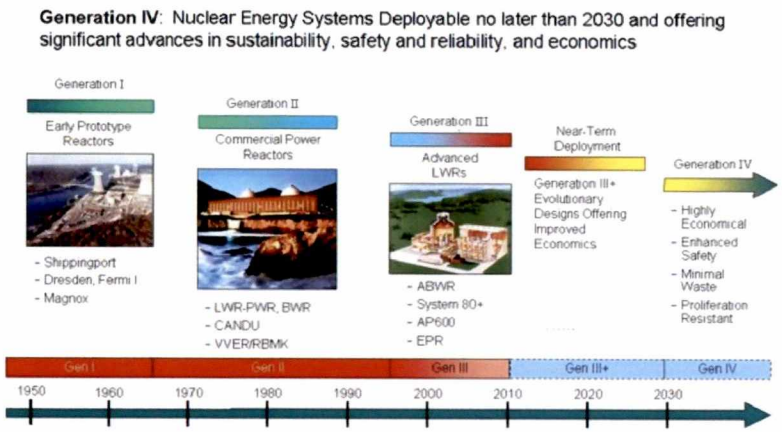
Generation IV Fission Reactor - Highlight on Materials Issues

DUBIEZ-LE-GOFF
Engineer PhD, Material and Chemistry Section
Mechanical Engineering Lyon Department
Division of Equipments
AREVA SAS

AREVA NP is dedicated to the design and construction of nuclear power plants and research reactors, instrumentation and control, modernization and maintenance services, components manufacture and the supply of nuclear fuel.

Abstract

A wide ranging discussion on the development of next generation nuclear energy systems known as "
Generation IV" has been initiated in 2000 by the U.S. Department of Energy, gathering governments, industry, and the research community worldwide.



Definition of the different nuclear plant generations

The objective is a new generation of nuclear energy systems that:

- advance nuclear safety;
- address nuclear nonproliferation and physical protection issues;
- are competitively priced,
- and minimize waste and optimize natural resource utilization.

A Technology Roadmap for Generation IV Nuclear Energy Systems, published in December of 2002, identifies six selected systems and describes the research and development pathways for establishing technical and commercial viability, demonstration and, potentially, commercialization : Very-High-Temperature Reactor (VHTR), Supercritical-Water-Cooled Reactor (SCWR), Molten Salt Reactor (MSR), Gas-Cooled Fast Reactor (GFR), Sodium-Cooled Fast Reactor (SFR), Lead-Cooled Fast Reactor (LFR).
Among those systems, Areva NP is mainly involved in two designs: SFR, the only GEN IV concept actually having a large industrial operating experience, and VHTR.

For SFR, structural materials issues mainly consist in selecting materials leading to a simplified and more robust design. Candidate materials have to be selected as a function of their/its microstructural stability during 60 years of service. It leads to the definition of an experimental program on representative products, including weldments, to assess creep behaviour, aging and irradiation damage.

For HTR, AREVA works on its own design/configuration, the so-called ANTARES. An extensive research program has been launched in France within this framework to evaluate the performances of convenient materials in HTR service environment. The experimental work is focussed on:

- Intermediate Heat Exchanger materials to assess their mechanical properties, thermal stability and corrosion resistance under primary and secondary environment in the temperature range [700°C – 1000°C] over long term.
- Reactor Pressure Vessel materials with expected increased creep strength without loss in toughness
- Necessity to use non metallic materials for some structures: graphite, C/C composites