Nuclear Research Institute Rez plc

and its mission and role in the Czech nuclear energy programme
Content

- Nuclear history in CR
- Snapshoot of the nuclear power in CR
- Nuclear power as part of energy mix
- Nuclear infrastructure (key players) in nuclear programme
- NRI Rez plc as the key technical support and R&D organization for nuclear power - examples of activities
- Conclusions
Nuclear history (1)

- 1955 Nuclear Research Institute (NRI) Rez
- 1956 Faculty of Nuclear Physics, Prague
- 1957 VVR-S research reactor at NRI Rez
- 1960 Construction of NPP A-1 (HWGCR)
- 1960’s Industrial development towards nuclear (Škoda, Vítkovice…)
- 1972 Startup of NPP A1 in Slovakia
- 1978 NPP V1 (VVER – 2x 440 MWe) (Slovakia)
• 1984 NPP V2  
(VVER – 2x440 MWe) (Slovakia)

• 1985 NPP Dukovany  
(VVER – 4x440 MWe) (Czech Republic)

• 2002 NPP Temelin (Czech republic)  
(VVER – 2x 1000 MWe)
Czech Energy Mix

- 2 Nuclear Plants
- 15 Coal Plants
- 32 Hydro Plants including 3 pumping stations (potential exhausted) + solar plants (boom in 2010)
- wind plants, biomass plants
Power Plants

In total 17 990 MW of installed power
Annual electricity production: cca 88 TWh

From it:
- 58 TWh fossil power plants (66%)
- 26 TWh nuclear power plants (30%)
- 4 TWh renewables (4%)
  (from it 2 TWh hydro plants)
Currently CR is 3rd exporter of electricity in Europe
Nuclear infrastructure

- **Energy provider:** CEZ plc (intelligent customer)
  - NPP Dukovany
  - NPP Temelin
  - Interim dry spent fuel storages at Dukovany and Temelin

- **System suppliers:** SKODA JS, SKODA Praha, VITKOVICE, SIGMA, …

- **Radioactive Waste Repository Authority (RAWRA)**
  - Repositories Litomerice, Jachymov, Dukovany

- **Regulatory body:** State Office for Nuclear Safety (SÚJ B)

- **Education and training institutions:** Technical Universities in Prague, Brno, Pilsen, Ostrava

- **Ministry of Industry and Trade**

- **Research organisation:** NRI plc (ÚJV Řež a.s.)
## List of RPV manufactured by SKODA JS

<table>
<thead>
<tr>
<th>Nuclear Power Plant</th>
<th>Units</th>
<th>Year</th>
<th>Prime Contractor for Plant Technological Part</th>
<th>Main Supplier of Primary Circuit and Fuel Handling Systems</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bohunice A1, Slovakia</td>
<td>1 x HWGCR (150MW)</td>
<td>1965-72</td>
<td>✓✓✓✓✓✓</td>
<td></td>
<td>Under decommissioning</td>
</tr>
<tr>
<td>Paks, Hungary</td>
<td>4 x VVER 440 / V-213</td>
<td>1980-87</td>
<td>✓<em>✓</em></td>
<td></td>
<td>Operable</td>
</tr>
<tr>
<td>Bohunice V2, Slovakia</td>
<td>2 x VVER 440 / V-213</td>
<td>1982-85</td>
<td>✓✓✓✓✓</td>
<td></td>
<td>Operable (Unit 1 - 1984, Unit 2 - 1985)</td>
</tr>
<tr>
<td>Dukovany, Czech Republic</td>
<td>4 x VVER 440 / V-213</td>
<td>1982-87</td>
<td>✓✓✓✓✓</td>
<td></td>
<td>Operable (Unit 1-1985, Unit 2 -1986, Unit 3 -1987, Unit 4 -1988)</td>
</tr>
<tr>
<td>Nord, Germany</td>
<td>3 x VVER 440 / V-213</td>
<td>1982-88</td>
<td>✓<em>✓</em></td>
<td></td>
<td>Under decommissioning</td>
</tr>
<tr>
<td>Zarnowiec, Poland</td>
<td>4 x VVER 440 / V-213</td>
<td>1986-88</td>
<td>✓<em>✓</em></td>
<td></td>
<td>Project cancelled</td>
</tr>
<tr>
<td>Mochovce, Slovakia</td>
<td>4 x VVER 440 / V-213</td>
<td>1987-99</td>
<td>✓✓✓✓✓</td>
<td></td>
<td>Units 1,2 in operation (1998-1999)</td>
</tr>
<tr>
<td>Belene, Bulgaria</td>
<td>1 x VVER 1000 / V-320</td>
<td>1988-</td>
<td>✓<em>✓</em></td>
<td></td>
<td>The equipment will be used for the completion of Kalinin 4 NPP in Russia</td>
</tr>
<tr>
<td>Temelín, Czech Republic</td>
<td>2 x VVER 1000 / V-320</td>
<td>1991-03</td>
<td>✓✓✓✓✓</td>
<td></td>
<td>Operable (Unit 1-2002, Unit 2 -2003)</td>
</tr>
</tbody>
</table>

* Reactor manufacture + supervision of the on-site installation
Nuclear Equipment for Ongoing Projects

EPR reactor components for Olkiluoto NPP/Unit 3 (in progress)

- Reactor internal parts
- Customer: Areva NP
- End-user: TVO, Finland
- Contract award – 03/2005
- To be supplied in 2009-2010
NRI research activities

Objectives

- ensuring safe, reliable and economical operation of existing NPPs with extended service life of up to 60 years
- solutions to the end fuel cycle and radioactive waste management
- development and innovation of new nuclear power generation III and III +
- research and development of Generation IV nuclear systems
NRI Rez plc
Mission - why we are here?

- NRI is a professional authority and promoter of the use of nuclear power and ionizing radiation

- NRI offers in national and international scale scientific, analytical, engineering and design support to both NPPs in operation and under construction as well as to other power plants

- NRI provides comprehensive R&D, in particular in the field of use of nuclear power and ionizing radiation sources
NRI Rez plc Owners

- ČEZ, a. s.: 52,4%
- SE, a.s.: 27,8% (ENEL, Italy)
- Škoda JS a.s.: 17,4% (OMZ, Russia)
- obec Husinec: 2,4%
NRI research activities

- Applied Research and Development (R&D)
- Design and engineering services
- Reactor services
- Manufacturing of special products and equipment
- Radiopharmaceuticals
- Expert activities in the energy, industry and medicine
- Technical support to regulatory authority

- 1000 employees
- 6 daughter companies
- Income ~ 60 M EUR

- TÜV certified QA ISO 9001:2000
- Certified confidentiality level NATO secret
Areas

- **Nuclear Energy:**
  - Safety of NPPs
  - Structural integrity/Material testing
  - NPP Lifetime management
  - Innovative reactors
  - Waste management and Fuel Cycle

- **other areas:**
  - Fossil power plants
  - Hydrogen economy
  - Radiopharmaceuticals
  - Aerospace industry
  - Chemical industry
  - Defense

Turbulences behind A380, the Institute participated in the far area analysis
Research infrastructure

Institute operates large infrastructure both for R&D and engineering services

- Research material reactor (10 MWt)
- Critical assembly (5 kWt)
- Hot and semi hot cells
- Cyclotrons
- Different Laboratories

Research reactor LVR-15

Critical assembly LR-0

Cyclotron

Hot cells
Personnel

Number of employees in 2005 – 2009

- Total
- Graduated
NRI Strategy of Controlled Rejuvenation

Hiring of young workers 1990 - 2008

- Graduated
- Others
Examples of activities
Safety of NPPs

- Deterministic Safety analyses (Thermal-hydraulics)
- Severe accident analysis
- Analyses of fuel behaviour
- Reliability and risk analyses (PSA)
- Fuel cycle and core reload optimization
- Core monitoring system SCORPIO-VVER
- On-line radiation monitoring
Examples of activities
Structural integrity, material testing

- Components diagnostics (primary and secondary circuits)
- Components qualification
- Material testing

In-service inspection

Diagnostics of valves
NPP Lifetime management

- RPV Surveillance Programmes (CR, SR, Ukraine)
- Cable Ageing Management Programmes
- NPP Ageing Management and Long-term Operation Studies

Qualification of connectors – thermal ageing

Electro-spark machining of Radioactive materials in Hot Cell
Examples of activities
Innovative reactors (Generation IV)

Participation in GIF through EURATOM:

- SCWR (supercritical water loop)
- VHTR (He reactor loop)
- LFR (operation of Pb-Bi out of pile material testing loop)
- MSR (demonstration of fluoride technology)
Generation IV Reactor Systems Objectives

- **Sustainability**
  - More efficient use of fuel
  - Reduced production of nuclear waste

- **Safety and reliability**
  - Improved safety and reliability
  - Reduced the likelihood of core damage
  - Eliminate the need for evacuation in the event of an severe accident

- **Economy**
  - Lower production cost el. energy in comparison to other sources
  - The level of financial risk comparable to other energy projects

- **Resistance against the misuse of nuclear materials**
  - (enhanced non proliferation of nuclear materials)
Examples of activities
R&D for waste and fuel cycle

R&D Waste
- Demonstration Bitumenation unit
- Vitrification – R&D
- Operation of RAD Waste Management Centre
- R&D for Deep Geological repository
- Decontamination and decommissioning services

Fuel Cycle
- Development of Spent Fuel Reprocessing Technology
- R&D - Partitioning and transmutation
Examples of activities
Design and Engineering Services - References

Division ENERGOPROJEKT Praha

- Basic Design of all fossil and nuclear power plants in former Czechoslovakia
- Basic Design NPP Mochovece, 2x440 MW - Slovakia
- Temelín 2x1000 MW - Czech Republic Basic Design NPP NPP
- Temelín – Interim spent fuel storage
- Power plant Prunerov II – Technical parameters optimization
- Combined Cycle Plant - Balloki (Pakistan)

Temelín - Spent fuel storage

Digitalised as-built NPP Temelín
Examples of activities
Hydrogen economy

- Participation in European Hydrogen & Fuel Cell Technology Platform

- FCZ – H₂ BUS

Demonstration of hydrogen application for public transport:

- Operation of bus with hydrogen fuel cells in 2008
- Construction and operation of hydrogen filling station
- Production and purification of hydrogen as byproduct in SPOLANA Neratovice
Examples of activities
Radiopharmaceuticals

Routinely produced:
- Sodium iodohippuricum (131I) (monitoring of renal functions)
- Sodium iodide (131I) (thyroid therapy)
- THALLOUS CHLORIDE (201Tl) (heart perfusion scintigraphy)
- GALLIUM CITRICUM (67Ga) (imaging of tumours and abscesses)
- 153Sm-EDTMP (palliative treatment of bone metastases)
- PET – Fludeoxyglucose (¹⁸F) (PET centers in Prague and Brno)
International Cooperation

- **IAEA**
  - Regional TC projects, Coordinated Research Projects, INPRO,
  - [RERTR - Reduced Enrichment for Research and Test Reactors Program](#)
  - [RRRFR - Russian Research Reactor Fuel Return Program](#)

- **OECD/NEA**
  - Participation in OECD/NEA Committees and WGs,
  - Joint Research Projects

- **EU**
  - The Institute is actively involved in 7th FP (more than 20 projects)

- **Bilateral cooperation:**
  - CEA, IRSN, France
  - GRS, Germany
  - ROSATOM, Russia
  - Ukraine, India and others

- **ETSON** – European Technical Support Organization Network
Conclusions

- There is a long historical experience with nuclear power in the CR
- CR energy policy follows the strategy of balanced “energy mix”
- There is sufficient infrastructure and competence to continue in nuclear programme
- NRI Rez plc is the key technical support and R&D organization for nuclear power – assisting to existing plants and ready to support construction of the new plant