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Overall Plan for Physics Outlining Steps Necessary for Insertion of the LTA and Operation Using a 1/3 MOX Loaded Core

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Russian Research Center "Kurchatov Institute"

**A Russian Contribution to the
Fissile Materials Disposition Program**

UT-BATTELLE
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Russian Research Center "Kurchatov Institute"
Institute of Nuclear Reactors
VVER Division

Joint U.S. / Russian Project to Update, Verify and Validate Reactor Design/Safety Computer Codes Associated with Weapons-Grade Plutonium Disposition in VVER Reactors

Overall Plan for Physics Outlining Steps Necessary for Insertion of the LTA and operation using a 1/3 MOX loaded core

General Order 85B-99398V

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Moscow 2000

SUMMARY

Document issued according to **Work Release KI-WR04RTP. P. 00-1** describes physics tasks that are included in the current version of "Roadmap.Level 2" concerning Reactor tasks of Weapon-grade plutonium disposition problem for VVER-1000. On this base the objective is to identify the physical tasks in FY2000 and in future as a part of global activities on weapon-grade MOX fuel introduction into VVER-1000.

CONTENT

1. Introduction

The present work is a part of Joint U.S. / Russian Project with Weapon-Grade Plutonium Disposition in Russian light-water reactors VVER. According to *"AGREEMENT BETWEEN THE GOVERNMENT OF THE UNITED STATES OF AMERICA AND THE GOVERNMENT OF THE RUSSIAN FEDERATION CONCERNING THE MANAGEMENT AND DISPOSITION OF PLUTONIUM DESIGNATED AS NO LONGER REQUIRED FOR DEFENSE PURPOSES AND RELATED COOPERATION"* signed in the 1 Sept. 2000 reactors VVER-1000 are to be involved in this problem.

"ROADMAP. Level 2" concerning VVER-1000 NPP activities with MOX is being developed by VNIIAES with the participation of specialists of RRC "Kurchatov Institute", OKB "Gidropress", Rosenergoatom and others. The current version of "ROADMAP. Level 2" is based on the scenario named "Variant 1": 4 Balakovo NPP units are involved with the transition from 1/3 to 41% MOX fuel in core.

This document presents blocks containing physical (neutronics) tasks included in "ROADMAP. Level 2". The most of these tasks is the subject of Work Releases 01, 02, KI-WR04RTP of GENERAL ORDER AGREEMENT 85B-99398V between UT-BATTELLE, LLC and RUSSIAN RESEARCH CENTER KURCHATOV INSTITUTE (RRC KI). On the base of the description presented below the objective is to identify the physical tasks in FY2000 (WR KI-WR04RTP) and in future Work Releases as a part of global activities on weapon-grade MOX fuel introduction into VVER-1000.

2. Description of blocks in Roadmap-level 2 including neutronics and safety tasks

In the Table below the Roadmap-level2 items, concerning neutronics and reactor safety aspects, are presented. These items demand involving of scientific and engineering personal that participates in neutronics and thermohydraulic project calculations of VVER reactors.

Block	Block Name	Description of physical part
RX-2	**Verification of Codes for Neutron Calculations to Justify/Assess Nuclear Safety of the Reactor**	Verify the MCU/ORIGEN-S precision code based on (1) the results of criticality experiments using VVER uranium fuel, (2) international test benchmarks and (3) the results of criticality experiments with MOX fuel conducted in the US and Europe, and (4) calculated benchmarks. Verify the RRC KI engineering software package (TBC-M / TVS-M, БИПР7-А / BIPR7-A and ПЕРМАК-А/PERMAK-A) based on criticality tests with uranium fuel, operational data for uranium core VVER reactors, data on irradiating uranium fuel, and calculated benchmarks. Modify and verify the 3-D neutron kinetics software packages (НОСТРА / NOSTRA and БИПР8-КН / BIPR8-KN), based on the results of criticality tests with uranium fuel, operational data, and calculated benchmarks. Verify the software for calculating fast neutron fluence to the reactor vessel (software package DOORS with codes DORT, ANISN and libraries of constants, BUGLE-96 and others). Verify the models and procedures for calculating the witness standard radiation load (code TORT with libraries of constants, BUGLE-96 and others). Verify the RRC KI code for calculating the release of dioxide-fuel fission products and the migration in the primary loop systems of VVER-type reactors under standard operating conditions and during design accidents (RELWWER-2.0 and LEAK3). Verify MELLOR, CONTAIN, VICTORIA, and ORIGEN codes for beyond-design accidents. Modify the methodology on leak-proof check the fuel element cladding

RX-3	**Select the Preliminary Assembly of the LTA and the Active Zone for 1/3 MOX Core Utilization**	Perform core neutron studies. Design the MOX-LTA mission. Perform research on various burnable poisons (absorbents) for the MOX fuel. Develop and study the equilibrium fuel cycles using 1/3 MOX core. Perform neutron studies on the fuel cycle transients. Generate the input criticality data for analyzing transients. Generate the input data for fuel fabrication and economic/commercial assessment. Study the effect of variations in the isotopic composition of the weapons-grade plutonium on the core neutronics. Evaluate the engineering safety factors for the MOX fuel assemblies. Perform calculations for the neutron fluence to the reactor vessel and construction materials for the MOX core. Analyze the stability of the MOX core. Manage Power distribution. Analyze the dynamic reaction (response) of the core (UOX and MOX cores) to various operational disruptions. Calculate the activity in the primary loop. Perform preliminary thermal-hydraulic calculations.
RX-4	**Select the Preliminary Variants for Higher Plutonium Disposition/ Burnup Rates**	Analyze the relationships between core characteristics and the percentage (amount) of MOX fuel. Select fuel loads for an alternative project with increased plutonium burnout rates. Develop a fuel management scheme in the VVER-1000 reactor for the alternative design with higher plutonium burnout rates.
RX-6	**Analysis of Safety Criteria of Operating Limits for MOX Fuel**	Perform calculations to analyze the performance of leaking MOX-fuel pins in the core. Determine the possibility of using the existing (specified by current regulations on uranium fuel) operating limits, design basis limits, and safety criteria for MOX fuel. Study and determine the relationship between the number of leaking fuel elements and the primary loop coolant activity in a reactor with MOX fuel. Analyze the feasibility of the procedures used at the NPP to control coolant activity and leak-proof check the fuel element cladding.
RX-9	**Verify the Nuclear and Radiation Safety Codes**	Verification of nuclear (code MCU/ORIGEN-S) and radiation (IPPE

	for the Handling/ Transfer/ Operation Processes	software package— СКАЛА (SKALA)) safety codes based on Russian criticality tests with uranium fuel, international criticality test benchmarks, foreign criticality tests, calculated benchmarks, and sphere transmission tests using the SINDBAD database.
RX-11	**Determine the Specifications of the MOX fuel**	Determine main conceptual characteristics of a fuel element: average burnup, linear heat rate, pellets peak burnup value, plutonium content, irradiation cycle time, emergency conditions criteria.
RX-12	**Calculate and Develop the Technical Specifications for Prototype Fuel Elements and LTA's**	Perform parametric research and configuration of the prototype LTA with MOX fuel. Perform core neutronics calculations for the VVER-1000 with three LTA's. Prepare the kinetic parameters for transient's analysis. Conduct preliminary calculations of the thermal-hydraulic, thermal-mechanical and structural properties of the core with the 3 prototype LTA-MOX assemblies. Prepare the Statement of Work for prototype fuel elements and LTA's, which include the major goals, technical requirements for fuel elements, and LTA's, brief design description, economical numbers as well as the volume of documentation and the order of the document approval.
RX-18	**Evaluate/Analyze the Safety of the Handling/Transfer/Operation Processes at Balakovo NPP**	Perform a nuclear and radiation safety analysis for the transportation and storage of 3 prototype MOX-LTA's at Balakovo NPP in accordance to the present scheme. Evaluate the potential radiation effects of accidents during the transportation of three prototype MOX LTA's. Develop documentation (diagrams, manuals, etc.) for handling 3 MOX fuel assemblies at the NPP.
RX-20	**Code Certification and Validation**	Assess the number and the volume of documents, the verification report, and the description and adequacy of the justification for software packages (SP), i.e., code, prepared for certification. Prepare the documentation for the neutron calculation software packages (MCU/ORIGEN-S, ТВС-М /TVS-M, БИПР7-А / BIPR7-A, ПЕРМАК-А /

		PERMAK-A). Send the application to the Certification Commission under Scientific and Technical Center of GAN of the Russian Federation to obtain the Certificate.
RX-24	**Develop an Addendum to the Primary System Safety Analysis Report (SAR) for Balakovo NPP Unit 4**	Corrections of SAR statements necessary for safety justification of Balakovo Unit 4 operation with 3 LTAs including: Neutronics characteristics, Thermohydraulics characteristics, Structural characteristics, Nuclear and radiation safety. Influence of new and modernized equipment on safety.
RX-26	**Select Fuel Loads and Perform Neutron Calculations for the Placement of Three MOX-LTA's**	Select the fuel load, determine the scope and conduct core neutronics calculations using the current fuel load as a reference. Analyze and process operational data from previous reactor feeds. Develop experimental procedures for determining core neutronics properties. Develop equivalence criteria for calculations and tests.
RX-29	**Perform Balakovo NPP Unit 4 Personnel Training**	Provide procedural software to the NPP personnel to perform neutronics calculations and conduct experimental research in the course of operations with LTA's. Conduct training of the following personnel involved in the operation of Unit 4 in context of operational documentation updates: Transportation and processing operations; Physicists and nuclear safety personnel; Radiation safety personnel; Security personnel; Heat engineers
RX-30	**Safety Analysis**	Perform safety analysis of installing 3 MOX LTA's into the reactor of Unit 4, Balakovo NPP. Obtain neutron (flux) characteristics of the core and the thermal-physical characteristics of the fuel and fuel elements used for calculating the safety parameters. Determine the safety operation parameters.

		Calculate thermal hydraulics of industrial, transient, and emergency (including reactivity accidents and conservative approximation) modes of reactor operation. Create different scenarios of operational modes and design accidents and develop initial data to justify the fuel elements choice. Calculate the primary loop activity under standard and emergency operational modes and design accidents.
RX-34	**Prepare the Documentation for Licensing the Irradiation of Three MOX-LTA's**	Develop a test operational program for the reactor with 3 MOX fuel assemblies. Prepare documentation for licensing the use of fissile materials in R&D, which includes the program for testing three prototype MOX-LTA's. Prepare documentation to make amendments to the licensing terms and conditions for the operation of Balakovo NPP Unit 4. Provide a preliminary assessment of operational documentation and of materials justifying safety.
RX-36	**Irradiate the Three MOX-LTA's Over a Three-Year Period**	Measure the reactor neutronics (Neutron flux measurements). Measure the fresh and irradiated fuel characteristics. Develop calculation-based support of the MOX-LTA's irradiation. Perform data acquisition and data analysis of the reactor operation.
RX-37	**Adjust, Verify and Certify the Neutronics Codes**	Correct and verify: MCU/ORIGEN-S code and the engineering codes ТВС-М (TVC-M), БИПР7-А (BIPR7-A), ПЕРМАК-А (PERMAK-A) based on the criticality tests at the СУПР (SUPR) test bed with domestically produced fuel and on the operational data on the irradiation of 3 MOX fuel assemblies at Unit 4 of the Balakovo NPP. 3-D neutron kinetics software НОСТРА (NOSTRA) and БИПР8-КН (BIPR8-KN) on space-time measurements of changes in the reactions rate at the SUPR test bed; DOORS software package for calculating the fast neutron fluence to the reactor vessel based on the mockup test data; RELWWER-2.0 software for calculating the activity of the primary loop based

		on the irradiation data of 3 MOX fuel assemblies. Estimation of documentation specification on verification and its completion for the codes to be certified. Prepare certification documentation for the MCU/ORIGEN-S, TBC-M (TVS-M), БИПР8-КН (BIPR7-A), ПЕРМАК-А (PERMAK-A), IPPE software package СКАЛА / SKALA, (RELWWER-2.0). Send the application to the Certification Commission under the Science and Technical Center of GAN of the Russian Federation to obtain a certificate.
RX-38	**Develop an Addendum to the Reactor Facility Safety Analysis Report**	Corrections of SAR statements necessary for safety justification of Balakovo Units 1-4 operation with 1/3 serial MOX fuel assemblies including: Neutronics characteristics, Thermohydraulics characteristics, Structural characteristics, Nuclear and radiation safety, Influence of new and modernized equipment on safety, Assessment of consequences of beyond design limit accidents.
RX-39	**Conduct Experiments Using the Criticality Testing Bed**	Develop a program for conducting research at the (SUPR) test bed The program will be developed using the analysis of the indeterminacy of the major characteristics of uranium and MOX cores in VVER-1000 and the uncertainty analysis of the experimental techniques previously determined by foreign experiments. The following characteristics/parameters will be measured: local micro-fields; efficiency of fuel and absorber elements and their interference; neutron and gamma-quantum loss/leakage and their spectrum; neutron balance in (fuel) cells and LTA's; spatial kinetics; statistical analysis of technological limits (margins) for MOX fuel elements; density and temperature factors of reactivity.

		The results of experiments will be used for code verification.
RX-40	**Conduct Post Irradiation Examination Studies**	Hold MOX-fuel assemblies, irradiated for 3 years, in the Balakovo NPP pool for 1 year. Develop a post irradiation examination (PIE) program for a prototype MOX-LTA.
RX-41	**Fuel Load Selection and Neutronics Calculations for Units 1 – 4 of the Balakovo NPP**	Determine scope and conduct neutronics calculations for intermediate loads during transfer from a uranium core (from the reactor core with 3 MOX fuel assemblies at Unit 4) to an industrial core with 1/3 MOX fuel core for Units 1 – 4 of the Balakovo NPP with current loads used as a reference. Develop equivalence criteria for calculations and tests. Acquisition and processing of operational data from previous reactor feeds
RX-42	**Safety Analysis**	Select modes and conduct thermal hydraulics calculations to justify the safety of operating with 1/3 MOX fuel assemblies in industrial, transient and emergency conditions, including reactivity accidents Prepare initial data to calculate the behavior of fuel elements. Prepare data to include into the reactor facility SAR.
RX-43	**Prepare Technical Specification for Serial Production of Fuel Pins and Mission MOX Fuel Assemblies**	Perform parametric research and configuration of serial mission MOX fuel assemblies with MOX fuel. Perform core neutronics calculations for the VVER-1000 with three LTA's. Prepare kinetic parameters for transient analyses. Conduct preliminary calculations of the thermal-hydraulic, thermal-mechanical and structural properties of mission MOX assemblies. Prepare the Statement of Work for the prototype fuel pins and mission MOX fuel assemblies which will include the major goals, technical requirements for fuel elements, and fuel assemblies, brief design description, economical numbers as well as the volume of documentation and the order of the document approval.
RX-45	**Establish Safety Criteria of Operating Limits for MOX Fuel**	Determine the Safety Criteria of Operating Limits for MOX Fuel on the base of experimental analysis of MOX fuel tests in research reactors and of calculational studies using the codes RELWWER2.0, LEAK3,

		MELCOR,CONTAIN, VICTORIA, ORIGEN.
RX-47	**Evaluate/Analyze the Safety of the Handling/Transfer/Operation Processes at a NPP**	Develop a design of spent fuel container. Develop a Statement of Work for calculating handling/transfer/process operations with MOX fuel at the NPP. Calculate nuclear and radiation safety during handling/transfer/process operations with fresh and spent fuel. Examine the existing handling/transfer/process equipment from the standpoint of its application for the mission MOX fuel. Determine the nomenclature of the required new and upgraded equipment and instruments. Analyze consequences of radiation accidents resulting from handling mission MOX fuel. Prepare and pass on initial data for analyzing available facilities and equipment for the storage and transportation of mission MOX fuel. Determine requirements for in-plant systems for reactor facilities with mission MOX fuel. Prepare the data to be included into the Reactor Facility Safety Analysis Report (SAR) of the Balakovo NPP.

RX-49	**Adjust, Validate and Certify the Codes for Neutron Calculations and Fuel Pin Codes**	Adjust thermal mechanical and neutronics characteristics of mission MOX fuel (including gaseous fission products, iodine and cesium yield from fuel pellets and spatial distribution of isotopes in the pellets) based on the results of reactor and post-reactor studies of capsules from the experimental fuel elements at MIR and the BIGR reactors and the test mission MOX fuel elements at Unit 4 of Balakovo NPP VVER reactor. The characteristics are calculated using fuel elements codes and neutronics software programs. Determine uncertainties in the characteristics of fuel elements and the core. Correct the neutronics program based on the analysis of discrepancies between the calculations and test results of irradiating mission MOX fuel assemblies at the 4th Unit of the Balakovo NPP. Estimation of documentation specification on verification and its completion for the codes to be certified. Prepare certification documentation for the fuel elements codes СТАРТ (START), РАПТА (RAPTA) and ФРЕД (FRED) and if necessary for MCU/ORIGEN-S, ТВС-М (TVS-M), БИПР7-А (BIPR7-A), ПЕРМАК-А (PERMAK-A). Send the application to the Certification Commission under the Science and Technology Center of GAN of the RF to obtain a certificate.
RX-55	**Develop an Addendum to the SAR for the Reactor Operation Safety of Balakovo-4 Reactor Unit with 1/3 MOX Core**	Introduce necessary changes to the SAR for Balakovo 4 that result from modifications and the analysis of radiation consequences of accidents with mission MOX fuel assemblies performed in RX-47.
RX-57	**Personnel Training**	Provide procedural software to the NPP personnel to perform neutronics calculations and conduct experimental research in the course of operations with 1/3 MOX Core. Conduct training of the following personnel involved in the operation of Unit 4 in context of operational documentation updates: Transportation and processing operations; Physicists and nuclear safety personnel; Radiation safety personnel; Security personnel;

		Heat engineers, Operations personnel.
RX-58	**Prepare the Documentation for Licensing the Balakovo-4**	Develop a test operational program for the reactor with 1/3 serial MOX fuel assemblies. Prepare documentation for obtaining a license for using fissile materials in R& D works. Prepare documentation for changing the terms and conditions of the license to operate Balakovo NPP Unit 4. Preliminary expertise of operating safety documentation
RX-60	**Irradiate the Mission Fuel Assemblies at Balakovo-4 for a Three-Year Period**	Conduct the irradiation of the 18 serial mission fuel assemblies over a three-year period with the annual addition of 18 new mission fuel assemblies. Measure the neutron parameters of the active core. Determine the radiation characteristics of new and irradiated fuel. Perform calculations of the mission fuel assemblies' irradiation. Gather and analyze the operational data from the reactor. Adjust the neutron codes. Conduct inspection to check the implemented activities. Implement changes into "Licensing Terms " for R&D and operation.
RX-64	**Update of the VVER-1000 Reactor Facility Detailed Design for 1/3 MOX Core**	Activities included: work related to reactor facility upgrades project, detailed design of MOX fuel assemblies, as well as update of the reactor facility system and equipment documentation, due to the introduction of MOX fuel. Expertize a completion of presented documentation.
RX-65	**Develop an Addendum to the Balakovo NPP Units 1 - 3 Safety Analysis Report for 1/3 MOX Core Operation**	Introduce necessary changes to the NPP SAR for Balakovo units 1-3 that result from modifications in Reactor unit SAR and the analysis of radiation consequences of accidents with mission MOX LTA's.
RX-67	**Prepare the Documentation for Licensing of operation of Balakovo NPP Units 1-3 with 1/3 Core Over a Three-Year Period**	Develop the program for test operation of 1/3 Core with mission MOX fuel assemblies. Prepare documentation for obtaining a license for using fissile materials in R& D works. Prepare documentation for changing the terms and conditions of the license to operate Units 1 through 3 at the Balakovo NPP. Perform a preliminary analysis of operating documentation and materials justifying safety.
RX-70	**Irradiate the 18 mission MOX fuel assemblies**	Conduct the irradiation of the 18 serial mission MOX fuel assemblies

	at Units 1-3 of Balakovo NPP Over a Three-Year Period	over a three-year period with the annual introduction of 18 new mission MOX fuel assemblies. Measure the neutron parameters of the active core. Determine the radiation characteristics of new and irradiated fuel. Perform calculations of the mission MOX fuel assemblies' irradiation. Gather and analyze the operational data from the reactor. Conduct inspection to check the implemented activities. Implement changes into "Licensing Terms " for R&D and operation.
RX-73	**Industrial Utilization of a 1/3 MOX Core at Balakovo NPP Units 1-4**	Conduct the operation at Balakovo Units 1-4 with annual introduction of 18 new mission MOX fuel assemblies. Measure the neutron parameters of the core. Determine the radiation characteristics of new and irradiated fuel. Perform calculations of the mission MOX-fuel assemblies' irradiation. Gather and analyze the operational data from the reactor.
RX-74	**Update of the Detailed Design of NPP Units 1-4**	Introduce corrections to the detailed design of Units 1 -4 of the Balakovo NPP based on the following: Correction of Reactor Facility Detailed Design for a serial VVER-1000; Project and Results of the modernization of Units 1-4 of the Balakovo NPP; Results of the post-reactor studies of the prototype mission MOX-fuel assemblies.

RX-75	**Evaluate/Analyze the Operating Safety Systems for Utilizing 41% MOX Core**	Analyze whether the control/protection and boron systems comply with the safety regulations during 41% MOX core operation.
RX-76	**Adjust, Correct and Verify the Neutron Codes**	Correct and verify neutronics codes based on results of reactor operation with 1/3 MOX core.
RX-77	**Select Fuel Loads and Perform Neutron Calculations for Utilizing a 41% MOX Core**	Choose fuel load and conduct core neutronics calculations for the transition from 1/3 MOX core utilization to 41% MOX core utilization. Determine the equivalence criteria for calculations and tests.
RX-78	**Analyze the Operating Safety Utilizing a 41% MOX Core**	Conduct thermal hydraulics calculations to justify the safety of operating with 41% MOX core in industrial, transient and emergency conditions, including reactivity accidents. Prepare data for an inclusion into the reactor facility SAR.
RX-79	**Adjust and Correct the Technical Project of the Reactor Unit for Utilizing a 41% MOX Core**	Introduce corrections based on the reactor facility equipment upgrade project and on the updated documentation for the reactor facility systems and equipment connected with the transfer to 41% MOX core mode of operation.
RX-84	**Develop an Addendum to the SAR NPP Safety Protocol for Utilizing a 41% MOX Core at**	Introduce corrections to the Balakovo NPP based on corrections of the Reactor Unit SAR.
RX-85	**Prepare the Documentation for Licensing of operation of Balakovo NPP Unit 4 with 41% MOX Core Core Over a One-Year Period**	Develop the program for test operation of 41% Core with mission MOX fuel assemblies. Prepare documentation for obtaining a license for using fissile materials in R& D works. Prepare documentation for changing the terms and conditions of the license to operate Units 4 at the Balakovo NPP. Perform a preliminary analysis of operating documentation and materials justifying safety.
RX-87	**Utilization of a 41% MOX Core at Balakovo Unit 4**	Conduct the irradiation of the Unit 4 with 41 mission MOX fuel assemblies over a one-year period. Measure the neutron parameters of the active core. Determine the radiation characteristics of new and irradiated fuel. Perform calculations of the mission MOX fuel assemblies' irradiation. Gather and analyze the operational data from the reactor. Conduct inspection to check the implemented activities. Implement

		changes into "Licensing Terms " for R&D and operation.
RX-88	**Revise the Reactor Facility and NPP Detailed Design for Utilizing a 41% MOX Core**	Revise and verify the technical design for a Reactor facility and for a NPP based on the modernization of the control/protection and boron systems. Expertise a completion of presented documentation
RX-89	**Prepare the Documentation for Licensing of operation of Balakovo NPP Units with 41% MOX Core**	Prepare documentation for changing the terms and conditions of the license to operate Balakovo NPP Units1-4 with 41% MOX fuel. Update the regulatory document "Nomenclature of Operational Neutronic Calculations and of Experiments for Fuel Loading of VVER 1000". Perform a preliminary analysis of operating documentation and materials justifying safety.
RX-91	**Industrial Utilization of a 41% MOX Core in Balakovo NPP Reactors**	Measure the reactor neutronics. Acquire data and perform data analysis of the reactor operation.

3. Connection of FY2000 (KI-WR04RTP) items with Roadmap-level 2

In the Table below the connection of KI-WR04RTP tasks of General Order 85B-99398V with Roadmap-level2 is presented.

FY2000	Roadmap	Comments
00-1		Presented document
00-2	RX-12	
00-3	RX-12	
00-4	RX-3, RX-11, RX-43	
00-5	RX-2	
00-6	RX-9	
00-7	RX-2, RX-9	
00-8	RX-2	
00-9		Funding of business trips
00-10	RX-4	
00-11	RX-2	
00-12	RX-2	

Comments from ORNL staff on *Overall Plan for Physics Outlining Steps Necessary for Insertion of the LTA and Operation Using a 1/3 MOX Loaded Core*

1. Page 4, last paragraph, fourth line from the end: “base” should be “basis.”
2. Page 5, in some places in the report, the nomenclature “ROADMAP.level 2” is used; elsewhere it is called “Roadmap-level 2.” A consistent phrase should be used.
3. Page 6, last sentence in the third column: The sentence, “Modify the methodology on leak-proof check the fuel element cladding” appears to be misplaced. If not, more explanation is needed.
4. Page 7, third column, second sentence: “absorbents” should be “absorbers.”
5. Page 9, third column, first sentence: suggest adding the phrase “for passport” after the word “application.”
6. Page 10, third column, third row: MOX-LTA’s should be MOX-LTAs.
7. Page 10, third column, fourth row, fifth line from the bottom: “reactions rate” should be “reaction rates.”
8. Page 11, third column, first row, fifth line: BIPR7-A should be BIPR8-KN.
9. Page 12, third column, second row, third line: the hyphen (-) between MOX and LTA should be replaced with a space.
10. Page 12, third column, fifth row, fifth line: the commonly used American English expression is “thermal hydraulics.” Various styles are used in this report.
11. Page 13, third column, second row, ninth line: “handling” should be “mishandling.” Handling of the fuel should not lead to accidents, per se.
12. Page 16, third column, third row, next to last line: delete the hyphen between “MOX” and “fuel.”
13. Page 17, third column, last row, first line: “41” should be “41%.”
14. Page 18, comment on RX-91. It would assist American reviewers if data for earlier Balakovo cores could be released for computer program model development and calculation.

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