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PBMR CORE DESIGN

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PBMR, Pty
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Objective

- Inform and educate NRC regarding key safety design features
- Describe application of analytical codes used by PBMR Pty.
- Reach agreement on what constitutes sufficient design information and analytical methodologies to support a US license application

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Topics

- Physical Layout
- Pebble Flow Overview
- Core Calculations
- Conclusions

Introduction

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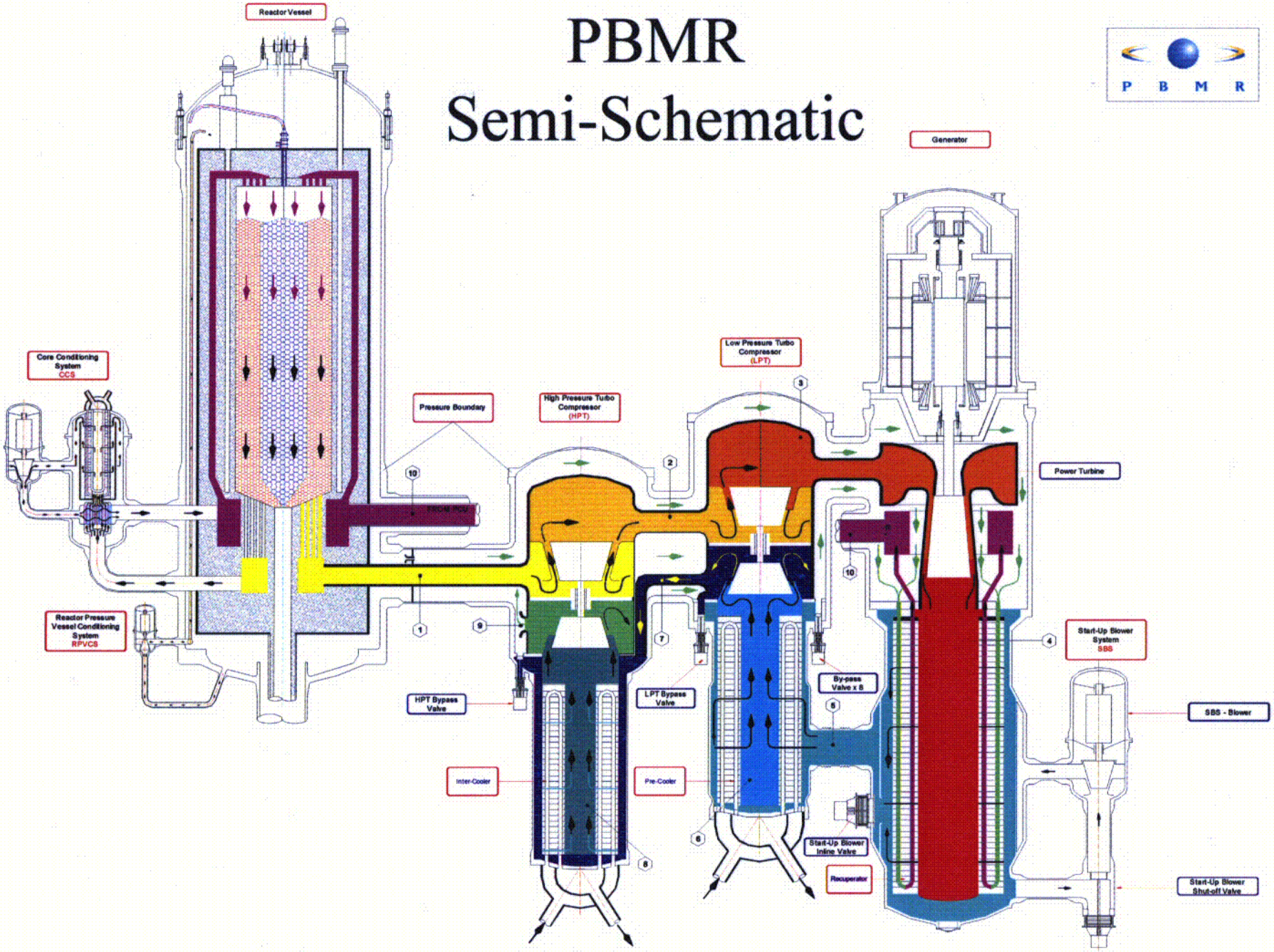
- Safety characteristics as basis for design
- HTR-MODUL Reactor Unit (RU) design as reference
  - Control elements in reflector only
  - H/D ratio increased 1:1 to 3:1
- Introduction of "graphite column" as central reflector

PBMR
Semi-Schematic



C01

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PBMR RPV Layout

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PBMR
FHSS
Schematic

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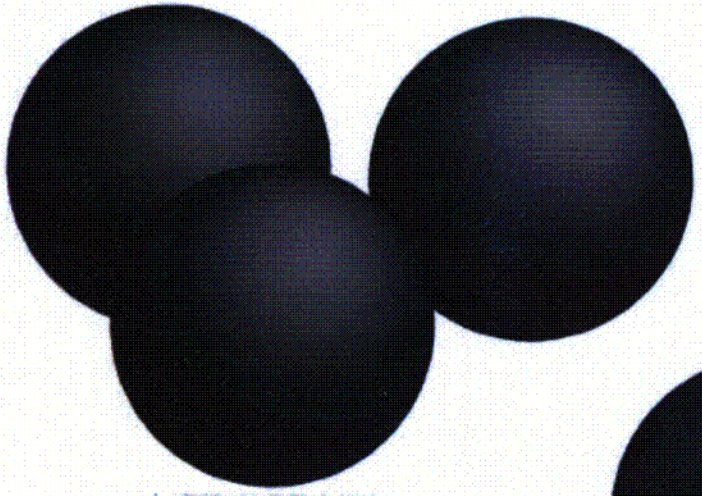
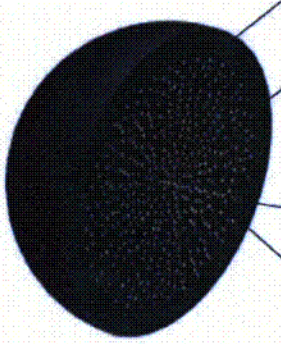
Fuel Sphere Design



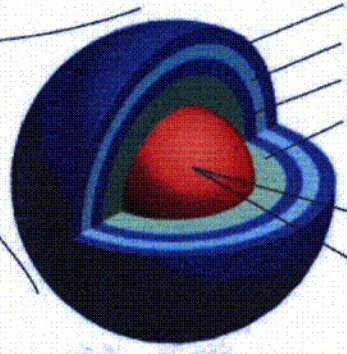
Dia. 60mm
Fuel Sphere



5mm Graphite layer

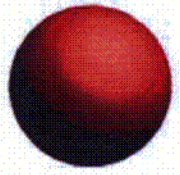
Coated particles imbedded in Graphite Matrix

Half Section



Pyrolytic Carbon 40/1000mm
Silicon Carbite Barrier Coating 35/1000mm
Inner Pyrolytic Carbon 40/1000mm
Porous Carbon Buffer 95/1000mm

Dia. 0,92mm
Coated Particle



Dia.0,5mm
Uranium Dioxide
Fuel

COZ

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Geometry

- Pebble Flow Experiments
  - R&D Final Report by Siemens
- Computer Simulation
  - Model development at FZJ
- Select Benchmark Experiment
  - Compare experiment and computer model
- Verify VSOP pebble flow model

PFC-3D code

- The *PFC*^{3D} code used for PBMR analysis is divided into two parts:
  - Analysis of the top of the core in a cylindrical vessel
  - Analysis of the pebble flow through the core

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Filling the Vessel

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Core Sphere Flow Analysis

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Core Sphere Flow

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Proprietary Information Removed

Flow Lines

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Local Distribution vs. Core Radius

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Calculational Approach

- Prepare input models for:
  - Fuel
  - Geometry
  - Pebble flow
  - Core compositions
- Perform equilibrium and/or initial core calculations
- RU status is preserved for later restart

Comments on Pebble Flow Experiments

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Flow of Pebbles

- Model Description:
  - Parallel flow in the upper part of the pebble bed
  - Effect of cone and discharge tube in the bottom region
  - Transition from parallel flow to flow pattern via interpolation

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VSOP Implementation

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VSOP RU Model

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Calculational Logic

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Temperature Coefficients

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Radial Fast Flux Distribution at Various Axial Positions

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Radial Thermal Flux Distribution from Top of Core

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RCSS Position: Inserted

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RCSS Characteristics

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Reactivity Balance

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Xenon Transient

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Benchmarking using PBMR

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