XA9950496

NATIONALNA ELEKTRICHESKA KOMPANIA

KOZLODUY NUCLEAR POWER PLANT

UNITS 1-4

Status of Safety Improvements

Revision II

1999

SUMMARY

This paper presents the results of the safety improvements activities carried out by the Kozloduy Nuclear Power Plant (KNPP) within the period 1990-1998.

The steam supply system of this units is based of the reactor WWER-440/ B-230, which is a PWR of russian design developped according to the safety standards in force in USSR in late 60-s. Now a days 10 reactor units of this type are in operation in four NPPs. Despite of efforts of the different plants to implement safety improvemets measures during first 10-15 years of operation of this type of reactor its major safety problems were not eliminated and were a subject of international concern..

The systematic evaluation of the defficiences of the original design of this type of reactors have been initiated by IAEA in the begining of 1990 and brought to developing a comprehensive list of safety problems which required urgent implementation of safety measures in all plants.

To solve this problems in 1991 KNPP initiated implementation of so called "short term" safety improvement program, developped with the help of WANO under agreement with Bulgarian Nuclear Safety Authority (BNSA) and consortium RISKAUDIT. The program was based on a stage approach and was forseen to be implemented by tree stages in very tight time scedulle in order to achive significant and rapid improvements of the level of safety in operation of the units.

The Short term program was implemented between the years 1991 and 1997 thanks of the strong safety commitment of NEC and KNPP staff and the broad international cooperation and financial support. Important part of resources were supplied under PHARE program of CEC, EBRD grant agreement and EDF support.

In paralel a special assessment process started in 1995 in order to evaluate the level of the safety, achieved by Short Term Program, according to current safety sandards and to define the measures, wich should be implemented by the Utility to complette the process of improving the safety in future operation of the units.

The plant current safety level analysis has been performed using IAEA analytical methodology according to 50-SG-O12 standard "Periodic safety review of operational nuclear power plants".The approach and criteria for acceptable safety level definition, developed by IAEA and presented in INSAG-8 "A common basis for judging the safety of nuclear power plants built to earlier standards", Vienna, 1995, have been used for analysis performance.

On the basis of this analysis a set of activities has been developed, which ensures further plant operation with the necessary safety level. The measures were combined in a pragram called Complex progrtam for modernization of units 1-4. The implementation of the program is foreseen for a period of four next fuel cycles and started in the beginning of 1998.

In respond to the requirements for the content of this paper a detailed description of the current status of resolving of the safety issues, clasified by IAEA in TECDOC 640 is presented in Appendix 1

The whole process of safety evaluation, short and long term safety improvements presents in a systematical manner the efforts of the Goverment of Bulgaria, NEK Ltd and KNPP to operate these units with due respect of their nuclear safety responsibility according to Nuclear Safety Convention signed at Viena in 1994 and ratificated by Bulgarian Parlament in 1995.

1. GENERAL PRESENTATION OF THE APPROACH FOR IMPROVEMENTS OF THE SAFETY OF THE UNITS

1.1. Description of the Short Term Program

The first four units of Kozloduy NPP that are in operation for more than 15 years belong to the plants built to earlier standards which, according to the current safety practice need to be checked for compliance with the recent safety standards in order to eliminate the old design deficiencies.

A systematic analysis of units compliance with the current safety requirements and internationally accepted standards and practices started in 1990 and have been initiated by IAEA's SRM and ASSET expert missions. The IAEA teams evaluated the status of the plant based on modern standards and made a lot of recommendations for the safety improvement of units 1 to 4. In response to these missions, the Council of Ministers took decision to ensure the implementation of a special Program for safety improvement of units 1-4. Through an open discussion with regulators the plant adapted a stage-by-stage approach for technical measures implementation during prolonged outages.

The process of plant safety evaluation and qualifying the adequacy of the proposed improvements has been a subject of international concern. This was the basis for the Commission of European Community (CEC) with the agreement of the Bulgarian Government to organize the following:

* Technical and financial assistance for Kozloduy NPP;

* BNSA assistance by the establishment of a Consortium from expert institutes and regulatory authorities from member countries of the European Community. The participating members of the Consortium are as follows:

- AIB - Vincotte Nuclear (AVN), Belgium;
- Gesellschaft Anlage und Reaktorsicherheit (GRS), Germany;
- Institute de Protection et de Surete Nucleaire (IPSN), France
- UK Atomic Energy Authority (AEA Technology), R&D

A "Short-term program" is developed including implementation of the safety measures for the first three stages. The program was based mainly on experts evaluations and covered proposals and recommendations received by IAEA, WANO and the plant itself. Measures were reviewed in depth by Bulgarian Nuclear Safety Authority (BNSA) together above mentioned consortium of regulatory bodies named RISKAUDIT.

The main goal of the Program is stage by stage upgrading of reliability and safety of units 1 to 4 operation by means of:

- providing the functional operability of unit systems and equipment especially to those important for the nuclear and radiation safety.
- upgrading of reliability and stability of the safety systems in compliance with the single failure and common cause failure criteria. (including human errors)
- increasing the reliability of the three main barriers containing the radioactive material (fuel cladding, confinement, primary circuit.).

Special attention was paid on the operational aspects of the program and on the improvement of the operational and safety culture.

1.2. Implementation of the Short Term Program

The implementation of the three stage program started during 1991 outages of the units. First stage measures were implemented during the Outages of units 1 to 4 in 1992 and 1993.

Within this stage more then 260 modifications were implemented. Significant part of them is on the safety systems of the units. A large scope of investigations and studies was performed as well.

During the process of restoration a number of special activities were performed, such as :

- Decontamination of Primary circuit
- Reactor pressure vessel ultrasonic inspection
- Eddy current test of Steam Generators tubes
- Chemical cleaning of secondary circuit
- Extended scope of In-Service Inspection
- Full scope test of confinement Spray System.

Starting in 1994 outages of Units practically all foreseen second and third stage measures were implemented till the end of 1997. The most significant of them are:

- cross connection between emergency feedwater systems of two adjacent units and connection to supply feedwater to the SG by fire-truck;
- a large scope activities for improvement of confinement tightness, ending with a full scope tightness test at high pressure;
- systematic evaluation and implementation of anti-seismic measures and measurers for fire protection;
- optimization of reactor protection and operator supports information systems;
- optimization of staggered loading of the DG in case of loss of off-site power supply;
- improvement of control room climatic conditions and habitability in case of accident.

Modifications in some important systems were completed within the framework of the third stage of the Program. Some of these modifications are:

- replacement of the Steam generator's Safety Valves;
- installation of Quick Acting MSIV on Main Steam Pipelines;
- implementation of an additional feedwater system for the SG;
- building of second fire protection pumping station;
- implementation of safety parameters display system;
- installation of additional PRZ's safety valves on I circuit, combined with special computerized control in order to protect RPV against cold overpressurization;
- installation of Generator Breakers.

All together more than 650 modifications of systems and equipment were implemented and several important new safety systems were installed. All modifications and installation of the new systems were carried out following the requirements of Quality Assurance system, developed and implemented meanwhile.

In parallel, a lot of studies on safety aspects were performed, such as:

- evaluation of reactor pressure vessel material properties on Unit 1 and 2, including taking samples from RPV metal and study of the embrittlement by re-irradiation of samples;

- certifying the LBB concept applicability for the main primary side pipeworks (a system for acoustic leack detection, is installed on all units within the framework of first stage);

- qualification of the equipment necessary to provide reactor's safety condition in a case of accident (including seismic impact);

- anti-seismic reinforcement of the main technological systems and constructions.

A part of implementation of these activities is financed in the framework of the EBRD's Project for NPP Kozloduy (related mainly to the delivery of the main equipment for the modifications on Units 3 and 4).

Other part, that concerns mainly studies, is financed as a part of PHARE Program as an extension of so called WANO 6 Months Programme for KNPP. The rest of resources was provided by the Bulgarian side.

Complementory to the technical improvements of the units systems a broad program for improving the operational safety was implemented. It includes the measures for improvement of the following elements:

- Management
- Operating procedures
- Plant operation
- Plant Maintenance
- Training
- Emergency planing

The process of plant safety upgrading was a subject of special attention of the IAEA in the framework of so called IAEA Extrabudgetary Program. All together eight ASSET and SRM missions were conducted on site to monitor the progress of the plant and fulfillment of the recommendation of IAEA experts missions. The experts from the IAEA gave a positive assessment regarding the implementation of the technical and safety culture improvement measures.

The completion of this program was achieved at the end of 1997.

1.3. In depth safety assessment process and description of Complex program for modernization

In paralel to the implementation of short term program an in depth safety assessment process was conducted in order to identify the measures for long term safety upgrading of the units from the point of view of current safety standards. The following studies have been carried out and the rezults were combined in a new, so called Complex program for modernization of the units 1-4 :

- deterministic safety assessment;
- probabilistic safety analysis level 1;
- analysis of the operational experience of the plant.

Safety assessment process and the main results are presenting in an independant paper, addressed to the topic "Safety Assessment Report" and will be not described here in detail.

As a result of the different studies all together 86 technical measures were proposed. The measures were united in a new Copmplex program for modernization of Units 1-4 (also known now under acronym **PRG'97)** in thirteen groups, according their relation to the barrier integrity or to the specific aspects of the plant operation. List of the measures is presented in Appendix 2.

Detailed descriptions of the technical requirements, conditions and implementation schedule for each activity also were included in the program as a basis for Terms of References for implementation. It is foreseen to implement the complete set of the measures during the normal outages within four fuel cycles.

The program was approved by special appointed Council of NEK and was presented to BNSA. In parallel realization of the measures of the program is being initiated in the framework of units outage program for 1998 and 1999 years according to the schedule for implementation proposed by the plant.

After the discussions between the BNSA, NEC and Russian organizations involved in the program development process in January 1998 it was concluded that the program is accepted by all parties as an approach consistent to the policy for systematically an continuos improvement of units safety toward the internationally accepted criteria for safe operation of NPPs. A set of additional stydies and evaluations of the in depth safety assessment results were initiated too.

1.4. International assessment of the KNPP approach for long term safety upgrading measures

The approach of safety evaluation adopted by the plant was a subject of international evaluation during 1998 in connection with the efforts of KNPP to assure the maximum efficiency of the upgrading process and consistency of the approach with the current safety evaluation procedures promoted by IAEA.

The methodology was presented in depth on the IAEA Experts Meeting concerning future modernization of V-230 reactors in Vienna, February 1998 together with the results and adopted action plan. Conclusions of the assessments made on safety categories developed by the plant and an evaluation of the degree of the fulfillment of each of TECDOC 640 safety issues were added to the IAEA database.

A presentation on the evaluation approach was made during the seminar on V-230 reactors safety upgrading experience, jointly organized by GRS and IPSN in Berlin, November 1998. It was fond that the methodology is very close to the approach, proposed by GRS for safety evaluation of this type of reactors and corresponds to the proposals of the Main Designer.

During 1998 two parallel studies were performed by Siemens and EdF independently for assessment of the approach of safety evaluation and the scope of the measures proposed. The results of both studies gave a high level assessment on the methodology developed and on the use of the current evaluation procedures. In addition a number of proposals for introducing additional measures were made and the plant is in process of adopting of the important part of them. Appendix 2 represents the list of proposed additional scope.

2. GENERAL DESCRIPTION OF THE STATUS OF IMPROVEMENTS IN THE SPECIFIC TOPICS CONCERNING BARIERS INTEGRITY

2.1. Reactor pressure vesel integrity

A full program to investigate by sampling the chemical composition, characteristics and the rest life time of reactor pressure vessel material on units 1 and 2 is completed The analyses are performed by the "Kurchatovsky" Institute under the supervision of Siemens. For units 3 and 4, designer certificate data and Russian standards are used for the evaluation of metal properties change. The investigations show that the RPV life time is sufficient to ensure units safe operation for the next several campaigns and their number is different for the individual unit.

Brittle fracture resistance calculations are done considering the actual status of unit's systems, RPV material properties and expanded list of initiating events leading to vessel brittle fracture hazard. The analyses are performed by Westinghouse, Siemens and OKB Hydropress. For units 3 and 4 analysis were performed by Siemens with colaboration with OKB "Gidropress" , Kurchatov Institut and Energoproekt - Sofia and are now under final acceptance by NEK. The neutron fluence calculations are verified on the basis of activity measurement of shavings from weld #4 and measurements performed on each unit with the means of ex-core activation detectors.

In order to ensure the required reliable RPV safe operation periodic ultra sonic inspection of each RPV is performed. The inspection sensitivity, frequency and scope comply with the Chief Designer requirements. The inspection techniques were verified by special test blocks during RPV-1 rest life time evaluation within outage '96.

All the measures required and recommended by IAEA and the Chief Designer to reduce the neutron fluence on the RPV are implemented. The status of the annulus tanks was investigated too. It was shown that no deterioration of metal characteristics is detected. The seismic assessment of the annulus tanks shows that the RPV support resistance corresponds to the site current seismic characteristics.

In the frame work of the Complex program the following actions are schedulled :

- completion of the assessments and justifications of the RPV rest life time;
- assessment of the probability of failure of the RPV.

2.2. Primary circuit piping integrity

In order to compensate the existing deviations from the current safety standards and IAEA recommendations a series of studies are performed and the corresponding technical and administrative measures are applied.Within the frameworks of the short term program, enhanced equipment is supplied for no-destructive in-service inspection (ISI) including remote control devices for ISI of areas for which the design does not foresee to be inspected or where the radiation conditions are unfavorable. Also, these include complete inspection of SG tube bundles with the means of manipulator. Based on these improvements and the recent safety standards requirements, a detailed instruction was developed for the ISI of all systems important to safety. The instruction is approved by the regulatory body.

An automatic leakage detection system (ALUS) is installed on each unit. To help validation of the LBB concept the supports of the pipelines connecting the PRZ and I circuit (Dn 200) are upgraded in order to reduce seismic event loads. Applicability of LBB conception was justified by Siemens in a large study financed by PHARE program.

All IAEA recommendations regarding improvement of I circuit isolation from its normal operation supporting systems and the safety systems are fulfilled . Equipment rest lifetime evaluations (including such based on destructive tests after 100 000 hours of operation) and static and dynamic stress calculations are being performed.

In the frame work of the Complex program the following actions are schedulled :

- the overall implementation of the LBB concept as a tool for early leakage detection should be interrelated with the probability of accidents with I circuit pipelines rupture.
- static and dynamic strenght- analysis of primary circuit equipment and pipework and realization of the corresponding measures.

2.3. Primary circuit overpressure protection

All PRZ Safety Valves (totally three sets) comply to the recent standards following the replacement of previous SVs by PRZ SVs "Sempell" type and installation of Pilot SVs "Sebim" type.

Check of flow rates, set points and test frequency of all valves is performed during installation of the supplementary (tandem type Sebim) valve according recent safety standards requirements.

The supplementary tandem valves "Sebim" type are consistent with the IAEA and Consortium recommendations regarding qualification and reliability indicators (the valves were licensed with the Consortium's collaboration). The valves are also intended to perform "feed and bleed" - they have manual control option and qualification for random operation environment in accordance with IAEA recommendations.

The diagnostics of potential leakage is carried out by temperature measurement after the valve and by ALUS system. The recommended by the Consortium additional ISI of the pipelines up to PRZ SF is performed.

In addition, the reactor scram type 1 signals are modified: reactor scram type 1 at PRZ low pressure and level is implemented in order to fulfill the above recommendations and the IAEA requirements.

2.4. Primary circuit cold overpressure protektion

The implemented system for protection of I circuit against cold overpressurisation which is based on a safety valve and automatic control system, completely corresponds to the requirements of the resent safety standards. During the justification of valve flow rate (it is also used for I circuit "feed and bleed" procedure) it was demonstrated that the all safety requirements, including all IAEA recommendations is eliminated. The system was assessed by the Main Designer as a unit which can protect the RPV in case the incidents too.

2.5. Controling the power in normal conditions

The existing deviations from the new safety standards and IAEA recommendations are eliminated or compensated by technical and administrative measures (described in details in the current Technical Specification). This includes:

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- measures to prevent presence of clean water in I circuit when reactor is in shutdown mode of operation;
- requirements to reduce reactor power when automatic power control is not available;
- special rules for insertion of positive reactivity. A reactivitymeter is installed in order to help the operator's actions;
- speed limitations for control rods withdrawal from the core. An automatic protection to prevent control rods lift up in case of wrong position of ionization chambers also is implemented as well as a system for automatic switching of the ranges of monitoring of the neutron flux measurement system;
-installation of automatic boron concentration measurement at I circuit.

An on-line system for neutron flux distribution measurement using the existing measuring channels of the neutron flux measurement system is implemented.

Additionally, in compliance with IAEA recommendations, a detailed justification of the load pattern for each refueling is being performed in relation to neutron-physical characteristics and thermal-hydraulic analyses which is based on resent verified software.

2.6. Preventing reactivity excursions during cold shutdown or refueling

The IAEA recommendations, classified within the category are completely met through the implementation of the short term program measures. The existing deviations from the new safety standards (excluding some of them) are either eliminated or effectively compensated by studies and application of corresponding technical and administrative measures.

The applied administrative measures to put the I circuit systems in the required mode for reactor refueling; the enhanced operational control for valves status which prevents non borated water appearance in I circuit and emergency systems' boron tanks; the periodic stirring, controlling and maintaining the boron concentration in the related tanks with boron solution; and the lack of automatic switching on of the Make-up pumps, in fact, exclude the uncontrolled dilution of boron acid in I circuit in reactor cold condition.

To prevent errors during refueling process a review and verification of the calculated core characteristics are carried out through physical experiments during units start up.
The design foresees availability of a fixed sampling for refueling but the pipelines tracing does not allow its use during the entire refueling period. A temporary sampling is introduced as a compensating measure.

During the refueling process the neutron flux is monitored by additional measurement system, using special chambers, temporary introduced around the core barrel, into the RPV. A project for replacement of the equipment of Source Range channels of the "INEY" system on units 3 and 4 by up-to-date, more sensitive instrumentation is in final stage. This measurements chanels will be used for monitoring of the neutron flux during the refueling process too.

In the frame work of the Complex program the following actions are schedulled :
- replacement of Neutron Flux Monitoring System for the "source range" for Units 1 and 2;
- assessment for storage, refueling and fuel transportation safety improvement.

In addition , as a result of assessment of operational experience feedback analises an automatic control of the refueling mashine was proposed.

2.7. Cooling the fuel in operating or transient conditions

In order to compensate the existing deviations from the new safety standards and IAEA recommendations a series of studies are performed and the corresponding technical and administrative measures are implemented (or under implementation).The set of technical measures includes:
- reliable reactor shutdown at minimum required water inventory in SG;
- special provisions to manage the accidents with lose of SG feedwater supply (i.e. fire extinguishing truck, connection between EFWP systems on adjacent units, etc.);
- an autonomous qualified system, independent from Turbine Hall is assembled, which in combination with the qualified SGSV (SG safety valves), FCIV (fast closing isolating valves) and FPS-2 (fire protection station) allows complete fulfillment of the residual heat removal function in all initiating events excluding LOCA. The design of the system was checked for taking into account the

recent safety standards requirements for reliability and failure resistance including common cause failure. (Units 1 and 2 have not been connected to the system during the short term program implementation but it is foreseen for the next stages);

- a "feed and bleed" procedure of I circuit is introduced in the set of EOPs. An additional set of automatic and manual controlled pressuriser relief valves is installed in order to increase the reliability of the operators actions during the procedure.

In the frame work of the Complex program the following actions are schedulled :

- On-line monitoring of fuel rods clad tightness by reference isotopes;
- Optimisation of the list of the permissible reactor modes of operation
- Connection of units 1 and 2 to the additional emergency feedwater supply system built with connection of units 3 and 4.

2.8. Cooling the fuel under LOCA conditions

In order to compensate the existing deviations from the new safety standards and IAEA requirements a series of studies are performed and as a result of this technical and administrative measures are implemented.To improve ECCS reliability the following measures are fulfilled:

- analyses are performed and technical measures are implemented to eliminate single failure probability and to prevent human errors on ECCS operation;
- compensating measures are introduced for protection of the Boron Center against common cause failures (second draining pump, water presents alarm signal, physical separation of HPIP, etc.);
- protective grids are installed against plugging of the line from the confinement to Emergency Boron Acid Tank (EBAT) and the related full scope testing is carried out in order to evaluate the efficiency of the decisions taken;
- quantitative analyses of systems reliability are performed.

The lack of an intermediate loop for boron solution cooling is compensated by implementation of effective measures (continuous monitoring of heat exchangers tightness, automatic measurement of boron concentration in the EBAT etc.).An administrative system is developed and implemented for position control of valves that might lead to I circuit draining.

Analyses of accidents related to LOCA are performed for pipeline up to Dn 100 (conservative approach) including opening and stuck of PRZ Safety Valve and PRZ Pilot Safety Valve. These accidents do not result in exceeding of fuel rod damage limits. No one of the design events analyses demonstrated a need of a special blowdown system for steam-gas mixture from the reactor and only a gas-off system for normal operation is installed.Accident transients related to SG tube rupture are analyzed and the corresponding procedures for actions are developed.

In the frame work of the Complex program the following actions are schedulled :
- Completition of accident analyses of fuel cooling in LOCA (Dn100-Dn500) conditions;
-assessment and measures for increasing of reliability in operation of primary circuit pipe lines Dn200 and Dn500;
- improvements of the safety systems according to PSA level 1 results
- prevention of unauthorized access to the Boron Center

2.9. Cooling the fuel during cold shutdown or refueling

In order to compensate the existing deviations from the current safety standards a series of studies are performed and the corresponding technical and administrative measures are implemented. The volume of spent fuel storage is expanded by the construction of a Intermediate Term Spent Fuel Storage.

In order to improve the reliability of the existing residual heat removal system, especially for units 1 and 2, during the reconstruction of the main steam lines for installation of fast closing isolating valves a rearrangement of connection to RHRS is being done. Additionally, during construction of the SG's EFWS the delivery of cooling water is backed up by supply from Fire Protection Station -2 (an independent system, qualified for accident conditions) towards the Spent Fuel Pool cooling systems heat exchangers.

2.10. Improving the original confinement function of WWER 440/230 plans

Through the systematically performed activities for untightness detection and removal, the containment tightness has reached the level defined by the Chief Designer and Chief Constructor (2504 m3/hour) at 0.3 bar positive pressure.

Related technical provisions to reach, check and maintain the required tightness are developed and implemented. A special procedure is developed to check spray system operation.Technical provisions to control the position of MCP deck doors lockage are introduced. This includes a procedure for the lockage usage and technical measures for upgrading of the trespassing lock of MCP desk. In the framework of the studies under Item HB of "WANO 6M Program", seismic loads resistance analysis was performed for confinement's armored concrete construction taking into account the new seismic characteristics of the site.

In the frame work of the Complex program the resolving the problem with the monitoring of the position of the confinrmrt relief valves schedulled

2.11. Major upgrading of the confinement function

In order to partially compensate the existing deviations from the normative documentation, a series of studies are performed and the corresponding technical and administrative measures are applied.It is recognized that a rupture of the I circuit pipeline with diameter 45 mm and 64 mm with simultaneous lose of off-site power supply and single failure presence do nor lead to core damage or confinement's degradation even in case of start-up of one HPIP and two SS pumps.

ABB's investigations show that without significant modifications of the existing structures it is possible to equip a system for emergency release of confinement's media and simultaneous purification using special filters which will make the unit not sensitive to I circuit leakage up to Dn 200 mm, and in the same time, no radiation release to the environment will occur. It is stated that such a system is capable to ensure the confinement's structure integrity in case of Dn 500 rupture.

In respond of IAEA requirements the classification of localization systems active components was performed within the studies of "WANO 6M Program", Item HB.The unavailability of localizing systems components was also evaluated within the frames of quantitative reliability indicators analyses.

In the frame work of the Complex program the following actions are schedulled :

- Justification of the permissible level of the confinement untightnes;
-Assessment of confinement conditions at large LOCA incidents;
- Confinement system improvement.

3. GENERAL DESCRIPTION OF THE STATUS OF IMPROVEMENTS IN THE SPECIFIC TOPICS CONCERNING SUPPORTING FUNCTIONS

3.1. Instrumentation and control

Safety systems I&C design is reviewed aiming to assign higher priority to emergency alarms in comparison with equipment protection alarms and personnel actions.The required corrective measures are implemented: automatic self-switching on of protections and interlocks and the switches for their switching off are removed; safety systems control logic are rearranged in order to provide systems testing without disturbing their readiness during on load operation; alarms in case of trains defects.

New design of staggered loading logic is introduced on units 1 and 2 to comply with the multi-trains and trains independence requirements as well as time based prohibition for switch off of safety systems equipment.

Analysis is performed and the corresponding measure are applied in order to eliminate the unacceptable interconnections between "control" and "protection" functions equipment. I&C equipment reliability is analyzed including assessment of single failure and common cause failure resistance, independence and physical separation, and rest life time evaluation. The recommended measures are implemented.

On units 1 and 2, as a compensating measure, a special control panel is equipped for the basic reactor parameters. A special procedure is developed to determine the reactor shutdown and cooldown sequence in case of MCR inhabitability. The IAEA recommendations regarding providing the required means to ensure MCR habitability are completely addressed - compressed air bottles, emergency ventilation, personal protective means, auxiliary communication means, etc.

The following equipment is additionally installed in the MCR:

- Reactivitymeter with automatic range switching and related display for operator information.
- Boron content measurements to control liquid poison concentration in I circuit and Safety Systems' tanks.
- Acoustic system for I circuit leakage detection - ALUS;

- Computerized system for operator's support and record of process parameters and emergency signals in case of accident.Additionally, within a GSI study, the MCR design is reviewed and related improvements are done:
- Installation of Safety Parameter Display System (SPDS) - for units 3 and 4 only.

The following issues are being addressed through the modifications within the short term program:
- Provisions for optional connection of a recording device to each measuring channel for the neutron flux on which basis a reactor trip signal is generated;
- Control signals independence for both valves is provided during the replacement of PRZ SV;
- Separation of power supply trains for the valves of a SG is provided during the replacement of SG SV;
- Three independent PRZ level indications are installed in order to implement the new signals for rector scram type 1 on PRZ level.
-Technical provisions are introduced to monitor the emergency protection circuits' availability.- Devices for H2 concentration measurement are installed in the compartments where H2 appearance is possible.
-The emergency protection on all process parameters actuates on at least three measuring channels. Precise digital equipment with high resistance to accident conditions is used to form process parameters signals. The power supply of these channels is additionally separated by UPS devices so independence of power supply channels is provided.

The requirements and conditions of equipment start-up and during operation testing are specified in the TS. Related testing procedures are developed.Techniques for metrological check of protection means are developed.The protections and interlocks operation points are analyzed and conformed in accordance with IAEA recommendations.The thresholds margins for protections and interlocks important to safety are assessed within the short term program.

In the frame work of the Complex program the following actions are schedulled :
- Justification of the conditions for units operation with reduced number of emergency protection trains or sets;
- Modernization of emergency control panels of units 1 and 2
- Implementation of SPDS for unit 1 and 2
- Modernisation of the systems for operational records.

3.2. Cooling water

The implemented set of measures allowed for Service Water System /which is common for units 1 and 2/ separation into two autonomous from technological, power supply and control point of view systems with physical separation in the frames of main building, and the option for water supply from one unit to the other is kept in order to provide systems redundancy and improvement of their reliability.

The Service Water Systems on units 3 and 4 comply with recent safety standards by the original design of the systems. The deficiency resulting from SWPs location in a common for both units building is eliminated through compensating measures i.e. el. motors protections against flooding from close located leakage, seismic upgrading of equipment, provisions for SWS redundancy for units 1 and 2 by the SWS of units 3 and 4, expanded ISI of service water pipelines etc.

Additionaly the most critical safety systems users (HPIP, EFWP) cooling is backed-up by demineralized water supply and implementation of autonomous DG cooling is in progress thus providing the above systems availability in case of lose of service water.

The consequences analysis for full lose of service water shows that the operational staff has enough time to restore system functioning.The design of newly installed Auxiliary feed water system (AFWS) and Fire Protection Station-2 (FPS-2) foresee the function of residual heat removal by cooling water supply from a qualified source (FPS-2). Also, Spent Fuel Pool cooling is provided by the same source. The results of system reliability analysis, considering the single failure, show that there are no single independent events leading to systems failure.

3.3. Ventilation and air conditioning

The temperatures and climatic conditions of I&C and electrical equipment compartments are analyzed. The required means to control the temperature in these compartments are implemented. Additional conditioners are installed in order to maintain the required conditions for normal functioning of C&PS equipment. Design for improvement of temperature conditions in batteries compartments is in progress.

The necessity of cooling the Boron Center in case of I circuit leakage are investigated and it was demonstrated that the existing ventilation are sufficient to maintain equipment functioning.

Within the frameworks of short term program for improvement analysis is performed and requirements are defined for equipment qualification on environment parameters in accident conditions. The detectors of emergency protection circuits are replaced by qualified ones and replacement of the rest safety related detectors is in progress.

3.4. Electrical power supply

Complete separation of d.c. supply systems on units 1 and 2 by separation of unit's d.c. panel and installation of an additional AB thus forming two independent systems with AB and d.c. panel for each unit was implemented. (The original design of units 3 and 4 provides three fully independent systems for d.c. supply).

Two independent systems for first and second category power supply on units 1 and 2 were assured including rearrangement of inputs to switchgear 6 kV and installation of additional breakers in order to separate the power supply from the systems for normal operation , separation of high voltage and control cable lines between the main building and corresponding DG; rearrangement of staggered loading system into a two-train system for each safety system providing the possibility to test system functionality during on load operation of the units; separation of DG starting systems.

Complete replacement of 6 kV supply cables and the 6 kV breakers in safety systems el. Circuits were performed. The new cables used are fire-proof and do not support burning. All the rest SS cables are coated with fire-proof covering. Cable shelves are being supported with respect to the loads and taking into account the seismic qualification of the site.

Additional measures included :

-Replacement of Reversible MG and installation of RMG computerized control system;

- Full replacement of AB. The required tests are performed and AB functionality for more of two hours in discharge mode on full load is proven;

- DG protection are minimized aiming to ensure priority of the safety function against facility's own protections;

In order to improve the control reliability for d.c. supplied systems, charging circuits control devices and a system for automatic searching of "earth" in d.c. lines are additionally installed.

A series of studies for equipment reliability assessment are carried out. Equipment functionality in accident conditions is being evaluated within the frameworks of WANO 6M Program, Item HB. Equipment reliability characteristics are analyzed and safety operation limits and conditions are introduced in the Technical Specifications.

Complete analysis of DG loading and evaluation of available DG power sufficiency are performed. Optimized times are defined for users starting by staggered loading; the correspondence of the new DG loading sequence to the safety requirements is checked through a series of accident analyses.

External power supply is provided by three start-up transformers which have off-site power supply thus providing supply for each unit from each transformer using the existing connection between the units. The existing connections allow for supply to be provided also from DG buses of adjacent units which significantly improves the reliability of safety systems' redundant supply. A special procedure is developed to manage the accident with total black out. The installation of Generator Breakers in units 3 and 4 provides option to use the House Loads Transformer as a redundant transformer in case of unavailability of the corresponding TG thus in accident conditions the units will have 4 more generators. As a final measure, use of a mobile DG is foreseen and related technical provisions to connect it to the corresponding buses and safety system users are being introduced.

In the frame work of the Complex program the following actions are schedulled :

- improvement of the reliability of breakers and cathode dischargers in Switchgear Yard (already completted for units transformers ;
- installation of generator breakers on Generators of units 1 and 2;
- replacement of breakers in switchgears (6 kV; 0.4 kV, d.c.);
- replacement of generators' sealing bearings.
- Analysis of components failures and related consequences.
- upgrading of the separation of RMG for units 1 and 2
- instalation of computerised information system for monitoring of the operation of the internal power supply system on units 1 and 2.

4. GENERAL DESCRIPTION OF THE STATUS OF IMPROVEMENTS IN THE SPECIFIC TOPICS CONCERNING PROTECTION AGAINST INTERNAL AND EXTERNAL HAZARDS

4.1. Fire protection

So far, a wide program of technical and organizational measures is implemented in order to avoid fires, for fire detection and fighting, These are based on fire risk analyses performed for the corresponding compartments. As a result, the fire protection means, there variety and effectiveness comply to the recent requirements for NPPs which in combination with their adequate maintenance allow for significant reduction of fire risks.

The second Fire Protection Station (FPS) is constructed and it is qualified in accordance with the requirements for seismic resistance, internal and external extreme events. It significantly improves the fire fighting system reliability.

Draining systems are reconstructed in relation to the shifting from foam to water extinguishing.Gas extinguishing system is installed in Control & Protection System compartment as well as fire alarm systems in the other control panels. The MCR is equipped with a system to isolate air ducts and to generate positive pressure in case of accident.

The adequacy of fire protection measures for reactor instrumentation compartment, Turbine Hall and compartments with safety systems equipment is analyzed within the frameworks of fire risk analyses, following a methodology approved by the BNSA and National Fire Protection Service. Fire proof coating is applied to the columns and trusses in Turbine Hall.

Through the implementation of the short term program's technical and administrative measures the current safety standards requirements are fulfilled in relation to:

- protection of the cables. The main protection of cables against common cause failures is provided by fire-proof coating and by replacement with fire proof cables;
- marking of evacuation ways;
- installation of fire doors, dampers, walls and bunds.Compartments are constructed to confine oil spreading from Main Oil Tank in case of fire. The control of emergency oil discharge valves is

protected by fire-proof fence.Fixed smoke removal systems are mounted in compartments of relay panels and C&PS. Smoke removal for all the rest compartment is provided by portable systems. Smoke-proof doors are installed to Turbine Hall, switchgear and related relay panels in order to isolate the stairs cells of the Main Building from smoke.

In addition in the framework of the Complex program implementation automatization of oil drainage pumps in the Turbine Hall and improvements of MCR ventilation system is implemented already .

In the frame work of the Complex program an additional assessment to improve safe personnel evacuation in case of fire is foreseen.

4.2 Flooding

Safety important compartments and failure probability in case of flooding with service water are analyzed. Required measures are implemented: installation of second alarm and additional draining system in the Boron Center, installation of warning level measurement in case of water appearance in the compartments of Make up System, Spent Fuel Pool Cooling Pumps and corridor of R-1 - the alarm signal is displayed in MCR.

Reconstruction of the draining system of cable traces is performed through the shifting from foam to water extinguishing in order to avoid flooding of traces' adjacent compartments in case of extinguishing actuation.

The installation of AFWS which is independent from the Turbine Hall, completely substitute the EFWP located in Turbine Hall (TH) thus canceling the need of special measures to avoid EFWP motors in case of rupture of adjacent pipelines in TH.
During the reconstruction of elevation 14.7 m, new solutions for floor's hydro-isolation are applied on each unit in order to prevent the possibility of failures occurrence in the compartments of electrical and I&C equipment located under elevation 14.7 m.

4.3. Pipe whip and secondary pipe integrity

Complete study is performed to assess the applicability of LBB (leak before break) concept for I circuit pipelines in accordance with the IAEA Guide and taking into account the full spectrum of factors that have impact on pipelines integrity (different combinations of stress, fatigue, temperature stratification, aging effects, water hammer, etc.)The study proved LBB behavior of Main Circulation Pipelines Dn. 500, the pipelines connecting PRZ to I circuit (Dn 200) on each unit and Emergency Core Flooding pipelines Dn 200 on units 3 and 4.

The static and dynamic analyses of I circuit are being performed within the frames of the short term program and include assessment of the need for special supports or other means to restrict pipe wipe.

Within the reconstruction of elevation 14.7 m, for all units it was performed check, reassessment and installation of the required supports of equipment, steam lines aiming fulfillment of non-rupture criteria of RCC-M standard. The pipelines that response to the criteria do not need additional means to protect adjacent pipelines and equipment against potential dynamic stresses (wiping) in case of rupture. Necessary supports of pipelines penetrations are being installed. In this way the issue of protection against dependent failures at rupture of pipelines on elevation 14.7 m is fully addressed.

The IAEA requirements for assessment of effects of I and II circuit pipelines' rupture on RPV integrity are being fulfilled during analyses for justification of RPV safe operation.

In the frame work of the Complex program the completition of static and dynamic strength-analysis of primary circuit equipment and pipelines is foreseen.

4.4. Seismic safety

Assessment of the site's seismic risks is performed within the implementation of the short term program for safety improvement and the structures' response spectrums are developed for the new seismic assessment (maximum calculated earthquake event /SST - 0.2g) in accordance with the recent safety standards requirements. On this basis, the loads on safety related equipment and structures are analyzed and corresponding measures are applied to minimize the loads to acceptable levels as required by the recent regulations.

Assessment of seismic loads resulting from local earthquakes is performed in consistency with the IAEA's Guides related to seismic impact and floor response spectrums are accordingly corrected. Within the frameworks of the study also evaluation of the implemented seismic supports of equipment is carried out and conclusions are given for supports validity versus the new spectrums. Required upgrading of safety systems components is fulfilled.

The resolution of issue for upgrading of structures where safety systems facilities are located, including those outside the Main Building, is related to the erection of new qualified systems and it is a subject of a separate program.

In the frame work of the Complex program the following actions are schedulled :

- Implementation of a special program for ensuring the safety functions during and after a seismic event. The basic principle applied is to ensure for each safety function availability of at least one system which is qualified to put and maintain the reactor in safety shutdown condition during and after maximum calculated earthquake event.

-Assessment of the resistance of spent fuel shelves in the Spent Fuel Pool at the new seismic characteristics of the site.

5. GENERAL DESCRIPTION OF THE STATUS OF IMPROVEMENTS IN THE SPECIFIC TOPICS CONCERNING ACCIDENT ANALIYSIS

5.1. Power monitoring and control during transients and accident conditions

Within the frameworks of the short term program are performed comprehensive set of accident analyses that show that reactor core characteristics are within the limits for safe operation during transients and accidents.Following items are analyzed:

- boron dilution;
- ejection of control rods;
- fast cooling down (pipeline rupture).Analyses are performed also to evaluate the risk of repeated criticality as a result of rapid cooldown or activation of the ECCS - no dangerous consequences for the core are defined.
- ATWS analysis performed shows that the design limits of fuel rod damages are not reached during such kind of accidents.

Analysis are performed to assess the emergency protection system reliability in the light of single failure and common cause failure and the results show that the protection function is carried out without failures due to the "safety in case of blackout" principle used. Measures are introduced against common cause failures (fire extinguishing, seismic upgrading, sealing of C&PS detectors).Numerous new emergency protections are implemented, improving fulfillment of in-depth protection principle by allowing reactor trip before actuation of emergency systems.

The implemented system for control of Kq in on-line mode, in combination with the control of the power and temperature on core outlet allows, in particular, reliable identification of self-split control rod drive.A series of modifications are performed to improve the reliability of neutron flux monitoring system (i.e. automatic input of the chambers from Source Range and Intermediate Range on signal for reactor scram type I, galvanic separation of the circuits that connect automatic neutron flux monitoring system with external systems; local separation of the neutron power thresholds in energy range with digital display of the margins etc.).

5.2. Accident analysis, related to bariers integrity assurance

Within the frameworks of the short term program and the fulfillment of IAEA recommendations, broad spectrum of accident analyses is performed (LOCA up to Dn 100, SGTR, MSLB, LOOP, etc.) to update the Safety Assessment Report (SAR) of the NPP. Latest licensed computer codes and initiating events are used as well as conservative assumptions complying to OPB-88 requirements thus fulfilling the normative requirements for the present DBA set.

The required analysis to identify the frequency of internal initiating events is carried out in accordance with the new safety standards requirements.The equipment rest lifetime analyses completely response to new safety requirements related to definition of possible actions during normal operation, normal operation deviations and DBA.

In the frame work of the Complex program the following actions are scheduled :

- Up-graded Safety Analysis Report

The approach and status of this activity is presented on this forum in a separate paper together with the discussions according the design basis requirements.

5.3. Specific measures for management of accidents.

Additional measures are applied to upgrade MCR equipment supports, sealing of the room and penetrations, provisions for protection against eventual events in the Turbine Hall, etc.Emergency ventilation system equipped with required filters is installed in MCR in order to improve its habitability. Reliable power supply is provided to the system.

An Accident Management Center is established, equipped with the needed facilities for communication and announcement, technical information for the condition of the units systems (including dubbling of the SPDS system information of units 3 and 4. The required technical provisions to perform the actions foreseen by the emergency plan are provided including portable ventilation devices.On the basis of scenarios for beyond design based accidents (BDBA) connected with break of large I circuit pipelines, an emergency plan is developed identifying personnel protection measures and their sequence. Personnel's and accident management team's actions are examined through periodic exercises.A system is established for automatic radiation control of the environment. Automatic monitoring of the meteorological conditions of the site is provided as well as meteorological information from neighboring national centers.A methodology is developed for urgent estimation of the expected power of a radioactive contamination source and potential public exposure rates.

The required technical provisions are ensured and management procedures are developed for the following types of BDBA:

- lose of power supply to unit's systems (optional lines for power supply from other units; mobile DG, etc.);
- lose of residual heat removal systems (optional lines, fire extinguishing truck, I circuit feed and bleed, etc.);
- lose of service water on units 1 and 2 (optional lines);
- lose of MCR.

In the frame work of the Complex program the following actions are schedulled :

- development of the list of BDBA, analyses and their classification and of coresponding procedures.
- improvement of the technological radiation control system for monitoring during BDBA including special post accident sampling system..
- PSA level 2

APPENDIX 1

LIST OF PRG'97 MEASURES

1. FUEL MATRIX INTEGRITY

Code	Description	Unit	Term	Status
M.1.1.	Replacement of Neutron Flux Monitoring System (NFMS) for the "source range (SR)"	1-2	2000	scheduled
M.1.2.	System for on-line monitoring of vertical power distribution in the core	1-2-4	1999	completed
M.1.3.	Optimization of the List of the Permissible Reactor Modes of Operation	1-2-3-4	1999	study

2. FUEL ROD INTEGRITY

Code	Description	Unit	Term	Status
M.2.1.	On-line monitoring of fuel rods clad tightness by reference isotopes	1-2-3-4	1999	tender
M.2.2.	Analysis of fuel cooling in LOCA Dn100-Dn500 conditions	1-2-3-4	2000	study
M.2.3.	Assessment of the reactor internals strength according to current standards	1-2-3-4	2000	tender
M.2.4.	Additional emergency feedwater supply to SG	1-2	1999	design
M.2.5.	Reliable power supply for demineralized water storage tank pumps	1-2	1998	completed
M.2.6.	Repair of the demineralized water storage tanks for unit 1 and 2	1-2	1999	design

3.REACTOR PRESSURE VESSEL INTEGRITY

Code	Description	Unit	Term	Status
M.3.1.	Assessment of probability for reactor pressure vessel failure	1-2-3-4	2000	study
M.3.2.	Reactor pressure vessels rest life time assessment	1-2-3-4	1999	study

4.PRIMARY CIRCUIT INTEGRITY

Code	Description	Unit	Term	Status
M.4.1.	Additional SG strength assessment	1-2-3-4	2000	tender
M.4.2.	Static and dynamic strength-analysis of primary circuit equipment and pipelines	1-2-3-4	1999	study & design
M.4.3.	Increasing of operational reliability of primary circuit pipelines Dn 200 to Dn 500	1-2-3-4	1999	study
M.4.4.	Replacement of SG blow-down lines with stainless steel ones	1-2-3-4	2000	design
M.4.5.	Backfiting of the SG blow-down water treatment system	1-2-3-4	1999	design

5.CONFINEMENT INTEGRITY

Code	Description	Unit	Term	Status
M.5.1.	Definition of permissible level of the confinement untightness	1-2-3-4	1998	completed
M.5.2.	Assessment of confinement conditions at large LOCA incidents	1-2-3-4	1999	study
M.5.3.	Confinement system improvement	1-2-3-4	2001	scheduled
M.5.4.	Upgrading of MCP deck trespassing lock	1-2-3-4	1998	completed
M.5.5.	Increasing the reliability of the SS	1-2	1999	design

6. SAFETY ASSESSMENT

Code	Description	Unit	Term	Status
M.6.1.	Probabilistic safety analysis (PSA) Level 1	1-2-3-4	1999	2 revision
M.6.2.	PSA Level 2 development	1-2-3-4	2000	scheduled
M.6.3.	NPP environmental impact assessment	1-2-3-4	1999	scheduled
M.6.4.	Development of FSAR	1-2-3-4	2000	study
M.6.5.	Improvements of safety systems according to PSA level 1 results	1-2-3-4	1999	realization
M.6.6.	Program for monitoring and management of the rest life time	1-2-3-4	2000	contract

7. SUPPORTING SYSTEMS

Code	Description	Unit	Term	Status
M.7.1.	Analysis of Reliable Power Supply System failures	1-2-3-4	1999	study
M.7.2.	Minimization of DG protections	3-4	1999	completed
M.7.3.	Physical Isolation of Reversible Motor-Generators	1-2	1999	design
M.7.4.	Generator circuit breakers installation	1-2	2000	tender
M.7.5.	Switch Yard circuit breakers replacement	1-2-3-4	1999	realization
M.7.6.	Metal Clad Switch-gears 6/0.4 kV and DC Boards Replacement	1-2-3-4	2001	tender
M.7.7.	Replacement of Generator Shaft Sealing	1-2-3-4	1999	realization
M.7.8.	System for Registration of transients in Units 1&2 In-House Power Supply System	1-2	2000	tender
M.7.9.	Replacement of generators' excitation systems	1-2-3-4	2000	tender
M.7.10.	Reconstruction of the service water system	3-4	2001	design
M.7.11.	Back-up cooling system of DGS	1-2-3-4	1999	realization
M.7.12.	Installation of hydrogen supply line from EP-2	1-2-3-4	1999	design
M.7.13.	Installation of one additional battery supply for unit consumers	1-2-3-4	2000	design
M.7.14.	Replacement of diesel generator batteries	1-2-3-4	1999	realization
M.7.15.	Replacement of diesel generator excitation controller	1-2-3-4	1999	realization
M.7.16.	Temperature control of both distillate and gas cooling systems of main generators	1-2-3-4	2000	scheduled
M.7.17.	Installation of additional start-up transformer 4ST	3-4	2001	design
M.7.18.	Replacement of Deaerator's, 9/12 auxiliary steam collector's, RPP's, and SSR's safety valves	1-2-3-4	1999	realization

8.CONTROL SYSTEMS

Code	Description	Unit	Term	Status
M.8.1.	Justification of the conditions for Unit operation with reduced number of emergency protection trains or sets	1-2-3-4	1999	study
M.8.2.	Modernization or emergency (reserve) control panel	1-2	1999	realization
M.8.3.	Implementation of safety parameters display system	1-2	1999	design
M.8.4.	Modernization of operator's support computer system	1-2-3-4	1999	completed
M.8.5.	SG level control system	1-2-3-4	2000	tender
M.8.6.	Modernization of generator temperature monitoring system	1-2-3-4	1999	realization
M.8.7.	Modernization of generator gas monitoring system	1-2-3-4	1998	completed
M.8.8.	System for information and control of water level in cold channel from the Danube river	1-2-3-4	1999	realization
M.8.9.	Replacement of communication system of the control rooms	1-2-3-4	1999	realization
M.8.10.	Vibration monitoring system of TG	1-2-3-4	2000	realization
M.8.11.	Separation of Atmosphere Steam Dumps control systems	1-2	1998	completed

9. RADIATION PROTECTION

Code	Description	Unit	Term	Status
M.9.1.	Modernization of radiation monitoring of Restricted Access Area	1-2-3-4	2000	design
M.9.2.	Reconstruction of Trespassing Facility to Restricted Access Area	1-2-3-4	1998	completed
M.9.3.	Neutron equivalent dose assessment	1-2-3-4	1999	realization
M.9.4.	Installation of additional tanks for storage of liquid radwastes	1-2-3-4	2001	pending
M.9.5.	Refurbishment of the liquid waste treatment systems	1-2-3-4	1999	design

10. FIRE PROTECTION

Code	Description	Unit	Term	Status
M.10.1.	Assurance of safe personnel evacuation in case of fire	1-2-3-4	1999	tender
M.10.2.	MCR ventilation system improvement	1-2-3-4	1998	completed
M.10.3.	Automatic control of drainage oil pumps	1-2-3-4	1998	completed
M.10.4.	Modernization of fire investigation system on Units 3&4	3-4	1999	completed

11. SEISMIC PROTECTION

Code	Description	Unit	Term	Status
M.11.1.	Equipment and structures anti-seismic reinforcement	1-2-3-4	2000	realization
M.11.2.	Assessment of strength of Spent Fuel Pool Shelves at SSE	1-2-3-4	1999	tender

12. STORAGE OF FRESH AND SPENT FUEL

Code	Description	Unit	Term	Status
M.12.1.	Upgrading of Fresh Fuel Center	1-2-3-4	1998	completed
M.12.2.	Storage, refueling and fuel transportation safety improvement	1-2-3-4	2001	pending
M.12.3.	Modernization of refueling machine	1-2-3-4	2000	contract
M.12.4.	Establishment of Units 1-4 internal security zone	1-2-3-4	1999	completed

13. OPERATIONAL ASPECTS

Tag	Description	Unit	Term	Status
M.13.1.	Equipment qualification under accidental conditions	1-2-3-4	1999	study
M.13.2.	Pipelines classification and welds categorization	1-2-3-4	1999	study
M.13.3.	Improvement of operational documentation	1-2-3-4	1999	completed
M.13.4.	Accident Instructions on BDBA	1-2-3-4	2001	tender
M.13.5.	Prevention of unauthorized access to the Boron Center	1-2-3-4	1999	realization
M.13.6.	Change of sampling scheme during refueling	1-2-3-4	1998	completed
M.13.7.	Draft program for Units decommissioning	1-2-3-4	2001	study
M.13.8.	Automatic system for II circuit water chemistry monitoring	1-2	1999	tender
M.13.9.	Increasing of demineralized water treatmennt system capacity	1-2-3-4	2000	design
M.13.10.	Replacement of nitrogen station	1-2-3-4	1999	realization
M.13.11.	Installation condensors' cleaning systems at 1-7TG	1-2-3-4	2000	design
M.13.12.	Implementation of simulation training of personnel	1-2-3-4	2001	tender
M.13.13.	Modernization of air-conditioning systems	1-2-3-4	1999	studies
M.13.14.	Replacement of tubes at turbine condensers	1-2-3-4	2001	studies
M.13.15.	Turbines reconstruction program	1-2-3-4	2001	pending

APPENDIX 2

LIST OF PROPOSED EXTENTION OF PRG'97 MEASURES

1. Use of more than one system for leak detection

2. Expansion of the methodology for analyzing the need of high energy piping support with justification of "safety areas" based on risk analyses

3. Lack of hazard consequences analysis in the light of safety in case of rupture of high energy pipeline in turbine hall

4. Program for identification of root causes of fuel issues and possible improvement of the methodology for fuel integrity control

5. Probabilistic analysis for passive failure of boron injection tank (incl. pipeline between SG compartment and Boron tank and formation of plugs on the pipeline)

6. Risk analysis of the impact of H2 generation on containment integrity at design based accidents

7. Evaluation of SPDS applicability for the whole Post accident monitoring system and upgrade if necessary

8. Expansion of PSA for the risk of turbine missiles

9. Analysis of the non-inspectionable areas of primary circuit and reactor pressure vessel, and provision of required inspection resources. Extension of the ISI program

10. identification of criteria for representative ISI results for primary circuit welds and limitations for the ISI within the frame of welds classification activities foreseen in the PRG'97

11. Temperature measurements on Dn 200 on each units.

12. Gas removal system from the reactor

13. Remote control of valves which are connected to the boron injection tank (part of SG compartment)

14. Installation of check valves on appropriate parts of the feedwater supply line to the SG, as close as possible to the SG

15. Installation of filters on B- I ventilation system

16. Installation of forced filtering venting facility for SG compartment for management of accidents related to core degradation, as a part of scope of work for SG compartment

17. Implementation of reactor level measurement

18. Replacement of I&C of safety systems on units 3 and 4 by advanced ones

19. Replacement of the ADG control system by an advanced one, having built-in diagnostics (incl. Exciting circuit breakers)

20. Replacement of staggered loading automation on units 3 & 4 by an advanced one having built-in diagnostics

Note: Some of the proposals represents extention of the scope of already existing items.

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