

## Needs and Present Status of the First Multipurpose Nuclear Facilities in Jordan

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Jordan is completely dependent on imports to cover its primary energy needs; about 98 percent of Jordan's electricity generation is fuelled by imports, of which about 70 percent is from Egyptian imported natural gas. The recent disruptions of the gas pipeline from Egypt highlight vividly this vulnerability and insecurity. Jordan is also one of the ten most water deprived countries in the world. The need of supply of water will increase in the coming decades, and desalination of water is one of the promising solutions to the water scarcity. However, water desalination is very energy intensive, and will further increase Jordan's need for electricity. Based on a pre-feasibility study conducted with the assistance of the IAEA, nuclear energy proved to be an important component of any future energy mix.

Realizing the vital importance of human resource development, a nuclear engineering department was established in 2007 at Jordan University of Science and Technology (JUST). This past June witnessed the graduation of the first 19 engineers out of total of total 140 students in the department. They were trained in radiation detection and measurements laboratory and a virtual research reactor laboratory done via teleconference with the research reactor at North Carolina State University.

To provide more practical experience for the students, Jordan Atomic Energy Commission (JAEC) launched two projects, a subcritical assembly and a research reactor, to be located at the campus of JUST.

The Jordan Subcritical Assembly (JSA) project was contracted to China Institute of Atomic Energy (CIAE) in 2009. The facility has been built, constructed, and assembled. It is now ready for fuel loading and commissioning. The JSA has a  $k_{\text{eff}}$  of  $<0.95$  using a core consisting of 313 fuel rods; each containing 43  $\text{UO}_2$  ceramic pellets of 3.4% U-235 in a Zr-4 cladding. These were assembled in a square lattice of 1.91 cm pitch and held between two perforated plates in a cylindrical tank filled with demineralized water. This JSA will witness the first fission chain reaction in Jordan triggered by the  $10^6 \text{ s}^{-1}$  from the Pu–Be Pneumatically driven neutron source situated in a flask under the vessel. This JSA will be the first real educational tool for reactor physics and nuclear engineering principles. It will provide experiments in flux measurements, approach to criticality and reactivity measurements.

The JAEC has also contracted in mid-2010 with a consortium of Korea Atomic Energy Research Institute (KAERI) and Daewoo Construction Company (KDC) for a turnkey project to build the Jordan Research and Training Reactor (JRTR) of 5 MW, upgradable to 10 MW, with a flux of  $1.45 \times 10^{14} \text{ cm}^{-2} \text{ s}^{-1}$ . This open pool light water cooled reactor will be of 14.2%  $^{235}\text{U}$  as  $\text{U}_3\text{Si}_2$  plate type fuel. The KDC are performing the basic designs and material procurement orders including fuel assemblies from CERCA with uranium from Russia.

The JRTR will include a training centre for students and researchers, a radioisotope production facility for isotopes such as  $^{131}\text{I}$ ,  $^{99}\text{Mo}/^{99\text{m}}\text{Tc}$ ,  $^{198}\text{Au}$ ,  $^{197}\text{Hg}$ ,  $^{32}\text{P}$ ,  $^{24}\text{Na}$ ,  $^{192}\text{Ir}$  and  $^{60}\text{Co}$  for medical, research and industrial applications. It will also have a NAA, NR, NS, ND and a TC for doping as well as a cold neutron source beam port for future expansion. The reactor will also accommodate a horizontal reflector assembly for biological studies.

The construction of the training centre building will start around the end of Aug 2011 and those for the other facilities will commence around the end of 2012. The JRTR is expected to be commissioned around May, 2015.

Jordan regards these two facilities as the first step to the peaceful uses of nuclear energy. It will provide great benefit for training students, researchers, operators, engineers, as well as medical and biomedical utilization.

Both projects are under the regulatory oversight of the Jordan Nuclear Regulatory Commission (JNRC).