Nuclear Engineering Education: Competency Framework Development

IAEA Training Meeting on Networking Educational Networks
15-19 June 2015
Vienna, Austria

Prof. A. Kosilov
National Research Nuclear University - MEPhI (NRNU-MEPhI), Moscow, Russian Federation
Restructuring of Russian System of Higher Education

2 National Universities – Moscow State University and S-Petersburg State University.

29 National Research Universities were organized in 2008-2010.

7 Federal Universities were organized in 2006-2010

Bologna Process finally started in September 2011

«University Atomic Consortium» The Association of Rosatoms Leading Universities was established in 2011

Main objective of National Research Universities – to ensure innovation development of the Russia economy through integration of education, science and production.
21 Russian universities train the specialists in the field of nuclear engineering on 32 specialties.

The main universities are:

- National Research Nuclear University - MEPhI – NRNU_MEPhI
- Moscow Power Engineering Institute (technical university) - MPEI
- D.Mendeleev University of Chemical Technology of Russia - UCT
- Moscow State Technical University n.a. N.E. Bauman - MSTU
  - St. Petersburg State Polytechnic University- SPbSPU
  - Ivanovo State Power University- ISPU
- State Technical University (Nizhnyi Novgorod) – NNSTU
  - Tomsk Polytechnic University - TPU
  - Ural State Technical University - USTU
MEPhI combines of 10 Higher Education Institutions and 15 colleges:
Over 31 thousand students;
over 1500 professors and associated professors,
60 main directions in Higher Professional Education
45 main directions in Secondary Professional Education

MEPhI priority is to train and retrain staff for:
- Nuclear Energy Complex (10 NPP, 25 facilities),
- Nuclear Defense Complex (VNIIEF, VNIITF, more than 20 facilities)
- Nuclear Research Complex (NRC «Kurchatov Institute», 46 Research Institutes)
- Nuclear and Radiation Safety Complex (Production Plant «Mayak», Siberian Chemical Plant, 17 facilities).
NRNU MEPhI: Synthesis of Education and Research

NRNU MEPhI is a regionally deployed education and research complex that:

- implements all of the programs of multilevel education: higher, postgraduate, secondary, primary, and additional;
- performs fundamental and applied investigations in different arias of nuclear field;
- develops and introduces of innovation programs in education and research.
Graduates accepted for employment in nuclear organizations

![Bar chart showing graduates accepted for employment in nuclear organizations from various institutions.]

- **OINPE** – Obninsk Institute of Nuclear Power Engineering
- **TPU** – Tomsk Polytechnic University
- **USTU** – Ural State Technical University
- **NSTU** – Nizhny Novgorod State Technical University

Legend:
- **R&D Institutes**
- **Industry**
- **Total**
Reform of Education: the new National Education Standards (NES)

1992
Introduction of multi-level education

1994
1-st generation of NES
To keep the best traditions of Soviet Education System with emphasis on:
• broad area of education
• fundamental disciplines

2000
2-nd generation of NES
To focus is on a competence-based-learning (learning-outcome-based-approach) taking into account of the industry and science requirements.

2003
Russia joined the Bologna Process
To increase the role of university in shaping education program though keeping information-based-learning orientation.

2009
3-rd generation of NES
To keep the best traditions of Soviet Education System with emphasis on:
• broad area of education
• fundamental disciplines
NRNU MEPhI Research & Educational Centers

- Nuclear power center
- Nuclear reactor center
- Radiation material science and radiation protection center
- Physical protection, control and accounting of nuclear materials center
- Radiation accelerator center
- Neutrino Lab
- Nuclear electronics center
- Carbon fiber and carbon-composite material center
- Superconductivity center
- Nanosystems, nanomaterials and nanotechnologies center
- Laser technological center etc.
NRNU MEPhI Nuclear Engineering Center

Nuclear Power Center is educational and research domain within the NRNU MEPhI combining:

- Department of Radiation Physics and Nuclear Safety - Moscow,
- Department of NPP I&C - Moscow,
- Department of Theoretical and Experimental Physics of Nuclear Reactors - Moscow,
- Department of Thermodynamic - Moscow,
- Department of Closed Fuel Cycle – Moscow,
- Department of NPP Reactor Design - Obninsk,
- Department of NPP Equipment and Operation - Obninsk,
- Department of Thermodynamic – Obninsk,
- Department of Automatics, Control and Diagnostics – Obninsk,
- Department of Mechanics and NPP Design Strength – Obninsk,
- Institute of Industrial Nuclear Technologies - Obninsk

Created in September 2014
The Center supports

- Bachelor programmes (BSc, Engineering),
- Master Programmes (BSc, Engineering),
- Engineering (Diploma) Programmes (Engineer-Physicist),
- PhD Programmes.

22 educational programmes and programmes of professional development
Competency Framework - 1

- Educational Standards
- Industry Requirements “ROSATOM”
- Benchmarking Nuclear Power Engineering Education (the new CRP)
- Improvement of Taxonomic Competency Map
- Optimization of Courses and Department Workload
Development of Competency Models for Educational Programs on Nuclear Engineering (Bachelor, Master, PhD)

Analysis of Implementation of the Competency Models - “providing means for modern education”

Proposals on Improving Quality of Nuclear Power Engineering Specialists

- Critical assemblies
- Codes
- Simulators
- Lectures
- Classroom training
- International partners

- Research reactor
- Labs
- IT tools
- Specialized equipment
- Industry facilities

Implementation, Monitoring, Evaluation, Continues Improvement
Vision of the new CRP – for our discussion!

Generic taxonomic Competency map of Nuclear Engineering Education including Searchable tool (subject, Educational domain, etc.)

Benchmarking Approach and tools. Among the members of the CRP and others. Industry requirements.

Reference Competency Models for Nuclear Engineering Education – (international recommendations)

Industry best practices to support competency building

Modern educational approaches and tools to support competency building of new engineers.

Web portal on Nuclear Engineering Education. Country/University Profiles.

Outreach best practices.

Recommendations To enhance quality of Nuclear Engineering graduates

Inputs from all elements
Thank you!

A.Kosilov@gfvg.org
Additional information about the NRNU MEPhI

The National Research Nuclear University –MEPhI, Kashirskoe shosse, 31, Moscow 115409, Russian Federation

http://mephi.ru
http://mephi.ru/eng/
MEPhI is Russian Nuclear Education Center (more than 40 programs)

- Nuclear reactors and power installations
- Nuclear power plants
- Radiation safety of human and the environment
- Security and non-proliferation of nuclear materials
- Physical protection, control and accounting of nuclear materials
- Material science and technology of new materials
- Nuclear and particle physics
- Theoretical physics
- Plasma physics
- Physics of kinetic phenomena
- Applied mathematics
- Medical physics
- Electronics and automation in physical facilities
- Device and methods of for quality control and diagnostics
- Ecology and others

More than 150 modern laboratories and educational-research centers, research nuclear reactor and 5 subcritical assemblies are used for education and training. Over 1500 professors and associated professors give the classes.
MEPhI is Training and Retraining Center
(more than 200 programs, retraining at 25 MEPhI regional branches near enterprises)

- Modern nuclear installations
- Safety of the nuclear fuel cycle
- Nuclear and radiation safety
- Culture of nuclear material management
- Technological aspects of nuclear non-proliferation
- Environmental protection
- Methods of reactor material diagnostics
- Methods for uranium and nonuranium isotopes separations
- Reliability of nuclear reactors and risk management
- Applied spectrometry of nuclear radiation
- Systems of the mathematical support of the exploitation of VVER type reactors
- Quality control in nuclear industry
- Nuclear physics methods in nanotechnologies
- Mass-spectrometric methods of isotope and element analysis
  and others
MEPhI is Postgraduate “Rosatom” Study Center
(more than 30 directions)

- Nuclear power installations (design, exploitation and decommission)
- Radiation safety of human and the environment
- Thermal physics
- High energy physics
- Plasma physics
- Laser physics
- Semiconductor physics
- Nuclear and particle physics
- Solid state electronics
- Micro- and nanoelectronics
- Theoretical physics
- Mathematical physics
- Medical physics
- Ecology etc.

MEPhI coordinates postgraduate study activity at “Rosatom” research and industrial centers.
MEPhI is International Center for Nuclear Education and Knowledge

**Aims:**

Aim of center creation is determined by the necessity to solve the tasks in the field of MEPhI international activity:

- Creation of system of continuous personnel training for EvrAzES states in the field of nuclear power applications based on the international standards;
- Development of educational service export as the leaders in the world educational market;
- Development of educational and scientific contacts to IAEA, WNU, ENEN, ANENT, biggest scientific centers and universities of USA, EU and Asia.

**Directions of activities:**

- Education. Transfer of knowledge to new generation, to new developing countries and cooperation with the nuclear education of leading powers;
- Scientific enlightening activity – students, specialists, decision makers;
- Informational and analytical work.
MEPhI is Russian center for international cooperation in nuclear education

- Training & Retraining of foreign students and specialists in the field of nuclear engineering and hi-tech (more than 300 people in 2009, Vietnam, Argentina, Jordan, Egypt: 2010 - ~50 students, 2011 – ~150 students, 2012-2014 - ~ 300 students per year).
- Cooperation with nuclear educational networks (MEPhI has agreement with ENEN and ANENT).
- Cooperation with the foreign nuclear universities for development common master of research programs, postgraduate training, curricula analysis and enhanced (MEPhI has agreement with more than 15 universities from USA and Europe).
- Participation at the IAEA activity and representation of the Russian Federation at the World Nuclear University.
- Coordination of Russian and International Innovation Nuclear Consortiums activity.
International collaboration

• Participation at the major international experiments in nuclear physics and high energy physics (STAR, ATLAS, ALICE, PAMELA etc.)

• Participation at the international programs of IAEA, ISTC, CERN, DESY etc., conferences and workshops

• Hosting of 30 international conferences and workshops (150 foreign delegations from nearly 25 countries visited MEPhI in 2009).
MEPhI International Center for Nuclear Education Activities

- Participation of the MEPhI experts in IAEA technical documents development activity ("NKM in research organizations", "NKM in academic organizations", "NKM in national programs", "Methodological background for nuclear nonproliferation and security education", "Reference curricula in nuclear security", "Reference curricula in nuclear engineering" and others)
- Participation at the IAEA activity "Nuclear nonproliferation. Responsible science". (ISTC Grant №-WS01-SB159-10).
- Participation at IAEA Technical Cooperation Programs of nuclear infrastructure development for Armenia and Belorussia.
- Participation of the experts at the IAEA NKM Missions.
- Preparation and presentation at the IAEA conferences the invited papers concerning with the Russian nuclear education system development and NKM at the Russian universities.
- Preparation of the international reference multimedia course “Nuclear Reactor Physics” in Russian language.
- Sign of the Agreements with the 3 USA universities for the cooperation in the field of nuclear education.
- Creation of the Russian video films library “From nuclear bomb to nuclear renaissance” (more than 400 films).