Integrated Training and Accident Analysis System

James Fisher

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Outline of Presentation

• Project Background
• Overview of RBMK Reactor Design
• Objectives of ITAAS
• Description of ITAAS Features
• Demonstration
Background

- Accident Analysis and Its Associated Training Programme for the RBMK-1000 Kursk-1 NPP
- Extrabudgetary Funds Provided by US and Swiss Governments
- In-Kind Contributions From German Government and IAEA NS
- “Develop and Establish A Sustainable Accident and Transient Analysis Infrastructure at a Russian Institution”
- Develop Capabilities of RBMK Plant Staff
  - Perform Independent Accident Analysis Verification/Audit Calculations
  - Perform Independent Safety Assessments
Welcome to the ITAAS
Integrated Training and Accident Analysis System

International Atomic Energy Agency

Idaho National Engineering and Environmental Laboratory, USA
Kursk NPP, Russia
Rosenergoatom, Russia

Russian Research Center “Kurchatov Institute”, Russia
SEI Ltd., Poland
Energy Research Inc., USA
GRS, Germany

Sponsored by: US DOS, US DOE, Swiss FNSI and IAEA
Overview of RBMK Reactor Design

• Channel-type Reactor, Boiling Water-Cooled, Graphite-Moderated
  – Graphite Bricks Arranged in a Lattice of Columns, 8 m High
  – Individual Pressure Tubes Contain Water-Cooled Fuel Assemblies (7 m fueled region)
  – Water-steam Mixture Exits to Drum Separator.
  – Steam Drives Turbine, is Condensed, Preheated, Pumped Back to Reactor
• Evolved From Uranium-Graphite Plutonium Production Reactor Design of Former Soviet Union
• Obninsk 1954 – 5MW Electricity-Producing Demonstration
• Seventeen Power Units Have Been Built
  – Leningrad (4 Units)
  – Chernobyl (4 Units)
  – Kursk (4 Units, Unit 5 Under Construction)
  – Smolensk (3 Units)
  – Ignalina (2 Units)
Objectives of ITAAS

- Comprehensive and Integrated Safety Analysis Capability
- Training Materials
- Graphical Interface
- Reference Materials
- Configuration Control Capability
- Modular Design and Connectivity
ITAAS Menu-Driven Screens

• Administrator-Controlled and User-Controlled Parts
  – Deterministic Analysis Module (DAM)
  – Training Module
  – Reference Module
  – Probabilistic Analysis Module (tbs)
• Buttons Execute Scripts, Perform CommonTasks
ITAAS Main Menu

Welcome to the ITAAS

INTEGRATED TRAINING AND ACCIDENT ANALYSIS SYSTEM for RBMK 1000 Kursk NPP
Training Module

• RELAP5-3D Training
  – Presentation Compendium
• RELAP5 Video Training
• Kurchatov Video Training
• PSA Training
• SAPHIRE Training
RELAP5-3D Training

- Self-taught or Instructor Guided – English Only
- Four Modules
  - RELAP5 Basics – Descriptions, Installation, Operation of RELAP5-3D
  - Modeling – Input Model Development, RELAP5 Components, Model Building Exercises
  - Analysis – Guidance for Performing Plant Transient Analysis, Design Basis Accidents, Code Assessment, Quality Assurance
  - Reference – Manuals, Example Input Files, Plant Database and Engineering Handbook
Reference Module

- Accident Analysis Guidelines
  - IAEA Safety Analysis Reports
  - GAN Safety Analysis Guidelines
- Code Manuals
  - RELAP5
  - SAPHIRE
- Phase I and II Reports
- Plant Database
- PSA
- Regulatory References
- RELAP5 Validation Cases
- Revision Control System
- VIM Editor
Deterministic Analysis Module

- Run Manager
- tkXMGR
- Switch Between Nodal Kinetics and Point Kinetics, Switch From High Power To Low Power
- Vim Editor
  - RELAP5 Input Files
  - Malfunctions file
  - Trip Signals File
- Pygi
- Configuration Files
- Gui Tools
- Access Standalone RELAP5
- Manuals
ITAAS Deterministic Analysis Module Main Menu
Run Manager

• Controls Data Transfer Among Various Applications
  – RELAP5
  – Plant Mimics
  – Real Time Plots

• Provides Simulation-User Interface

• Provides Control Window Access To All Simulation Functions And Real Time Plots

• Displays Running Status of RELAP5

• Displays Plant Safety Status and Plant System Status
Run Manager Features

• Simulation Access
  – Start, Stop, Pause, and Restart
  – Malfunction Utility (Interactive Control of Valves, Pumps, Trips)
  – Events Log Viewer
  – Replay
  – Archive

• Real Time Plot Windows
  – Local Plot Variable Frequency Control
  – Can Be Annotated with System Events
  – New Plot Windows Can Be Easily Added
Input Files

• RELAP5-3D Input Files
  – 3200 MW (Full Power)
  – 160 MW (Low Power)
  – Writes to indta.sss
• RELAP5-3D Restart Input Files
  – Writes to indta.res
• Simul.in
  – Malfunction Table
  – Writes to simul.dat
• Signal.in
  – List of RELAP5 Variable Trip Signals
  – Signals Written to Run Manager Events Log
  – Writes to signal.dat
Configuration Files

• Manager.in – Primary Configuration File for Run Manager
  – Network Interface Parameters
  – File Locations
  – Interactive Plot Frequency
• Systo.in, Infow.in, Pltxy.in, Simdb.in
  – Specify Code Parameters For Display
• SIMDB Update
Technological and Nodalization Screens

- Technological Screens Display System Configuration
- Nodalization Screens Display RELAP5 Nodalization
- All Screens Display Current Values for Parameters of RELAP5 Volumes and Junctions
- Core Screens Display Rod Positions
- Edit Feature Allows Modification

• Displayed on Next 11 Slides
### Feedwater System

#### Feedwater and Steam Drum (Non-Accident Side)

- Time-Dependent Volume
  - 280
  - 281
  - 282
  - 283
  - 284
  - 286
  - 287
  - 288
  - 289

#### Feedwater and Steam Drum (Accident Side)

- Time-Dependent Volume
  - 002
  - 004-02
  - 004-01
  - 006
  - 008

- Steam Drum L(2)
  - 302
  - 304-02
  - 304-01
  - 306
  - 308

- Steam Drum R(1)
  - 009
  - 182
  - 181
  - 192
  - 191
  - 190

### Containment

- Time: 00:00:10.8
- Time: 10.8
Steam System

Кольцо высокого давления

Система аварийного приема пара

Система технического водоснабжения

Система циркуляционного водоснабжения
Reactor Cavity Venting System
the system is not presented in RELAP5-3D calculations
Power Adjusting Control Rods (LAR & LARC)

- Shutdown Signal
  - AZ
  - BSM