the temperature of the water in it is always greater than the temperature of the water in the steam generators under the roof of the reactor.

7.14. The emergency cooling pumps should be connected to the primary circuit after pressure in the primary circuit has been reduced to 20 kilogram force per square centimeter and the cooling circuit should be warmed up so that the difference between the temperature of the water in the primary circuit and cooling circuit is no greater than 30C.

It is recommended that the cooling circuit be connected to the primary circuit once its rate of cooling by the systems of the secondary circuit reaches 10C per hour, but one may connect the cooling circuit once the cooling rate of the primary circuit reaches 30C per hour.

On the basis of the operating conditions of the primary circulation pumps, once the pressure in the primary circuit reaches 20 kilogram force per square centimeter, nitrogen under pressure of 20 kilogram force per square centimeter should be connected to the pressure compensator for the purpose of maintaining constant pressure in the primary circuit.

7.16. In the process of cooling the nuclear steam generation plant, one must:

1) disconnect the hydroaccumulator tanks of the core emergency cooling system from the reactor if pressure in the primary circuit is no greater than 70 kilogram force per square centimeter;

2) shut down primary circulation pumps which are still in operation once the temperature of the water....[Trans: bottom line of page 53 missing];

54/ 3) monitor th concentration of dissolved gas in the heat transfer agent of the primary circuit when a nitrogen blanket is used. This concentration should be no greater than 20 milligrams per kilogram;

4) switch the delivery of feed water to the steam generators from the feed turbopumps to the auxiliary feed pump once the flow of feed water has decreased to 300 tons per hour.

7.17. After all the primary circulation pumps have been shut off, further cooling of the reactor should meet the following requirements:

1) the pressure compensator should be cooled by delivering water from the makeup system of the primary circuit;

2) pressure in the hydroaccumulator tanks of the core emergency cooling system should be reduced to 35 kilogram force per square centimeter;

Not reducing the pressure in the hydroaccumulator tanks is permissible if the fast acting valves are closed, their electrical circuits are disconnected, and the valves themselves are locked;

3) during the operation of the emergency cooling system pressure in the primary circulation circuit should not exceed permissible levels.

7.18. In the process of cooling the nuclear steam generation plant, the pressure differential on the makeup lines of the primary circuit should be minimized by means of:

1) activating special water treatment unit No. 1 for bypass purification of the heat transfer agent with the valves on its piping fully open;

2) maximizing the output of the makeup-purge system of the primary circuit while maintaining the necessary level in the pressure compensator.

7.19. By the time the temperature of the water in the primary circulation circuit reaches the limits indicated by the design (cold power unit, 60 to 70C), the condition of the systems and equipment of the power unit should meet the following requirements:

1) the reactor should be plugged by all the control rods, and the boric acid concentration in primary circuit water should be no lower than the level indicated for the fuel charge in question (12 grams per kilogram);

2) the subcriticality of the reactor should be monitored by the source range subsystem of the reactor monitoring system;

3) at least two emergency power supply channels of the second reliability category should be ready for operation;

4) at least one emergency cooling channel should be in operation and at least one channel should be ready for operation;

5) the process water supply channels for critical users (group A) corresponding to the serviceable emergency cooling channels should be in operation;

6) the condition of the valves should meet the requirements of the operations manuals for the systems and equipment of the power unit.

55/ 7.20. The water level in the steam generators may be reduced to nominal after the primary and secondary circuits have been cooled to 60 to 70C.

7.21. The quality of water in the primary circuit must be maintained in the process of cooling the nuclear steam generation plant by adding the necessary reagents on the intake sides of the makeup pumps.

7.22. The primary circulation circuit may be unsealed for recharging the reactor fuel after the following conditions have been met:

1) the circuits from the actuators of the control and safety system, the neutron measurement channels, and the devices for compensating the cold junctions of the temperature monitors have been disconnected; and the removable parts of the insulation units and air ducts for cooling the actuators of the control and safety system and the electrical wiring and air unit of the reactor have been removed;

2) water temperature in the primary circulation circuit does not exceed 70C and pressure in the primary circuit has been reduced to atmospheric pressure;

3) water in the primary circulation circuit has been drained to a level lower than the main joint of the reactor (200 to 300 mm below, 2400 to 2500 mm as determined by the level gauge of the pressure compensator;

4) the boric acid content in the water of the primary circuit is no lower than the level stipulated for a given reactor fuel charge;

5) the water in the primary circuit has been changed three times and the water level in the primary circuit has been agitated three times for the purpose of removing inert radioactive gases from the primary circulation circuit through the air units.

7.23. When unsealing the primary circulation circuit for the purpose of making repairs on the equipment of the primary circuit, in addition to meeting the requirements of 7.22 one must also circulate primary circuit water in the following way: "cold" strand of the loop of the primary circulation circuit - emergency cooling pump - "hot" strand of the loop of the primary circulation circuit, and water should be drained from the primary circulation circuit to a level no lower than the axis of the "cold" inlets of the reactor.

7.24. It is prohibited to unseal the nuclear steam generation plant without first removing radioactive gases from the primary circulation pump several times or when the gas treatment system or holding pond ventilation systems are malfunctioning. ([illegible] 49, 21)

56/ 8. RECHARGING THE REACTOR FUEL

8.1. Prior to beginning the recharging process, the following conditions must be met:

1) the requirements of point 7.19 and point 7.22 have been met;
2) all the documents used in the recharging process have been prepared;
3) the materials handling equipment outside the containment vessel and inside the containment vessel has been adjusted and checked out;
4) the sample-taking subsystem, equipment, and control panels for detecting fuel element can leaks outside the containment vessel and the piping and panels for detecting fuel element can leaks inside the containment vessel should be certified using the defective assembly leak detection system and prepared for operation;
5) steps have been taken to prevent distillate from accidentally getting into the primary circulation circuit and charging pond (holding pond);
6) the reactor has been disassembled immediately prior to recharging.

Prior to removing the top module of the reactor, the connecting rods of the control rod actuators should be disconnected from the control rods. The shielding tube assembly should not be removed unless this step has been taken.

The unit shift supervisor is personally responsible for making sure that the control rods and connecting rods have been disconnected and that the connecting rods are in the transport position and must make an entry indicating this in his operations log;

7) the radiation situation in the rooms of the reactor section must be continuously monitored;
8) the system for filling (emptying) the recharging pond must be prepared and certified for operation;
9) at least two recharging pond cooling channels should be ready for operation, while one may be under repair;
10) reliable communications should be established between the unit control panel operators and operator of the charging machine, the operator of the fuel element can leak detection system, and the dosimetry service;

8.2. In disassembling the reactor for recharging and in assembling it after recharging, the water level in the primary circulation circuit should not fall lower than 400 millimeters below the main joint marker. Any further drop should be prevented.

8.3. Recharging the reactor fuel is prohibited if:

1) the requirements of point 8.1 have not been met;

57/ 2) all new fuel elements have not undergone acceptance tests in accordance with supply requirements;
3) less than 72 hours has elapsed since the reactor was shut down. Water temperature at the outlet of the reactor core is higher than 70C;
4) the subcriticality of the reactor has not been monitored by means of reactor monitoring equipment on at least two channels, one of which is equipped with sound alarms;
5) the boric acid content in the water of the primary circuit is less than the required level for a given reactor fuel charge (12 grams per kilogram);
6) steps have not been taken to abstract heat from the reactor core by circulating heat transfer agent through the cooling circuit;
7) the water level in the recharging pond and reactor shaft is less than 15.5 meters, boric acid concentration does not meet the requirements for fuel recharging (at least 12 grams per kilogram). Water quality should meet the requirements of National Standard 95.962-82;
8) operations involved in the addition and removal of heat transfer agent from the reactor's cooling system have not been completed, with the exception of treatment operations;

8.4. All operations involved in preparing the reactor for recharging and recharging itself should be conducted in accordance with the requirements of reactor fuel recharging guidelines;

8.5. In the recharging process the content of boric acid in the water of the primary circuit and recharging pond (holding pond) should be maintained at a level no lower than 12 grams per kilogram and should be checked twice per shift;

8.6. The valves for draining water from the shielding tube assembly inspection shaft and reactor internal equipment inspection shaft should be closed and locked;

8.7. The temperature and water level in the reactor and compartments of the holding pond (recharging pond) should be monitored during the recharging process.

Working with a TV camera is not recommended if the temperature of the heat transfer agent is higher than 60C.

If the temperature rises above 70C, recharging operations should be halted.

8.8. The condition of the ventilation systems for the rooms of the primary circuits should meet the requirements of appropriate operations manuals.

8.9. During the recharging process steps should be taken to prevent extraneous objects from getting into the reactor;

58/ 8.10. During the recharging process the radiation situation at the level of the reactor room in the area of the recharging pond should be continuously monitored;

8.11. One-time and experimental recharging operations not governed by appropriate guidelines should be conducted on the basis of special programs coordinated and approved according to the established procedure.

8.12. Assembly of the reactor is permitted after documents which indicate that all recharging operations have been completed and that the reactor equipment and its components and systems have been inspected have been written up according to the established procedure;

8.13. After reactor fuel has been charged, cartograms of the fuel charge in the reactor and a cartogram of the location of used fuel in the racks of the holding pond should be drawn up according to the established procedure.

8.14. In transporting the shaft of the recharger to the pond and from the reactor internal equipment pond personnel may not remain in the steam generator and primary circulation pump boxes.

59/ ## 9. SPECIAL TESTS

9.1. Physical and thermohydraulic tests on a power unit must be conducted on the basis of programs coordinated according to the established procedure and approved by the chief engineer of the plant.

9.2. The programs should indicate anticipated changes in reactivity and outline safety measures and damage control procedures.

9.3. The chief engineer or a person appointed by him are responsible for the general direction of test programs.

The unit shift supervisor is responsible for the immediate supervision of testing with the technical assistance of the staff and developer of the program.

When experimenting with major variations in reactivity, the test team should include a supervising physicist.

9.4. Deviations from the requirements of these rules should be indicated in the program and always include proof of safety and the program itself must be coordinated with the scientific director, the chief designer, and inspectorates.

60/

APPENDIX

STANDARD INDICATORS WHICH CHARACTERIZE THE SAFE OPERATION OF A POWER UNIT CONSISTING OF A STANDARD NUCLEAR STEAM GENERATION PLANT (V-320)

61/ 1. GENERAL PRINCIPLES

1.1. Standard indicators which characterize the safe operation of a power unit may be revised on the basis of operational experience and technological advances.

62/ 2. LIMITS OF SAFE OPERATION OF THE REACTOR

2.1. Limits of Safe Operation of the Reactor Core

2.1.1. In all kinds of normal operation the thermal power of the reactor should not exceed 102% of nominal (allowing for dynamic error). Power determination error should not exceed 2%.

The nominal thermal capacity of the reactor is 3000 megawatts.

2.1.2. The thermal power of the reactor, the average heating of a heat transfer agent in the reactor, heating in the fuel assembly, the temperature at the outlet of the fuel assembly, temperature at the inlet of the reactor, reactor core energy release unevenness coefficients, and pressure in the primary and secondary circuits should not exceed the limits indicated in the table of permissible nuclear steam generation plant operating conditions in stable operation on four, three, or two loops.

2.2. Permissible Rates of Change of Reactor Power

The rates of change of reactor power should not exceed the values given in Table 1.

Table 1

Planned increase (decrease)		After prolonged operation for more than 12 days at a reduced power level		Load buildup	
100%		100%		100%	
	1% per min		0.08% per min		Gradual increase by 10% nominal (once every 3 hours)
80%	holding for 3 hours	90%		50%	
	1% per min		0.17% per min		Gradual increase by 20% nominal (once every 3 hours)
45%		50%			
	3% per min				
0%				0%	

63/

3. LIMITS AND CONDITIONS FOR THE SAFE OPERATION OF SAFETY-CRITICAL SYSTEMS

3.1. Primary Circulation Circuit

3.1.1. Operating components:

a) primary circulation pumps

- at least two primary circulation pumps should be in operation when bringing the reactor to the minimum controlled power level;

- turning on two or more primary circulation pumps at the same time is prohibited;

b) the reactor main joint

- the power unit should be switched to cold when pressure appears in the main joint leak monitoring system. The chief engineer of the plant is responsible for determining the time of the switch.

c) pressure compensator

- prior to bringing the reactor to the minimum controlled level a steam blanket free of nitrogen impurities should be generated in the pressure compensator and the level in the compensator should be no less than 4500 millimeters and pressure should be at least 70 kilogram force per square centimeter;

- when the nuclear steam generation plant is operating at nominal power (3000 megawatts, thermal), the level in the compensator should be 8770 millimeters;

d) the pulse safety devices of the pressure compensator

- all three devices should be serviceable prior to bringing the reactor to the minimum controllled level;

- in a shut-down reactor when the primary circuit is sealed and the top assembly is mounted on the vessel, at least one pulse safety device should be serviceable (except when hydraulic tests of the primary circuit are underway);

- when one pulse safety device is unservicable the power of the nuclear steam generation plant should be reduced to 50% of nominal;

- when two or more pulse safety devices are unserviceable (or one device for 24 hours), the unit must be switched to cold;

e) prior to bringing the reactor to the minimum controlled level, all instruments, alarms, controllers, and safeties and interlocks of the equipment of the primary circulation circuit must be fully serviceable.

3.1.2. Pressure in the primary circulation circuit

Pressure in the circuit should not exceed the following limits: 160 kgf/cm^2 in power operation, 180 kgf/cm^2 under transient conditions, 280 kgf/cm^2 in hydraulic leak tests of the primary circuit, and 250 kgf/cm^2 in hydraulic strength tests of the primary circuit.

64/ 3.1.3. Warming and cooling of the primary circulation circuit:

a) the rate of change of the temperature of the heat transfer agent should not exceed 10C per hour in heating or 15C per hour in cooling (in the process the temperature of the heat transfer agent in the "hot" strands of the loops is critical);

b) in heating and cooling the primary circuit the temperature of the heat transfer agent in the pressure compensator should be 20 to 70C higher than that in the "hot" strands of the circulation loops;

c) the primary circuit may be cooled when the boric acid concentration in the heat transfer agent of the primary circuit is at least 12 grams per kilogram (a reduction in the average temperature of the heat transfer agent below 260C should be considered the beginning of cooling);

d) when the primary circuit is heated and cooled the difference in the temperatures of the "hot" and "cold" strands of the loops should not exceed 55C;

e) the rate of change of pressure in the primary circuit should not exceed 10 kgf/cm^2 per minute during heating and cooling;

f) in the heating and cooling of the primary circuit there should be at least a 15C margin between the actual temperature and the boiling point of the heat transfer agent at the outlet of the fuel assembly;

g) pressure in the primary circuit may be raised to 35 kgf/cm^2 when the temperature of the outside of the reactor vessel is at least 15C.

Raising the pressure in the primary circuit to more than 35 kgf/cm^2 is prohibited if the temperature of the heat transfer agent of the primary circuit and dead-end areas is less than 85C at the initial period of operation, and subsequently as indicated by Table 2. The temperature of the outside (surface) of the pressure compensator should be greater than 80C.

Table 2

Time since the beginning of operation, yrs	1	4	8	12	16	20	24	28	30
Temperature, °C*	85	86	97	103	108	112	115	118	120

*from the point of view of the pressure compensator's brittle strength

3.14. The activity of the heat transfer agent of the primary circuit:

a) the limit of volume activity of the heat transfer agent of the primary circuit during power operation of the nuclear steam generation plant is determined on the basis of an overall volume radionucleide activity of no more than 0.1 curies per liter (3.7 times 10^9 becquerels per liter);

65/ b) once the overall volume activity of the heat transfer agent in terms of iodine 131-135 radionucleides reaches a level of 1.5 times 10^{-2} curies per liter (5.5 times 10^8 becquerels per liter), the power unit should be switched to cold and the fuel element cans of all the fuel assemblies should be tested for leaks.

Note: the activity in question as defined as the mean arithmetic value of three or more samples taken over the course of several hours.

3.1.5. Primary circuit heat transfer agent quality standards.

If primary circuit heat transfer agent quality standards (National Standard 95.962-82) are violated in the course of power operation of the reactor, operators must take steps to restore acceptable concentrations. If such steps prove to be ineffective, then if total chloride and fluoride concentrations are higher than 0.1 mg/kg then after 24 hours, the power unit should be switched to cold (after 48 hours if there are violations with respect to other indicators).

The unit should be operated for no more than five days a year with the aforementioned violations.

3.2. The Reactor Control and Safety System

a) prior to bringing the reactor to the minimum controlled power level the following items should be fully serviceable:

- the group and individual control system for the control rods;

- the control rod position monitoring system;

- the reactor's scram system (including the reactor power regulation and limitation device);

- the automatic reactor power regulator;

- the neutron flux monitoring equipment;

- the power supply for the control and safety system's electrical equipment;

b) during power operation deviations from the conditions indicated in item a required to make it possible to repair a defective channel of the scram system or neutron flux monitoring equipment are permissible. In the process an emergency signal on any of the other two channels still in operation should lead to the operation of an appropriate safety;

c) if the automatic power regulator has become unserviceable, reactor power should be reduced to 10% of nominal;

3.2.2. Scram signal transmission time. Control rod reset time.

a) the time between the appearance of a scram signal and the movement of a control rod should not exceed 0.3 seconds (with the exception of time-delay safeties);

66/ b) when the characteristics of the primary circuit are normal (pressure, heat transfer agent temperature, flow through the reactor), it should take each control rod no more than 4 seconds to descend to the bottom of the reactor core; if this is not the case, the actuators of the control rods should be inspected;

3.2.3. The serviceability of control rods and position indicators:

a) if there are malfunctions in control rod control circuitry which could lead to disruption of the designed sequence of movement of the control rod groups, reactor power should be reduced to the minimum controlled level until the malfunctions are corrected;

b) if it proves impossible to monitor the position of one control rod the thermal power of the nuclear steam generation plant must be reduced to 90% of permissible.

c) in the event that one control rod gets stuck at a height of less than 100 centimeters from the bottom of the reactor core, the thermal power of the nuclear steam generation plant should be reduced to 90% of permissible.

In the event that one control rod gets stuck at a height of more than 100 centimeters or two or more get stuck at a level less than 100 centimeters from the bottom of the reactor core, reactor power must be reduced to the minimum controlled level until the malfunctions are corrected:

Note: Sticking is defined as a situation where a control rod will not move down on command from the control switch or a scram system signal.

In the event that two or more control rods in a group are at levels more than 35 centimeters apart, the thermal power of the plant should be reduced to 90% of nominal until the problem is corrected.

3.3. The Reactor Monitoring System

a) prior to bringing the reactor to the minimum controlled power level and in power operation, the reactor monitoring system must be fully serviceable (both when it operates in combination with the intrareactor monitoring system and independently);

b) in combined operation with a computer when the reactor is in power operation at least 75% of the temperature sensors at the outlet of the core assemblies out of a total of 95 and no less than two thirds of the neutron measurement channels out of a total of 64 should be serviceable* (*Neutron measurement channels should be considered unserviceable if they contain just one pair of adjacent unserviceable direct charge sensors or any three unserviceable direct charge sensors). The measurement processing system should output a complete three-dimensional cartogram of the distribution of energy release in the reactor core. The reliability of measurements and data processing should be checked by means of comparing them with the results of neutron physical calculations of energy release distribution for appropriate reactor core conditions:

67/ When the Hindu Kush intrareactor monitoring system is operating independently, the thermal power of the reactor plant should be reduced by 3%, and 90% of the thermocouples and instruments should be serviceable. The nonserviceable sensors should be evenly distributed over the reactor core;

c) if condition (b) is not met, the thermal power of the reactor should be reduced to 50% of nominal under the condition that the characteristics of the nuclear steam generation plant lie within the ranges called for by the "Table of Permissible Conditions."

If the serviceability of the reactor monitoring system has not been restored in the course of 72 hours (as a minimum, in accordance with condition b), the unit should be switched to hot.

d) if the intrareactor monitoring system should fail (under the condition that the power range readings of the neutron flux monitoring equipment and positions of the control rods confirm that energy release in the reactor core is symmetric), the power of the nuclear steam generation plant should be reduced to 75% of nominal within 10 minutes. (If the failure occurred in the process of raising the power of the plant, then any subsequent rise in plant power should be halted.) If the serviceability of the intrareactor monitoring system has not been restored, then in one hour one must reduce the power of the nuclear steam generation plant to 50% of nominal, and in three hours, if the serviceability of the system has not been restored, one should switch the unit to hot. If, in the event that the intrareactor monitoring system fails, the distribution of energy release in the reactor core (as determined by the information subsystem (and) neutron flux monitoring equipment) is unbalanced, the thermal power of the nuclear steam generation plant should be reduced to 50% of nominal; if serviceability has not been restored within one hour thermal power should be reduced to 30% of nominal, and if serviceability has not been restored within three hours the unit should be switched to hot. The coefficients for calculating the energy release field should be changed every 14 days to enable the intrareactor monitoring system to operate in an independent mode. At least once per shift one must get printouts of the signals from the temperature sensors at the outlet of the fuel assemblies and direct charge sensors and then analyze their serviceability and the reliability of their readings.

3.4. Reactor Core Emergency Cooling Systems

3.4.1. The reactor core passive cooling system.

a) prior to bringing the reactor to the minimum controlled level the core passive cooling system should be fully serviceable:

- all four hydroaccumulator tanks should be filled with water whose quality meets the requirements of National Standard 95.962-82 to a level of 6500 $\pm$ 100 millimeters (there should be at least 50 cubic meters of water in each tank), working nitrogen pressure should be 55-60 kgf/cm^2 and the operating temperature should be 20-60C.

- the check valves on the piping connecting the hydroaccumulator tanks to the reactor should be serviceable;

- the fast acting valves on the piping connecting the hydroaccumulator tanks to the reactor should be serviceable and open;

- the valves on the line for adjusting the level in the hydroaccumulator tanks, on the drainage lines, on the nitrogen delivery line, and on the check valve bypass should be serviceable and closed;

- both safety valves on every hydroaccumulator tank should be serviceable;

- the instrumentation, alarms, and interlocks of the core passive cooling system should be serviceable;

3.4.2. The core emergency cooling system.

Prior to and in the process of warming up the unit and during power operation and cooling one should make sure that:

- the level of a boron solution with a strength of at least 12 grams per kilogram in the pit tank is 5300 millimeters (no less than 500 cubic meters);

- the level of a boron solution with a strength of at least 40 g/kg in the supply tanks at the intake of the PT 6-160 pump is 3100 millimeters (15 cubic meters);

- the level of condensate in the emergency desalinated water supply tanks at the intake of the PE 150-80 pump is 5500 millimeters (volume of at least 450 cubic meters);

- the flow of process water through the....[Trans: the abbreviation ("t.o.") is not included in the lis of abbreviations accompanying the article and its meaning cannot be readily deciphered from the available references] of the core emergency cooling system should be 3000 tons per hour.

In the event that parameters should deviate from the aforementioned values in one safety system channel, one should activate two [Trans: bottom line of page 68 in original
69/ illegible] until the problem is corrected.

In the event that it is impossible to restore the proper parameter values within the time indicated or if there are deviations on more than one channel, the unit should be switched to cold.

The boron-10 isotope content of the boric acid should be at least 19.0% of the total boron isotope content.

3.5. Sealed Rooms Designed to Withstand Pressure (Containment Vessel)

a) prior to bringing the reactor to the minimum controlled level and during power operation the integrity of the containment vessel should be ensured:

- the transport opening should be closed and sealed;

- all the doors of the locks for the access of personnel into the containment vessel should be closed and sealed;

- all the sealed tunnels should be serviceable;

- leakage from the containment vessel over the entire range of abnormal pressures should not exceed 1% of the volume of air inside the containment vessel (at a pressure of 4 kgf/cm^2) per day;

- the underpressure in the containment vessel should be in the range to 15 + 20 mm H_2O.

b) in the event of major leaks in the containment vessel the unit should be switched to cold. One indication of a major leak is pressure higher than 15 mm H_2O when the TL22 ventilation system is serviceable.

3.6. Steam Generators and Their Purging System

3.6.1. The radioactivity of steam and purge water.

If the total volume activity of purge water reaches a level of 1.10^{-8} curies per liter ($1.31 - 2.10^{-10}$ curies per liter in terms of iodine), the power unit should be switched to cold.

Once the readings of total volume activity of live steam or steam at the outlet of the primary ejectors have stabilized, one should get analyses of the activity of the water of all the steam generators within 30 minutes and if this activity is geater than 1.10^{-9} curies per liter (1.31 to 2.10^{-10} curies per liter in terms of iodine), the power unit should be switched to cold.

3.6.2. Testing the joints for leaks.

a) steam generators must be taken out of operation for no more than 72 hours if only one gasket (first or second) in the flange joint of the primary circuit header hatch is leaking. The power unit should be switched to cold, and the hatch should be resealed....[Trans: portion of text on the bottom of page 69 and
70/ top of 70 in original missing]...The unit should be switched to cold, and the hatch should be resealed.

b) steam generators should be taken out of service for no more than 72 hours if both gaskets in the flange joint of the secondary circuit hatch are leaking.

Note: The emergency signal limit (output to the unit control panel) for the primary circuit header hatch leak monitoring system is 20 kgf/cm^2, while that for the same secondary circuit system is 20 kgf/cm^2.

3.6.3. Temperature and pressure in steam generators

a) the rate of heating and cooling of a steam generator should not exceed 20C per hour and 30C per hour respectively;

b) in power operation, the temperature of a steam generator's feed water should be within the 164 to 220C range[1];
1. 164 $\pm$ 2C when the high pressure heaters are shut off.

c) the water temperature when cooled and emptied steam generators are filled on the primary and secondary circuits should differ by no more than 60C from the temperature of the steam generator's metal.

In replenishing a nonoperational heated steam generator on the secondary circuit the difference between the temperature of the makeup water and temperature of primary circuit water should not exceed 120C.

d) pressure should not exceed·

250 kgf/cm^2 in hydraulic strength tests of the primary circuit;
110 kgf/cm^2 in hydraulic strength tests of the secondary circuit;

The temperature of the heat transfer agent of the primary circuit in hydraulic tests is indicated in Table 2.

The temperature of the sides of the components of the secondary circuits of steam generators should be no greater than 70C in hydraulic tests.

Notes: 1. 164 $\pm$ 2C when the high pressure heaters are shut off.

2. When the nuclear power plant has been deenergized and the water feeder has malfunctioned, water with a temperature of 5 to 20C may be delivered to the steam generators on a separate line over the entire course of the cooling period.
3. In emergency situations, when feed water with a temperature of less than 60C is delivered to a steam generator, activation of the steam generator must be preceded by an inspection of the feed water emergency delivery lines.

3.7. The Primary Circuit Emergency Gas Removal System

a) prior to bringing the reactor up to the minimum controlled level the emergency gas removal lines from the air units and both headers of every steam generator and the line for emergency release of pressure on the pressure compensator to the bubbling tank should be serviceable;

71/ b) one of three simultaneously activated valves on each line may be taken off line for repairs in reactor power operation. One may take all the valves on the emergency gas removal lines on no more than two steam generators off line for repairs if all the other lines are serviceable. The valves should not be taken off line for repairs for more than twenty four hours, but if this is necessary the reactor should be reduced to the minimum controlled power level or cooled down if the valves have to be inspected;

c) in cooling, as indicated by the operations manual of the chief designer of the steam generators, heat transfer agent should be removed through the air units of the primary circuit of the steam generator for the purpose of levelling out the vertical distribution of temperatures over the steam generator headers. There should be a flow of one cubic meter per hour from each steam generator.

3.8. The Primary Circulation Circuit Drainage System

a) prior to bringing the reactor to minimum controlled power, all four primary circuit drainage lines and the organized leak heat exchanger must be serviceable.

b) in power operation of the reactor no more than two primary circuit drainage lines may be taken out of service for repairs, and if they have not been repaired within this period the reactor should be reduced to the minimum controlled level or cooled if the valves or organized leak heat exchanger must be repaired.

72/ 4. LIMIT CONDITIONS FOR FUEL RECHARGING

a) fuel recharging may begin once the following conditions are met:

- the reactor has been subcritical for at least 72 hours;

- the average temperature of the heat transfer agent of the primary circuit is no more than 70C;

- the holding and charging ponds have been filled with water to a level of 15.5 meters;

- the holding pond cooling system (cooling pumps, pump for delivering holding pond water for treatment) is serviceable;

- at least one process strand of special water treatment unit No. 4 is serviceable (anionite filters are in boron form);

- the boron solution emergency supply tank is filled with water with an H_3BO_3 concentration of at least 12 grams per kilogram (at least 500 cubic meters of water in the tank);

- the recharging machine and overhead cranes are serviceable;

- all six channels of the recharging neutron flux monitoring system and monitoring instruments mounted on the recharging machine are serviceable;

- three source range channels of one set of neutron flux monitoring equipment, the reactor runaway sound alarm, and the recharging neutron flux monitoring equipment installed on the unit control panel are serviceable;

- steps have been taken to prevent accidental delivery of water with an H_3BO_3 concentration of less than 12 grams per kilogram to the primary circuit and holding pond;

- the fuel element can leak detection system is serviceable;

- at least two emergency cooling systems and the appropriate systems of safety valves of the control and safety system and process water systems for critical users are servicable;

- auxiliary power for the unit is supplied by the backup transformer and at least two diesel generators are serviceable (in addition to the circuitry for gradual startup in a cooling mode and the corresponding loads);

- the TL04, TL21, and TL41 ventilation systems are serviceable;

- the radiation situation in the central room is continuously monitored;

- communications between the unit control panel and recharging machine panel are serviceable;

b) in the fuel recharging process, periodic checks (twice per shift) of boric acid concentration should be made and include taking samples from the reactor vessel. If boric acid concentration should fall below 12 g/kg in the reactor vessel,
73/ fuel recharging operations should be halted until the causes of the problem are discovered and the proper concentration is restored (no less than 12 g/kg H_3BO_3).

In the fuel recharging process periodic checks (at least once per shift) should be made of the steps taken to prevent the ingress of water with a boric acid concentration of less than 12 g/kg into the primary circuit and holding pond.

The average temperature of the heat transfer agent of the primary circuit should not exceed 70C at the outlet of the reactor during recharging.

c) one may take one process strand of the holding pond cooling system out of service for repairs for a period in which water temperature in the pond will not exceed 70C if the last strand should become unserviceable (including when the nuclear steam generation plant is in power operation);

d) if two adjacent reactor monitoring channels are found to be unserviceable, fuel recharging operations should be halted and may be continued only after full serviceability has been restored.

74/ 5. MAXIMUM PERMISSIBLE DISCHARGES OF RADIOACTIVE SUBSTANCES INTO THE ENVIRONMENT

a) in all kinds of nuclear steam generation plant operation the discharge of radioactive substances from the ventilation stacks of the reactor sections of two units and the special facility should not exceed the following levels:

- inert radioactive gases - 500 curies per day · 1000 megawatts (electrical)

- I^{131} - 0.01 curies per day · 1000 megawatts (electrical)

- aerosols: (DZhN)* - 0.015 curies per day 1000 megawatts (electrical)
  (KZhN)* - 0.2 curies per day 1000 megawatts (electrical)

*[Trans: abbreviations not explained in document or any other available reference]

If the aforementioned limits are exceeded the unit should be switched to cold.

Note: A one-time (daily) discharge of radioactive substances five times greater than the average daily permissible discharge is permissible under the condition that the total discharge in one quarter does not exceed acceptable levels.

b) in all kinds of nuclear steam generation plant operation the monthly discharge from the ventilation stacks of the reactor sections of two generation units and the special facility should not exceed the following levels in terms of:

- strontium-90	- 1.5	millicuries per month	·	1000 MW (elec)
- strontium-89	- 15	millicuries per month		1000 MW (elec)
- cesium-137	- 15	millicuries per month		1000 MW (elec)
- cobalt-60-	- 15	millicuries per month		1000 MW (elec)
- manganese-54	- 15	millicuries per month		1000 MW (elec)
- chromium-51	- 15	millicuries per month		1000 MW (elec)

Note: In exceptional cases the average monthly discharge may be exceeded by a factor of five if the annual discharge limit is not exceeded.

75/

6. ORGANIZATIONAL MEASURES

6.1. The Procedure to be Followed in the Event that Limits are Exceeded and Safe Operating Conditions are Violated

The State Nuclear Power Supervisory Agency, the Chief Designer, the Scientific Director, and the General Designer must be immediately notified of all incidents where limits are exceeded and safe operating conditions are violated, and the power of the nuclear steam generation plant must be appropriately changed (to operation at lower power, to reactor shutdown, or to shutdown and cooling).

The way in which the nuclear power plant is to be operated in the future must be determined on the basis of the results of an analysis of the incidents with the authorization of the State Nuclear Power Supervisory Agency.

76/ 7. TABLE

OF PERMISSIBLE NUCLEAR PLANT POWER UNIT NOMINAL POWER OPERATING CONDITIONS

Parameters	Number of Operating Primary Circulation Pumps			
	4	3	2	
			opposite	adjacent
1. max permissible thermal power on the primary and secondary circuits, %, MW (on the basis of intrareactor monitoring system readings)	100+2 3000+60	67+2 2010+60	50+2 1500+60	40+2 1200+60
2. max permissible heating of the heat transfer agent on the basis of measurements of temperature in the loops, C (intrareactor monitoring system readings)	30	27	24	*
3. max permissible heating of the heat transfer agent at the fuel assemblies of the reactor core, C (on the basis of intrareactor monitor system readings)	31	29	32	*
4. max perm temp at the outlet of the fuel assemblies, C (intrareactor monitoring system	319	310	313	*

readings)

5. scram system operate setting, % of N, nom.	107.0	77.0	60.0	50.0
6. power reg and lim device operate setting, % of N,. nom.	102.0	69.0	52.0	42.0

* ultimately determined on the basis of scheduled preventive maintenance results

7. Maximum permissible coefficient of unevenness of energy release over the volume of the reactor core (on the basis of intrareactor monitoring system readings)

Mode	No. of energy release sensor						
	1	2	3	4	5	6	7
1	1.75	1.75	1.75	1.62	1.49	1.36	1.23
2	1.90	1.90	1.90	1.77	1.64	1.51	1.33

Mode 1: independent intrareactor monitoring system operation
Mode 2: combined operation of the system and Khortitsa software

Note: The maximum permissible values indicated in points 2-4 are valid for a power grid frequency of 50 Hz.

At frequencies of f: permissible heating for points 2 and 3: $\Delta t = \Delta t_{ncn} \times 50/f$
permissible temps for points 4
$t = 288 + \Delta t_{ncn} \times 50/f$

77/ 1. The parameters of the reactor plant in nominal power operation should be maintained within the following ranges:

- heat transfer agent temperature at the inlet of the reactor (in any cold strands of the loops): no more than 288C;

- heat transfer agent pressure above the reactor core: 160 $\pm$2 kgf/cm^2;

- steam pressure in the steam generators: (64 $\pm$2) kgf/cm^2

In the event that any of the above thermohydraulic parameters are exceeded, the thermal power of the reactor should be reduced to a level at which reactor plant parameters do not exceed the levels indicated in the table.

2. The margin until the scram system operates on the basis of neutron power excess signals in the power range on any neutron flux monitoring equipment channel should not exceed 7% when the

plant is operating on four loops or 10% when the plant is operating on three and two loops of the nominal level used for the operation of the neutron flux monitoring equipment;

3. No matter how many primary circulation pumps are in operation, the distribution of the energy release field over the reactor core should not exceed the limits indicated in point 7 of this table.

In the event that the coefficient of unevenness $K_y^{доп}$ is exceeded, reactor power should be reduced in accordance with the formula:

$$N_T = N_T^{доп} \times \frac{K_y^{доп}}{K_y} \quad /1/$$

where: $N_T^{доп}$ is permissible thermal power (see point 1 of this table). If K_y exceeds 2.5 in any properly functioning sensor, the thermal power of the reactor should be reduced to 50% of the current permissible level.

One may "suppress" xenon oscillations in the reactor core in accordance with the algorithm given in Appendix 8. The Hindu Kush intrareactor monitoring system may operate in mode 1 (independent operation) for no more than 1 hour at the nominal power level, in accordance with the reactor plant operations manual.

4. The reactor may not be operated for prolonged periods (more than one to one and a half hours) when the working group of control rods occupies a position below 70%.

5. The safeties and interlocks should be tested and activated in accordance with the "List of Safeties and Interlocks..."

6. Operation at nominal power is permitted when all the regulators indicated in the design are operational.

7. This table may be revised on the basis of startup results with the approval of the Kurchatov Institute of Atomic Energy and the Gidropress Special Design Office.

8. Existing nuclear steam generation plants may be operated in accordance with the requirements of a "Table of Permissible Conditions" written for the design of a nuclear power plant and coordinated with the Gidropress Special Design Office, Institute of Atomic Energy, and National Nuclear Power Plant Operation Research Institute.

/78/ 8. An Algorithm for Controlling Energy Release in a VVER-1000 Reactor Core (Suppressing Xenon Oscillations)

8.1. The steady state of a VVER-1000 reactor core in power operation is characterized by the following conditions:

8.1.1. The thermal power of the reactor is maintained by the power regulator with an accuracy of $\pm 2\% N$ [illegible] ;

$$/N^{тек.}_{тепл.} \leq N^{доп.}_{тепл.}/$$

8.1.2. The working group of control rods is maintained within the adjustment range of movement (H_{op} = 70-90% from the bottom of the reactor core (by varying boric acid concentration in the heat transfer agent).

8.1.3. Measured energy release unevenness coefficients (measured by means of a standard intrareactor monitoring system) do not exceed the levels indicated in the "Table of Permissible Conditions:"

$$/K^{тек.}_{v,i,j} \leq K^{доп.}_{v,i}/,$$

where i is the number of the point on the vertical axis of the reactor core (i = 1, 2,..., 7);

and j is the number of the fuel assembly of the reactor core (j = 1, 2,...., 163).

8.1.4. The axial offset measured by means of a standard intrareactor monitoring system should be in the -0.02 to 0.15 range.

8.2. Conditions for the occurrence of xenon oscillations may include:

8.2.1. Shedding the load of the power unit (emergency or planned) involving movement of the working group of control rods below the adjustment range for more than one to one and a half hours.

8.2.2. Unforeseen movement of a working group of control rods from the adjustment range (lower than 70% from the bottom of the reactor core) for more than one to one and a half hours.

8.3. If in operation at a steady power level the measured current values of the volume coefficients of unevenness of energy release reach (exceed) permissible levels, the following actions must be taken.

8.3.1. If volume coefficients of energy release unevenness in the bottom of the reactor core ($K^{TEK}_{V1,2,3}$ = $K^{доп}_{V1,2,3}$) or axial offset becomes greater than 0.15 in an individual control mode one must lower the control rod with the partial absorber length to the bottom of the reactor core and remove it from the reactor core once the axial offset reaches 0.2.

Reactivity must be compensated upon movement of a control rod of partial absorber length by moving the working group of control rods within the adjustment range and/or by varying boric
79/ acid concentration.

The time that a control rod of partial absorber length stays in the bottom position may vary from 1.0 to 1.5 to 10 to 12 hours.

8.3.2. In the event that volume coefficients of energy release unevenness in the top part of the reactor core are ($K^{\text{тек}}_{V5,6,7} > K^{\text{доп}}_{V5,6,7}$) one should lower the working group of control rods to a position 50% from the bottom of the core or until axial offset reaches 0.05 to 0.08 and volume coefficients of energy release unevenness $K^{\text{тек}}_{V5,6,7} \leq K^{\text{доп}}_{V5,6,7}$. In the event that axial offset increases to 0.15 the working group of control rods must be returned to the adjustment range. Reactivity should be compensated upon movement of a working group of control rods by varying the boric acid concentration.

The time that the control rods of a working group stay at a position of 50% from the bottom of the core may vary from 1.0 to 1.5 to 10 to 12 hours. Lowering a working group of control rods lower than 50% from the bottom of the core at the nominal power level is prohibited.

Once the permissible time has elapsed (12 hours) reactor power and the position of the control rods should be brought into conformity with the graph of optimal control rod positions by varying the concentration of boric acid in the heat transfer cases.

8.3.3. One may not allow the permissible volume coefficients of energy release unevenness indicated in the Table of Permissible Conditions to be exceeded in any kind of reactor operation. In the event that current values $K^{\text{тек}}_{Vi,j}$ exceed permissible values $K^{\text{доп}}_{V,i}$, the thermal power of the reactor should be reduced in accordance with the formula:

$$N^{\text{тек.}}_{\text{тепл.}} = N^{\text{доп.}}_{\text{тепл.}} \times \frac{K^{\text{доп.}}_{V,i}}{K^{\text{макс.}}_{V,i}}$$

where $N^{\text{доп}}_{\text{тепл}}$ is permissible thermal power as indicated in the Table of Permissible Conditions;

$K^{\text{доп}}_{V,i}$ is the permissible volume coefficient of energy release unevenness in the reactor core for a permissible reactor thermal power in the corresponding ith cross section;

and $K^{\text{макс}}_{V,i}$ is the maximum K_V in the ith cross section.

The position of the working group of control rods and thermal power of the reactor should conform to the control rod optimal position group.

8.4. In emergency or planned reductions in the power level of the unit to a thermal power of $N^{тек}_{тепл} \geq 35\% N^{ном}_{тепл}$ one should take steps to generate a vertical energy release field in the reactor core which would make it impossible to exceed permissible volume coefficients of energy release unevenness $K^{доп}_{vi,j}$ when the power of the unit is subsequently raised. For this purpose one should:

80/ 8.4.1. Compensate for xenon-135 poisoning of the reactor core by removing the groups of control rods moved in reducing the power of the unit (the working and preceding group of the standard sequence) until the working group reaches the adjustment range of 70 to 90% from the bottom of the reactor core for no more than 1.5 to 2.0 hours. Control rod groups should be removed in the standard sequence. Once the time indicated above has elapsed reactor power and the position of the control rods should be brought into conformity with the graph of the optimal position of the control rods of the working group by varying the concentration of boric acid in the heat transfer agent.

8.4.2. If in operation at a reduced power level the axial offset should exceed 0.15, one must lower the control rods with partial absorber lengths to the extreme lower position in an individual control mode.

In the event that the power level is unchanged, reactivity should be compensated by moving the working group of control rods and varying the boric acid concentration after this group of rods has been returned to the adjustment range. Control rods with partial absorber lengths should be removed either once the maximum offset reaches 0.02 or in the process of raising the power level of the unit, thus compensating for the effect of reactivity.

After the control rods of partial absorber length have been removed, further compensation of reactivity should involve moving the working group of control rods and varying the boric acid concentration after this group has been returned to the adjustment range.

8.4.3. If in the process of raising the power of the unit or afterwards in operation at the nominal steady level the measured current values of volume energy release unevenness coefficients should reach permissible levels, one should follow the recommendations of points 8.3.1. and 8.3.2. and if necessary 8.3.3.

8.5. In emergency or planned reductions in the power level of the unit to a thermal power level $N^{тек}_{тепл} < 35\% N^{ном}_{тепл}$; the use of control rods to affect the energy release field in the reactor core for the purpose of generating a favorable field.....[Trans: meaning very unclear]

If in the process of subsequently raising the power of the reactor the measured energy release unevenness coefficients ($K^{TEA}_{Vi,j}$ should get close to impermissible levels, then one should follow the recommendations of points 8.3.1. or point 8.3.2., and if necessary point 8.3.3.

81/ 9. The Safeties and Interlocks Which Must Be Tested Prior to Starting Up a Power Unit After a Shutdown of No More than Seven Days

1. The scram and preventive systems of the control and safety system (scram system and preventive system)
2. The safeties of the core emergency cooling system

3. YAP01 / 1 + III units/
4. YAP04
5. YBP01 /1 + III units/
6. YBP04
7. YBS14, 15
8. YTS02
9. YZS01
10. YZS01, YBS03
11. УДР01
12. УДР11
13. УДР12
14. УДР13
15. УДР14
16. IPF02
17. TQS01 /02,03/
18. TQS04 /05,06/
19. TKS01 //02,03/
20. TKP03
21. TKS10
22. TXS28
23. TXS21
24. TXS19
25. TXS16
26. TXS17
27. TXS18
28. TXS22
29. TXS24
30. TXS26
31. TXB36
32. TXB37
33. TXB38
34. TXB39
35. UTS04
36. UTS11
37. UTS12

32/ 10. List of Conditions Incorporated in the Design of a Nuclear Steam Generation Plant. Number of Cycles over a Life of 30 Years ("The V-320 Reactor Plant. Specifications 320.00.00.00.000, 1979)

1. Normal Operating Conditions

1.1. Filling the equipment with working medium and sealing the equipment:	
- for the reactor	100
- for the other equipment	60
1.2. Separate hydraulic testing on the primary and secondary circuits:	
- for leaks	100
- for strength	30
1.3. Scheduled warmup from a cold state at a rate of 20C/hr	130
1.4. Changing power:	
- bringing the reactor from hot to nominal power: at a rate of 3% N_{nom} per min to a a level of 40 to 45% of nominal, at a rate of 1% N_{nom} per min to 100% nominal (reactor must be kept at 75 to 85% nominal for at least three hours.	90
- reducing reactor power from nominal to the hot level at a rate of no more than 3% N_{nom} per minute	90
- building up the load from the current power level: when the current level is no more than 50% nominal, the load may be gradually increased by 20%; when the current level is greater than 50% nominal the load may be gradually increased by 10% and the reactor must be kept at a steady level for at least three hours prior to raising it to the next level	10
1.5. steady operation: power fluctuations of $\pm 2\%$ nominal due to the operation of the regulation system	unlimited
1.6. operation at the auxiliary power level	

	(up to 10% N_{nom} thermal) with natural heat transfer agent circulation	30
1.7.	false operation of the scram system	150
1.8.	planned shutdown of the primary circulation pump	200 (per pump)
1.9.	activation of a primary circulation pump of a loop which has not been in operation	230 (per pump)
83/ 1.1.0	shutdown of high pressure heaters and subsequent reactivation	300
1.11.	closure of the cutoff valves of one of two operating turbines	200
1.12.	testing of the safety valves of the pressure compensator	by the rules
1.13.	testing of the safety valves of the steam generator	by the rules
1.14.	testing of the passive subsystem of the core emergency cooling system	50
1.15.	planned cooling to a cold level at a rate of 30C per hour	70
1.16.	emptying and unsealing of equipment: - reactor - other equipment	 100 60
1.17.	replenishment and purging of the heat transfer agent in the primary and secondary circuits, organized leaks	-
1.18.	delivery of nitrogen to the equipment and removal of gas blowoff	-
1.19.	cooling the equipment with air, process water, and process circuit water	-
1.20.	fuel and intrareactor equipment handling operations	-

2. Violatic.s of Normal Operating Conditions

2.1.	deenergization of the primary circulation pumps (all possible combinations)	30
2.2.	closure of the cutoff valves: - of the last operating turbine of a unit	

with two turbines	100
- the turbines of a monoblock	100
2.3. complete deenergization of the nuclear power plant and delivery of 5-40C feed water	10
2.4. cutoff of the delivery of feed water to the steam generators	30
2.5. uncontrolled removal of a control rod group from the reactor core	30
2.6. reduction in the boric acid concentration in the heat transfer agent due to disruptions in the boron regulation system	30
2.7. steam generator leakage: rupture of a heat exchanger tube	30
2.8. false injection into the pressure compensator from a standard makeup unit with a water temperature of 60 to 70C	10
Note: Afterwards the pressure compensator should be inspected.	
2.9. sudden transition to replenishment of the primary circuit with a water temperature of 60-70C	30
84/ 2.10. accidental deviations of frequency in the grid:	
- from 50.5 to 51 hertz (up to 10 seconds but no more than 60 seconds per year)	10
- from 49 to 48 hertz (up to 5 minutes but no more than 20 minutes per year)	20
- from 48 to 47 hertz (up to 1 minute but no more than 20 minutes per year)	15
- from 47 to 46 hertz (up to 10 seconds)	10
2.11. operation accompanied by disruption of heat abstraction from the containment vessel	30
2.12. accelerated cooling at a rate of 60C/hr	30
3. Emergency Situations	
3.1. minor leaks: rupture of a Du100mm pipeline on the primary circuit	15
3.2. major leaks: rupture of a Du100mm pipeline on the primary circuit, including the Du850mm	1

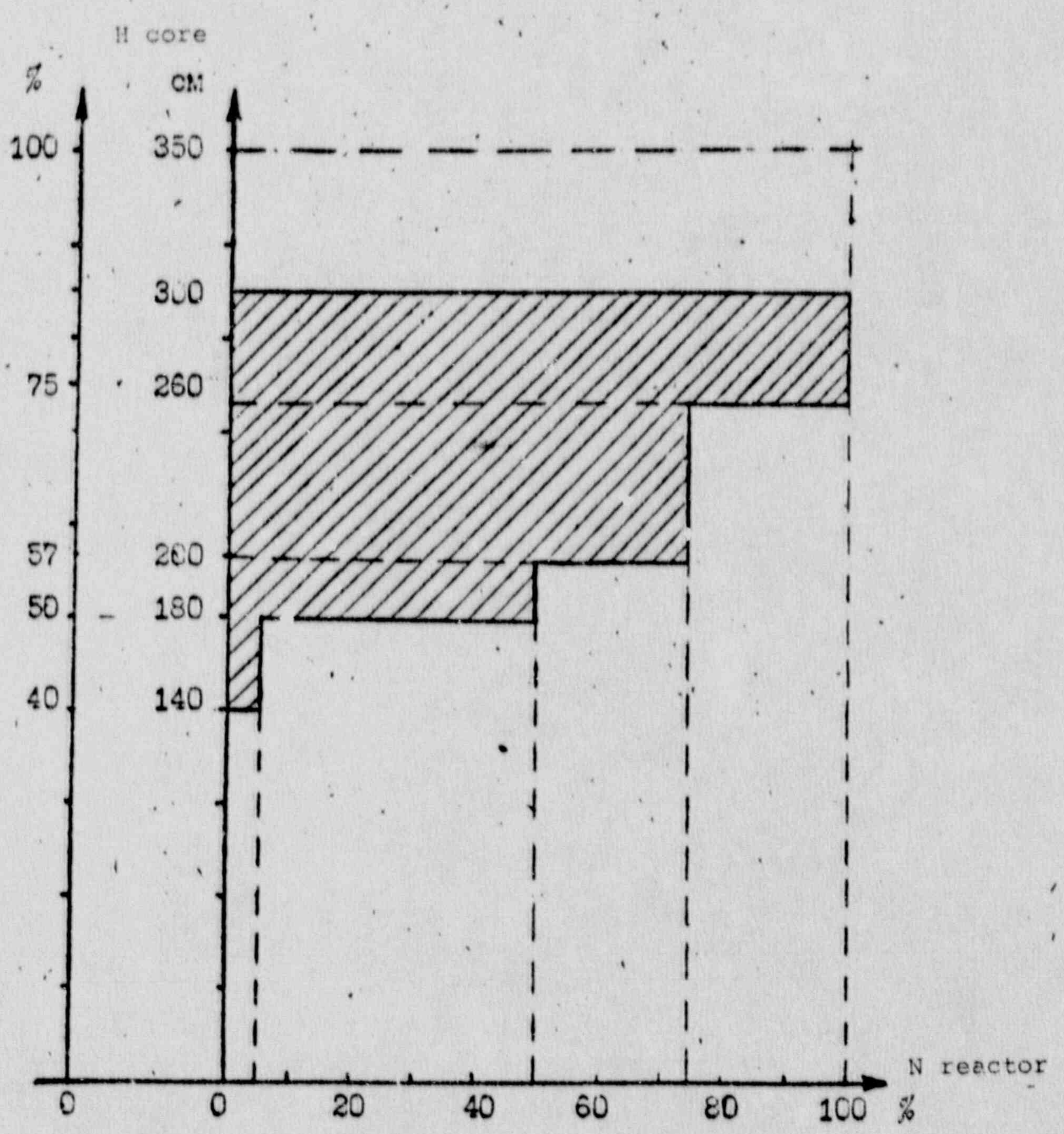
3.3. pressure compensator safety valve leaks	1 (per valve)
3.4. steam generator safety valve leaks	1 (per valve)
3.5. leaks in the valves of the devices for discharging steam from the steam generators	1 (per device)
3.6. ejection of a control rod in the event of rupture of the cap of an actuator	5
3.7. instantaneous jamming of a primary circulation pump	1 per pump
3.8. rupture of a steam generator steam line	1 per steam generator
3.9. rupture of a steam generator feed water line	1 per steam generator
3.10. rupture of the live steam header	1
3.11. fuel handling accidents	-

Comments: 1. Persons examining this list should also take seismic stability requirements.

2. The nuclear steam generation plant must be examined after emergency situations.

3. If frequency as indicated in point 2.10. drops below 49 hertz the reactor may be operated at a lower level

5/ GRAPH OF THE OPTIMAL POSITION OF A GROUP OF CONTROL RODS AS A FUNCTION OF REACTOR POWER



86/ SUPPLEMENT TO THE RULES FOR STARTING UP AND BRINGING A VVER-1000 REACTOR WITH A TWO-YEAR FUEL CHARGE UP TO FULL POWER (WITH A POSITIVE REACTIVITY COEFFICIENT IN TERMS OF HEAT TRANSFER AGENT TEMPERATURE AT THE BEGINNING OF A RUN)

1. GENERAL PRINCIPLES

1.1. This supplement to the rules was written in accordance with "Decision Concerning the Prevention of Positive Heat Transfer Temperature Reactivity Coefficients and the Procedure for Starting Up and Operating New and Existing Power Units with VVER-1000 Reactors Using a Two-Year Fuel Charge," approved by the first deputies of organizations of the Ministry of Nuclear Power of the Soviet Union and... [Trans: meaning of last abbreviation in original unclear]

1.2. This supplement to the rules applies to reactor plants with 61 control rods and is a supplement to "Operational Rules for Power Units with VVER-1000 Reactors " which define the conditions and procedure for starting up and bringing to power a VVER-1000 reactor with a two year fuel charge when there is a positive primary circuit heat transfer agent temperature reactivity coefficient and a negative primary circuit heat transfer agent density reactivity coefficient in the initial period of fuel charge operation.

1.3. This supplement will go into effect as indicated by the chief engineer of the nuclear power plant prior to the beginning of startup operations on a reactor. The necessary changes (additions) to the operations manuals should also be made according to the established procedure prior to the beginning of startup operations.

1.4. This supplement will no longer be in effect once the chief engineer of the power plant so indicates after enough fuel has been burned to make temperature reactivity coefficients negative (density reactivity coefficients positive) for the critical states of a reactor without power and not poisoned by xenon-135 with a heat transfer agent temperature of 260 to 280C and the control rods of the tenth group lowered 20 to 40%.

1.5. While this supplement is in effect, the required (by safety considerations) reactivity coefficients are maintained by the control rods of the 8th, 9th, and 10th groups lowered into the reactor core.

The control rods of the 8th and 9th groups should be removed as the power level increases, as xenon-135 poisoning increases, and fuel burns without an excessive boric acid concentration in the primary circuit.

In switching to the 9th and then the 10th group of control rods, operators should check to see that motion is transmitted properly to the control rods of the 9th and 10th groups and that the control rods of these groups are linked in an individual control mode.

1.6. The procedure for starting up and bringing a VVER-1000 reactor with its first fuel charge to power is defined by a

Physical Startup Program which must take the requirements of this supplement into consideration.

88/ 1.7. This supplement defines the requirements for the condition of nuclear steam generation plant systems, the combination and sequence of operations, and for the execution of records not described in the operational rules and required to ensure nuclear safety in the startup and operation of a nuclear power plant and restrictions on the configuration of current fuel charges.

1.8. A certificate should be written up on the basis of the results of a reactor startup carried out in accordance with this supplement and copies should be sent to the Kurchatov Institute of Atomic Energy, the Gidropress Special Design Office, and the "Energiya" National Nuclear Power Plant Operation Research Institute.

2. THE CONFIGURATION OF CURRENT FUEL CHARGES

The configuration of current fuel charges, in the event that the design configuration is not employed, should ensure a negative temperature reactivity coefficient of less than -0.001%/degree when the control rods of the 10th group and some of the control rods of the 8th group are lowered into the core.

3. THE CONDITION OF EQUIPMENT AND SYSTEMS PRIOR TO REACTOR STARTUP

The following technical and organizational measures should be taken in preparing for reactor startup during the effective period of this supplement:

3.1. DPI position sensors should be installed on the actuators of the control rods of the fifth, eighth, ninth, and tenth groups used in startup operations for regulating power and the distribution of energy release in the reactor core, and if these sensors are not available DD-2 sensors should be used.

3.2. One should make it impossible to control the control rods of the 9th and 10th groups by keeping them in the initial (bottom) position by means of the holding "catches" of the actuators (with position monitoring):

- the MI module (breaking the 9th group control circuits) should be removed in the 13PKU-3 UFK and 14PKU-1,2,3,4 panels;

- the MI module (breaking the 10th group control circuits) should be removed in the 15PKU-1,2,3,4 UFK and 16PKU-1,2 UFK panels.

3.3. The 13PKU-3,4 UFK, 15PKU-1,2,3,4 UFK, and 16PKU-1,2 panels and the points of installation of the MI modules should be sealed, and notices should be posted on the panels prohibiting the installation of the modules. Work on the aforementioned panels is prohibited without special programs;

3.4. The access of personnel to the rooms of the control and safety system panel should be restricted...[Trans: last line of
89/ page 88 missing]...of the chief engineer of the nuclear power or his deputies for operations transmitted by the unit shift supervisor and approved by a representative (chief) of the inspection team of the State Nuclear Power Inspectorate at the nuclear power plant.

Appropriate entries concerning the operations should be made in the operations logs. In walking inspections of the equipment, the control and safety system inspector [Trans: first abbreviation in this sentence unclear] of the thermal control and measurement department should check the voltage on the instruments of the BRP and BSV power units every two hours and make appropriate entries in the operations log.

The operators of the reactor section should systematically monitor the positions of the control rods of the 9th and 10th groups on appropriate fragments and use the readings of the neutron flux monitoring equipment to monitor the symmetry of the neutron field (misalignments in the neutron field may indicate that the control rods have moved).

3.5. The necessary information on the startup and operating conditions of the nuclear steam generation plant governed by this document should be entered in the reactor fuel charge neutron and physical characteristics book.

3.6. The primary circuit of the nuclear steam generation plant should be heated to a temperature of at least 260C (or 150 degrees if three primary circulation pumps are in operation, while the boric acid concentration should be no less than 12 grams per kilogram (when the charge begins to operate).

4. REACTOR STARTUP PROCEDURE

4.1. The reactor should be started up under the direction of the chief engineer of the nuclear power plant or his deputy for operations (in physical startups under the direction of the scientific director of startups) only when a representative of a State Nuclear Power Inspection Agency inspection team is present at the unit control panel.

4.2. Groups 1-7 of the control rods of the control and safety system should be extracted in turn, in 35 centimeter steps (transmitting control signals to the control rod actuators for 18 seconds) with a one minute delay between steps when there is the proper concentration of boric acid in the primary circuit. The 8th group of control rods should be raised in the same order to a level of 20-40%.

4.3. The boric acid concentration in the primary circuit should be reduced and the reactor should be brought up to the minimum controlled level by replenishing it with pure condensate with a flow rate of no more than:

- 40 tons per hour when the boric acid concentration is higher than 11 grams per kilogram;

- 20 tons per hour when the boric acid concentration is less than 11 grams per kilogram (outside the startup range of boric acid concentrations);

- 10 tons per hour in the startup range of boric acid concentrations.

90/ The startup range of boric acid concentrations is 1 gram per kilogram, and the lower limit of the startup range is equal to the anticipated critical concentration of boric acid in the primary circuit heat transfer agent.

4.4. At the beginning of the startup range of boric acid concentrations the concentrations of boric acid in the primary circuit, the pressure compensator, the makeup deaerator, and in the organized leak tanks.

4.5. At the minimum controlled level after replenishment of the primary circuit has been completed and boric acid concentrations in the reactor, pressure compensator, and makeup deaerator, one must record the startup condition of the reactor and determine the sign and magnitude of the temperature reactivity coefficient using a procedure approved by the chief designer and scientific director of the project.

4.6. After the temperature reactivity coefficient (close to zero) has been experimentally determined when the reactor is in its startup condition, one must determine more accurately the permissible boric acid concentration in the heat transfer agent corresponding to a zero temperature reactivity coefficient and write down instructions for the operators to maintain the boric acid concentration in the primary circuit at a level no lower than permissible.

4.7. When the temperature reactivity coefficient is greater than zero and the 8th group of control rods is in the 20% position, the reactor should be plugged and the control rods should be lowered and the boric acid concentration should be put at 12 grams per kilogram. Further actions in starting up the unit should be indicated in writing by a special decision.

5. BRINGING THE REACTOR UP TO POWER

5.1. Depending on the results of measurements according to point 4.5. of this supplement, reactor power should be raised above the minimum controlled level by:

- removing groups of control rods from the reactor core (if the experimentally determined temperature reactivity coefficient is less than 0.001% per degree;

- boric acid should be removed from the primary circuit by periodically delivering pure condensate on the makeup line with a flow of up to 10 tons per hour (if the experimentally determined temperature reactivity coefficient is less than 0.001 percent per degree), for the purpose of reducing the boric acid concentration in the primary circuit to a level appropriate for temperature reactivity coefficients of less than 0.001% per degree. Subsequently power should be raised by removing groups of control rods.

5.2. In the process of raising reactor power, raising the concentration of boric acid in the primary circuit above the permissible level is prohibited.

91/ 5.3. After the 8th group of control rods has been raised to the 80% level and when boric acid concentration in the primary circuit is lower than the permissible level, upon receipt of written instructions from the chief engineer of the plant or his deputy for operations the MI modules should be installed in the 13PKU-3,4 UFK and 14PKU-1,2,3,4 UFK panels (the breaks in the control circuits of the 9th group of control rods should be eliminated), reactor power should be raised to 50%(40%) of nominal by successively removing the 8th and 9th groups of control rods.

5.4. Power should be raised to 70%(75%) of nominal (in 5 to 6% increments) over the course of 15 to 20 hours accompanied by compensation for the power effect and xenon-135 poisoning by successive removal of the 8th group of control rods from the core (no higher than 80%) followed by, if necessary, the removal of boric acid from the primary circuit.

5.5. The breaks in the control circuits of the 10th group of control rods may be eliminated after the reactor has been raised to a level 70% (75% in power startup of a reactor with its first fuel charge and if it has been experimentally confirmed that the temperature reactivity coefficient is equal to or less than -0.001% per degree) of nominal.

5.6. Taking the thermal relaxations of the fuel in the fuel elements into account, power should be raised from 70% (75% for power startup of a reactor with its first fuel charge) to 100% of nominal accompanied by compensation for reactivity effects by removing the 9th and 10th groups of control rods to the standard position and removing boric acid from the primary circuit until the reactor core reaches a steady state.

6. STARTING UP AND BRINGING THE REACTOR TO POWER AFTER A SHUTDOWN

6.1. In the event of a shutdown or operation of the scram system, one should take steps to stabilize the boric acid concentration at a level 1 gram per kilogram higher than the last startup concentration with the 8th group of control rods in the 20 to 40% position. In preparing the reactor for startup after a prolonged shutdown lasting more than 12 hours, the initial condition of the wiring of the control and safety system devices should be restored in accordance with point 3.2. of this supplement. In the event of a shutdown of lesser duration one may avoid disassembling the control circuits of the 9th group of control rods if a negative temperature reactivity coefficient of less than -0.001% per degree for startup boric acid concentrations can be provided by lowering only the 9th and 10th group of control rods.

92/ 6.2. The reactor should be started up in accordance with points 4.2. and 4.3. of this supplement with an initial boric acid concentration in the primary circuit determined by reactor shutdown conditions in accordance with operational rules.

6.3. When power is raised and the reactor is operating under conditions of unstable xenon-135 poisoning, the required control rod positions (see point 7.2. of this supplement) should be maintained by varying the boric acid concentration in the primary circuit but changing it no higher than the permissible level.

7. SAFETY MEASURES

7.1. In the process of starting up the reactor and bringing it to power the neutron power level settings of the scram system should conform to the following values:

- prior to going to the minimum controlled level	- 5(5)%;
- to 50(40)% of nominal	- 55(45)%
- to 70(75)% of nominal	- 75(80)%
- to (90)% of nominal	- (95)%
- to 100% of nominal	- 104(104)%

The numbers in parentheses indicate the power levels and corresponding scram system settings for physical and power startup of a reactor with its first fuel charge.

7.2. When the 9th and 10th control rod groups are fully lowered into the reactor core, reactor power should not exceed 80% of nominal and when the 10th control rod group is fully lowered it should not exceed 90% of nominal with energy release unevenness coefficients in the reactor core less than the maximum permissible for the specific power levels.

7.3. The concentration of boric acid in the heat transfer agent of the primary circuit should be systematically monitored and maintained within permissible limits in the process of raising the reactor to power and in power operation:

7.3.1. On the basis of the readings of the NAR-B concentration meters and the results of chemical analyses (twice per shift).

7.3.2. On the basis of the positions of the control rods and the symmetry of the distribution of energy release in the reactor core.

7.4. The symmetry of the distribution of energy release and the heating of the heat transfer agent in the reactor core and the conformity of these parameters to the Table of Permissible Conditions should be systematically monitored on the basis of data provided by the intrareactor monitoring system with reactor power higher than 35% of nominal.

93/ 7.5. In a transition to control of the 10th group of control rods, any LD-2 sensors installed on the 8th group of control rods should be replaced with DPL type sensors.

Note: When physical calculations used to justify cartograms of current fuel charges indicate the possibility of ensuring a negative temperature reactivity coefficient of less than -0.001% per degree when the 10th and 9th group of control rods are lowered 20 to 40%, one must revise this supplement in light of the specific physical calculations with the approval of the Energiya National Nuclear Power Plant Operation Research Institute and the representative (head) of the inspection team of the State Nuclear Power Inspection Agency at the power plant.

14/ 8. DEMONSTRATION OF THE POSSIBILITY OF REMOVING THE 10TH GROUP OF CONTROL RODS IN THE PROCESS OF BRINGING A VVER-1000 REACTOR UP TO POWER AND OPERATING IT

The experience of starting up the first unit of the Balakovskiy Nuclear Power Plant after the first recharge in meeting the requirements of this supplement (with a positive temperature reactivity coefficient at the beginning of the run) indicated that the steps taken to ensure negative reactivity coefficients were effective. Measurements revealed that the temperature reactivity coefficient at the minimum controlled level with a heat transfer agent temperature of 274C in an unpoisoned state with a boric acid concentration in the heat transfer agent of 8.7 grams per kilogram with the 8th group of control rods raised to a height of 30% and the 9th and 10th groups lowered was -0.004% per degree.

However startup and operational experience has indicated that failure to remove the group of control rods in the process of building up power and xenon-135 poisoning leads to an increase in the maximum energy release unevenness coefficients and heating on the fuel assemblies and operation of the reactor core under design conditions and is redundant from the point of view of ensuring a negative temperature reactivity coefficient, because when the reactor is brought to power from a hot unpoisoned state and boric acid concentration is below the permissible level (with a negative temperature reactivity coefficient), the following changes take place in the reactivity budget:

No.	Reactivity effect	Change, %
1.	Increasing power to 100% of nominal and heating to 302C	-1.7
2.	Xenon-135 poisoning	-3.5
3.	Removing the 8th, 9th, and 10th control rod groups	+2.0

Thus, in order to compensate for a total negative contribution to the reactivity budget of approximately 3%, an additional 2.1 g/kg of boric acid will have to be removed. In view of the fact that the margin between boric acid concentration and the maximum permissible at nominal power [Trans: meaning of following clause unclear] is approximately 2 grams per kilogram (in terms of reactivity, and the reactivity compensation margin of the 10th group of control rods (when the 10th group is in the 70-80% position) is 0.2 to 0.1%, then if boron is intentionally or accidentally removed and its concentration is higher than permissible, the power of the reactor may drop and could go as low as the shutdown level.

Thus, the current concentration of boric acid, which determines the sign and magnitude of the temperature reactivity coefficient in the process of bringing the reactor up to power, will change only negatively and will not exceed the maximum permissible boric acid concentration under practically all conditions.

In the event that the scram system operates, additional poisoning will occur in the first two hours due to the accumulation of xenon-135. The level of this poisoning will depend on initial power and may get as high as 2% (for an initial power of 100%).

In any case, the amount of stable xenon-135 poisoning, which is equal to 3.5% (see the table), is 1.5% greater than the overall efficiency of the 8th, 9th, and 10th control rod groups, which guarantees that the maximum permissible concentration of boric acid will not be exceeded in the process of going to power operation after the scram system has operated. Xenon poisoning will reach its initial stable level for the nominal power level only 25 hours after the scram system has operated.

95/ Thus, the above indicates that the "Decision Concerning the Prevention of Positive Temperature Reactivity Coefficients and the Procedure for Starting Up and Operating New and Existing Nuclear Steam Generation Plants with VVER-1000 Reactors Using a Two-Year Fuel Charge" which was proposed by the Gidropress Special Design Office, Kurchatov Institute of Atomic Energy, and the National Nuclear Power Plant Operation Research Center and which calls for removing the 10th group of control rods (point 2.5) is well-founded and should be implemented.

[Trans: This section is followed by a form indicating that pertinent individuals have acknowledged familiarization with the operational rules for unit No. 3 of the Rovno Power Plant, a list of changes and additions to the operational rules for unit No.3 indicating the points or paragraphs in question and justification and acknowledgement of the change, and a review sheet for the aforementioned operational rules indicating changes and additions respectively, all of which indicate paragraphs, pages, and dates and the persons acknowledging the changes and additions respectively]

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The general reactor operation principles for unit No. 3 of the Rovno nuclear power plant are given. These include preparing the power unit for startup, starting up the power unit, power operation of a power unit, basic characteristics of a unit in operation, and disruptions of normal operating conditions leading to shutdown of the primary equipment of the unit or a reduction in its power. A discussion is also given of handling accidents and disruptions of normal operation, shutting down the power unit, recharging the reactor fuel, special tests, and standard indicators which characterize the safe operation of a power unit consisting of a standard nuclear steam generation plant.

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