Highlights of the IAEA Scientific Forum Nuclear Science: Physics Helping the World

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Nuclear Energy

- Primary energy demand projected to double by 2050.
  - Most of the increase will be in the developing world
- Climate change concerns favor carbon free energy.
- No one energy source can solve the problem, but nuclear could be a part of the solution.

- Nuclear energy is projected to be about 1000 GWe **IF** 3 issues are addressed:
  - –Nuclear waste disposal
  - –Weapons proliferation potential
  - –Nuclear plant safety

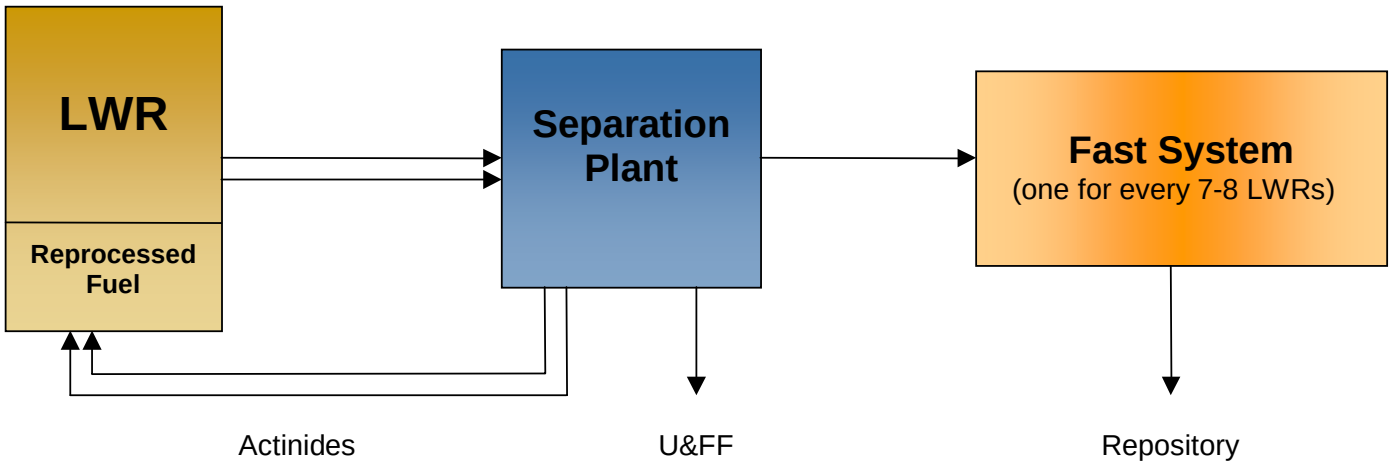
Spent Fuel Treatment

- Two choices for treatment:

1) Isolate for 300,000 years (“once-through” fuel cycle)
2) Separate the long-lived part (about 1%) and break it down so that it only needs isolation for 1000 years (reprocess and transmute)

- Consensus; with 1000 reactors in the world:
  - “Once-through” cannot work (a new, large repository every 2-3 years)
  - Reprocessing and transmutation can work with a combination of today’s style reactors and “fast spectrum” reactors

Two-Tier Schematic



- Fast system (sodium cooled, for example) are part of the Gen IV program
- They can be used as waste burners even before they are widely used for power (1 burner for 7-10 LWRs)
- After 2010 only 2 fast reactors will be available for R&D, one in Japan and one in Russia
- A coordinated international program is needed to support the operation and use of these facilities

Proliferation

- **ALL** fission and fusion fuel cycles have a proliferation potential.
  - Enrichment phase – Uranium weapons
  - Spent Fuel phase – Plutonium weapons
  - Fusion: when deployed, neutrons from fusion on Uranium give Plutonium
- Only enforceable, international agreements can control proliferation.
- Technical safeguards can only give early warning and search for clandestine facilities for action by governments.

- Advanced safeguards technology: IAEA Safeguards department has no budget for such work. Is this wise?
- Safeguards Department is only ~400 people: it cannot handle a 1000 reactor world without expansion.
- The science community applauds the efforts to internationalize the fuel cycle, but notes:

POLITICS IS HARDER THAN PHYSICS.

Safety

- 3 Mile Island (1979) was a wake-up call.
- Resulted in a sharp increase in safety consciousness
- Institute of Nuclear Safety Operations set up in U.S. by reactor operators.
- No more accidents (Chernobyl, a special case) and, more remarkable, beginning in the mid 1980s a steady increase in reactor up time to now over 90% in the U.S.


Rain does not fall on one rooftop alone.
…proverb from Cameroon

Events Studied

Have looked at five events in detail:





- Columbia (2003) (and Challenger) Shuttle Disaster
- UK Railway Accidents (1991-1999)
- Piper Alpha (1988)
- Longford Gas Explosion (1998)
- JCO Criticality Accident (1999)

Several more have been addressed, including other nuclear events (e.g. Wylfa, Davis-Besse, Paks)

Key Common Issues

- Maintaining competence
- Application of acceptable standards
- Questioning attitude
- Organisational “complacency”/Loss of focus/Organisational drift
- Poor communication
- Loss of “oversight”
- Management of change(often involving contractorisation)
- External pressures

- Questions from the floor not answered satisfactorily:
  - If nuclear power expands, how will nations new to nuclear operations develop the operations and regulatory skills required?
- An important role for the IAEA?

Fusion

- ITER site finally chosen
- Success is necessary but not sufficient for fusion power
- If it works as expected, next step is a demonstration power plant
- Only after that can we know if it is workable *and* affordable
- Time frame is 2040-2050 if all works out

Applications of Radiation & Accelerators

- Strengthening tires for cars
- Improving insulation on wires
- Implanting ions to make microchips work
- Sterilizing insects to suppress disease
- Sterilizing food to make it last longer
- “X-Raying” materials with x-rays and neutrons
- Imaging the inside of the body
- Treating cancers
- …

Conclusions

- Physics is indeed helping the world and the IAEA
- Applications of nuclear are continuing to grow
- Nuclear power is likely to increase dramatically
- Work on “Beyond Kyoto” should begin and nuclear should be part of any “Clean Development Mechanism”

- IAEA should look again at the role of R&D in safeguards
- IAEA should look at safety issues in newly nuclear countries
- Internationalizing the fuel cycle is right **IF** you can do it