Readiness of the U.S. Nuclear Workforce for 21st Century Challenges

A Report from the APS Panel on Public Affairs
Committee on Energy and Environment

EXECUTIVE SUMMARY

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Overview

It is time to reexamine the adequacy of the U.S. nuclear workforce and its ability to deal with many old and new challenges our nation faces. This report draws attention to critical shortages in the U.S. nuclear workforce and to problems in maintaining relevant educational modalities and facilities for training new people. This workforce comprises nuclear engineers, nuclear chemists, radiochemists, health physicists, nuclear physicists, nuclear technicians, and those from related disciplines. As a group they play critical roles in the nation's nuclear power industry, in its nuclear weapons complex, in its defense against nuclear and other forms of terrorism, and in several aspects of healthcare, industrial processing, and occupational health and safety.

Today there is increasing public concern about anthropogenic global warming and global climate change, and much public anxiety about future sources of abundant but clean (low "carbon footprint") energy. About 20% of the electricity in the U.S. comes from its fleet of 104 commercial nuclear reactors, which annually displace hundreds of millions of metric tons of carbon emissions. In the U.S., it has been over three decades since a nuclear reactor began construction. Today's increasing demand for clean, affordable energy demands renewed positive emphasis on nuclear power.

University nuclear engineering programs and the reactors that support them have experienced "feast or famine" funding. Recently, the Department of Energy (DOE) substantially increased funding for university nuclear engineering programs and the number of undergraduates increased significantly. For the FY 2007 and FY 2008 budget cycles, DOE declared the low student enrollment problem solved and proposed terminating its university programs. Consequently, Congress transferred the responsibility for educating nuclear scientists and engineers to the Nuclear Regulatory Commission (NRC).

Nuclear scientists, engineers, and technicians specializing in nuclear reactor design, construction, and maintenance need to be trained on nuclear reactors and simulators. Although some students can be trained at vendor and utility facilities or non-defense-related reactors owned by the government, the diminishing pool of university-based reactors imperils student training opportunities.

The continuing, largely static, nuclear engineering workforce needs of U.S. firms have been met through a combination of hiring those trained in university nuclear engineering programs and retraining others whose original expertise was in some other field (usually mechanical engineering). This somewhat *ad hoc* approach may be sufficient as long as the number of nuclear reactors remains relatively static.

There are likely to be severe shortages of nuclear scientists, engineers and technicians in governmental sectors responsible for regulatory, safety, and emergency responses of national concern (e.g. nuclear power industry, transportation and shipping). It is clear that Federal and state governments must train and maintain this workforce.

Reduced university-based training opportunities in nuclear science and engineering have not had a dramatic effect on the manpower levels in the nuclear weapons complex. Moreover, the design and construction of nuclear weapons will never be a part of publicly-available nuclear science and engineering curricula. Rather, on-the-job training has filled workforce needs. However, expanding efforts in nuclear forensics and other parts of the Homeland Security portfolio and replacing retirees across all sectors will

require a significant number of talented, well-trained nuclear engineers, nuclear physicists, nuclear chemists, radiochemists, health physicists, mathematicians, and computer scientists at the Ph.D. level.

The continually growing use of radiation in medicine, biological research, and in industry has led to a shortage of health physicists and other workers who are trained to use many kinds of radiation sources, including tracer radioisotopes, X-ray facilities, PET scanners, and medical cyclotrons.

Designing the next generation of nuclear reactors requires better measurements of nuclear fission and neutron capture cross sections and the development of an improved theory of nuclear fission and neutron capture based upon fundamental physics rather than the phenomenological models currently in use.

Recommendations

The federal government should assume significant responsibility for educating the next generation of nuclear scientists and engineers by doing the following:

Naming a single Federal agency to act as steward for an ongoing, robust university-based nuclear science and engineering education program.

Stabilizing the long-term funding and management of nuclear science and engineering education programs, including university-based reactors.

Establishing a two-part funding program for university reactors that: (i) negotiates with universities to provide one-time funding to bring each reactor up to an acceptable level of modernization, and (ii) then provides annual Federal funding to maintain that level.

Helping to establish two-year nuclear technician training programs at community colleges to meet future nuclear workforce needs.

Helping to establish the use of distance-learning methods to exploit training reactor facilities more effectively.

Instituting educational programs that train displaced workers in other engineering and science disciplines to perform nuclear engineering and technology jobs.

Establishing a cross-cutting workforce initiative that addresses the national security, energy, and public health needs for trained nuclear chemistry and radiochemistry personnel.

Providing adequate funding for degreed health physics programs to train the necessary numbers of health physicists for nuclear power and other industries.

Supporting research on the fundamental physics of actinide fission and neutron capture, along with measurements of relevant data.

Nuclear vendors and utilities should expand undergraduate student internships, graduate student traineeships, cooperative education opportunities, and training on reactor simulators at their facilities.