

Development Projects of Supercritical-water Cooled Power Reactor (SCPR) in JAPAN

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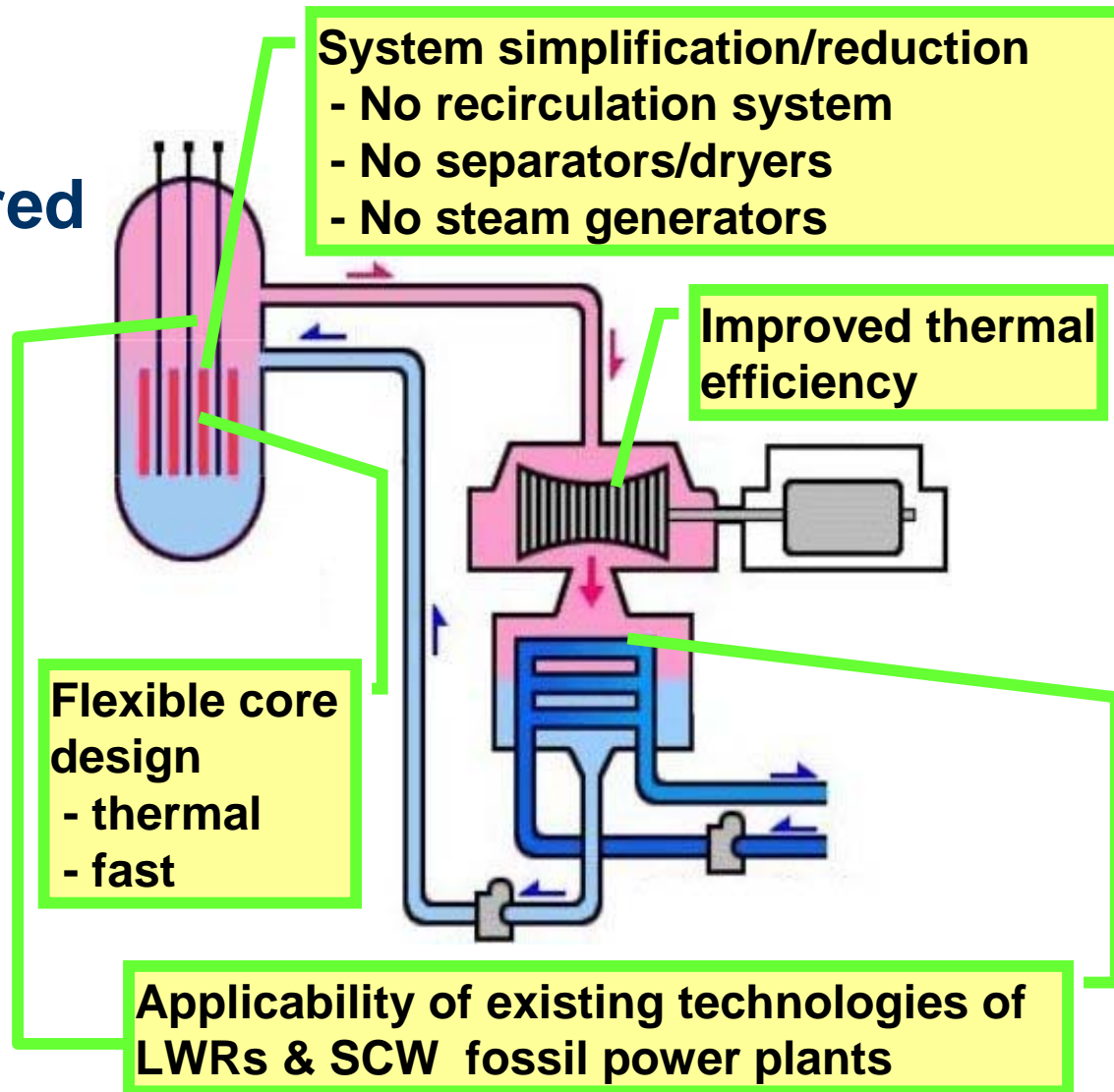
**Information Exchange Meeting
on SCWR Development**

November 19, 2002

**The University of Tokyo
Toshiba Corp.
Hitachi, Ltd.
Kyushu University
Hokkaido University**

Background

- **SCPR's potential advantages**
 - Japanese R&D pioneered (in 1989) and lead by the Univ. of Tokyo
- **A Joint Study among a Japanese utility and vendors(1994 - 1995)**
 - Technical feasibility verified
 - Economical feasibility mainly dependent on outlet coolant temp.



Studies of the University of Tokyo

- Core design of thermal reactors
- Core design of fast reactors
- Plant heat balance, thermal efficiency
- Safety systems & criteria
- Transient and accidents analyses
- LOCA analyses, PSA
- Plant control, start-up & stability

SCPR Development Project

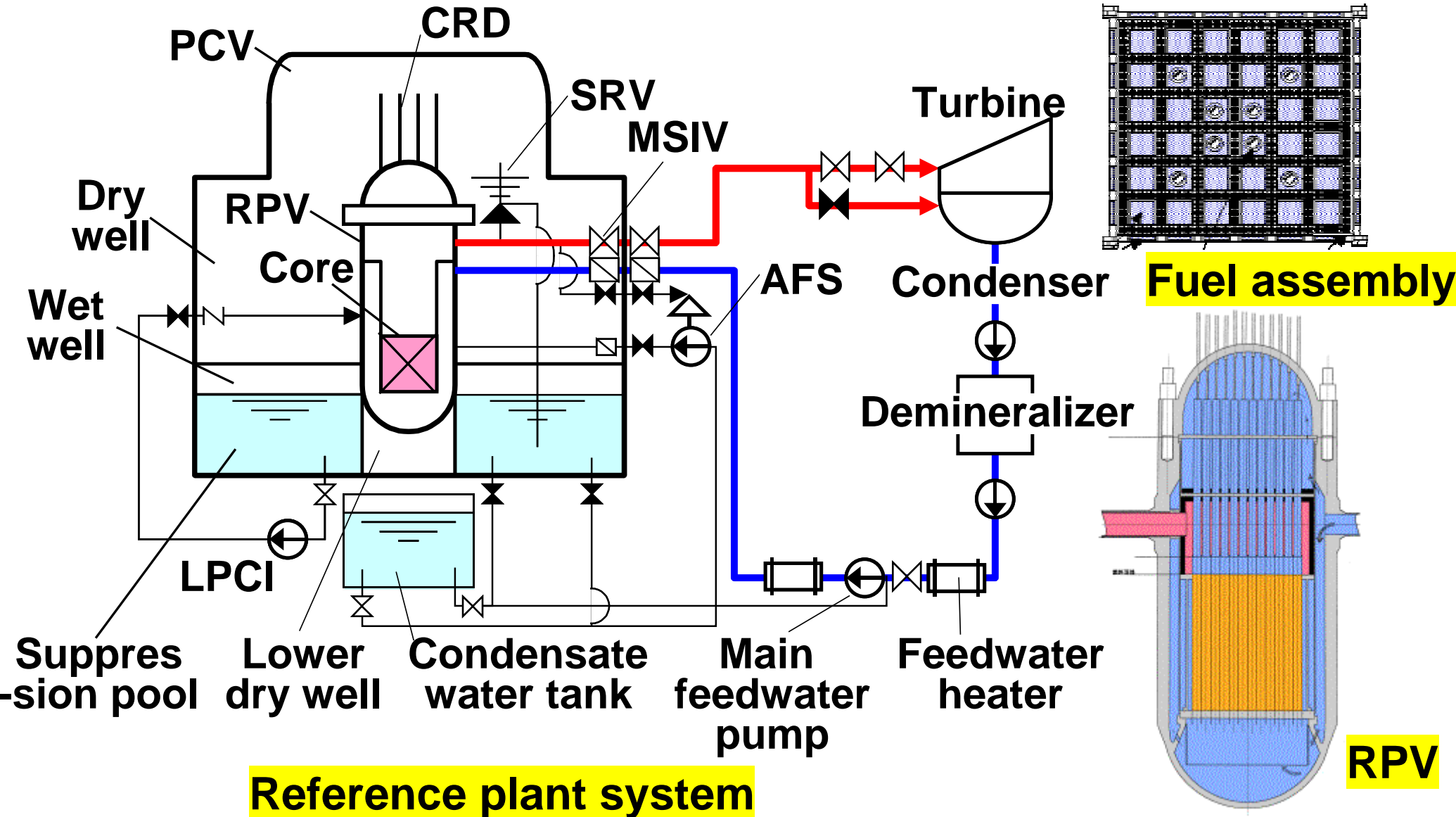
- **Japanese SCPR R&D project proceeding from FY2000 through FY2004**

- **Plant conceptual design**
 - **The design of the University of Tokyo referred**
 - **Alternatives for optimizations**

- **Thermal-hydraulics of supercritical fluid**
 - **Heat transfer tests of R22 (Steady state/Transient)**
 - **Heat transfer simulation by analyses**

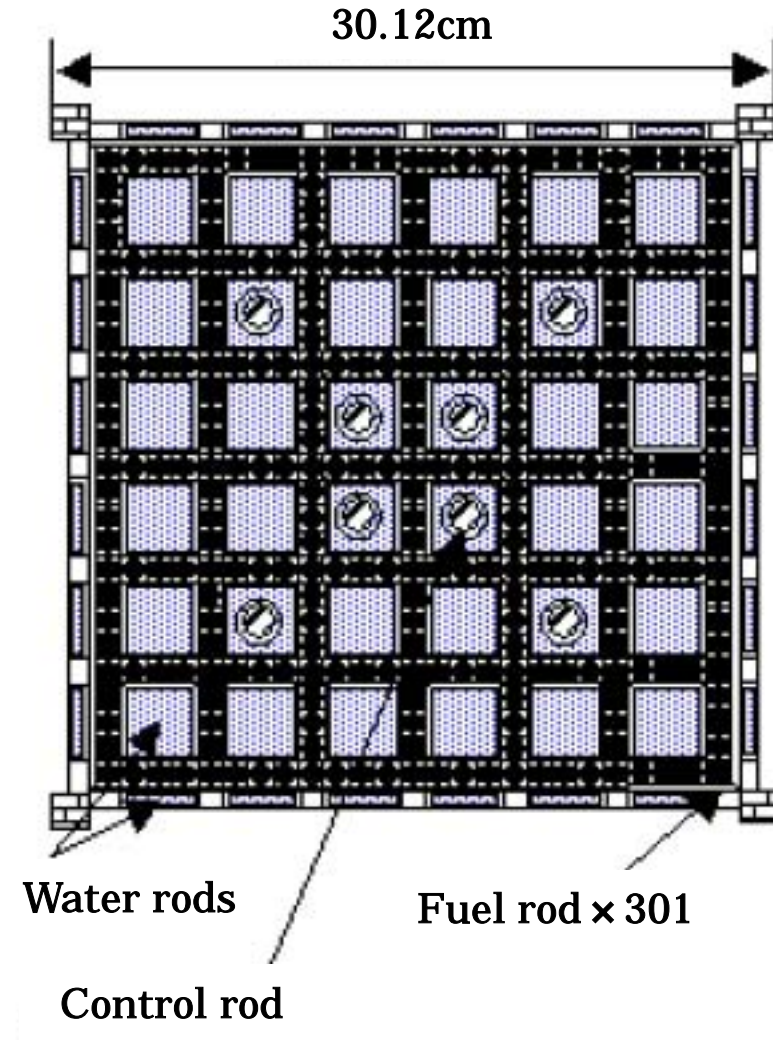
- **Materials**
 - **Material screening**
 - **Corrosion tests**
 - **Electron irradiation tests**

Plant conceptual design



Core & fuel design

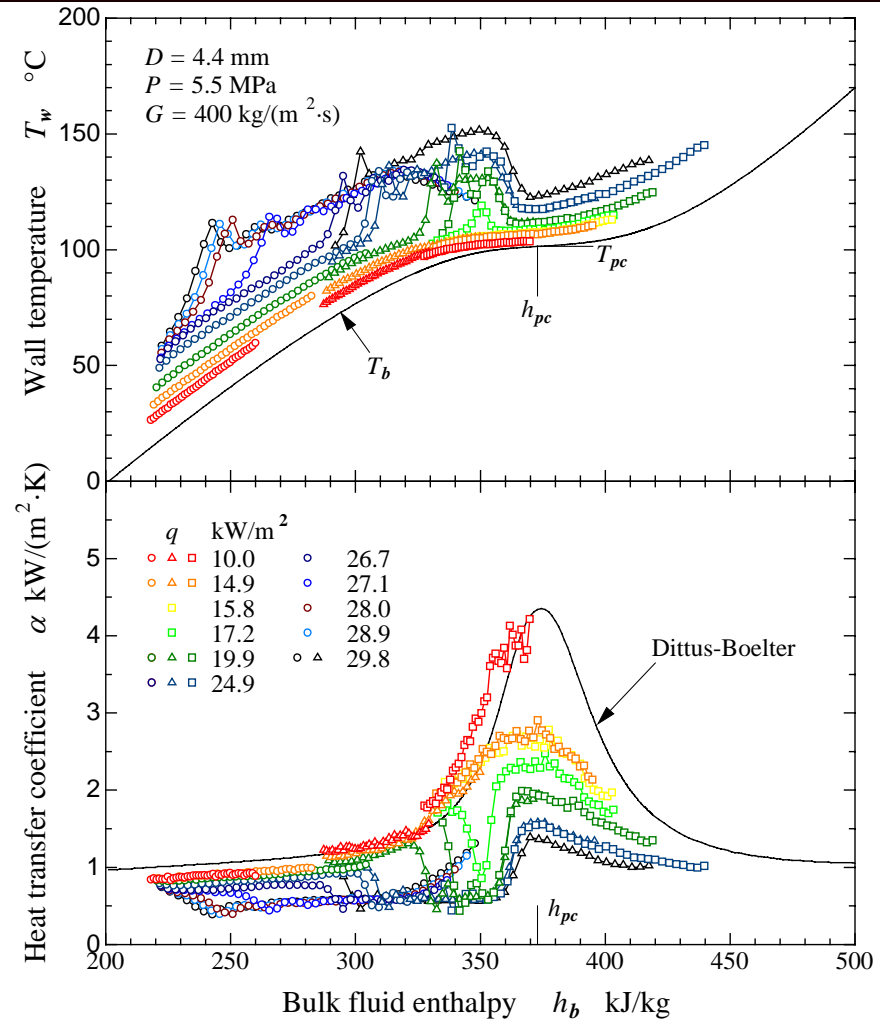
- High coolant outlet temp. ~ 500
- Low outlet coolant density (~ 1/4 of BWR, 1/7 of PWR)
 - many water rods in fuel subassembly
 - axial power flattening by enrichment split and gadolinia
- Low core coolant flow rate (~ 1/8 of BWR, ~ 1/12 of PWR)
 - need to enhance coolant velocity in fuel channels
- No steam water separation
 - adjusting power/flow ratio of fuel subassembly by orifice flattening subchannel flow distribution



Thermal-hydraulics of supercritical fluid

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- **Supercritical fluid heat transfer including deterioration**
 - Lots of correlations from SCW FPP experiences
 - Specific conditions for SCPR
 - Small hydraulic diameter
 - Multi-rods with grid-spacers
- **Transient heat transfer tests**

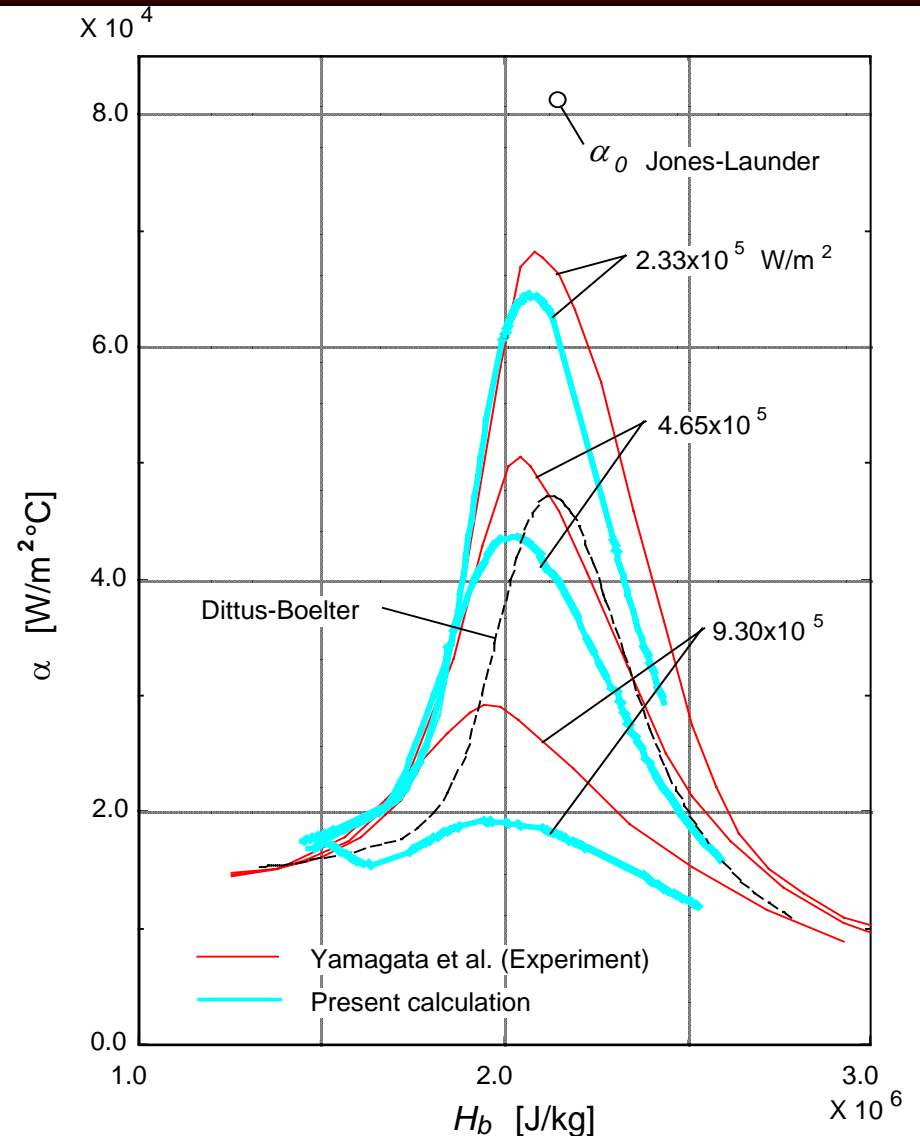


Single-tube test results
(Kyushu University)

Heat Transfer Analysis by Numerical Simulations

Comparison between simulation and experiment

- heat flux \nearrow
-> heat transfer coeff. \searrow
- good **agreement** with experiment by Yamagata et al.
- Simulation provides **conservative** result.

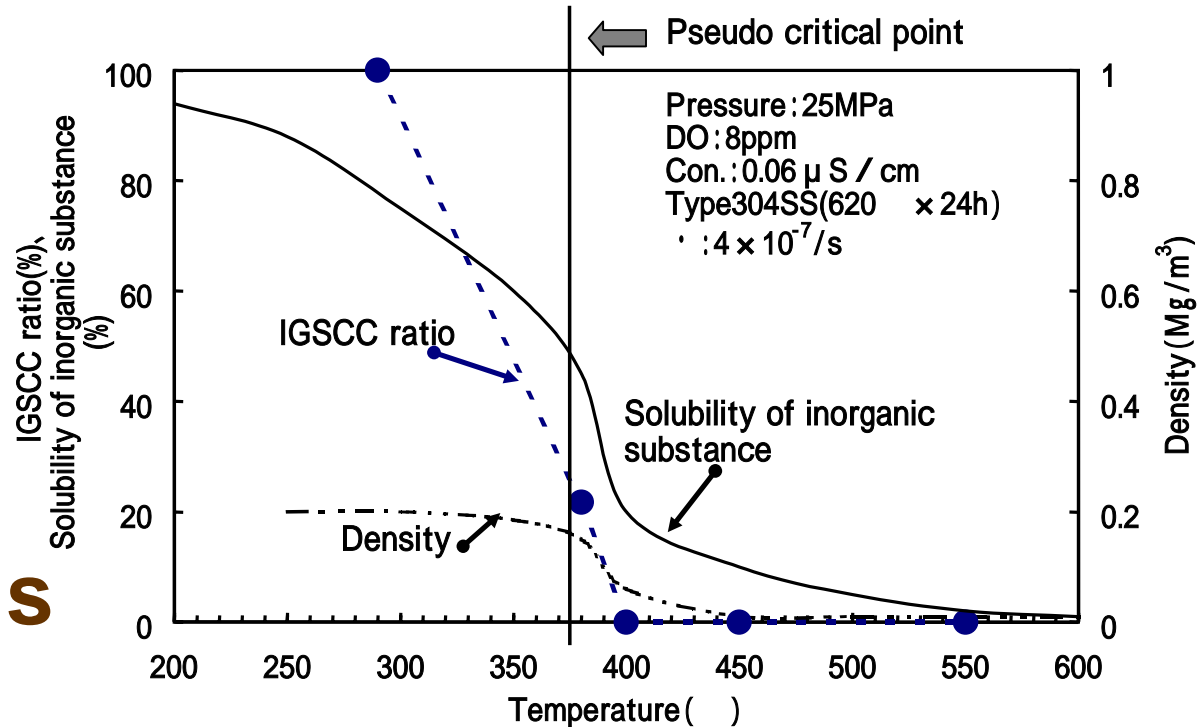


■ Cladding material tests

- Screening from existing materials
 - High-temp. strength
 - Corrosion & SCC
 - Irradiation

■ Structural materials

- Existing materials
- Low cobalt



Test results of SCC susceptibility

Project on Water Chemistry of SCW

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To understand water chemistry under SCW conditions

Project planned to be started in FY2002 through 2006

γ -irrad. SCW loop (up to 600°C, 25 - 40 MPa)

***Radiolysis of Water* G-values, rate constants ...**

Radiation Effect at Interface

corrosion under radiation field

Behavior of Corrosion Products

solubility measurement - thermodynamic analysis

monitoring - electrochemical potential, pH ...

ζ -potential measurement of crud and colloid

Candidate areas of collaborations

- **Information exchange meetings**
- **Thermal-hydraulic tests of SC fluids**
 - Different fluid tests
 - Test matrix sharing
 - Single tube to Full bundle
- **Material tests**
 - Test matrix sharing
 - Electron vs. neutron irradiation
- **Others**
 - Water chemistry
 - Safety (e.g. Safety analysis cross check)



Summary

- **SCPR R&D projects proceeding in JAPAN**

- **Major R&D items**
 - **Plant conceptual design**
 - **Thermal-hydraulics of SC fluid**
 - **Materials**
 - **Water chemistry**

- **Collaborative R&D**
 - **Information exchange meetings**
 - **Thermal-hydraulic tests of SC fluids**
 - **Material tests**
 - **Others**