Education and Research Using the Kindai University Reactor

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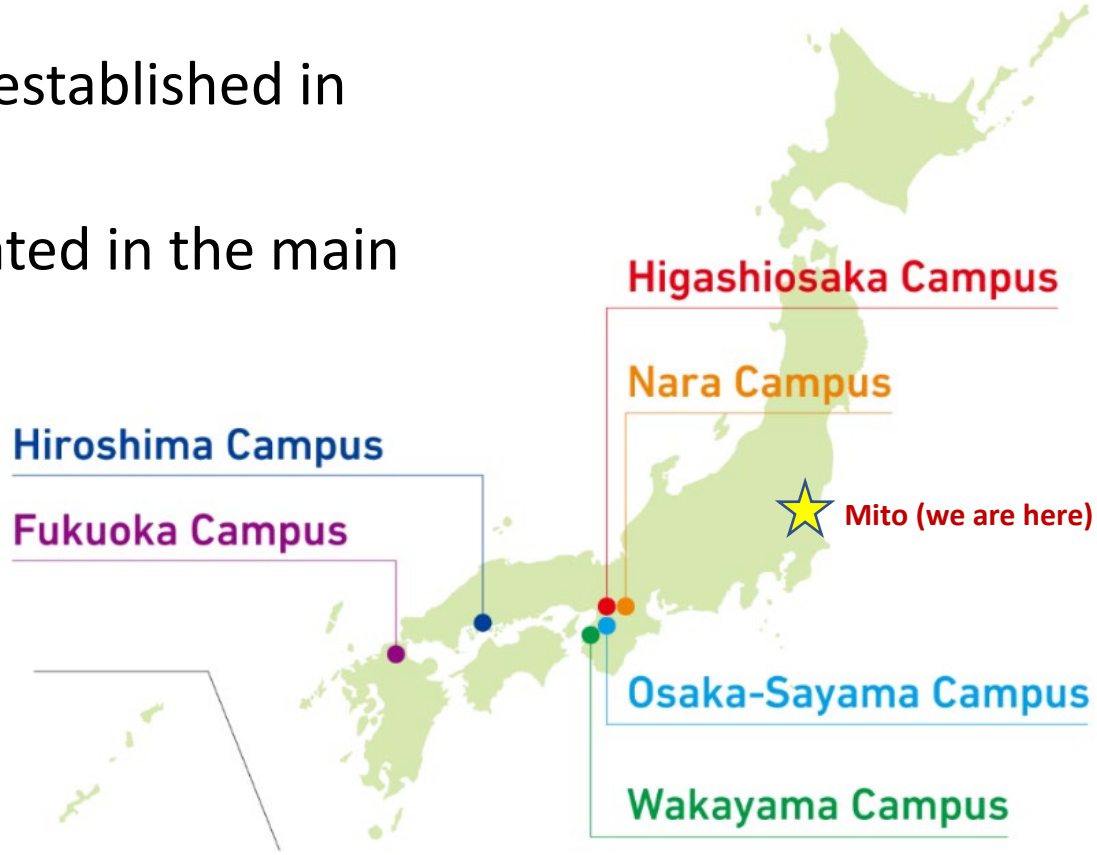
Introduction

- The Kindai University Reactor (UTR-KINKI) is an educational and training reactor with a rated thermal power of 1 W.
- The reactor has been utilized for nuclear education, training and research in Japan for more than 60 years.
- There are currently only three university-owned research reactors in Japan.
  - **UTR-KINKI** (Kindai University)
  - **KUCA** and **KUR** (Kyoto University)
- UTR-KINKI is a valuable facility where students can practise using a real nuclear reactor, and is fully utilised for education and research.
- The current status of education and research using UTR-KINKI will be reported, as an update to the previous report at IGORR 19.

Introduction

Atomic Energy Research Institute
Kindai University

- Kindai University is a private university established in 1925 with about 40,000 students.
- Atomic Energy Research Institute is located in the main campus in Osaka.



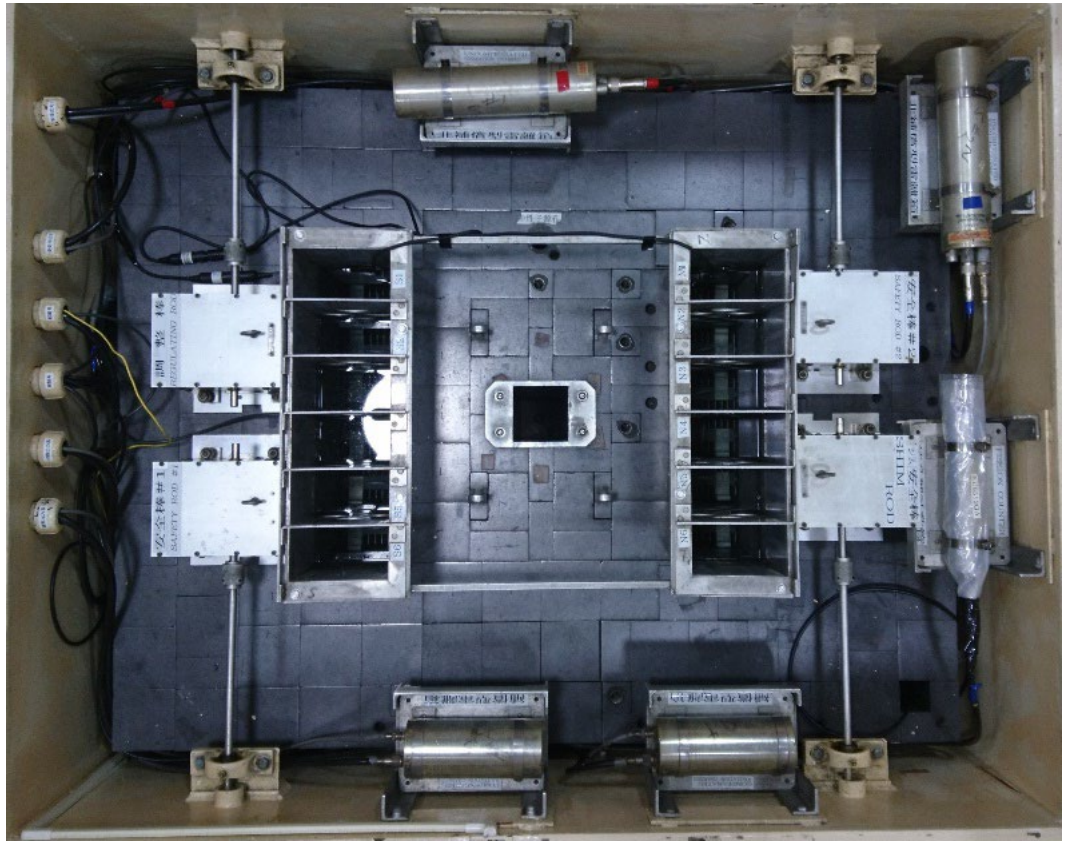
UTR-KINKI: Overview

- **UTR**: **U**niversity **T**eaching and **R**esearch Reactor
- One of many UTRs designed and built in the 1950s and 1960s by U. S. companies, based on the Argonaut-type reactor as a prototype.
- Licensed thermal power: **1W**

Mr 1W

- Safe for students to operate.
- No cooling function required.
- Negligible fuel burn-up.
- Small residual activity and leakage radiation.
- Biological shield tank is filled with sand and water.

UTR-KINKI: Design and Specification



Reactor core of UTR-KINKI

- Graphite reflected / light-water-moderated reactor.
- Two core tanks are set in a graphite reflector to have a dry and uniform irradiation field in the centre.
- The core tanks are filled with light water as a moderator.
- The reactor is controlled by four control rods (Cd plates).
- Each core tank has 6 fuel assemblies, and each fuel assembly has space for 12 fuel plates.

UTR-KINKI: History

- 1959: The US Atomic Energy Commission operated a UTR in the Tokyo International Trade Fair.
- 1961: UTR-KINKI reached its first criticality on November 11 and started operation with a licensed thermal power of 0.1 W.
  - The first private nuclear reactor in Japan.
  - The first university owned nuclear reactor in Japan.
- 1974: the licensed thermal power was increased to 1W.
- 2014-2016: Suspended operation to undergo safety reviews by the newly established Nuclear Regulation Authority (NRA) after the 2011 Fukushima NPP accident.
- 2017: Resumed operation as the first research reactor completed new regulatory requirements in Japan.

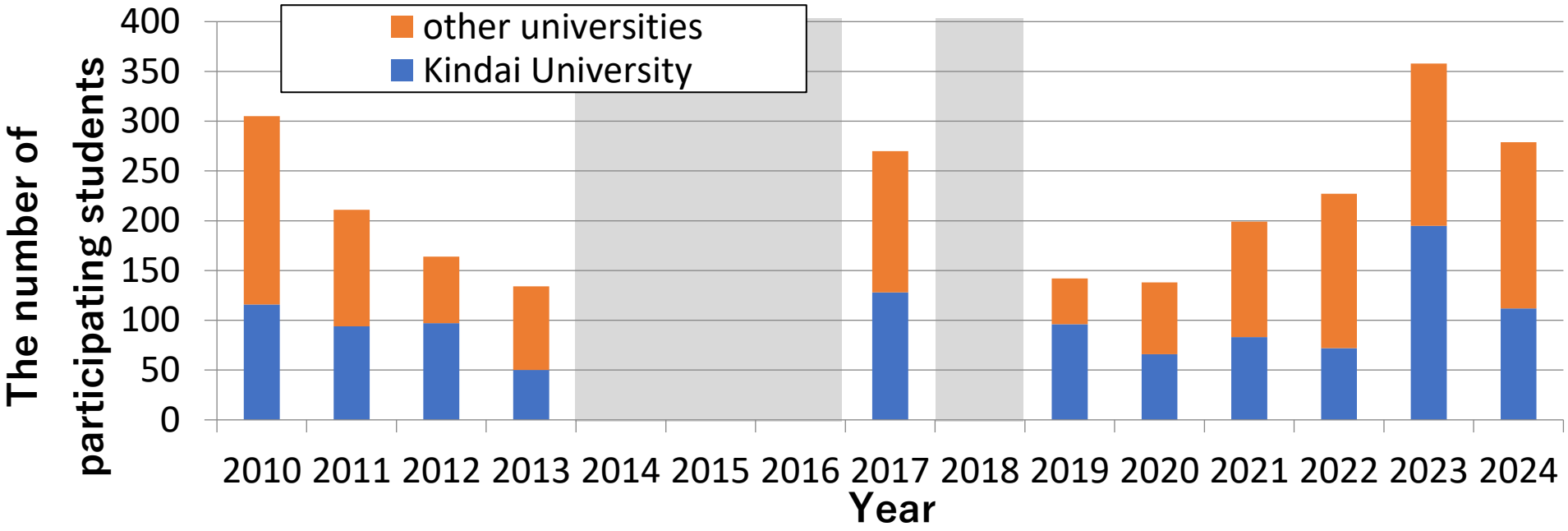
Their majesties the Emperor and Empress visited the reactor operated in the Tokyo International Trade Fair on May 12, 1959.

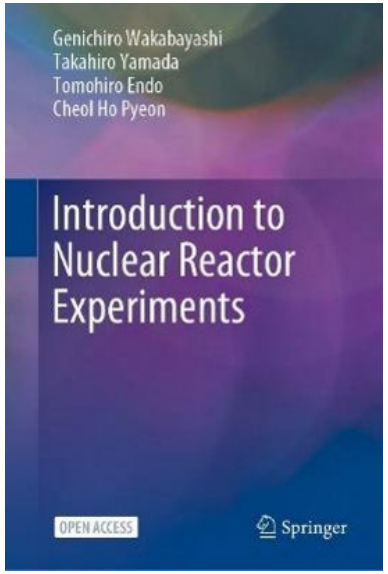
Koichi Seko (the founder of Kindai University) decided to purchase the UTR to develop future nuclear engineers at his university.

Education and Training: Higher Education (1)

- UTR-KINKI is designed for education and training in university nuclear engineering programs, and has been jointly used by many universities in Japan since it was built in 1961.
- In 2021, a new consortium for nuclear human resource development (ANEC; Advanced Nuclear Education Network for Future Society) was established with funding from the government.
- **14 universities and technical colleges** use UTR-KINKI for nuclear education programmes.

ANEC
ADVANCED NUCLEAR EDUCATION CONSORTIUM FOR THE FUTURE SOCIETY





Textbook for UTR-KINKI

Education and Training: Higher Education (2)

- Deepen understanding by applying lecture-based knowledge in hands-on training with a real nuclear reactor.
- Foster interest in nuclear science and technology, and encourage careers or further studies in the nuclear field.
- Gain firsthand experience of how nuclear facilities operate under systems of safety, security, and radiation protection—not replicable with simulators.

PROGRAMME

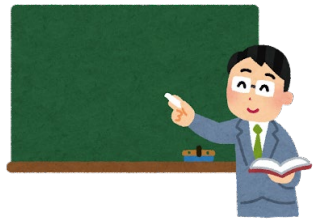
Reactor Operation
Rod Worth Measurement
Approach to Criticality
Neutron Flux Mapping by Activation Method
Al-foil Activation and Half-life Measurement
Leakage Gamma Spectrometry
Neutron and Gamma Dose Measurement
Neutron Radiography
Subcriticality Measurement
- Inverse Kinetics Analysis
- Source Jerk Method
- Reactor Noise Analysis

83% of participants pursued careers or further studies in the nuclear field.

Education and Training: Outreach to Secondary Education (1)

Workshop for Science Teachers

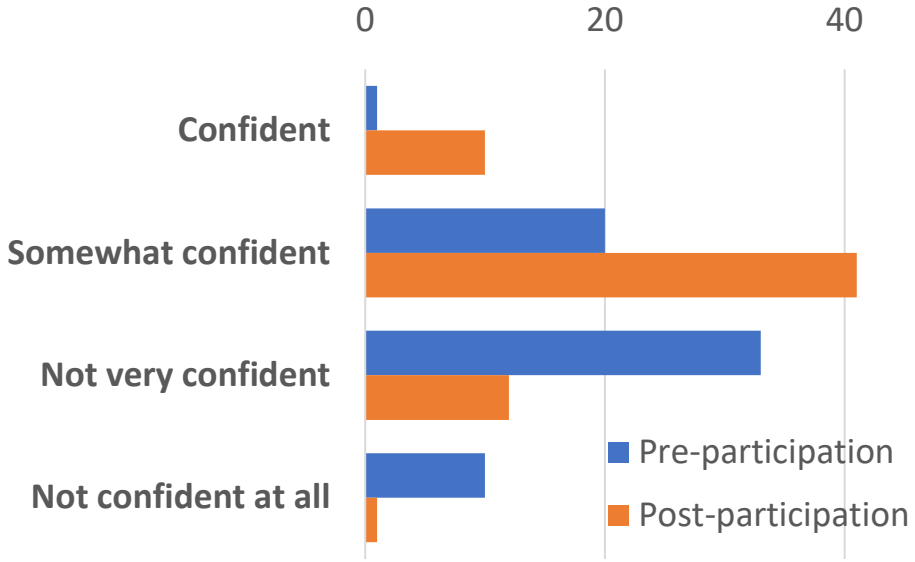
- Started in 1987 to provide science teachers with scientifically correct knowledge on nuclear science and technology.
- Held several times a year (16 participants per workshop)

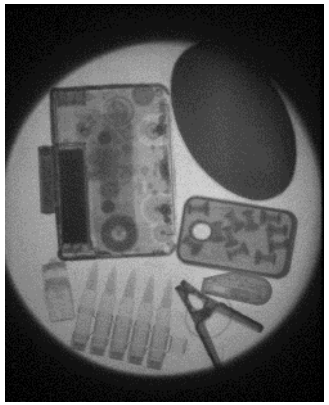


PROGRAMME

Reactor Operation
Neutron Radiography
Radiation measurement
Building a Cloud Chamber
Facility Tour
Lectures
- Basics of Radiation
- Basics of Nuclear Reactors
- Applications of Radiation
- Health Effects of Radiation

How confident are you in teaching nuclear science and technology? (2024)





X-ray and neutron radiography

Education and Training: Outreach to Secondary Education (2)

Reactor Workshop for High School Students

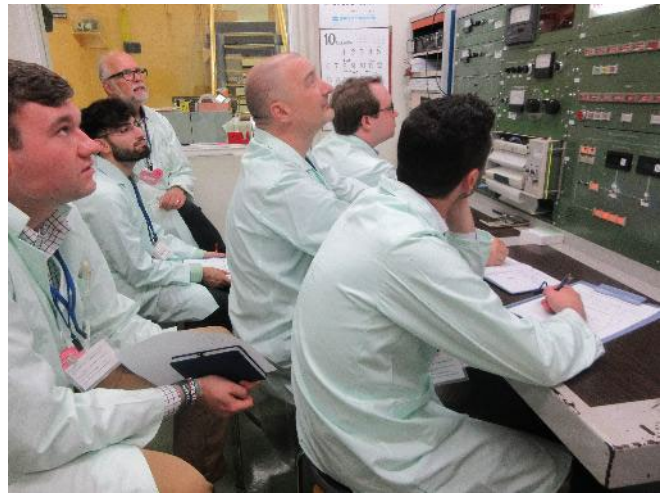
- Aim to encourage young generations to pursue their careers in nuclear science and technology.
- Held several times a year during summer and spring breaks (16 students per workshop).
- Hands-on one-day workshop: reactor operation, neutron radiography, and current topics in nuclear energy.
- Despite concerns after the Fukushima Daiichi NPP accident, the workshops attract far more applicants than the capacity.

Nuclear Open Campus (co-hosted with MEXT) introduces career and academic paths in nuclear science and technology to high school students.

Education and Training: International Cooperation

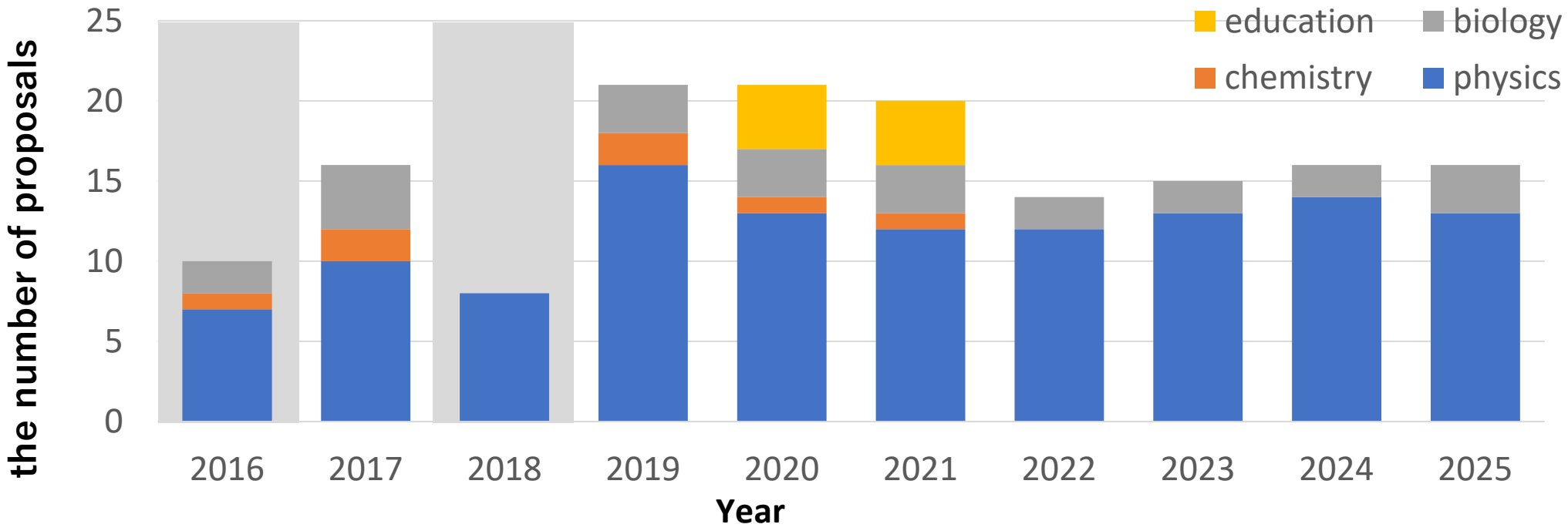
In recent years, international training programs have been held more frequently.

- **IAEA Regional Research Reactor School**
  - Two-week training program for young researchers and engineers from the Asia–Pacific region
  - First held in Japan in 2019; second in 2022 (postponed from 2021 due to COVID-19); Third school scheduled for October 2025.
  - Co-hosted with Kyoto University and Wakasa Wan Energy Research Center.
- JAEA Instructor Training Program for Asian Countries
- Reactor Workshop for Young Professionals of NNSA/DOE.
- Reactor Physics Asia Experiment Program (RPHA-XP)



Research Use

- Open to researchers from universities and research institutes across Japan.
- Research proposals are accepted once a year; reactor time is allocated to selected projects.
- Recent topics include neutron detector development, reactor physics experiments, and biological irradiation



Future Outlook

Conversion and HEU return

- UTR-KINKI is fuelled with HEU of US origin.
- In 2022, Japan and the U.S. agreed to convert UTR-KINKI to a low-enriched uranium (LEU) core and return the HEU fuel to the U.S.
- To minimize the negative impact on nuclear education in Japan, the reactor will first be converted to LEU before the HEU fuel is returned.
- Work toward conversion is underway with support from both governments.

Our goal is to operate UTR-KINKI as long as possible and contribute to nuclear research and human resource development in Japan and abroad.

(Photo from DOE/NNSA website)