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Ljubljana TRIGA Mark II, 40 Years of Successful Operation

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Ljubljana TRIGA Mark II Research Reactor

http://www.rcp.ijs.si/ric/

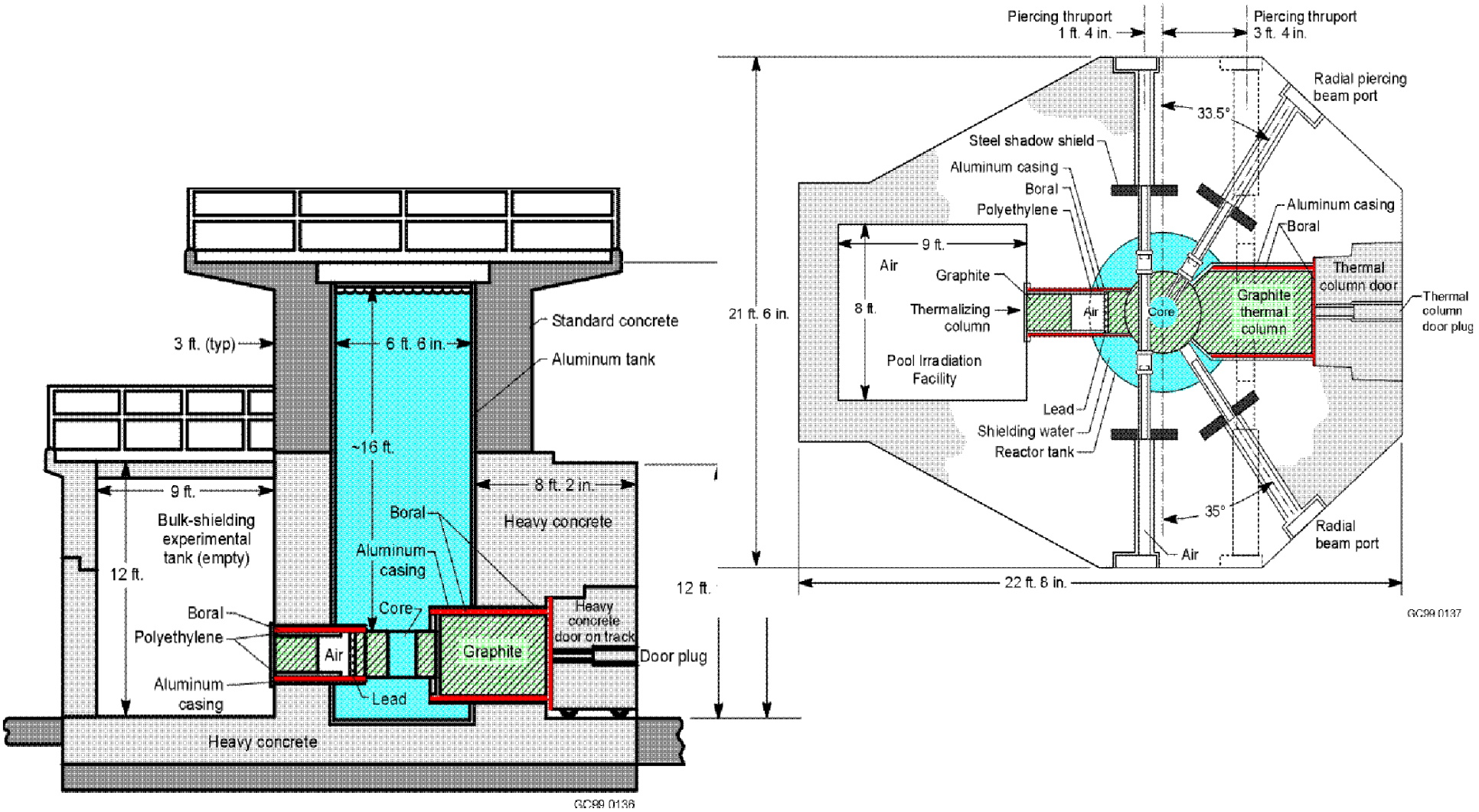
Ljubljana TRIGA Mark II Research Reactor (cont')

- Product of General Atomic
- Built in 1966 by "Jožef Stefan" Institute, pool type reactor
- Reconstruction for pulse mode operation in 1991
- Enforcement provided by national and international bodies
- According to a plan the reactor will operate at least until 2016

Technical Characteristic

- Light water reactor, natural convection
- Thermal steady mode 250 kW, pulse mode 1.800 MW
- Neutron flux 10^{13} n/cm^{2}s
- Fuel mixture of U and ZrH, 12 % of U, 20 % enrichment
- Core lattice not periodical structure, radial graphite reflector
- 4 control rods, transient control rod
- 8 horizontal, 5 vertical channels

Technical Characteristic (contd.)



Operating, General

- 4 operators, strong emphasis on personnel qualification and responsibilities
- 12 MW day per year, normally in steady state mode, pulse mode operation mainly for education purposes
- Annual budged for operation provided yearly by State, financial provisions for decommissioning provided by Agency for Radwaste Management http://www.arao.si/
- Operation according to the “Operating Procedures”

Operating, General (contd.)

- Emergency operating procedures are in place, annual emergency drills
- Permanent and systematic radiation monitoring, results reported and published by Slovenian Nuclear Safety Administration http://www.ursjv.gov.si/
- No abnormal releases of radioactivity into environment
- No abnormal events in 40 years of operation

Operating, Major Modifications after 1991

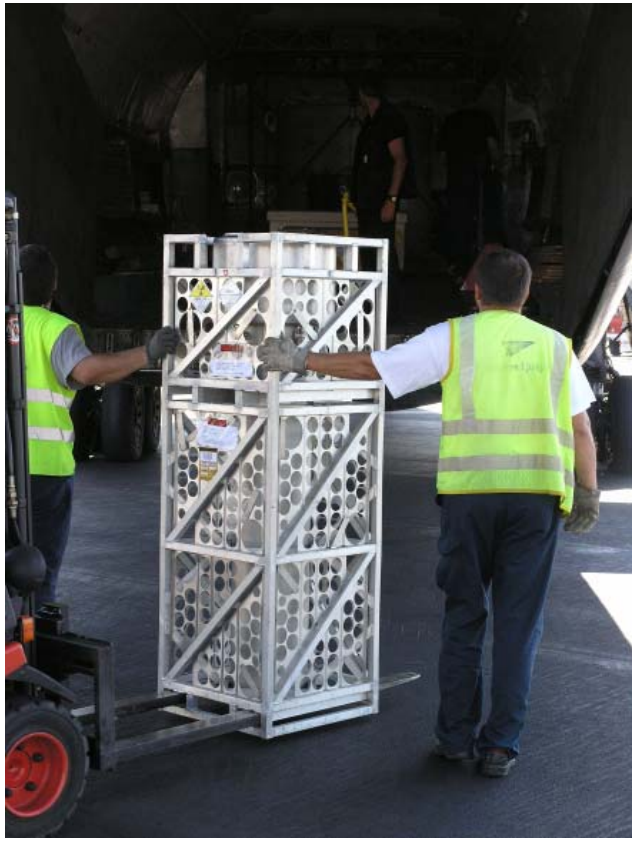
Year	Modification
1991	Reconstruction for pulse mode operation
2001	Replacement of primary coolant pumps
2003	Replacement of main parts of crane for fuel elements handling
2004	New fast pneumatic mail for short time neutron activation analyses

Operating, Safety Performance Indicators

SPI	2005	2006
Unscheduled shutdowns	4	2
Collective radiation doses (man mSv)	0.293	0.050
Noble gases released (GBq)	920	900
Maintenance	1/176	1/180
Knowledge of operators (course)	1	1
Fuel integrity	0	0
Irradiated samples	1706	1863

Operating, Nuclear Fuel

- All spent fuel elements back to USA in 1999
- 10 fresh fuel elements exported to France in 2007
- Currently no spent fuel at TRIGA
- Fuel elements in good conditions, capacity until 2016 or longer



Fuel exported to France

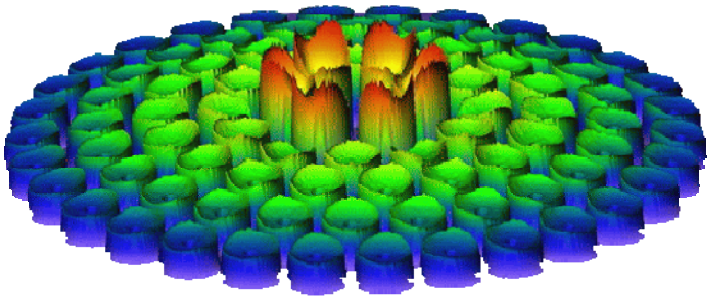
Research and Other Activities

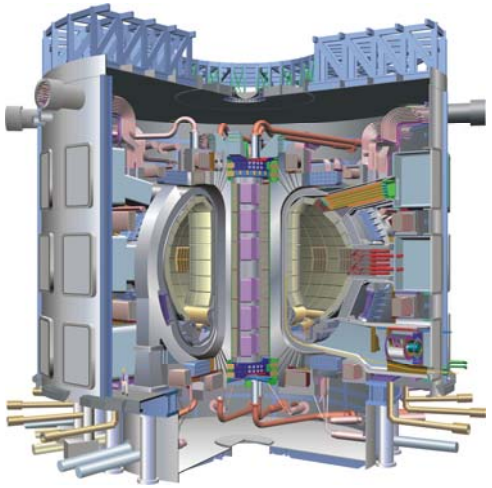
- Prior to TRIGA reconstruction:
  - Experiments with neutron beams (activation analyses, neutron scattering, neutron dosimetry, gamma spectrometric examination of irradiated nuclear fuel)
  - Isotope production (medical, industry)
  - Training

- After TRIGA reconstruction:
  - Experiments with neutron beams (activation analyses, material studies, reactor physics experiments, BNCT project, thermal neutron radiography)
  - Training, education, promotion

Research and Other Activities (contd.)

- At present (2002-2007):
  - Experiments with neutron beams (neutron activation analyses, material studies, reactor physics research, neutron dosimetry and spectroscopy, activation of materials, irradiation of materials, studies of radiation damage, irradiation of high temperature superconductors)
  - Training, education, promotion





Safety Assessment

- "Safety Analysis Report" from 1991 following IAEA standard format, main document for safety evaluation
- Reactor Safety Committee of "Jožef Stefan" Institute review and control all important safety issues
- Approval from Slovenian Nuclear Safety Administration (SNSA) for all safety relevant modifications
- SNSA regulatory inspections and assessments
- IAEA INSARR mission in 1992 at the request of the SNSA

Regulatory Supervision

Regulatory and inspection authorities:

- Slovenian Nuclear Safety Administration (safety issues)
- Slovenian Radiation Protection Administration (radiation protection)
- Administration for Civil Protection and Disaster Relief (emergency preparedness)
- Ministry of the Interior (physical protection)

Regulatory Supervision (contd.)

- "Act on Protection against Ionizing Radiation and Nuclear Safety" from 2002 and related Regulations
- Regulations contain specific requirements for research reactor (design basis, reporting, content of safety analysis report, operating feedback experience program), other requirements are the same as for NPP
- Application of Graded Approach to Safety in new Regulations
- Application of IAEA "Code of Conduct on the Safety of Research Reactor", 2004

Reporting

- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (2003, 2006)
- Annex of the 2001 National Report according to the Convention on Nuclear Safety
- Annually report of IAEA Safety Performance Indicators in accordance with the follow-up system for monitoring the safety of research reactor (2005, 2006)
- National coordinator at the SNSA for International Reporting System for Research Reactors

Strategy for Future Operation

- Good technical conditions of the reactor for at least 10 years of operation
- It will be confirmed through Periodic Safety Review (PSR)

Options:

a. Operation at least 2016 and return of fuel elements to the USA before 2019

b. Extended operation beyond 2016, then managed spent fuel together with spent fuel from NPP Krško

Conclusions

- No significant events in 40 years of operation
- Good technical conditions of Ljubljana TRIGA Mark II
- Capacity of nuclear fuel with low burn-up ensures continuous operation until 2016 or longer
- The PSR will be performed to confirm conditions of all main reactor components
- New experiments related to fusion reactor research work, new materials, new measurements methods, new benchmarks experiments
- Important education and training role in future in view of NPP program