Appendix A

Members of the Working Group

Sekazi Mtingwa (Chair)
Senior Lecturer
Office of the Dean for Undergraduate Education
Massachusetts Institute of Technology

Carol Berrigan
Director, Industry Infrastructure
Nuclear Energy Institute

Robert Eisenstein
Director
Santa Fe Alliance for Science

Lynne A. Fairobent
Legislative and Regulatory Affairs Manager
American Association of Physicists in Medicine

Darleane Hoffman
Professor of the Graduate School
Department of Chemistry
University of California, Berkeley &
Faculty Sr. Scientist
Nuclear Science Division
Lawrence Berkeley National Laboratory

Ruth Howes
Professor and Chair
Department of Physics
Marquette University

Andrew C. Klein
Director of Education, Training & Research Partnerships
Idaho National Laboratory

William D. Magwood, IV
Principal, Advanced Energy Strategies
Former Director of DOE Office of Nuclear Energy, Science and Technology

Patrick Mulvey
Lead Research Associate
Statistical Research Center
American Institute of Physics

Marc Ross
Chair of POPA Committee on Energy and Environment
Professor of Physics
University of Michigan

Jeanette Russo
(Administrator of Study)
Office Manager
APS Office of Public Affairs

Allen Sessoms
President
Delaware State University

Francis Slakey
Associate Director of Public Affairs
APS Washington Office

Appendix B

Experts at First Workshop (July 30-31, 2007)

Jim Bresee
Senior Technology Specialist
NE-54
DOE-NE

Gregory Choppin
Professor of Chemistry
Department of Chemistry
Florida State University

Michael Corradini
Associate Dean
College of Engineering
University of Wisconsin-Madison

Dallas Frey
Director of Staffing & Organizational Development
Westinghouse International Headquarters

Ayman Hawari
Director, Nuclear Reactor Program
Associate Professor
Department of Nuclear Engineering
North Carolina State University

Nancy Hebron-Isreal
Program Analyst
NE-3
DOE-NE

John Lee
Professor of Nuclear Engineering and Radiological Sciences
University of Michigan

Bob Long
CEO
Nuclear Stewardship, LLC

Heino Nitsche
Professor of Chemistry
University of California, Berkeley
Faculty Senior Scientist
Lawrence Berkeley National Laboratory

Buzz Savage
Director
Office of Fuel Cycle Research & Development
NE-54
DOE-NE

Appendix C

Acronyms Used in This Report

ACS	American Chemical Society
ANS	American Nuclear Society
APS	American Physical Society
CEA	Commissariat à l'Energie Atomique (French Governmental Agency)
CERN	European Organization for Nuclear Research
DEN	Directorate for Nuclear Energy (in France's CEA)
DNCT	Division of Nuclear Chemistry and Technology (of the ACS)
DOE	Department of Energy
DOE-NE	DOE's Office of Nuclear Energy, Science and Technology
DOE-SC	DOE's Office of Science
EPAct	Energy Policy Act of 2005
GNEP	Global Nuclear Energy Partnership
HBCU	Historically Black Colleges and Universities
HEU	Highly enriched uranium
HP	Health Physics
HPS	Health Physics Society
HSI	Hispanic Serving Institutions
INIE	Innovations in Nuclear Infrastructure and Education
INSTN	National Institute for Nuclear Science and Technology (in France's CEA)
LANSCE	Los Alamos Neutron Science Center
LEU	Low-enriched uranium
LWR	Light Water Reactor
Moly-99	Molybdenum-99 (Radioisotope of chemical element, molybdenum)
MURR	University of Missouri Research Reactor
MUSIC	Multi-University Southeast INIE Consortium
NCSU	North Carolina State University
NEI	Nuclear Energy Institute
NERAC	Nuclear Energy Research Advisory Committee (to DOE)
NERI	Nuclear Energy Research Initiative
NNSA	National Nuclear Security Administration
NRC	Nuclear Regulatory Commission
NSTC	National Science and Technology Council
OECD	Organisation for Economic Co-Operation and Development
ORISE	Oak Ridge Institute for Science and Education
PET	Positron Emission Tomography
POPA	Panel on Public Affairs (of the American Physical Society)
PCAST	President's Committee of Advisors on Science and Technology
RINSC	Rhode Island Nuclear Science Center
R&D	Research and Development
RPI	Rensselaer Polytechnic Institute
TVA	Tennessee Valley Authority
UM-C	University of Missouri-Columbia
UM-Rolla	University of Missouri-Rolla
UC-X	University of California at X (X is the name of the specific UC campus.)
WG	Working Group (for this Study)

Appendix D

DOE Programs in Nuclear Science and Engineering Education

- *Reactor Fuel Assistance*, which comprised essentially all DOE's support to universities before 1997 and provides fresh fuel to, and takes back spent fuel from, the operating university research and training reactors in the United States

- *Nuclear Engineering/Health Physics Fellowships and Scholarships*, a competitive program which provides direct support to students studying in these fields

- *Radiochemistry*, under which DOE awards three-year grants to support education activities in the field of radiochemistry

- *Nuclear Engineering and Science Education Recruitment Program*, which is designed to increase the number of students entering nuclear engineering by providing a core curriculum to instruct high school science teachers in nuclear science and engineering topics

- *International Student Exchange Program (ISEP),* which sponsors U.S. students studying nuclear engineering to spend 3-4 months abroad doing research at nuclear facilities in Germany, France, and Japan

- *DOE/Industry Matching Grants*, through which DOE and participating companies provide matching funds, up to $60,000 from each side, to universities for use in funding scholarships, improving nuclear engineering and science curricula, and modernizing experimental and instructional facilities

- *Nuclear Energy Research Initiative (NERI)*, which uses peer-review selection of proposals to support fundamental research in nuclear science and engineering at universities, national laboratories, and in private industry

- *Nuclear Engineering Education Research (NEER) Grants*, a highly competitive, independently peer-reviewed research grants program aimed at university nuclear engineering programs

- *Reactor Use Sharing*, through which DOE enables universities with reactors to provide students and faculty from other institutions with access to their research facilities

- *Reactor Upgrades*, through which DOE provides assistance to universities to improve the operational and experimental capabilities of university research and training reactors

- *Innovations in Nuclear Infrastructure and Education (INIE),* a program which encourages strategic partnerships among the universities, the DOE national laboratories, and industry, and leverages resources made available by the partners.

Appendix E

Reports on Nuclear Science and Engineering Education and University-Based Research and Training Reactors

1. *University Research Reactors in the United States – Their Role and Value*, National Research Council, Washington, DC, 1988.

2. *U.S. Nuclear Engineering Education: Status and Prospects*, National Research Council, National Academy Press, Washington, DC, 1990.

3. *Nuclear Engineering in Transition: A Vision for the 21st Century*, J. Freidberg and M. Kazimi, Editors, Nuclear Engineering Department Heads Organization, December 1998.

4. *Manpower Supply and Demand in the Nuclear Industry*, Gary S. Was and William R. Martin, Editors, Nuclear Engineering Department Heads Organization, 1999.

5. *The Future of University Nuclear Engineering Programs and University Research and Training Reactors*, Michael L. Corradini, Marvin L. Adams, Donald E. Dei, Tom Isaacs, Glenn Knoll, Warren F. Miller, and Kenneth C. Rogers, Nuclear Energy Research Advisory Committee, U.S. Dept of Energy, Washington, DC, May 2000.

6. *Report of the University Research Reactor Task Force to the Department of Energy Nuclear Energy Research Advisory Committee*, Robert L. Long, Jose Luis M. Cortez, and Allen L. Sessoms, Nuclear Energy Research Advisory Committee, U.S. Department of Energy, April 2001.

7. *Nuclear's Human Element: Defining the Federal Government's Role in Sustaining a Vibrant U.S. University-Based Nuclear Science and Engineering Education System for the 21st Century*, Special Committee on Federal Investment in Nuclear Education, American Nuclear Society, December 2006.

8. *A Vision For Nuclear Science Education And Outreach For The Next Long Range Plan*, Lawrence Berkeley National Laboratory, Berkeley, CA, LBNL/PUB-970, January 2007.

9. *Review of DOE's Nuclear Energy Research and Development Program*, National Research Council, National Academies Press, Washington, DC, October 2007.

Appendix F

Reports on Nuclear Chemistry and Radiochemistry

1. *Report of the Ad Hoc Committee on Training of Nuclear and Radiochemists*, published by the ACS/DNCT, G. R. Choppin, Rolfe Herber, G. D. O'Kelley, 1979. More Information on this survey can be found on the DNCT Website at http://www.cofc.edu/~nuclear/HistoryofSummerSchools1997.htm.

2. *Training Requirements for Chemists in Nuclear Medicine, Nuclear Industry, and Related* Areas - Report of a Workshop, National Academy Press, Washington, DC, 1988.

3. *DOE's Isotope Production and Distribution Program*, E.S. Pierce, I.J. Green, H.R. Morgan and M.C. Wittels, AAAS Subcommittee of Senior Scientist and Engineer Volunteers, 1995.

4. *Status of Education in Nuclear and Radiochemistry in the U.S,* G. R. Choppin, S. B. Clark, H. Nitsche, J. Peterson, pp. 16-31, in Assessment of the teaching and applications in radiochemistry, Report of a technical meeting held in Antalya, Turkey, 10-14 June, 2002, International Atomic Energy Agency (IAEA), Vienna, 2002.

5. *Education in Nuclear Science: A Status Report and Recommendations for the Beginning of the 21st Century*, The DOE/NSF Nuclear Science Advisory Committee Subcommittee on Education, J. Cerny (Chair), U.S. Department of Energy-Office of Science-Office of Nuclear Physics; National Science Foundation-Division of Physics-Nuclear Physics Program, November 2004. http://www.sc.doe.gov/np/nsac/docs/NSAC_CR_education_report_final.pdf

6. *The Future of U.S. Chemistry Research: Benchmarks and Challenges 2007*, Committee on Benchmarking the Research Competitiveness of the United States in Chemistry, Board on Chemical Sciences and Technology, Division of Earth and Life Studies, National Research Council of the National Academies, The National Academies Press, Washington, D.C. This report has just been released and can be viewed at http://books.nap.edu/catalog.php?record_id=11866, where copies can also be ordered.

Appendix G

Listing of INIE Consortia
(Innovations in Nuclear Infrastructure and Education)

Western Nuclear Science Alliance
FY 2006 Funding: $1.25 Million
Oregon State University (Lead)
University of California-Davis
Washington State
University of California-Berkeley
Idaho State University
Reed College
University of California-Irvine
University of Utah
University of Nevada-Las Vegas

Consortium of Big-10 University Research and Training Reactors
FY 2006 Funding: $1.9 Million
Pennsylvania State University (Lead)
Ohio State University
University of Wisconsin-Madison
Univ. of Illinois at Urbana-Champaign
Purdue University
University of Michigan
University of Cincinnati

New England Consortium
FY 2006 Funding: $1.0 Million
Mass Institute of Technology (Lead)
Rhode Island Nuclear Science Center
University of Massachusetts – Lowell
Rensselaer Polytechnic Institute

Midwest Nuclear Science and Engineering Consortium
FY 2006 Funding: $1.34 Million
University of Missouri-Columbia (Lead)
University of Missouri-Rolla
University of Missouri-Kansas City
Linn State Technical College
Polytechnic University of Puerto Rico
Kansas State University

Multi-University Southeast INIE Consortium
FY 2006 Funding: $2.65 Million
North Carolina State University (Lead)
University of Maryland
Georgia Institute of Technology
University of Tennessee
University of Florida
University of South Carolina
South Carolina State University

Southwest Consortium of Research Reactors
FY 2006 Funding: $1.27Million
Texas A&M University (Lead)
University of Texas
University of New Mexico

Appendix H

Survey Responses from INIE Consortia

Table H-1: Reactor Power and Threat for Decommissioning

Reactor	Power	Under Threat?
MUSIC		
N. Carolina St	1 MW	No
U Florida	100 KW	No
U Maryland	250 KW	Yes
NEW ENGLAND		
MIT	5 MW	No
UMass-Lowell	1 MW	No
RINSC	2 MW	No
SOUTHWEST		
Texas A&M	1 MW	No
U Texas	1.1 MW	No
U New Mexico	5 W	No
BIG 10		
Penn St	1 MW	No
Wisconsin	1 MW	No
Purdue	1 MW	No
MIDWEST		
MURR (UM-C)	10 MW	No
U Missouri-Rolla	200 kW	No
Kansas St	250 kW, upgrade to 1.25 MW pending	No
WESTERN		
Oregon St	1.1 MW	No
Washington St	1 MW	No
UC-Davis	2 MW	No
UC-Irvine	250 KW	Yes
Reed	250 KW	No
Idaho St	0.005 KW	No

Table H-2: Most Important Reactor Needs

Reactor	Needs
MUSIC	Sustainable long-term funding to hire operations and technical staff and to upgrade equipment periodically.
New England	
MIT	Base support of operations
UMass-Lowell	e+ beam, neutron scattering, etc., in support of nanotech
RINSC	Upgrade to console, electronics
Southwest	Long-term funding for the following: (i) Sustained support for undergrad and graduate students (ii) Additional reactor research staff to mentor students (iii) Instrumentation upgrades and development
Big 10	Reactors are in good shape. Researchers are needed.
Purdue	Upgrades to reactor instrumentation
Midwest	
MURR (UM-C)	Operational: continued fuel support, including support for the successful conversion from HEU to LEU. R&D: support for developing U.S. source of Moly-99 and support to further enhance research and education
U Missouri-Rolla	Upgrade to digital instrumentation Computerization of procedures
Kansas St	Support staff and effluent monitoring
Western	
Oregon St	Replace secondary water system, neutron diffractometer, replace reflector assembly, sustainable long-term funding
Washington St	Reactor console and control upgrades
UC-Davis	Reactor fuel, retaining staff, maintaining equipment
UC-Irvine	Base operations support for staffing
Reed	Funding for sharing, operating, and instrumentation
Idaho St	Funding for operations and instrumentation

Table H-3: Minimum Funding Needed for Modernization

Reactor	Initial Funding Needed	Items For Initial Funding	Annual Funding Needed
MUSIC	Achieved earlier		$700-900K*
New England			
MIT	$3M		$100-200K
U MA Lowell	$200K		$20K
RINSC	$150K-$200K	Upgrade reactor console, electronics	$100K
Southwest			
Texas A&M	Currently OK		$75K
U Texas	$750K	Rehire research staff and students released due to INIE closeout and fund instrumentation projects	$250K
U New Mexico	$150K	Upgrade reactor Console	$15K
Big 10	Already upgraded w/INIE funds		$500K
Purdue	$120K	New console	$15K
Midwest			
MURR (UM-C)	$4.3M	Operational items**	Operational: $250K
U Mo Rolla	$800K		$100K
Kansas St	$200K	Support staff and effluent monitoring	$50K
West			
Oregon St	$1M	Replace secondary water system & reflector assembly, neutron diffractometer	$50-100K
Wash St	$750K		$50K
UC-Davis	$6M		$2M
UC-Irvine	Systems in good shape		$10K
Reed			$20-30K
Idaho St	$100K	Neutron detectors/cables, Health physics instrum.	$40K

* $20-50K is needed annually for reactor instrumentation maintenance.
$700-900K is needed to support personnel and R&D activities in all southeast university reactors.
Also, if NCSU implements a power upgrade, it would need approximately $1.5 M.
**Cooling tower modification ($2.0M), New Be reflector ($0.8M),
New Type B shipping cask for fuel and radioisotopes ($1.5M)

Table H-4: Average Annual Funding Received Since 2000

Reactor	Federal	Local	Industrial	Other
MUSIC				
N. Carolina St	$400K	$500K		$100-150K*
U Florida	$130K	$140K		$50-100K*
U Maryland	$100K	$0		$50-100K*
New England				
MIT	$1.1M	$0	$800K	
U Mass-Lowell	$56K		$175K	
RINSC	$100K	$800K	$50K-$100K	$0
RPI **	$54K			
Southwest				
Texas A&M	$400K	$200K	$300K	
U Texas	$300K	$250K	$25K	
U New Mexico	$15K	$25K	$0	
Big 10				
Penn St				
Wisconsin				
Purdue	$7.5K	$75K		
Midwest				
MURR (UM-C)	$1.2M[#]	$2.3M[##]		$10M[###]
U Mo Rolla	~$80K since 2004			
Kansas St	$30K	$200K	$5K	
West				
Oregon St	$500K	$500K		
Wash St	$52K	$358K	$115K	
UC-Davis	$1M		~$700K	$300K
UC-Irvine	$25K	$25K	$15K	
Reed	~$60K			
Idaho St	$42K	<$2K	$0	

*For MUSIC, "Other" refers to service income, such as activation analyses and irradiations.
**RPI (Rensselaer Polytechnic Institute) joined the New England Consortium in 2006.
[#]Estimated cost of average annual reactor fuel support for MURR from DOE
[##] State portion of funding for operational costs of MURR
[###] "Other" refers to operational costs to provide reactor services to industry, national laboratories, and academia.

Appendix I

Cross Sections Needed for Next-Generation Nuclear Reactor Systems

Fission Cross Section Measurements

- Np237, Pu238, Pu239, Pu240, Pu241, Pu242, Am241, Am242m, Am243, Cm244, Cm245

Capture Cross Section Measurements

- Si28, Np237, U238, Pu239, Pu240, Pu242

Inelastic Cross Section Measurements

- Na23, U238, Fe56

Average number of fission neutrons

- Pu238, Pu240

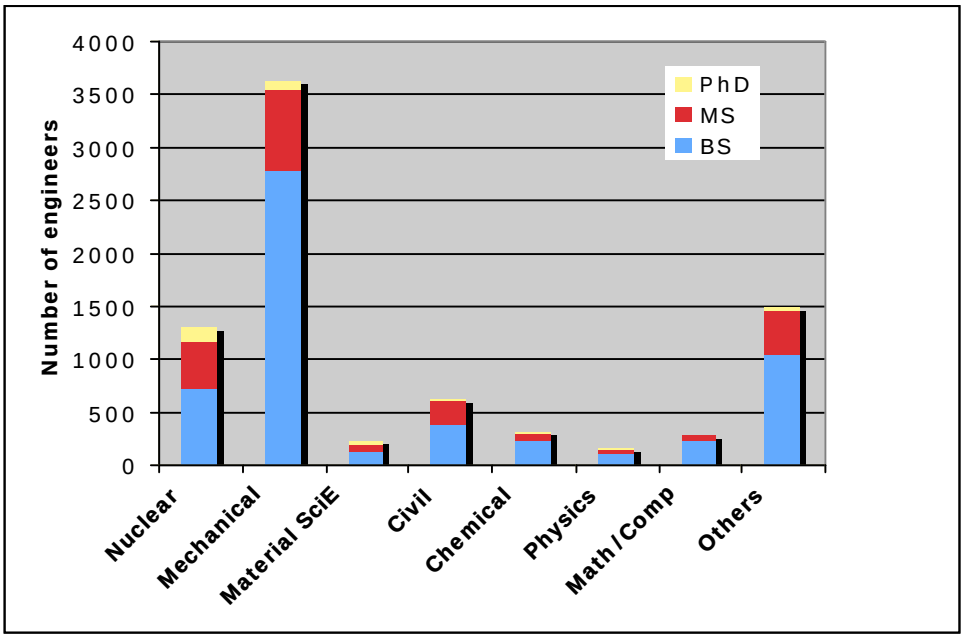
Source: *Reactor Research: 2007 Accomplishments*, Presentation at the October 2007 Annual GNEP Review, Tony Hill, Nuclear Reactor Research Team Leader for the Neutron and Nuclear Science Group, Los Alamos Neutron Science Center (LANSCE), Los Alamos National Laboratory. He also serves as the co-chair of the GNEP physics working group.

Nuclear physicists and nuclear chemists are prime contributors to both fundamental and applied research in these areas.

Appendix J

Information Related to Manpower in the Nuclear Power Industry

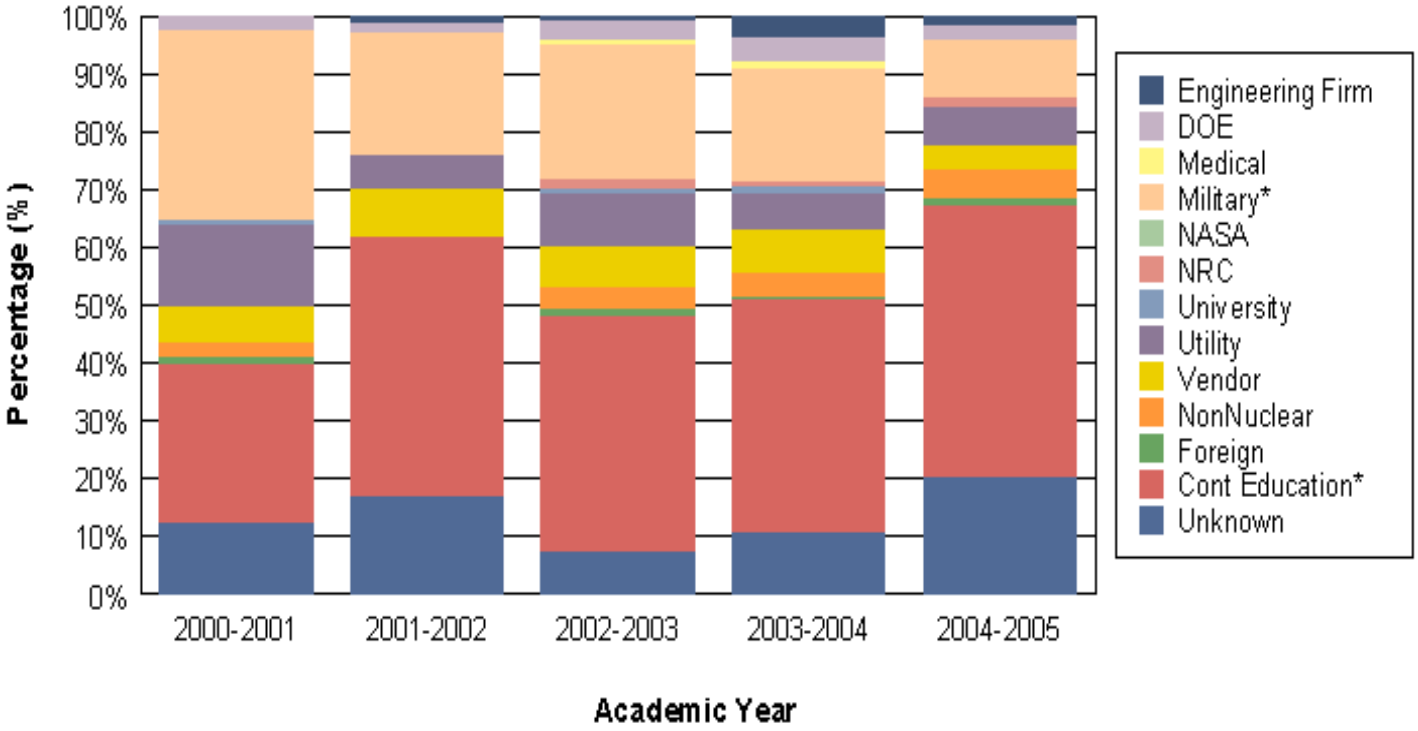
Fig. J-1. Engineers Currently Employed at Reactor Vendors



Data are current as of 2007. The total number of engineers is 7967, of which 5569 hold BS degrees, 2058 hold MS degrees, and 340 are Ph.D.'s.

Taken from *Reactor Engineers and Staffing Nuclear Plants*, Workshop Presentation to the Working Group by Professor John Lee, Department of Nuclear Engineering and Radiological Sciences, University of Michigan, Workshop held in Washington, D.C., July 2007.

Figs. J-2 and J-3. Initial Outcomes for Nuclear Engineering Bachelor's and Master's Degree Recipients Since 2000



Of the known activities for Bachelor's Degree recipients, continuing education and the military are the most popular. For Master's Degrees, it is continuing education. (Data from DOE-NE).

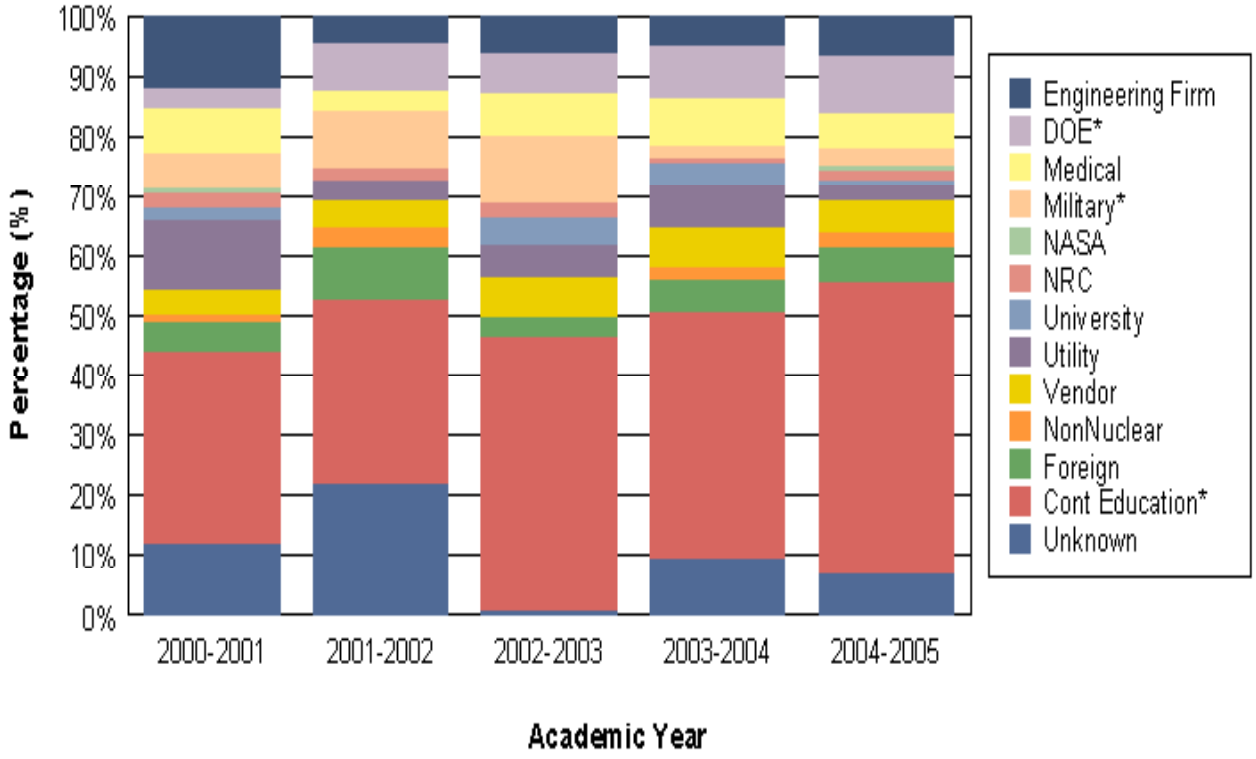
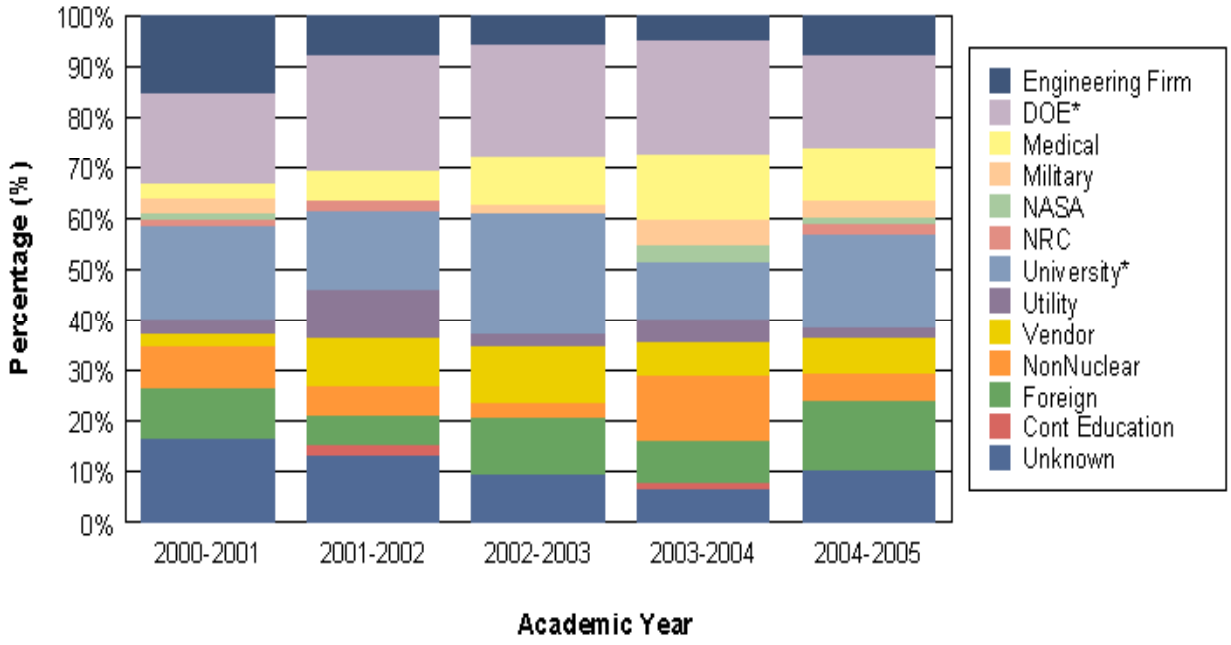


Fig. J-4. Initial Outcomes for Nuclear Engineering Ph.D. Degree Recipients Since 2000



Of the known activities for Ph.D. Degree recipients, careers in academe or with the DOE are most popular. (Data from DOE-NE).

Table J-1. Initial Employment or Other Post-Graduation Plans For Nuclear Engineering Degree Recipients, Class of 2006

	B.S. degree	M.S. degree	Ph.D. degree
Continued Study	135	77	12
Academic Employment	2	2	9
Federal Government Employment	10	21	5
DOE Contractor Employment	9	9	3
State and Local Government Employment	2	1	0
Nuclear Utility Employment	29	23	2
Other Nuclear-Related Employment	11	14	9
Other Business Employment	8	7	10
Foreign (non-U.S.) Employment	0	9	10
U.S. Military, Active Duty	47	4	2
Other Employment	3	1	1
Still Seeking Employment	8	5	0
Not Reported	82	41	7
Totals	346	214	70

Data obtained from *Nuclear Engineering Enrollments and Degrees Survey,* Oak Ridge Institute for Science and Education**,** http://orise.orau.gov/sep/files/NE_E_D_Brief60_03-07.pdf .

Table J-2. Nuclear Engineering Degrees by Year

	Degrees		
Year	B.S.	M.S.	Ph.D.
2006	346	214	70
2005	268	171	74
2004	219	154	75
2003	166	132	78
2002	195*	130	67
2001	120	145	80
2000	159	133	74
1999	199	142	86
1998	222	160	98

*Three programs were discontinued/out-of-scope after 2002 and not included in the 2003 survey. These three programs reported a total of 17 B.S. degrees in 2002.

Data obtained from *Nuclear Engineering Enrollments and Degrees Survey,* Oak Ridge Institute for Science and Education, http://orise.orau.gov/sep/files/NE_E_D_Brief60_03-07.pdf**.**

Table J-3. Nuclear Engineering Degrees by Academic Institution, 2006

State	Name of Institution	Degrees, Sept. 1, 2005 – Aug. 31, 2006 B.S.	M.S.	Ph.D.
CA	University of California, Berkeley	8	8	8
FL	University of Florida	10	5	0
GA	Georgia Institute of Technology	22	18	1
ID	Idaho State University	2	2	1
IL	University of Illinois at Urbana-Champaign	13	12	4
IN	Purdue University	21	15	5
KS	Kansas State University	13	2	0
MA	Massachusetts Institute of Technology	16	20	20
MA	University of Massachusetts, Lowell	2	1	0
MD	University of Maryland	5	2	0
ME	University of Maine	1	0	0
MI	University of Michigan	25	13	4
MO	University of Missouri - Columbia	0	2	2
MO	University of Missouri - Rolla	14	0	0
NC	North Carolina State University	21	5	6
NM	University of New Mexico	10	10	2
NV	University of Nevada, Las Vegas	3	2	1
NY	Rensselaer Polytechnic Institute	27	4	0
NY	United States Military Academy	14	0	0
OH	Air Force Institute of Technology	0	8	1
OH	Ohio State University	0	4	1
OH	University of Cincinnati	0	4	2
OR	Oregon State University	22	5	2
PA	Pennsylvania State University	31	11	3
SC	South Carolina State University	2	0	0
SC	University of South Carolina	0	8	0
TN	University of Tennessee	15	20	0
TX	Texas A&M University	31	9	1
TX	University of Texas	2	6	1
UT	University of Utah	0	3	0
WI	University of Wisconsin	16	15	5
	TOTALS:	**346**	**214**	**70**

Data obtained from *Nuclear Engineering Enrollments and Degrees Survey,* Oak Ridge Institute for Science and Education, http://orise.orau.gov/sep/files/NE_E_D_Brief60_03-07.pdf **.**

Table J-4. Retirement Eligibility Data for Engineers and Health Physicists at the NRC

Aggregate Summary for All Employees – Series 0800 (Engineering)					
Eligibility Status	**2008**	**2009**	**2010**	**2011**	**2012**
Not past Retirement Eligibility Date	1392	1336	1277	1222	1175
0 to 4.3 yr Past Retire. Elig. Date, Age + Years Service < 92	142	163	173	178	162
More than 4.3 yr Past Retire. Elig. Date, Age + Years Service < 92	17	24	34	40	54
Age + Years Service >= 92	132	160	199	243	292
Totals	**1683**	**1683**	**1683**	**1683**	**1683**

Totals include 0-4.3 yrs. Past Retirement Elig. Date, More than 4.3 yrs Past Retirement Elig. Date, and Age plus Years in Service >=92

0800 Series (Engineering) Past Retirement Eligibility

2008 291 - (17% of total number in job series)
2009 347 - (21% of total number in job series)
2010 406 - (24% of total number in job series)
2011 461 - (27% of total number in job series)
2012 508 - (30% of total number in job series)

Aggregate Summary for All Employees – Series 1306 (Health Physics)					
Eligibility Status	**2008**	**2009**	**2010**	**2011**	**2012**
Not past Retirement Eligibility Date	144	138	124	118	112
0 to 4.3 yr Past Retire. Elig. Date, Age + Years Service < 92	15	16	23	24	23
More than 4.3 yr Past Retire. Elig. Date, Age + Years Service < 92	6	6	5	4	3
Age + Years Service >= 92	12	17	25	31	39
Totals	**177**	**177**	**177**	**177**	**177**

1306 Series (Health Physics) Past Retirement Eligibility

2008 33 – (19% of total number in job series)
2009 39 – (22% of total number in job series)
2010 53 – (30% of total number in job series)
2011 59 – (33% of total number in job series)
2012 65 – (37% of total number in job series)

Data obtained from the Nuclear Regulatory Commission.

Appendix K

France's Approach to Training its Nuclear Workforce[1]

Companies, such as AREVA, have limited research activities. In France, most nuclear research is conducted by its Commissariat à l'Energie Atomique (CEA), with modest support from universities and its Centre National de le Recherche Scientifique. Within CEA, the Nuclear Energy Directorate (DEN) is in charge of nuclear R&D on reactors and fuel cycles, and it employs a staff of roughly 4,500. Turnover is approximately 5%; thus, DEN hires about 200 persons per year, half being technicians and half being engineers.

In 1976, Cogéma began as a subsidiary of CEA with technologies and facilities that France developed for its weapons program after World War II. It operates two large reprocessing plants at La Hague under contracts with both the military and the French electric utility, Electricité de France.

Usually, CEA hires technicians with a degree corresponding to two years study beyond college at Technical Institutes. For reprocessing research, CEA hires these technicians after they concentrate in chemistry, chemical physics, or some other analytical field at one of the Institutes, with some training in nuclear chemistry and radiochemistry. At CEA, the National Institute for Nuclear Science and Technology (INSTN) provides further training for periods of several weeks in such skills as remote handling of radioisotopes and working in glove boxes.

INSTN is the major organization for dispensing specific nuclear knowledge at different levels in France. Part of CEA for more than 50 years, it operates as an institution of higher education under the joint supervision of the Ministries of Education and Industry. The INSTN headquarters are located at the Saclay CEA Center and has branches at CEA locations in Cadarache, Marcoule and Grenoble.

CEA hires engineers who must study for an additional five years beyond college at engineering schools called Grandes Écoles, such as Polytechnics. It hires a lesser number of graduates from more traditional universities. Experts from CEA perform most of the instruction in nuclear chemistry and radiochemistry for students at the academic institutions. A large proportion of the engineers that CEA hires come with a doctoral degree, which involves about three years of research in a laboratory after the polytechnic or university degree. Annually, there are about 100 Ph.D. student or postdoctoral workers at CEA and it chooses the best to hire.

To summarize, France is able to maintain its competency in nuclear chemistry, radiochemistry, as well as nuclear engineering, by charging its governmental agency that does the reprocessing and related research, namely CEA, with educating the workforce according to the country's needs.

[1] Source: Dominique Warin, Radiochemistry and Process Department Head, CEA, France.