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REACTIONS

FROM THE AMERICAN NUCLEAR SOCIETY TO TEACHERS INTERESTED IN THE NUCLEAR SCIENCES

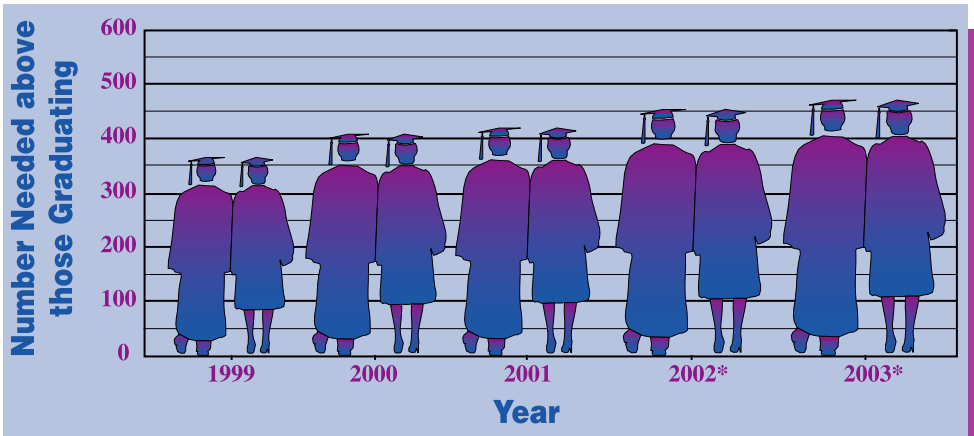
Career Opportunities

Nuclear Science and Technology: Demand for Grads Exceeds Supply

There is a high demand for graduates of nuclear engineering programs with either B.S. or M.S. degrees. In fact, many industry experts have been concerned about the shortage of graduates and are eagerly working to increase recruitment of students.

A study for the American Society of Engineering Education, completed in 1999, found a significant gap between the number of BS/MS trained workers needed by the fission nuclear power industry and those graduated. The study projected that the gap would increase in coming years. That study concerned itself only with the "fission nuclear power industry"; clearly the demand for workers extends to other areas.

At the 1999 Winter Meeting of the American Nuclear Society, a special workshop addressed the supply and demand imbalance affecting the nuclear industry workforce. Speakers detailed how the number of graduates has declined and demand is growing. One speaker noted the enthusiasm with which companies contact nuclear engineering departments seeking graduates and the fact that many graduates receive multiple job offers.



**2002/03 supply proj. at max. for 1999-2001.*

Expected excess demand for B.S. and M.S. graduates in nuclear engineering for the period 1999-2003.

Data Source: *Manpower Supply and Demand in the Nuclear Industry,* a publication of Nuclear Engineering Department Heads Organization (NEDHO), 1999.

Supply and Demand Imbalance

This imbalance may come as a surprise to some. They may think, "No power reactors have been constructed in the United States for over twenty years. So, why is there a growing demand for workers with nuclear degrees?"

Sadly, that perspective has contributed to the growing shortage of trained workers. Because no new reactors were being built, college students considering engineering education have assumed that nuclear engineering didn't offer much of a career opportunity. As a result, fewer students have pursued nuclear engineering education, shrinking the supply of potential workers.

But, other factors have also played a role. One is the aging of our nuclear workforce. Many of the people who pioneered development of commercial nuclear power plants have retired. Others are at or near retirement age.

Power Industry

The 103 operating nuclear power plants in America continue to contribute nearly 20 percent of the nation's electricity. Utilities and generating companies are applying to extend the operating licenses of existing plants. There will clearly be a need for engineers to maintain and operate these plants for the duration of these extended licenses. In those cases where plants are decommissioned rather than operated longer, there will be a need for nuclear engineering graduates to manage the decommissioning process.

Non-Power Needs

Power plants are not the only place where specialists trained in nuclear science find employment. Engineers using nuclear technology skills are needed in industry for applications which include gauging techniques, food irradiation, medical sterilization, and chemical processing,

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Demand for Grads...

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to name a few.

The growing utilization of nuclear science and technology in medicine has created a whole range of opportunities. Companies which manufacture diagnostic equipment require people with special knowledge of nuclear science and technology to design, manufacture, and maintain the equipment. Medical technicians and medical specialists need knowledge of nuclear science and technology in order to complete their diagnostic and treatment tasks. Health physicists are needed to assure safety for medical personnel and patients when these technologies are applied.

Research in the basic sciences, pharmacology, and many other fields utilizes nuclear technology. Highly skilled workers with knowledge of nuclear science and technology are needed to accomplish that research at universities, national laboratories and private companies.

America's highly regarded national laboratories continue to conduct research in the basic sciences (see the January 2001 issue of *REACTIONS* for an example), environmental topics, energy, waste disposal and remediation, national security applications, etc.

Recent Developments

The recent and continuing electricity crisis in California (see our April 2001 issue) has contributed to a changing attitude about the use of nuclear power for electricity generation. National leaders have begun talking about the need to include nuclear in the mix of power sources for electricity generation. Recent surveys of public opinion show significant support for nuclear power. Several power generating companies have shown renewed interest in construction of nuclear powered generating plants. There is discussion of new plant designs which can be built in less time and at lower cost than earlier designs. This changing public arena suggests the possibility of an expanding market for nuclear engineering graduates.

Summary

There is a demand for nuclear engineering graduates. The demand is greater than the current supply. That demand is projected to continue as our application of nuclear science and technology grows. Nuclear engineering is an attractive field with opportunity for your students, now and in the years ahead.

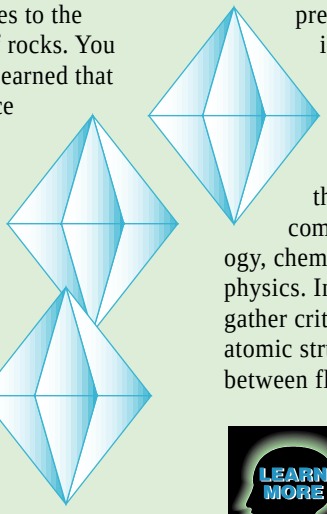
What You Can Do

Evaluating the career opportunities in nuclear science and technology will be easier for students who have learned some basic information about the field.

Students need to know that there are many applications of nuclear science and technology, that nuclear science and technology is environmentally friendly, that this specialty makes a contribution to the health and well-being of people throughout the world, and that there is a future for them in this field.

Want to know more about the many applications of nuclear science and technology? Find a full-day ANS Teacher Workshop near you and attend. ■

X-rays help probe interaction of minerals and fluids



Water contributes to the weathering of rocks. You undoubtedly learned that in a grade school science class. That's the big picture. What's in the details? How does the weathering occur? Well, scientists want to know a whole bunch of details. So, they are studying the interactions of fluids and mineral surfaces.

Researchers believe that knowing more about those interactions – and the atomic structures where they take place — can be a key to predicting and manipulating the interactions. They think that this knowledge may help cut costs in cleaning contaminated areas.

To gather the information they need, scientists are combining the techniques of geology, chemistry, materials cience and physics. Intense X-ray beams are used to gather critical information about the atomic structures of the interfaces between fluids and minerals.

The X-ray beams of Argonne's Advanced Photo Source (APS) are making a contribution to the research. (Learn more.) ■

Related Career Resources

http://stats.bls.gov
see Career Guides - Occupational Outlook Handbook; this is a Bureau of Labor Statistics publication with guidance on how to search for job information

http://www.ans.org/pi/teachers/reactions/pdfs/2000-02.pdf
The February 2000 issue of *REACTIONS* contains suggestions on how students might go about investigating career options

http://www.ans.org/pi/teachers/reactions/pdfs/2000-09.pdf
The September 2000 issue of *REACTIONS* contains an activity (based on content of that issue) to stimulate thinking about careers

http://energy.gov
A DOE site with career opportunities listed

http://www.energy.gov/aboutus/org/natlabs.html
A list of national labs with links where additional employment info may be found

http://www.nei.org/index.asp?catnum=1&catid=7
Nuclear Energy Institute career information ■

Energy Information

New Web Sites Focus on California Energy Situation

Track Supply vs. Demand in Real Time. Researchers at the Department of Energy's Lawrence Berkeley National Laboratory have created a new web site which shows total demand for electricity in California along with the supply available to meet that demand. The site is found at http://energycrisis.lbl.gov

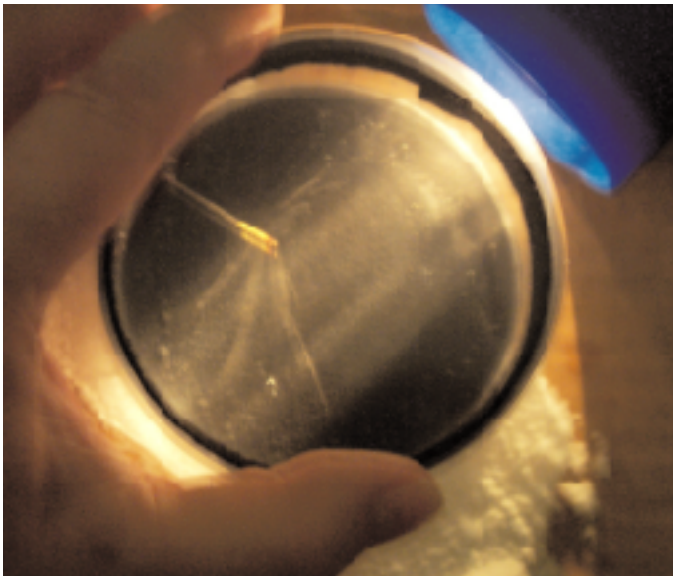
The site shows California electricity demand, availability of power within the state, exports and imports, and capacity out of service. The site utilizes information provided by the California Independent System Operator, the California Energy Commission, and other sources.

Tips on Reducing Energy Use. The Berkeley lab has also developed *The 20% Solution* web site, designed to provide California residents with suggestions on how to reduce energy use by 20 per cent in order to qualify for a rebate under the Governor's 20/20 Rebate Program. The site is found at http://savepower.lbl.gov ■

Project 65 – Activity

Cloud Chamber Demonstration/Activity

You can make the study of radiation more interesting to your students by introducing cloud chambers in the classroom. The first appearance of the telltale "tracks" in a cloud chamber is almost certain to capture the interest of even your most disinterested student. Suddenly, the abstract concept of radioactivity begins



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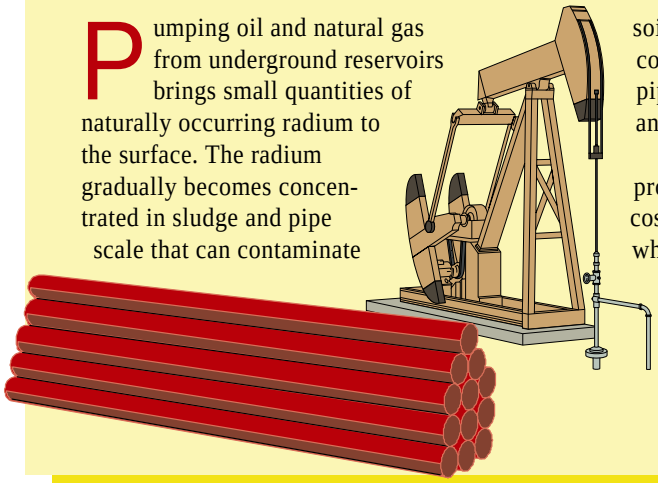
Web Resources

Radiation Information. Students of health physics at University of Michigan have created and maintain a web site focused on Radiation and Health Physics. These future radiation safety officers have created a web site packed with documents and interesting links. Check it out at http://www.umich.edu/~radinfo

Capsule Views of Physics. Rod Nave, a physics professor at Georgia State University, has created interactive capsule views of material contained in introductory physics. This resource, *HyperPhysics*, is available on the web at http://hyperphysics.phy-astr.gsu.edu/hphys.html ■

Who is concerned about radioactive contamination of soil? Surprise! Producers of oil and natural gas, that's who!

Pumping oil and natural gas from underground reservoirs brings small quantities of naturally occurring radium to the surface. The radium gradually becomes concentrated in sludge and pipe scale that can contaminate soil and equipment. Cleaning contaminated sites, such as a pipe yard, can be very costly and time consuming.



A new procedure shows promise in cutting the time and cost involved in determining what is in the soil and removing naturally occurring radioactive materials.

The method involves a global positioning system and a hand-held gamma ray detector to determine the location of contamination and plan for detailed characterization of the soil. Application of the method can reduce the volume of soil which must be removed — and significantly cut clean-up costs. In fact, researchers are estimating the new method may cut costs to about 1/10 that of more traditional methods. (Learn more.) ■

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to come to life.

Cloud chambers are a good small-group lab activity. Some instructors shy away from this activity because they've had discouraging results in previous tries. We encourage you to try again. Having multiple chambers in operation helps assure that a number of students will have success and that everyone can observe the phenomenon.

We'll give you some tips that have helped others to success.

How does a Cloud Chamber work?

Radioactive elements undergo radioactive decay; their nuclei emit particles (alpha and beta) that are too small to be observed, even under a microscope, and rays (gamma). The cloud chamber is designed for studying the **trails** of these radioactive emissions.

The air in the cloud chamber must be saturated with vapor (alcohol). Then, when the high energy particles move through the air in the cloud chamber, electrons are knocked loose from some of the atoms, forming ions (charged particles). The ions act as places for the vapor to condense. Of course, the condensation takes place only if the air **is** cool enough. But, when the air is cool enough, the vapor condenses on the ions and leaves a vapor trail – and lights the eyes of students!

(Show me the tips!) ■

Research Reactor Provides Critical Isotope

Skeletal Targeted Radiotherapy combines drugs and a radioactive isotope, Holmium-166, to destroy some forms of bone cancer. A university research reactor is the sole source producing this isotope for clinical trials. (Learn More.) ■

Attend a Teacher Workshop and Learn…

Insights for Teaching about Radioactivity and Nuclear Science and Technology

ANS Workshops provide a variety of information and educational materials. Teachers learn how to use Geiger counters to detect radiation from natural and man-made sources.

After completing a workshop, teachers receive a FREE CD-V700 Geiger Counter (analog) along with ideas for classroom use of the Geiger counter, information about radioactive sources that can be used safely in the classroom and an ANS Teacher Handbook on Detecting Radiation.

Click for a current schedule of ANS teacher workshops. ■

Research/Medical

Nuclear Magnetic Resonance Spectroscopy Helps Create Images in Effort to Fight Cancer

To continue their growth, tumors need the nourishment provided by new blood vessels. The growth of blood vessels to tumors – angiogenesis – is an interesting phenomenon. There is the barrier of existing body tissues and the proteins that constitute them. Yet, blood vessels manage to grow to the tumor. That's due to the action of a chemical called MMP.

MMP (matrix metalloproteinase) has been described as a chemical machete that cuts through the proteins of those existing body tissues, making way for the growth of blood vessels. Generally, where cancers are growing there is a surplus of MMP.

There are four known TIMP (tissue inhibitor of metalloproteinase) proteins that can stop the action of MMP. Structural biologist Steven Van Doren (University of Missouri-Columbia) has been studying TIMP-1, one of the four.

The hope is that researchers may develop drugs which, like naturally occurring TIMP, have the ability to stop the action of MMP. Van Doren is actively pursuing research that may one day contribute to the development of those drugs.

In order to develop anti-angiogenesis drugs, scientists must understand how TIMP is able to "disarm" MMP. Using computers and NMR (nuclear magnetic resonance) spectroscopy, Van Doren is developing visual images of how TIMP locks onto and disables MMP.

Van Doren is the first researcher who has shown visually how an individual molecule of TIMP-1 locks onto a molecule of MMP and stops it from "cutting" through existing tissues.

Scientists consider Van Doren's work to be at the forefront of biological research. There is the possibility that his findings may contribute not only to cancer research, but also to the development of medications to fight arthritis and promote wound-healing.

To read more about this interesting research and how NMR (nuclear magnetic resonance) spectroscopy makes it possible, click here. ■