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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.

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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

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.