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**IGNALINA
RBMK-1500**

A Source Book

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ABSTRACT

This publication provides an overview of design and operational data regarding the RBMK-1500 Nuclear Power Plants located at Ignalina, Lithuania. The content is modeled on the data presentation scheme employed by U.S. FSAR reports with modifications made as required by the unique RBMK design. Particular emphasis is placed on safety related design data. Subjects covered include: description of the site characteristics, design of structures and components, descriptions of the reactor, the fuel channels, reactor shielding structures, control rod channels and refueling equipment plus procedures. An extensive section deals with various aspects of the main circulation system and systems for cooling control rods, instrumentation and shielding. In addition, such systems as the Reactor Cavity Overpressure Protection System, Fuel Cladding Integrity Monitoring System, Emergency Power Protection System, Electric Power System, Steam and Power Conversion System, Service Water System, Intermediate Circuits System as well as other auxiliary systems are described. Presented engineered safety features include the accident confinement system, radiation protection features, reactor power control systems, emergency core cooling and water purification systems and safety management. System description includes also an overview of their evaluated response during design basis accidents. The results of the In-Depth Safety Assessment of the Ignalina NPP are discussed, this includes results of system and accident analyses, safety improvements performed at the Ignalina plant after the Chernobyl accident and during implementation of the first as well as the second Safety Improvement Program.

TABLE OF CONTENTS

| | Page |
|--|------|
| ABSTRACT | 3 |
| TABLE OF CONTENTS | 4 |
| LIST OF FIGURES | 8 |
| LIST OF TABLES | 10 |
| LIST OF ABBREVIATIONS | 13 |
| ACKNOWLEDGMENTS | 15 |
| INTRODUCTION FOR THE EXTENDED AND UPDATED VERSION | 16 |
| | |
| 1. INTRODUCTION AND HISTORICAL CONTEXT | 17 |
| 1.1 GENERAL PLANT DESCRIPTION | 18 |
| 1.1.1 Location of Plant | 18 |
| 1.1.2 Plant Panorama | 18 |
| 1.1.3 Plant Layout | 20 |
| 1.1.4 Power Plant Parameters | 22 |
| 1.2 COMPARISON WITH OTHER FACILITIES | 22 |
| 1.3 IDENTIFICATION OF DESIGN ORGANIZATIONS AND CONTRACTORS | 22 |
| 1.4 OPERATIONAL RESPONSIBILITY FOR THE IGNALINA NPP | 24 |
| 2. SITE CHARACTERISTICS | 28 |
| 2.1 GEOGRAPHY AND DEMOGRAPHY | 28 |
| 2.2 POPULATION DISTRIBUTION | 29 |
| 2.3 NEARBY INDUSTRIAL REGIONS | 29 |
| 2.4 METEOROLOGY | 29 |
| 2.5 HYDROLOGIC ENGINEERING | 31 |
| 2.6 GEOLOGICAL AND SEISMOLOGICAL EFFECTS | 33 |
| 3. DESIGN OF STRUCTURES, COMPONENTS, EQUIPMENT AND SYSTEMS | 35 |
| 3.1 DESIGN LOADING | 35 |
| 3.1.1 External | 35 |
| 3.1.1.1 Air-Shock Wave | 35 |
| 3.1.1.2 Water | 35 |
| 3.1.1.3 Missiles | 35 |
| 3.1.1.4 Seismic | 36 |
| 3.1.2 Internal | 38 |
| 3.1.2.1 Postulated Piping Ruptures | 38 |
| 3.1.2.2 Assumed Missile Effects | 41 |
| 3.2 DESIGN OF STEEL STRUCTURES | 42 |
| 3.2.1 Standard Practices | 42 |
| 3.2.2 Material Properties | 42 |
| 3.2.3 Failure Design Criteria | 45 |
| 3.2.4 Qualification Tests of Reactor Components | 46 |
| 3.3 DESIGN OF CONCRETE STRUCTURES | 49 |
| 3.3.1 Standard Construction Practices | 49 |
| 3.3.2 Material Properties Used | 49 |
| 3.4 SELECTION OF MECHANICAL AND ELECTRICAL EQUIPMENT | 51 |
| 3.4.1 Compliance with Code Requirements | 51 |
| 3.4.2 Qualification Tests and Analyses | 52 |
| 4. REACTOR | 55 |
| 4.1 DESIGN BASIS | 55 |
| 4.2 DESCRIPTION OF SYSTEM | 55 |
| 4.2.1 The Graphite Stack | 57 |
| 4.2.2 Reactor Metal Structures | 59 |
| 4.2.3 Biological Shielding | 60 |
| 4.2.4 Fuel Assembly and Fuel Channel | 62 |
| 4.2.4.1 Fuel Assembly | 62 |
| 4.2.4.2 Fuel Channel | 63 |

| | |
|--|-----|
| 4.2.4.3 Pressure Tube - Graphite Gap..... | 65 |
| 4.3 REACTIVITY CONTROL SYSTEM..... | 66 |
| 4.3.1 Special Purpose Channels | 67 |
| 4.3.2 Fuel Handling System | 68 |
| 4.3.3 Control Rod Drive Characteristics..... | 70 |
| 4.4 REACTOR DRAINING SYSTEM..... | 72 |
| 4.4.1 The Reactor Cavity Draining System..... | 72 |
| 4.4.2 Metal Structures and Peripheral Ionization Chambers Draining System | 73 |
| 4.5 OPERATIONAL PROCEDURES | 73 |
| 4.5.1. Startup..... | 73 |
| 4.5.2 Shutdown..... | 76 |
| 4.5.3 Refueling Operation..... | 76 |
| 5. MAIN CIRCULATION CIRCUIT | 78 |
| 5.1 THE MCC THROUGH THE CORE..... | 80 |
| 5.1.1 Group Distribution Header, Water Piping, Isolation and Control Valve..... | 80 |
| 5.1.2 Fuel Channels: Operation Parameters | 82 |
| 5.1.3 Steam-Water Piping..... | 82 |
| 5.2 SEPARATION OF STEAM | 82 |
| 5.2.1 Separator Drums | 82 |
| 5.2.2 Connections at the Liquid and Steam Level between Separator Drums..... | 84 |
| 5.2.3 Downcomers | 85 |
| 5.2.4 MCP Suction Headers | 85 |
| 5.3 FORCED CIRCULATION | 85 |
| 5.3.1 Main Circulation Pumps..... | 85 |
| 5.3.2 Suction and Pressure Piping of the MCPs | 87 |
| 5.3.3 MCP Pressure Header | 88 |
| 5.3.4 Pipe Connections between Suction Headers and Pressure Headers | 88 |
| 5.3.5 Pipe Connections between the Pressure Header and the Group Distribution Header | 89 |
| 5.4 STEAM PIPING..... | 89 |
| 5.4.1 Protection of the MCC from Pressure Surges | 89 |
| 5.4.1.1 Fast-Acting Steam Discharge Valve SDV-C..... | 90 |
| 5.4.1.2 High Pressure Steam Loop..... | 91 |
| 5.5 THE WATER FEEDBACK SYSTEM..... | 91 |
| 5.5.1 Operation | 91 |
| 5.5.2 Operation Parameters of the Water Feedback System | 92 |
| 5.5.3 Components of the System | 93 |
| 5.5.3.1 Condensate Pumps..... | 93 |
| 5.5.3.2 Filtration of the Condensate..... | 93 |
| 5.5.3.3 Pre-Heating the Condensate..... | 93 |
| 5.5.3.4 Deaerators | 95 |
| 5.5.3.5 Main Feed Water Pumps | 95 |
| 5.5.3.6 Auxiliary Feed Water Pumps..... | 96 |
| 5.5.3.7 Main Feeder | 96 |
| 5.5.3.8 Auxiliary Feeder | 97 |
| 5.5.3.9 Mixers..... | 97 |
| 5.5.3.10 Valves in the Feedwater Piping | 97 |
| 5.6 PURIFICATION AND COOLING SYSTEM..... | 98 |
| 5.7 CONTROL ROD COOLING CIRCUIT..... | 101 |
| 5.7.1 Top Storage Tank | 102 |
| 5.7.2 Distribution Piping | 102 |
| 5.7.3 Connections between the Instrumentation Channels and the Heat Exchangers..... | 103 |
| 5.7.4 Coolers..... | 103 |
| 5.7.5 Connections between the Coolers and the Circulation Pumps | 103 |
| 5.7.6 Bottom Storage Tank..... | 103 |
| 5.7.7 Circulation Pumps | 103 |
| 5.7.8 Connections between the Pumps and the Top Tank..... | 104 |
| 5.7.9 Other Piping and Auxiliaries..... | 104 |
| 5.8 FUEL CLADDING INTEGRITY MONITORING SYSTEM..... | 104 |
| 5.9 MATERIALS | 105 |

| | |
|---|-----|
| 6. ENGINEERED SAFETY FUTURES | 108 |
| 6.1 MEASUREMENT OF REACTOR PARAMETERS | 108 |
| 6.2 PLANT RADIATION PROTECTION | 109 |
| 6.2.1 Habitability Requirements | 109 |
| 6.2.2 Examination Techniques and Procedures..... | 111 |
| 6.2.3 Radiation Monitoring Instrumentation | 111 |
| 6.2.4 Scheduling of Inspections | 111 |
| 6.3 ACCIDENT CONFINEMENT SYSTEM..... | 112 |
| 6.3.1 Purpose and Applicability..... | 112 |
| 6.3.2 Design Characteristics of the ACS | 113 |
| 6.3.3 ACS Structural Characteristics..... | 114 |
| 6.3.4 Condenser Tray Cooling System | 116 |
| 6.3.5 Reactor Cavity Overpressure Protection System..... | 118 |
| 6.3.6 Description of ACS Response..... | 119 |
| 6.3.6.1 Accident in the Reinforced Leaktight Compartment..... | 119 |
| 6.3.6.2 Rupture of the Group Distribution Header..... | 119 |
| 6.3.6.3 Rupture of a Fuel Channel..... | 120 |
| 6.3.6.4 Inadvertent Opening of the MSV's | 120 |
| 6.3.6.5 Small Pipe Break Accident | 121 |
| 6.3.6.6 Hydrogen Release | 121 |
| 6.3.7 ACS Leakage Testing..... | 121 |
| 6.4 REACTOR POWER CONTROL | 122 |
| 6.4.1 Reactivity Coefficients | 122 |
| 6.4.2 Measurement and Control of Reactor Power..... | 125 |
| 6.4.2.1 Reactor Neutron Flux Measurement..... | 125 |
| 6.4.2.2 Power Density Distribution Monitoring System | 127 |
| 6.4.3 Control and Protection System | 130 |
| 6.4.3.1 Neutron Flux Control..... | 131 |
| 6.4.3.2 Control Rods..... | 131 |
| 6.5 EMERGENCY PROCESS PROTECTION SYSTEM..... | 133 |
| 6.6 EMERGENCY CORE COOLING SYSTEM | 134 |
| 6.6.1 Purpose of the ECCS | 134 |
| 6.6.2 System Description | 135 |
| 6.6.3 Operation of the ECCS | 137 |
| 7. AUXILIARY SYSTEMS..... | 138 |
| 7.1 SYSTEM FOR COLLECTION AND PURIFICATION OF DEMINERALIZED WATER..... | 138 |
| 7.1.1 The Pumping Station of Contaminated DW | 138 |
| 7.1.2 The DW Purification Facility | 139 |
| 7.1.3 The Pumping Station of Purified DW | 139 |
| 7.1.4 System Operation..... | 140 |
| 7.2 AUXILIARY DEAERATOR MAKEUP SYSTEM..... | 140 |
| 7.2.1 General Description | 140 |
| 7.2.2 Operational Procedures of the Auxiliary Deaerator Makeup System | 141 |
| 7.3 SERVICE WATER SYSTEM | 142 |
| 7.3.1 General Description | 142 |
| 7.3.2 HEs of ACS Condenser Tray Cooling System..... | 144 |
| 7.3.3 Diesel Generators Cooling System | 144 |
| 7.4 INTERMEDIATE CIRCUITS..... | 144 |
| 7.4.1 Intermediate Circuit of the PCS Water Final Coolers IC-1 | 145 |
| 7.4.2 Intermediate Circuit for MCC Equipment IC-2 | 145 |
| 7.5 FISSION PRODUCT REMOVAL AND CONTROL SYSTEM..... | 146 |
| 7.5.1 Reactor Gas Circuit and Vented Gas Cleaning System | 146 |
| 7.5.2 Reactor Channel Integrity Monitoring system | 147 |
| 7.5.3 Venting System for the Reactor and the MCC Compartments | 148 |
| 8. ELECTRIC POWER SUPPLY SYSTEM | 149 |
| 8.1 OFF-SITE POWER SYSTEM | 149 |
| 8.2 ON-SITE POWER SYSTEM | 150 |
| 8.2.1 Normal Power Sources | 150 |
| 8.2.2 Auxiliary Power Supply | 150 |

| | | |
|---------|---|-----|
| 8.2.2.1 | 6 kV Power Supply | 150 |
| 8.2.2.2 | 0.4 kV Power Supply | 151 |
| 8.2.2.3 | DC 220 V Normal Power Supply | 151 |
| 8.2.2.4 | Cables..... | 151 |
| 8.2.3 | Emergency Power Supply System..... | 152 |
| 8.2.3.1 | Reliable Power Supply System | 152 |
| 8.2.3.2 | Uninterruptible Power Supply System | 154 |
| 8.2.4 | Power Supply to Instrumentation and Control Systems..... | 156 |
| 9. | STEAM AND POWER CONVERSION SYSTEM | 158 |
| 9.1 | MAIN STEAM SUPPLY SYSTEM..... | 158 |
| 9.2 | TURBINE AND CONDENSER | 158 |
| 9.3 | GENERATOR..... | 161 |
| 10. | SYSTEM ANALYSIS..... | 163 |
| 10.1 | REACTOR CONTROL AND PROTECTION SYSTEM | 164 |
| 10.2 | EMERGENCY PROCESS PROTECTION SYSTEM | 166 |
| 10.3 | EMERGENCY CORE COOLING SYSTEM..... | 169 |
| 10.4 | ACCIDENT CONFINEMENT SYSTEM | 170 |
| 10.5 | FEEDWATER AND STEAM SUPPLY SYSTEM..... | 172 |
| 10.6 | SUPPORT SYSTEMS | 173 |
| 11. | ACCIDENT ANALYSIS..... | 175 |
| 11.1 | REQUIREMENTS FOR ACCIDENT ANALYSIS | 175 |
| 11.2 | ACCIDENTS INITIATED BY EQUIPMENT FAILURES | 178 |
| 11.3 | LOSS OF COOLANT ACCIDENTS | 179 |
| 11.4 | REACTIVITY INITIATED ACCIDENTS | 180 |
| 11.5 | ANTICIPATED TRANSIENTS WITHOUT SCRAM | 181 |
| 11.6 | POTENTIAL INITIATORS OF MULTIPLE PRESSURE TUBE RUPTURE..... | 182 |
| 11.7 | PROBABILISTIC SAFETY ASSESSMENT..... | 182 |
| 12. | SAFETY MANAGEMENT AND PLANT OPERATION..... | 185 |
| 12.1 | OPERATIONAL ORGANIZATION | 185 |
| 12.2 | ROLE OF OPERATOR..... | 186 |
| 12.3 | SAFETY MANAGEMENT..... | 189 |
| 13. | PLANT MODIFICATIONS | 191 |
| 13.1 | POST-CHERNOBYL MODIFICATIONS | 191 |
| 13.2 | MODIFICATION IMPLEMENTED DURING THE SAFETY IMPROVEMENT PROGRAM..... | 192 |
| 13.3 | NEW SAFETY IMPROVEMENT PROJECT..... | 193 |
| | REFERENCES..... | 196 |

LIST OF FIGURES

- Fig. 1.1 General panorama of the Ignalina NPP
- Fig. 1.2 General units arrangements
- Fig. 1.3 Panorama of auxiliary services
- Fig. 1.4 Plan of the Ignalina NPP main buildings
- Fig. 1.5 Cross-section A-A of one unit of the Ignalina NPP
- Fig. 1.6 Cross-section B-B of one unit of the Ignalina NPP
- Fig. 1.7 Heat cycle diagram
- Fig. 1.8 Scope of responsibility for the Ignalina NPP project
- Fig. 1.9 Relationship of the Ignalina NPP with the authorities of the Republic of Lithuania
- Fig. 2.1 Location of the Ignalina NPP
- Fig. 2.2 Configuration of lake Drūkšiai, location of the Ignalina NPP and permanent testing stations (1-6)
- Fig. 2.3 Bathymetric curves of lake Drūkšiai
- Fig. 2.4 Glacial accretions of the ground-cover in the Ignalina NPP area
- Fig. 3.1 The relation between seismic scales
- Fig. 4.1 General view of the reactor
- Fig. 4.2 General view of the graphite stack and the water-steam piping
- Fig. 4.3 Segment of the graphite stack
- Fig. 4.4 Cross-section of the reactor vault
- Fig. 4.5 Top metal structures
- Fig. 4.6 Segment of the top cover
- Fig. 4.7 Fuel channel shielding plug
- Fig. 4.8 Shielding sleeves in the top reflector
- Fig. 4.9 Fuel assembly
- Fig. 4.10 Fuel channel
- Fig. 4.11 Graphite and zirconium interaction zone
- Fig. 4.12 Fuel channel seal plug
- Fig. 4.13 Change of hole diameter in graphite bricks and equivalent diameter of pressure tubes (pressure tube & graphite rings) during operation of Ignalina NPP unit 1
- Fig. 4.14 Reactor - control and protection system channel
- Fig. 4.15 Reflector - cooling channel
- Fig. 4.16 Refueling machine
- Fig. 4.17 Grabber
- Fig. 4.18 Control rod drive
- Fig. 4.19 Block diagram of the reactor draining system
- Fig. 4.20 Refueling machine operation
- Fig. 5.1 Schematic representation of one loop of the main forced circulation circuit
- Fig. 5.2 Elevations of the MCC
- Fig. 5.3 Isolation and control valve
- Fig. 5.5 Operation parameters of the isolation and control valve
- Fig. 5.6 Vertical variation of coolant parameters along the maximum designed power 4.5 MW fuel channel
- Fig. 5.7 Separator drum
- Fig. 5.8 Connections at the liquid and steam level between separator drums
- Fig. 5.9 The pump equipment of the RBMK type reactor
- Fig. 5.10 Schematic of the RBMK-1500 pump
- Fig. 5.11 A schematic representation of the throttling-regulating valve
- Fig. 5.12 A schematic representation of the GDH check valve
- Fig. 5.13 Steam piping
- Fig. 5.14 Water feedback system
- Fig. 5.15 A schematic representation of purification and cooling system

- Fig. 5.16 Control rod cooling circuit
- Fig. 5.17 Schematic of fuel cladding integrity monitoring system
- Fig. 6.1 Section of RBMK-1500 measurement parameters
- Fig. 6.2 Principal ACS schematic
- Fig. 6.3 Condensing compartment and pool
- Fig. 6.4 Sketch of steam distribution devices
- Fig. 6.5 Fifth steam-condensing pool
- Fig. 6.6 Gas-delay chamber
- Fig. 6.7 Condenser tray cooling system
- Fig. 6.8 Simplified schematic of the reactor pressure relief system
- Fig. 6.9 GDH rupture after the check valve
- Fig. 6.10 Void reactivity coefficient versus fuel burnup
- Fig. 6.11 Neutron flux measurement location
- Fig. 6.12 Cross-section of a suspension bracket of the fission chamber
- Fig. 6.13 Suspension bracket section of the ionization chamber for reactor startup
- Fig. 6.14 Cross-section of the suspension bracket ionization chamber for normal reactor operation
- Fig. 6.15 Sensor for the radial power density monitoring PDMS-R
- Fig. 6.16 The suspension bracket for in-core power density sensor of axial monitoring PDMS-A
- Fig. 6.17 Tri-axial bi-sectional chamber used in the PDMS-A detector
- Fig. 6.18 Reactor power density distribution monitoring system sensor distribution in the reactor cross-section
- Fig. 6.19 Arrangement of control and protection system absorber rods in the core
- Fig. 6.20 Control rod design
- Fig. 6.21 Emergency core cooling system
- Fig. 6.22 ECCS actuation logic
- Fig. 7.1 Schematic representation of system for the recovery and purification of demineralized water
- Fig. 7.2 Process scheme of auxiliary deaerator makeup system
- Fig. 7.3 Flow diagram of the HEs of the ACS condenser tray cooling system SWS
- Fig. 7.4 Reactor gas circuit with released gas cleaning system
- Fig. 8.1 Circuit diagram of power supply at units 1 and 2
- Fig. 8.2 Circuit diagram of emergency power supply system
- Fig. 11.1 Damage and accident contributors in different initiating event classes
- Fig. 11.2 Damage and accident contributors in short, intermediate and long term cooling
- Fig. 12.1 The Ignalina NPP organizational chart
- Fig. 12.2 The Ignalina NPP operating service organization chart
- Fig. 13.1 The modernization of the RBMK-1500 manual control rods
- Fig. 13.2 Fast-acting scram system test, at reactor power $N = 0.4N_{nom}$

LIST OF TABLES

| | |
|------------|--|
| Table 1.1 | Specific status of the RBMK plants |
| Table 1.2 | Fundamental parameters of the RBMK-1500 reactor |
| Table 1.3 | Comparison of BWR and RBMK - 1500 reactor parameters |
| Table 2.1 | Population distribution |
| Table 2.2 | Main data of hydrologic and hydrothermic regime of water cooling reservoir of the Ignalina NPP |
| Table 2.3 | Filtration properties of glacial accretions of the ground-cover in the Ignalina NPP area |
| Table 2.4 | Engineering-geological properties of glacial accretions of the ground-cover in the Ignalina NPP area |
| Table 3.1 | Seismic stability of the Ignalina NPP structures |
| Table 3.2 | Chemical composition of steels, used for the main equipment of RBMK-1500 reactors |
| Table 3.3 | Physical-mechanical properties of steels, used for the main equipment of RBMK-1500 reactors |
| Table 3.4 | Thermo-physical properties of low-alloy steels |
| Table 3.5 | Steel 08Ch18N10T properties at 20 °C after exposure to fast neutrons with different fluencies |
| Table 3.6 | Physical-mechanical zirconium alloy properties |
| Table 3.7 | Influence of fluency exposure on physical-mechanical properties of alloy Zr+2.5 % Nb |
| Table 3.8 | Chemical compositions of different concretes |
| Table 3.9 | Neutron and gamma quantum attenuation parameters of concrete |
| Table 3.10 | Radiation influence to strength of concretes |
| Table 4.1 | Composition and dimensions of principal biological shield components |
| Table 4.2 | Biological shielding parameters of the office premises which are adjacent to the operating equipment |
| Table 4.3 | List of non-service compartments |
| Table 4.4 | Fuel assembly parameters |
| Table 4.5 | Fuel channel inspection program for unit 1 of the Ignalina NPP |
| Table 4.6 | The channels and their number |
| Table 4.7 | Reactivity control system rods |
| Table 5.1 | Water and steam volumes of one loop of the MCC |
| Table 5.2 | Coolant operating conditions at 4200MW(th) power operation |
| Table 5.3 | Parameters of the fuel channels |
| Table 5.4 | Specifications of the separator drum |
| Table 5.5 | Specifications of the suction header of the MCP |
| Table 5.6 | Pump characteristic |
| Table 5.7 | Electric motor characteristics |
| Table 5.8 | Specifications of throttling-regulating valve |
| Table 5.9 | Specifications of the pressure header of the MCP |
| Table 5.10 | Operation parameters of the steam |
| Table 5.11 | Parameters of the protective steam discharge valves |
| Table 5.12 | Fast-acting steam discharge valve to turbine condenser |
| Table 5.13 | Fast-acting steam discharge valve to fifth pool of the ACS tower |
| Table 5.14 | Operation parameter of feedwater |
| Table 5.15 | Specification of the condensate pump of first stage |
| Table 5.16 | Specifications of the condensate pump of second stage |
| Table 5.17 | Specifications of condensate filters |
| Table 5.18 | Low pressure reheater PND-1 |
| Table 5.19 | Low pressure reheater PND-2 |
| Table 5.20 | Low pressure reheater PND-3 |
| Table 5.21 | Low pressure reheater PND-4 |
| Table 5.22 | Low pressure reheater PND-5 |
| Table 5.23 | Specifications of the deaerator |
| Table 5.24 | Specifications of the main feed water pump |
| Table 5.25 | Specifications of the auxiliary feed water pump |

| | |
|------------|--|
| Table 5.26 | Specifications of the filter |
| Table 5.27 | Specifications of the control valve for main feeder |
| Table 5.28 | Specification of the filter |
| Table 5.29 | Specification of the control valve for auxiliary feeder |
| Table 5.30 | Specification of the mixer |
| Table 5.31 | Specification of the control valve |
| Table 5.32 | Purification pump |
| Table 5.33 | Specification of the regenerator |
| Table 5.34 | Specifications of the additional cooler |
| Table 5.35 | Specifications of water quality |
| Table 5.36 | Specifications of the filter |
| Table 5.37 | Specification of the ion exchanger |
| Table 5.38 | Specification of the CRCC |
| Table 5.39 | Specification of the top tank |
| Table 5.40 | Specification of the coolers |
| Table 5.41 | Specifications of the bottom storage tank |
| Table 5.42 | Specifications of the pump |
| Table 5.43 | Specification of the discharge pump |
| Table 5.44 | Materials |
| Table 6.1 | Main measured parameters |
| Table 6.2 | Limits of safe operation of Ignalina NPP with RBMK-1500 |
| Table 6.3 | Main dose limits |
| Table 6.4 | Allowable release of radioactive gases and aerosols from Ignalina NPP |
| Table 6.5 | Principal ACS design characteristics |
| Table 6.6 | ACS components |
| Table 6.7 | ACS leakage test results of the Ignalina NPP unit 1 |
| Table 6.8 | ACS leakage test results of the Ignalina NPP unit 2 |
| Table 6.9 | The state of the reactor at the Ignalina NPP |
| Table 6.10 | Measurements of steam reactivity coefficient and means of reducing it at the Ignalina NPP unit 1 |
| Table 6.11 | Measurements of steam reactivity coefficient and means of reducing it at the Ignalina NPP unit 2 |
| Table 6.12 | Neutron flux measurement |
| Table 6.13 | Reactor power density distribution monitoring system sensors |
| Table 6.14 | Structural types of control rods |
| Table 6.15 | Thermal power of an RBMK-1500 reactor as a function of time, during emergency protection AZ-1 |
| Table 6.16 | Estimate of ECCS flow rate during a DB-LOCA |
| Table 6.17 | Characteristics of the ECCS and Auxiliary Deaerator Makeup System Pumps |
| Table 6.18 | Water Reservoir Capacities for the ECCS |
| Table 7.1 | Specifications of reception tank for contaminated DW |
| Table 7.2 | Specification of pumps |
| Table 7.3 | Design specification of the DW purification facility |
| Table 7.4 | Specifications of tank of purified DW |
| Table 7.5 | Specification of pumps |
| Table 7.6 | Required water quality |
| Table 7.7 | Technical specification of the auxiliary deaerator makeup system pump |
| Table 7.8 | Required water quality in the ADMS system |
| Table 7.9 | Service water flow rates to main equipment at $t_{cool} = 28^{\circ}C$ |
| Table 7.10 | Specification of the SWS pump |
| Table 7.11 | The nominal SWS operating parameters |
| Table 7.12 | IC-1 conditions |
| Table 7.13 | Technical specification of heat exchangers of IC-1 and IC-2 |
| Table 7.14 | Technical specification of pumps of IC-1 and IC-2 |
| Table 7.15 | IC-2 conditions |

| | |
|------------|---|
| Table 7.16 | Main components connected to intermediate circuit IC-2 |
| Table 7.17 | Water quality in IC-1, IC-2 |
| Table 7.18 | Special venting system structure |
| Table 8.1 | List of loads according to steps |
| Table 8.2 | The characteristics of diesel generator of ASD-5600 type |
| Table 8.3 | Main characteristics of rectifier of TPPS-800 type |
| Table 8.4 | Main characteristics of inverter PTS-200 type |
| Table 8.5 | Main characteristics of switching device TKEP-100 type |
| Table 8.6 | Main characteristics of disconnecting device TKEO type |
| Table 9.1 | Fast-acting steam discharge valve to deaerators |
| Table 9.2 | Main Technical characteristics of turbine K-750-65/3000 |
| Table 9.3 | Technical specification of steam - separator reheater SPP-750 |
| Table 9.4 | Technical specification of turbine condenser K-16560 |
| Table 9.5 | Technical specification of main turbine ejector of EPO-3-220 type |
| Table 9.6 | Main characteristics of turbine generator TVV-800-2UZ |
| Table 11.1 | Temperatures of failure by cladding collapse at P=7 MPa |
| Table 11.2 | Temperature of failure by cladding ballooning |
| Table 11.3 | Meteorological parameters |
| Table 13.1 | EBRD funded safety improvement projects at Ignalina NPP |

LIST OF ABBREVIATIONS

| | |
|-------------|---|
| AC | Automatic Control |
| ACR | Automatic Control Rod |
| ACS | Accident Confinement System |
| ADMS | Auxiliary Deaerator Makeup System |
| AFWP | Auxiliary Feed Water Pump |
| ATWS | Anticipated Transients Without Scram |
| AZ-1 - AZ-6 | Emergency Protection “AZ-1” - “AZ-6” |
| BS | Baltic System |
| BSRC | Bottom Steam Reception Chamber |
| BWCC | Bottom Water Communication Compartments |
| BWPC | Bottom Water Pipes Compartments |
| BWR | Boiling Water Reactor |
| CANDU | Heavy Water Reactor with Pressure Tubes |
| CKBM | Central Design Office of Mechanical Engineering |
| CNIITMASH | Central Research Institute of Mechanical Engineering |
| CPS | Control Protection System |
| CRCC | Control Rod Cooling Circuit |
| CTCS | Condenser Tray Cooling System |
| CVCS | Chemical and Volume Control System |
| DAZ | Supplementary Emergency Protection |
| DB-LOCA | Design Basis LOCA |
| DBA | Design Basis Accident |
| DC | Direct Auxiliary Feed Water |
| DG | Diesel-Generator |
| DS | Drum Separator |
| DSA | Permissible Contents of Radionuclide in Sensitive Organ |
| EBRD | European Bank of Reconstruction and Development |
| ECCS | Emergency Core Cooling System |
| EHCS | Electric Hydraulic Control System |
| EPPS | Emergency Process Protection System |
| FAS | Fast Acting Scram |
| FASR | Fast Acting Scram Rod |
| FASS | Fast Acting Scram System |
| FC | Fission Chamber |
| FCIM | Fuel Claddings Integrity Monitoring |
| FSAR | Format on Safety Analysis Report |
| GDH | Group Distribution Header |
| HCC | Hot Condensate Chamber |
| HCS | Hydraulic Control System |
| HE | Heat Exchanger |
| HPC | High Pressure Cylinder |
| IAEA | International Atomic Energy Agency |
| IC | Intermediate Circuits |
| ICS | Information Computing System |
| ISAG | Ignalina Safety Analysis Group |
| ISI | In-Service Inspection |
| ISP | Ignalina Safety Panel |
| KOM | Emergency Protection With Special Key “KOM” |
| LAC | Local Automatic Control |

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| LACR | Local Automatic Control Rod |
| LAP | Local Automatic Protection |
| LEI | Lithuanian Energy Institute |
| LEP | Local Emergency Protection |
| LOCA | Loss Of Coolant Accident |
| LPC | Low Pressure Cylinder |
| LPR | Low Pressure Reheater |
| LSR | Local Scram Rod |
| MCC | Main Circulation Circuit |
| MCP | Main Circulation Pump |
| MCR | Manual Control Rod |
| MFWP | Main Feed Water Pump |
| MSIV | Main Steam Isolation Valve |
| MSK-64 | Seismic Stability Scale |
| MSV | Main Safety Valve |
| NAL | Normal Affluent Level |
| NIKIET | Russian Acronym for RDIPE |
| NPP | Nuclear Power Plant |
| NSA | Nuclear Safety Account |
| PIE | Postulated Initiating Events |
| PCS | Purification and Cooling System |
| PDDMS | Power Density Distribution Monitoring System |
| PDMS-A | Power Density Monitoring Sensor - Axial |
| PDMS-R1 | Power Density Monitoring Sensor - Radial (with hafnium oxide emitter) |
| PDMS-R2 | Power Density Monitoring Sensor - Radial (with silver emitter) |
| PROMETEI | Institute of Material Research |
| PSA | Probabilistic Safety Assessment |
| QA | Quality Assurance |
| RBMK | Russian Acronym for "Channelized Large Power Reactor" |
| RC | Reactor Cavity |
| RCIM | Reactor Channel Integrity Monitoring |
| RDIPE | Research and Development Institute of Power Engineering |
| RLC | Reinforced Leaktight Compartment |
| RRCC | Radial Reflector Cooling Channels |
| RSR | Review Safety Report |
| SA | Supplementary Absorber |
| SACR | Shorted Automatic Control Rod |
| SAR | Safety Analysis Report, Shorted Absorber Rod |
| SDV-A | Steam Discharge Valve to ACS Pool |
| SDV-C | Steam Discharge Valve to Turbine Condenser |
| SDV-D | Steam Discharge Valve to Deaerator |
| SFA | Single Failure Analysis |
| SGAM | Steam-Gas-Air Mixture |
| SIP | Safety Improvement Project |
| SWP | Service Water Pumps |
| SWS | Service Water System |
| TIRV | Turbine Isolation and Regulating Valve |
| VATESI | Lithuanian State Atomic Energy Safety Inspection |
| VNIIAES | Research and Development Institute for Nuclear Power Plants |
| VNIPIET | Russian Acronym for "Research and Development Institute for Energy Technology" |
| VVER | Russian Acronym for Soviet Design PWR |
| WPOPE | Working Place for Operator Process Engineer |

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INTRODUCTION FOR THE EXTENDED AND UPDATED VERSION

The first edition of the "Ignalina RBMK-1500. A Source Book" was issued in 1994. It has received a broad distribution worldwide and has been recognized as one of the most definitive data source available on the RBMK-1500 power plant.

There are several reasons why an updated version of this publication has been prepared. The most important one is that the safety improvement process at the Ignalina Nuclear Power Plant is both active and ongoing. The first significant Safety Improvement Program was defined in 1993 and has implemented. It led to the signing of a Grant Agreement in 1994 between the Lithuanian Government, the Ignalina NPP and the European Bank for Reconstruction and Development on behalf of the Nuclear Safety Account. A Safety Improvement Program sponsored by NSA are not only safety upgrading projects at Ignalina NPP. In addition several bilateral safety enhancement projects with USA, Sweden, Finland and other Western countries completed or underway. These projects have led to implementation of hardware and modification of operating procedures.

The second reason for updating the "Source Book" is that several extensive projects were initiated and completed which analyzed safety issues of the Ignalina NPP and considerably expanded the available information in this area. An In-Depth Safety Assessment of the Ignalina NPP sponsored by EBRD has been completed and a Western-type plant-specific Safety Analysis Report was produced in 1996. The results of the fourth phase of the Barselina project - a probabilistic study of the Ignalina NPP - is also available. A thermal-hydraulic evaluation of the RBMK-1500 Accident Confinement System has been performed in 1995-96. This study was performed using state-of-the-art codes RELAP5 and CONTAIN and includes analyses not only short-term, but also the long-term (up to 24 hours) aspects of LOCA transients for primary system and the ACS.

On the base of the recommendation of the In-Depth Safety Assessment project a new Safety Improvement Program of Ignalina NPP (SIP-2) has been prepared and was approved by the Lithuanian authorities in April, 1997. The SIP-2 program includes a safety upgrades which should be implemented at the plant by 2000.

Finally, this version of the "Ignalina RBMK-1500. A Source Book" is not only updated but also considerably extended. In addition to the systems described in the first version, it includes a description of such systems as the Reactor Cavity Overpressure Protection System, Fuel Cladding Integrity Monitoring System, Emergency Power Protection System, Electric Power System, Steam and Power Conversion System, Service Water System, Intermediate Circuits System as well as other auxiliary systems. Results of the In-Depth Safety Assessment of the Ignalina NPP, especially results of system analysis and accident analyses, as well as Barselina project are discussed in Sections 10 and 11. Safety management and plant operation are described in Section 12. Section 13 discusses safety improvements performed at the Ignalina plant after the Chernobyl accident and during implementation of the first Safety Improvement Program as well as the new Safety Improvement Program.