Manpower Supply and Demand in the Nuclear Industry

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NEDHO
A publication of the
Nuclear Engineering
Department Heads Organization

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Forward

This report contains the outcomes of two workshops and a survey addressing the supply of nuclear engineers by the nation's universities and the demand for these individuals by industry and the government. The report was compiled by the Nuclear Engineering Department Heads Organization (NEDHO) with the assistance of the American Nuclear Society (ANS) and the American Society for Engineering Education (ASEE) and with financial support from the Office of Nuclear Energy, Science and Technology of the U. S. Department of Energy. The wealth of information in this document is intended to provide educators, policymakers and industry leaders with a view of the manpower situation in nuclear engineering as seen from the perspectives f the respective institutions as of the year 2000. The challenge is how this information is used to provide for a viable and stable nuclear energy future for the United States.

Acknowledgements

The editors would like to acknowledge the assistance of the Manpower Subcommittee of NEDHO (A. Klein, G. Brown, J. Tulenko, C. Williamson, J. Valentine, J. Sherrard, and H. Dodds) for their help in developing and distributing the survey, improving the response rate and interpreting survey results. Greatly appreciated is the hard work of Michael Gibbons of ASEE for conducting the survey, Ted Quinn and Mike Diekman of ANS for their help with industry contacts and Leslie Barbour and Angie Howard of NEI for bringing visibility to the issue. Bill Magwood, Madeline Feltus and John Gutteridge were instrumental in making this report possible by providing support for the idea and for providing financial support for the manpower survey and the publication of this report.

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Manpower Report Summary

Background

The Nuclear Engineering Department Heads Organization (NEDHO) has been concerned for some time with the manpower issue in the nuclear industry. Enrollments in nuclear engineering had been declining at a steep rate since 1992.[1] Prior to 1998, employment in the industry appeared to be in reasonable balance with the supply of nuclear engineering graduates with demand lagging supply to a small extent. However, in the Spring of 1998, several nuclear engineering department chairs noted a sharp upturn in the demand for nuclear engineering graduates. As a result, Gary Was (University of Michigan), who was then Chair of NEDHO, contacted Bill Naughton of Commonwealth Edison, Inc. to recommend a workshop to focus attention on this issue. Naughton was a member of the committee that prepared the 1990 National Academy of Science (NAS) Report, *U.S. Nuclear Education: Status and Prospects*[2] and this report led directly to the innovative and effective DOE University/Industry Matching Grants Program. Since 1990, no effort had been made to update the supply/demand issue. The concern was that since the enrollment in nuclear engineering had contracted so sharply throughout most of the decade (a 72% decline in undergraduate enrollment and a 46% decline in M.S. enrollment), any increase in demand may cause a imbalance to arise. The problem is even more acute given the magnitude of the potential supply; only 527 students enrolled in undergraduate nuclear engineering programs vs. 1850 in 1992, and only 431 students enrolled in M.S. programs vs. 800 in 1992.

Discussions between Gary Was and Bill Naughton led to the proposal for a Workshop at the Winter 1998 ANS meeting in Washington D.C. The purpose of the workshop was to address the growing imbalance between supply and demand in the nuclear workplace, an imbalance that could lead to a manpower crisis in the coming years if not addressed by academe, industry, and the government. This imbalance may be fueled both by an increase in demand for nuclear engineers and a decline in enrollments and graduations from nuclear engineering departments and programs, and the intent of the workshop was to examine these issues and discuss potential solutions to address this imbalance.

Naughton and Was then invited Gregory M. Rueger (Pacific Gas and Electric Company) and William R. Martin (University of Michigan) to be the industry and university co-chairs, respectively. In addition, Naughton asked Robert C. Evans (Nuclear Energy Institute) to assist in

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[1] Nuclear Engineering in Transition: A Vision for the 21st Century, J. Freidberg and M. Kazimi, editors, Nuclear Engineering Department Heads Organization, December, 1998.

[2] U.S. Nuclear Engineering Education: Status and Prospects, national Research Council, National Academy Press, 1990.

organizing the workshop and to invite the keynote speaker. The ANS (Ted Quinn) gave their strong support for the workshop and provided assistance in making the arrangements for this activity at the Washington, DC meeting of the ANS. Section 1 of this report provides a complete description of the workshop entitled "Crisis in the Workplace - Manpower Supply and Demand in the Nuclear Industry: The Imbalance."

A continued strong demand for nuclear engineering graduates into the Fall of 1998 led NEDHO to propose to conduct a survey of both the supply of and demand for nuclear engineers. To be surveyed were nuclear engineering departments that supply nuclear engineers, and the organizations that employ nuclear engineers; the nuclear industry and government facilities and offices. The survey was drafted by NEDHO and distributed in February, 1999. The results of the survey were expected in the summer of 1999. Preliminary results indicated that the suspected imbalance was real and plans for a second workshop began. Section 3 of this report provides a description of the survey, the implementation procedure, the results and interpretation.

A second workshop entitled "Crisis in the Workplace II: Addressing the Growing Supply/Demand Gap in the Nuclear Industry," was planned for the Winter 1999 meeting in Long Beach. Organizers were Don W. Miller; Ohio State University, Ted Quinn; MDM Corporation, and Gary S. Was; University of Michigan. A one day workshop with invited talks and panel discussion was planned. Release of the manpower survey was also planned for this meeting. Section 2 of this report contains a complete description of the workshop including authors presentations and the identification of critical issues.

The following sections detail the two workshops and the survey on the manpower imbalance in the nuclear industry.

Executive Summary

<u>Crisis in the Workplace I</u>

The first workshop on the manpower crisis identified some 40 issues regarding the supply and demand of nuclear engineers. Among the 40 issues, there were 17 problems identified and 23 solutions proposed. The 17 problems were condensed into 4 classes of problems and are presented below.

P1. Imbalance in supply vs. demand. Enrollments and other key metrics for NE departments and programs are continuing to decline while demand from industry and government is expected to remain steady. This imbalance needs to be quantified and communicated to the community.

P2. Image of the discipline. Nuclear engineering is perceived to be a stagnating field with few opportunities for people who enter this field.

P3. Need to improve communication and cooperation. There needs to be more cooperative activities and better communication among the major constituencies (industry, academe, government) in nuclear engineering and related fields.

P4. Decline in university research reactors. The number of research reactors at universities is rapidly declining. This needs to be quantified and analyzed and its impact on NE departments needs to be assessed.

The 23 solutions discussed were condensed into 4 classes of solutions and are as follows:

S1. Quantify the imbalance in supply vs. demand. There appears to be little sense of urgency in the nuclear community outside academe regarding the future supply of nuclear engineering graduates vs. what appears to be a strong and steady demand for nuclear engineers by industry and government.

S2. Diversification of NE Curriculum. NE departments should diversify their activities while at the same time continuing to offer nuclear engineering curricula and maintaining their core competencies in nuclear power.

S3. Communication and marketing. The nuclear community needs to communicate to prospective students (and the public) the need for nuclear energy and the wide array of interesting and challenging career opportunities in industry, research, and government that are available today and will continue to be available for the foreseeable future.

S4. Partnerships. Universities, industry, and government need to form strategic partnerships to identify, analyze, and address major issues facing the nuclear community. For example, developing marketing plans and initiatives should be a centralized activity from which all participants could benefit but not everyone should attempt to do on their own.

Crisis in the Workplace II

The second workshop on "Crisis in the Workplace II: Addressing the Growing Supply/Demand Gap in the Nuclear Industry," identified 6 major issues that needed to be addressed to solve the supply/demand problem. They are as follows:

Issue 1: Declining enrollment. The declining enrollment is a continuing problem for university programs and for the industry. The enrollment has led to closures and mergers of departments and a reduction in the curriculum that can be offered.

Issue 2: Lack of excitement in the field. There is a lack of excitement and draw to the field. The field does not possess the allure of the computer field or the biomedical field and recruitment of students against these other more attractive disciplines is difficult and seldom successful.

Issue 3: Jobs vs. careers. Students are not just looking for jobs, they want exciting, challenging, and rewarding careers with a future. Students do not see the nuclear industry as providing these attributes to the jobs.

Issue 4: Low visibility. The discipline suffers from low visibility and a proper understanding of the breadth of the field. While the Vision Report articulated the true breadth of nuclear engineering programs in the U.S., this breadth is not understood nor appreciated.

Issue 5: Industry needs engineers of all types, not just nuclear. While a shortage of nuclear engineers was generally acknowledged, they comprise a small fraction of the engineers in all the nuclear companies. Today, there is a shortage of engineers of all types, not just nuclear. This is a significant concern on the part of the nuclear industry.

Issue 6: Recruiting of graduates needs improvement. It was generally acknowledged that industry needs to do a better job of recruiting graduates for positions in their companies. Graduates often receive little contact with engineers and know little of what is expected of them in their jobs.

Manpower Survey

The Manpower Survey resulted in a quantitative assessment of both the supply and the demand for nuclear engineers out to the year 2003. The results show that the demand – supply gap increases monotonically from 363 in 1998-1999 to 468 in 2002-2003. These figures are supported by the survey data which is summarized below.

For the supply side:

• 29 nuclear engineering departments continue to award either the B.S. or the M.S. in nuclear engineering or both,

• Nuclear engineering departments report a relatively stable supply of NE graduates through the year 2000-2001,

• Nuclear engineering departments will graduate an average of 110 B.S. students per year that have focused their studies in fission engineering, of which about 83 are expected to be available for employment in the nuclear industry,

• Nuclear engineering departments will graduate an average of 106 M. S. students per year that have focused their studies in fission engineering, of which about 80 are expected to be available for employment in the nuclear industry.

For the demand side, the survey results are summarized as follows:

• 52% of organizations contacted responded to the survey,

• 91% of respondents expect to hire nuclear engineers within the next 5 years,

• 78% of organizations will hire fresh graduates,

• 74% will hire non nuclear engineers with nuclear engineering knowledge,

• 61% are having difficulty recruiting nuclear engineers,

• The average yearly demand of 52% of the organizations contacted is 337 engineers with either a B.S. or a M.S. degree,

• Of 497 vacancies in 1998, 316 were filled by nuclear engineers.

In order to compare supply and demand, the demand of the non-respondents was assumed to follow the same profile as that of the respondents. That is, the demand for the entire nuclear industry was assumed to be 100/52 x that for the 52% responding. The results show that demand for nuclear engineers substantially outstrips the supply and the gap is expected to increase through the year 2003.

Section 1

Crisis in the Workplace

Manpower Supply and Demand in the Nuclear Industry: The Imbalance

ANS/NEI Workshop

American Nuclear Society 1998 Winter Meeting
Wednesday, November 18, 1998
Washington, D.C.

Introductory Talks

Robert C. Evans (Nuclear Energy Institute) opened the workshop, welcomed the audience and introduced the keynote speaker, the Honorable Joseph Knollenberg, who is U.S. Representative from the 11th Congressional district (Michigan).

William F. Naughton (Commonwealth Edison, Inc.) briefly described the events which led to this workshop. Naughton was a member of the committee that prepared the 1990 National Academy of Science (NAS) Report, *U.S. Nuclear Education: Status and Prospects* and this report led directly to the innovative and effective DOE University/Industry Matching Grants Program.

Mr. Knollenberg reviewed and number of initiatives and topics of longstanding interest to the nuclear community, including commercial nuclear power, the use of mixed uranium-plutonium oxide (MOX) fuel, non-proliferation, the ramifications of the Kyoto and Buenos Aires environmental agreements, greenhouse emissions, de-regulation of the electrical power industry, nuclear waste legislation, the Nuclear Energy Research Initiative (NERI) and the Nuclear Engineering Education Research (NEER) initiative, both of which were passed by Congress this past summer. Mr. Knollenberg was very supportive of nuclear power as a source of electricity and demonstrated a clear and well-articulated understanding of these issues, many of which are complex from both technical and societal standpoints. He praised the nuclear research bills (NERI and NEER), in particular remarking on the fact that both were peer-reviewed initiatives. He noted that the 1997 Report of the President's Committee of Advisors on Science and Technology (PCAST) criticized the Clinton administration for allowing the Department of Energy (DOE) research programs related to nuclear energy to whither, and he strongly supported the PCAST Report in its recommendation to increase research and development in nuclear safety, nuclear waste, non-proliferation, and economic viability. He noted that the NERI program, as a new program, would provide $19,000,000 towards this end and the NEER program would provide $11,000,000 for university-based research and support of university research reactors.

Carolyn Heising (Iowa State University) welcomed the workshop attendees on behalf of the American Nuclear Society (ANS) Professional Women organization, which was one of the co-sponsors for the workshop.

Panel I – Morning Session -- *Scope of the Supply/Demand Gap*

This panel session was intended to define the manpower issues, both from the standpoint of the supply side, namely nuclear engineering departments, and the demand side represented by employers in the nuclear community, including utilities, vendors, national laboratories, government agencies, and educational institutions. The panelists first gave short presentations regarding their experiences and perspectives on the manpower shortage. The panelists for the morning session included:

Ms. Amy Clark, Virginia Power
Dr. Barclay G. Jones, University of Illinois
Dr. Anthony J. Baratta, Penn State University
Mr. John Gutteridge, DOE University Programs
Dr. Jeffrey P. Freidberg, MIT
Dr. Arden L. Bement, Jr., Purdue University

Appendix A includes copies of the panelists' presentations and notes provided by the panelists subsequent to the workshop.

Following the presentations, the floor was opened for questions from the audience, although several questions were asked during the presentations. The panel discussion was concluded by having the audience contribute to a listing of the important issues raised during this session regarding the manpower problem. The issues are reproduced below as agreed to by the workshop panelists with minor editing for clarity. A later section of this report analyzes these issues and recommends appropriate follow-on actions. The issues raised in the morning session are listed below with numbers for subsequent reference:

- Nuclear Engineering (NE) departments have experienced precipitous declines in enrollments at all levels over the past decade although some departments reported modest increases during the past year. This needs to be quantified and substantiated with data. [p1]
- The number of NE departments and programs has declined substantially over the past decade. [p2]
- The number of university research reactors has declined precipitously over the past decade. [p3]
- NE departments are perceived to focus on nuclear power, even when the departments are considered to be very diverse. [p4]
- There is a poor public image of the discipline of nuclear engineering for students, parents, and colleagues (including deans). [p5]
- Placement offices at many engineering schools do not provide assistance to potential employers, nor do they assist graduating students looking for employment. This could be a result of long term neglect of placement offices by the nuclear industry. [p6]
- The future need for nuclear engineers is not well-articulated. [p7]

- There is a lack of industry support for research in NE departments. [p8]
- For NE departments to survive, one must think in terms of actions to address infrastructure needs for the short-term (1-4 years), medium-term (4-8 years), and the long-term (8-15 years). [p9]
- There has been a sharp decline in research support for NE departments from Electric Power Research Institute (EPRI) and the national laboratories. [p10]
- There needs to be stronger partnerships between industry, universities, and the government. [p11]
- The looming manpower crisis needs to be communicated to the industry. [p12]
- There is a lack of urgency among industry decision-makers regarding the manpower crisis that is looming, primarily due to a lack of quantitative facts regarding this issue. [p13]
- Due to de-regulation and the need to be more competitive, utilities are eliminating training programs for new hires, forcing them to hire experienced graduates. Lack of nuclear training programs also makes it more difficult to train engineers from other fields, such as mechanical engineering, to take on positions requiring a knowledge of nuclear engineering. [p14]
- There is a perception of insufficient opportunities in the nuclear industry to attract new employees and to attract prospective students into the field. [p15]
- There will be a need for new nuclear engineers even if no new plants are built. This need has not been articulated and should be quantified with data from the nuclear industry. [p16]
- The “glamor factor” is working against nuclear energy as it is not perceived to be a challenging and interesting field, with a limited future and dim prospects for responsible and high paying jobs. [p17]

Panel II - Afternoon Session – *Exploring Solutions*

This panel session was intended to discuss solutions to the manpower imbalance, perhaps addressing many of the issues raised in the morning panel. As with the morning panel, the panelists first gave short presentations regarding their experiences and thoughts about addressing the manpower imbalance. The panelists for the afternoon session included:

Mr. Carl D. Terry, Niagara Mohawk Power Corp.
Mr. John Kotek, DOE Associate Director for Technology
Dr. Thomas Isaacs, Lawrence Livermore National Laboratory
Dr. Andrew C. Klein, Oregon State University
Dr. Gilbert A. Emmert, University of Wisconsin
Dr. Donald J. Dudziak, North Carolina State University

Similar to the morning session, a panel discussion followed the presentations and the following list summarizes the potential solutions and remedies suggested during the afternoon session. These are discussed in more detail later and are presented here as summarized at the workshop. Potential solutions 22 and 23 were added after the workshop was adjourned.

- NE departments need to diversify. It is risky to associate an academic department with a single technology, such as nuclear power. [s1]
- The benefits and opportunities presented by nuclear energy need to be articulated and promoted. [s2]
- The nuclear community need to reach prospective high school students early and often. Marketing is key. [s3]
- High school teacher workshops in nuclear energy need to be revitalized and should include industry and government involvement as well as university participation. [s4]
- Other resources should be tapped to reach prospective students, including retired nuclear professionals and emeritus faculty. [s5]
- High school (and grade school) textbooks and curricula should include a balanced treatment of nuclear power and radiation. [s6]
- A program similar to the successful “Space Grant” and “Sea Grant” programs should be initiated at universities. [s7]
- The web should be exploited for linking potential employers with prospective employees in nuclear engineering fields. [s8]
- The curriculum could be made more interesting to students by adding options such as international opportunities, internships, and co-op programs. [s9]
- Undeclared freshmen are a large and readily available source of qualified students. [s10]
- There needs to concerted action by leaders of industry, national laboratories, and the government to support actions to address this manpower crisis. [s11]
- High school teacher workshops are important. [s12]
- NE departments should communicate with periodic mailing and other means with high school teachers and counselors. [s13]
- NE departments should consider proactive activities such as honors programs or programs to encourage undergraduate students to get involved in real research projects. [s14]
- Undergraduate scholarships and summer internships are very important for attracting students into a department. [s15]
- Employment opportunities need to be communicated better, such as through an ANS website for example. [s16]
- Departments should enlist help of industry, such as through their advisory boards. [s17]
- Distance learning should be considered both to increase overall enrollments as well as to develop closer ties with utilities. [s18]

- NE departments should consider highly visible events to help improve public perception for nuclear energy as well as to promote the departments for prospective students. [s19]
- NE faculty and nuclear professionals should participate in science fairs. [s20]
- A special session should be planned for the Boston ANS meeting in June 1999 to discuss the key issues that have been identified in this workshop and a draft action plan that should be developed over the next couple months. [s21]
- [added] The federal government should be urged to recognize and accept its critical role to nurture and sustain for the long-term an adequate supply of expertise in nuclear-related fields, including nuclear energy, non-proliferation, waste management, health physics, and stockpile stewardship. [s22]
- [added] An independent survey of manpower supply an demand in the nuclear industry should be conducted. This survey should obtain data regarding enrollments, number of undergraduate and graduate degrees, faculty headcount, number of accredited degree programs, and the number of departments, as well as the projected number of new hires over the next 5-10 years. [s23]

Preliminary Classification of Problems and Potential Solutions

The workshop was well-attended, with perhaps 40-50 attendees, with representation from universities, industry, and government, including a number of students. The problems and potential solutions identified above were not prioritized or discussed in depth by the audience, but there seemed to be agreement that the list was reasonably complete and that the next step should be to examine these issues in more detail and decide which should be further developed and who should participate in these activities.

The following is an attempt to classify and group the 40 identified issues into a more manageable collection of issues which can then be discussed in depth by separate groups.

Classification of 17 “Problems”:

P1. Imbalance in supply vs. demand. Enrollments and other key metrics for NE departments and programs are continuing to decline while demand from industry and government is expected to remain steady. This imbalance needs to be quantified and communicated to the community.

P2. Image of the discipline. Nuclear engineering is perceived to be a stagnating field with few opportunities for people who enter this field.

P3. Need to improve communication and cooperation. There needs to be more cooperative activities and better communication among the major constituencies (industry, academe, government) in nuclear engineering and related fields.

P4. Decline in university research reactors. The number of research reactors at universities is rapidly declining. This needs to be quantified and analyzed and its impact on NE departments needs to be assessed.

Classification of 23 "Solutions":

S1. Quantify the imbalance in supply vs. demand. There appears to be little sense of urgency in the nuclear community outside academe regarding the future supply of nuclear engineering graduates vs. what appears to be a strong and steady demand for nuclear engineers by industry and government.

S2. Diversification of NE Curriculum. NE departments should diversify their activities while at the same time continuing to offer nuclear engineering curricula and maintaining their core competencies in nuclear power.

S3. Communication and marketing. The nuclear community needs to communicate to prospective students (and the public) the need for nuclear energy and the wide array of interesting and challenging career opportunities in industry, research, and government that are available today and will continue to be available for the foreseeable future.

S4. Partnerships. Universities, industry, and government need to form strategic partnerships to identify, analyze, and address major issues facing the nuclear community. For example, developing marketing plans and initiatives should be a centralized activity from which all participants could benefit but not everyone should attempt to do on their own.

Grouping of Problems and Solutions

The 17 problems and 23 solutions identified in the workshop fall into broad categories defined above.

Problems Arranged by Problem Areas

P1 Imbalance in supply vs. demand. Enrollments and other key metrics for NE departments and programs are continuing to decline while demand from industry and government is expected to remain steady. This imbalance needs to be quantified and communicated to the community.

p1 Nuclear Engineering (NE) departments have experienced precipitous declines in enrollments at all levels over the past decade although some departments reported modest increases during the past year. This needs to be quantified and substantiated with data.

p2 The number of NE departments and programs has declined substantially over the past decade.

p7 The future need for nuclear engineers is not well-articulated.

p12 The looming manpower crisis needs to be communicated to the industry.

p13 There is a lack of urgency among industry decision-makers regarding the manpower crisis that is looming, primarily due to a lack of quantitative facts regarding this issue.

p14 Due to de-regulation and the need to be more competitive, utilities are eliminating training programs for new hires, forcing them to hire experienced graduates. Lack of nuclear training programs also makes it more difficult to train engineers from other fields, such as mechanical engineering, to take on positions requiring a knowledge of nuclear engineering.

p16 There will be a need for new nuclear engineers even if no new plants are built. This need has not been articulated and should be quantified with data from the nuclear industry.

P2 Image of the discipline. Nuclear engineering is perceived to be a stagnating field with few opportunities for people who enter this field.

p4 NE departments are perceived to focus on nuclear power, even when the departments are considered to be very diverse.

p5 There is a poor public image of the discipline of nuclear engineering for students, parents, and colleagues (including deans).

p6 Placement offices at engineering schools do not provide assistance to potential employers looking for graduates, nor do they assist graduating students looking for employment. This could be a result of long term neglect of placement offices by the nuclear industry.

p15 There is a perception of insufficient opportunities in the nuclear industry to attract new employees and to attract prospective students into the field.

p17 The “glamor factor” is working against nuclear energy as it is not perceived to be a challenging and interesting field, with a limited future and dim prospects for responsible and high paying jobs.

P3 Communication and cooperation. There needs to be more cooperative activities and better communication among the major constituencies (industry, academe, government) in nuclear engineering and related fields.

p8 There is a lack of industry support for research in NE departments.

p10 There has been a sharp decline in research support for NE departments from EPRI and the national laboratories.

p11 There needs to be stronger partnerships between industry, universities, and the government.

P4 Research reactors. The number of research reactors at universities is rapidly declining. This needs to be quantified and analyzed and its impact on NE departments needs to be assessed.

p3 The number of university research reactors has declined precipitously over the past decade.

Solutions Arranged by Solution Strategies

S1 Quantify the imbalance in supply vs. demand. There appears to be little sense of urgency in the nuclear community outside academe regarding the future supply of nuclear engineering graduates vs. what appears to be a strong and steady demand for nuclear engineers by industry and government.

s23 An independent survey of manpower supply an demand in the nuclear industry should be conducted. This survey should obtain data regarding enrollments, number of undergraduate and graduate degrees, faculty headcount, number of accredited degree programs, and the number of departments, as well as the projected number of new hires over the next 5-10 years.

p9 For NE departments to survive, one must think in terms of actions to address infrastructure needs for the short-term (1-4 years), medium-term (4-8 years), and the long-term (8-15 years).

s21 A special session should be planned for the Boston ANS meeting in June 1999 to discuss the key issues that have been identified in this workshop and a draft action plan to be developed over the next couple months.

S2 Diversification of NE Curriculum. NE departments should diversify their activities while at the same time continuing to offer nuclear engineering curricula and maintaining their core competencies in nuclear power.

s1 Nuclear Engineering (NE) departments need to diversify. It is risky to associate an academic department with a single technology, such as nuclear power.

s6 High school (and grade school) textbooks and curricula should include a balanced treatment of nuclear power and radiation.

s7 A program similar to the successful “Space Grant” and “Sea Grant” programs should be initiated at universities.

s9 The curriculum could be made more interesting to students by adding options such as international opportunities, internships, and co-op programs.

s15 Undergraduate scholarships and summer internships are very important for attracting students into a department.

s18 Distance learning should be considered both to increase overall enrollments as well as to develop closer ties with utilities.

S3 Communication and marketing. The nuclear community needs to communicate to prospective students (and the public) the need for nuclear energy and the wide array of interesting and challenging career opportunities in industry, research, and government that are available today and will continue to be available for the foreseeable future.

s2 The benefits and opportunities presented by nuclear energy need to be articulated and marketed.

s3 The nuclear community need to reach prospective high school students early and often. Marketing is key.

s4 High school teacher workshops in nuclear energy need to be revitalized and should include industry and government involvement as well as university participation.

s5 Other resources should be tapped to reach prospective students, including retired nuclear professionals and emeritus faculty.

s10 Undeclared freshmen are a large and readily available source of qualified students.

s12 High school teacher workshops are important.

s13 NE departments should communicate with periodic mailings and other means with high school teachers and counselors.

s14 NE departments should consider proactive activities such as honors programs or programs to encourage undergraduate students to get involved in real research projects.

s19 NE departments should consider highly visible events to help improve public perception for nuclear energy as well as to promote the departments for prospective students.

s20 NE faculty and nuclear professionals should participate in science fairs.

S4 Partnerships. Universities, industry, and government need to form strategic partnerships to identify, analyze, and address major issues facing the nuclear community. For example, developing marketing plans and initiatives should be a centralized activity from which all participants could benefit but not everyone should attempt to do on their own.

s8 The web should be exploited for linking potential employers with prospective employees in nuclear engineering fields.

s11 There needs to concerted action by leaders of industry, national laboratories, and the government to support actions to address this manpower crisis.

s16 Employment opportunities (and hiring opportunities) need to be communicated better, and the ANS should consider developing a central jobs/graduates website for potential employers and graduating students.

s17 Departments should enlist help of industry, such as through their advisory boards.

s22 The federal government should be urged to recognize and accept its critical role to nurture and sustain for the long-term an adequate supply of expertise in nuclear-related fields, including nuclear energy, non-proliferation, waste management, health physics, and stockpile stewardship.

Related Topics

There are a number of activities that are underway that are directly or indirectly related to the issues and concerns addressed by this workshop. Some of these are referenced in this report and/or the attached presentations but are included here for completeness and convenience.

ASEE Survey and Report on Manpower. The last review and analysis of manpower in the nuclear industry was performed as part of the 1990 report of the National Academy of Sciences, *U.S. Nuclear Engineering Education: Status and Prospects*. Due to the long lead times associated with NAS reports, the American Society for Engineering Education (ASEE) was approached by the Nuclear Engineering Department Heads Organization (NEDHO) to conduct a survey and issue a report on manpower issues in the nuclear industry. The ASEE has indicated a willingness to do this and the ANS (Ted Quinn) has pledged support for this activity. DOE (John Gutteridge) has agreed to provide the funding needed to get this effort completed during 1999. Gary Was (University of Michigan) coordinated this initiative for the ANS and NEDHO. The survey questions regarding manpower supply and demand and sent to nuclear engineering departments and to industry are provided in Section 3 of this report.

NEDHO Vision Document. NEDHO, under the leadership of Jeffrey Freidberg, is preparing a vision document for Dr. Ernest Moniz of DOE. This document is nearly complete and is pertinent to a number of the issues raised in this workshop. Dr. Freidberg's presentation, which is included in Appendix A, refers to this document, which is entitled *Nuclear Engineering in Transition: A Vision for the 21st Century*.

NEA Activity. The Nuclear Energy Agency (NEA), an independent agency of the OECD whose members work on programmatic and scientific nuclear issues of international importance, is sponsoring a major survey and analysis of education in the nuclear field as a result of concerns about the adequacy of nuclear education in its member countries, including the U.S. This survey was initiated in spring 1998 and is summarized in Tom Isaacs' presentation which is included in Appendix A. This survey has collected considerable data from 16 participating countries and much of this information complements the information being collected by the ASEE.

European Commission Activity. A comprehensive survey is being conducted a French company, SOFRES Conseil, to "assess the status, recent evolution, and future needs of nuclear expertise in Europe and other leading countries, with the aim to build a solid knowledge base to be used, among other applications, for specifying future European Commission research activities". This survey was commissioned by the European Commission, DG XII (Science, Research and Development). According to Tom Isaacs, the results of this survey will be incorporated into the above-referenced NEA report on nuclear education.

Next Steps

This document should be reviewed by members of the nuclear community and used to develop an action plan of specific solution strategies:

- what should be done,
- who needs to contribute,
- when should it be completed, and
- who is responsible for getting it done.

The draft action plan should be developed over the next few months and presented and discussed at a special session of the ANS Summer Conference in Boston in June 1999. Each solution strategy will have its own task group of representatives from industry, government, and academe who are responsible for completing the task on schedule.

List of Panelists: Crisis in the Workplace I

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Section 2

Crisis in the Workplace II

Addressing the Growing Supply/Demand Gap in the Nuclear Industry

ANS/DOE Workshop

American Nuclear Society 1999 Winter Meeting
Tuesday, November 16, 1999
Long Beach, CA

Introduction

The purpose of the workshop is to define and address the growing gap between the supply of nuclear engineers from the nation's nuclear engineering departments, and the demand for these engineers by industry and government. The first workshop on this subject was held at the 1998 Winter ANS meeting and brought to light the potential growing supply/demand imbalance. This workshop will characterize and quantify the current and future extent of the gap, solicit solutions from both the nuclear industry and from other industries that have faced similar problems, and identify specific strategies to achieve the solutions. Encouraged to participate were all organizations that hire and employ nuclear engineers: nuclear utilities, reactor manufacturers and suppliers, government laboratories, architect engineers, etc., and the nation's nuclear engineering departments that supply provide the workforce.

The workshop consisted of four sessions with a total of 12 talks. Session 1 was directed at obtaining a more quantitative definition of the supply/demand gap. Session 2 included speakers that have addressed the issue of declining interest in other fields that were critical to their primary business. Sessions 3 and 4 addressed industry perspectives including how the supply has or has not balanced with their demand and how to address the current and projected situation. Panel Discussions were held at the end of sessions 2 and 4 and included as panelists, all speakers in all of the sessions; session 1 and 2 speakers in the morning panel and sessions 3 and 4 in the afternoon panel.

A detailed listing of the speakers in this workshop is provided at the end of the section and copies of the panelists' presentations and notes provided by the panelists subsequent to the workshop are provided in Appendix B of the report.

Session 1 - Scope of the Supply/Demand Gap

This session was intended to define the manpower issues, primarily from the standpoint of the supply side, namely nuclear engineering departments. The speakers for the morning session included:

William Martin, Professor of Nuclear Engineering and Radiological Sciences, University of Michigan, "Nuclear Manpower Supply and Demand: Status and Prospects."
Tom Isaacs, Policy Planning and Special Studies Office, Lawrence Livermore National Laboratory, "Survey and Analysis of Education in the Nuclear Field."
Gary S. Was, Professor of Nuclear Engineering and Radiological Sciences, University of Michigan, "Manpower Supply and Demand in the Nuclear Industry."

Session 2 – Solutions from Nuclear and Other Industries

This session presented experience from nuclear and other industries in dealing with fields in which student interest is declining and therefore, are experiencing few numbers of graduates with the requisite backgrounds.

Dr., Madeline Feltus, Associate Director of Technology, Office of Nuclear Energy, Science and Technology, U.S. Department of Energy DOE's Nuclear Energy University Programs, "Educating the Next Generation of Nuclear Engineering Professionals."
Bill Sorensen, Executive Director, Foundry Educational Foundation, "A Secret Weapon in Landing Top Talent."
Richard Clegg, Head of Corporate Research and Technology, BNFL, "BNFL Centre of Excellence in Radiochemistry at Manchester University."

PANEL DISCUSSION for Sessions 1 and 2

A 30 minute panel discussion consisted of a freeform exchange between the audience and the panelists. While a number of questions were discussed, a few key issues were identified as major points of interest and concern among the audience and panelists alike. They were as follows:

Issue 1: Declining enrollment. The declining enrollment is a continuing problem for university programs and for the industry. The enrollment has led to closures and mergers of departments and a reduction in the curriculum that can be offered.

Issue 2: Lack of excitement in the field. There is a lack of excitement and draw to the field. The field does not possess the allure of the computer field or the biomedical field and recruitment of students against these other more attractive disciplines is difficult and seldom successful.

Issue 3: Jobs vs. careers. Students are not just looking for jobs, they want exciting, challenging, and rewarding careers with a future. Students do not see the nuclear industry as providing these attributes to the jobs.

Session 3 - Potential Solutions and Strategies 1

This session was intended to discuss solutions to the manpower imbalance, perhaps addressing many of the issues raised in the morning panel. The speakers for this session included:

Jack Brons, Special Assistant to the President, Nuclear Energy Institute, "An Industry Perspective of the Nuclear Manpower Situation."
Camille Kovach, Manager, Organizational Development, Westinghouse Electric Company, "Electrifying the Future: Attracting Engineers to the Nuclear Discipline."
Ann Winters, Manager, Educational Assistance Program, National Academy for Nuclear Training, "National Academy Educational Assistance Program – Part of the Solution."

Session 4 - Potential Solutions and Strategies 2

Mujid Kazami, Professor, Nuclear Engineering, Massachusetts Institute of Technology, "Nuclear Engineering in Transition: A Vision for the 21st Century."
Rick Westcott, Nuclear Operations, Omaha Public Power, "What Utilities can do to Support their Manpower Needs for the Coming Years."
Christine DeBenedetto, San Onofre Nuclear Power Station, "Developing Summer Hire Programs

PANEL DISCUSSION for Sessions 3 and 4

Similar to the morning panel discussion, this panel discussion consisted of a freeform exchange between the audience and the panelists. The following are the major issues raised by panelists and the audience and are continued from the list begun in the morning panel discussion:

Issue 4: Low visibility. The discipline suffers from low visibility and a proper understanding of the breadth of the field. While the Vision Report articulated the true breadth of nuclear engineering programs in the U.S., this breadth is not understood nor appreciated.

Issue 5: Industry needs engineers of all types, not just nuclear. While a shortage of nuclear engineers was generally acknowledged, they comprise a small fraction of the engineers in all the nuclear companies. Today, there is a shortage of engineers of all types, not just nuclear. This is a significant concern on the part of the nuclear industry.

Issue 6: Recruiting of graduates needs improvement. It was generally acknowledged that industry needs to do a better job of recruiting graduates for positions in their companies. Graduates often receive little contact with engineers and know little of what is expected of them in their jobs.

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Section 3

Survey of Manpower Supply and Demand in the Nuclear Industry

Conducted by the American Society for Engineering Education (ASEE)

for the Nuclear Engineering Department Heads Organization (NEDHO)

Financial support provided by: Office of Nuclear Energy, Science and Technology, U.S. Department of Energy

October, 1999

Introduction

Through financial support by the Department of Energy (DOE) and technical guidance of the Nuclear Engineering Department Heads Organization (NEDHO) and the American Nuclear Society (ANS), the American Society for Engineering Education (ASEE) conducted a survey of degree-granting nuclear engineering programs (supply) and companies that hire nuclear engineers (demand) to assess the relation between the two. A set of survey questions was developed by NEDHO that was reviewed by both ANS and ASEE. The questionnaire was mailed out in February, 1999, with a due date of April. By the due date, most all questionnaires sent to universities had been completed, but only a small fraction of those sent to industry had been returned.

The last review and analysis of manpower in the nuclear industry was performed as part of the 1990 report of the National Academy of Sciences, *U.S. Nuclear Engineering Education: Status and Prospects*. Due to the long lead times associated with NAS reports, the American Society for Engineering Education (ASEE) was approached by the Nuclear Engineering Department Heads Organization (NEDHO) to conduct a survey and issue a report on manpower issues in the nuclear industry. The ASEE has indicated a willingness to do this and the ANS (Ted Quinn) has pledged support for this activity. DOE (John Gutteridge) has agreed to provide the funding needed to get this effort completed during 1999. Gary S. Was (University of Michigan) coordinated this initiative for the ANS and NEDHO.

Survey and Procedure

The survey consisted of two questionnaires designed to obtain quantitative data on the supply of nuclear engineering graduates and the demand for those graduates. The goal was to address the need for nuclear engineers in the nuclear industry. As such, the questions were focused about a definition of nuclear engineering that is relevant to the nuclear industry. For purposes of the survey, a nuclear engineer was defined as an engineer that deals with reactor physics, reactor engineering, reactor safety, fuel management, handling and disposal or radiological health engineering (health physics), or any part of the nuclear fuel cycle. This definition excludes the broader activities of nuclear engineering departments such as plasma physics, materials processing, medical applications of radiation, etc. While these are important areas in their own right, the belief was that determination of the companies who demand these engineers would be difficult to do and would extend well beyond the nuclear power field. Further, the survey was confined to the graduation and hiring of B.S. and M.S. degree holders and does not include technical degrees or Ph.Ds. The survey questionnaires sent to nuclear engineering departments and to industry appear at the end of Section 3.

The survey was sent to 32 nuclear engineering departments and 168 companies that fit the description of a firm that would hire nuclear engineers or were known to hire nuclear engineers. The survey was distributed in the month of February, 1999 and requested a response within 2 months. At the end of the request period, the number of responses was very low. Michael Gibbons of ASEE initiated contact with those companies that had not responded. Part of the contact was to assess whether the survey was received and whether it had made it to the correct individual within the organization. A subcommittee within NEDHO assisted in contacting the not-respondants. This process continued until September 30, 1999 at which point the survey was closed.

Responses were compiled by Michael Gibbons in an Microsoft Excel spreadsheet and in a Microsoft Word document. The results were checked by ASEE and forwarded in October, 1999 to the NEDHO Manpower Subcommittee (consisting of A. Klein, G. Brown, J. Tulenko, C. Williamson, J. Valentine, J. Sherrard, H. Dodds, W. Martin and G. Was) for analysis. Analysis was completed by the end of October for presentation at the Manpower Workshop.

Table 1. Summary of Responses from Nuclear Engineering Departments.

	1998-99	1999-2000	2000-2001	
B.S. grads	151	179	153	
% B.S. in nuclear	68	67	69	
B.S. grads in nuclear	103	124	105	
Available B.S. grads in nuclear	77	93	79	
M.S. grads	200	220	219	
% M.S. in nuclear	48	49	52	
M.S. grads in nuclear	96	108	114	
Available M.S. grads in nuclear	72	81	86	
	Freshman	Sophomore	Junior	Senior
Class size	122	118	178	200
# responding with a number	15	18	22	21
Year of first class	7	8	5	0

Survey Results

Of the 32 nuclear engineering departments contacted, 28 responded to the survey. Of the 4 non-responding institutions, only the University of Idaho still graduated B.S. and M.S. nuclear engineers. Hence, 28 of 29 departments with active programs (97%) responded to the survey. Table 1. summarizes the results of the responses from universities and the response from each university is presented at the end of this section.

Of the 168 companies to which surveys were mailed, contact was established (defined by either a completed survey or phone or fax contact with the company) with 145. Of those 145 companies with which contact was established, 76 (52%) responded. Responses are summarized in Table 2 and the responses from each company are presented at the end of this section. The complete list of 168 companies , their response status and their responses to question 8 are given at the end of Section 3.

Table 2. Summary of Responses from the Nuclear Industry.

Question	Responses	Percent
Employs nuclear engineers	70 of 76	92%
Total number of engineers employed by organization	40,589	
Total nuclear engineers employed by organization	2,666	
Hires new graduates from school	52 of 67	78%
Require a minimum number of post-graduate work	15 of 21	71%
Hire non nuclear engineers with nuclear knowledge	51 of 69	74%
Plan to hire nuclear engineers within next 5 years	60 of 66	91%
Having difficulty recruiting nuclear engineers	40 of 66	61%
Nuclear engineers needed in 1998	497	
Positions filled by nuclear engineers in 1998	316	
Average yearly demand from 1998-2002	337	
Have tasks changed over last 5 years	28 of 65	43%

Interpretation of Data

In order to arrive at the balance between supply and demand for nuclear engineers in the U.S., a minimal level of data interpretation is required. The reasoning is explained in the following paragraphs and graphs.

Supply

The data in Table 1 shows the total number of anticipated B.S. and M.S. graduates for the 1998-99, 1999-2000 and 2000-2001 academic years. Also shown are the % of graduates studying fission engineering and the total number of graduates with expertise in fission engineering. This distinction is important since many departments have broadened their curriculum such that students may specialize in areas outside of fission/power engineering (such as medical applications, plasma processing, materials, etc.). These students are assumed to be unavailable to the job market in nuclear engineering as defined above. Therefore, the number of graduates at each level that are educated according to the definition of a nuclear engineer is the product of the total number of graduates and those that studied fission engineering. Further, not all graduates interested in fission engineering will be available for employment in the nuclear industry. Some B.S. graduates will elect to attend graduate school and some M.S. graduates will elect to enroll in the Ph.D. program. Further, some graduates intend to seek careers outside the nuclear power industry. Based on historical trends, a lower bound estimate of the fraction of students that will ***not*** be available for employment for these reasons is about 1/4. The number of graduates available for employment in the nuclear industry for the three-year period surveyed is presented in the top half of Table 3. A projection is made for the years 2001-2002 and 2002-2003 to allow comparison with hiring demand. The projection is that the number of graduates will be the same as the highest of the three years (1998-99 to 2000-2001)for which data was supplied, 174. The justification is that although enrollment has been falling monotonically since 1992, there are indications in an upturn in undergraduate enrollment in the 1999-2000 academic year.

Table 3. Comparison of Supply and Demand for Nuclear Engineering Graduates, 1999-2003.

Year	Supply					Demand		Gap
	B.S. grads in NE	Avail B.S. grads in NE	M.S. grads in NE	Avail M.S. grads in NE	Total avail grads in NE	52% of industry	Total	Demand-Supply
1998-99	103	**77**	96	**72**	**149**	266	**512**	**363**
1999-00	124	**93**	108	**81**	**174**	304	**585**	**411**
2000-01	105	**79**	114	**86**	**165**	305	**587**	**422**
2001-02					**174***	326	**627**	**453***
2002-03					**174***	334	**642**	**468***

* Projection of supply using the highest value for the 1998-99 to 2000-2001 time period.

Demand

The demand for nuclear engineers for the years 1998-1999 to 2002-2003 as totaled from the responses to the survey is given in the first column under the heading "Demand" in Table 3. However, this represents only 52% of the 168 companies surveyed. To account for the total industry demand, the figures for the 52% responding were scaled to a 100% response rate and are given in the column labeled “Total” under “Demand” in Table 3. The justifications for this estimation procedure are 1) a number of large companies known to employ significant numbers of nuclear engineers did not respond, and 2) an extrapolation is the only valid estimation that does not introduce a bias into the projection. Results from Tables 1-3 are graphed in Figs 1-5.

Supply/Demand Gap

The data presented in Table 3 and in Figures 4 and 5 show a significant gap between the supply of B.S. and M.S. graduates in nuclear engineering and the demand for these graduates over the time period 1998-1999 to 2002-2003. The magnitude of the gap was determined using two major assumptions; 1) that 1/4 of BS. and M.S. grads were not available for employment due to either graduate school or employment in other fields, and 2) that the total industry demand is 1/0.52 times that from the 52% of the surveyed industry that responded. These assumptions and other developments may lead to a smaller or larger gap than projected in Table 3.

Factors which could lead to a larger gap include:
- more than 1/4 of B.S. and M.S. grads are unavailable for employment in the nuclear industry,
- the supply will experience additional decreases because of the closing or merging of existing NE departments,
- the hiring needs of the non-respondents are greater than those of the respondents,
- some companies that hire nuclear engineers were not included in the survey.

Factors that could lead to a smaller gap include:
- less than 1/4 of B.S. and M.S. grads are unavailable for employment in the nuclear industry,
- some of the non-fission engineering graduates take jobs in the nuclear industry,
- the hiring needs of the non-respondents are less than those of the respondents,
- a greater fraction of the non-respondents don’t hire nuclear engineers.

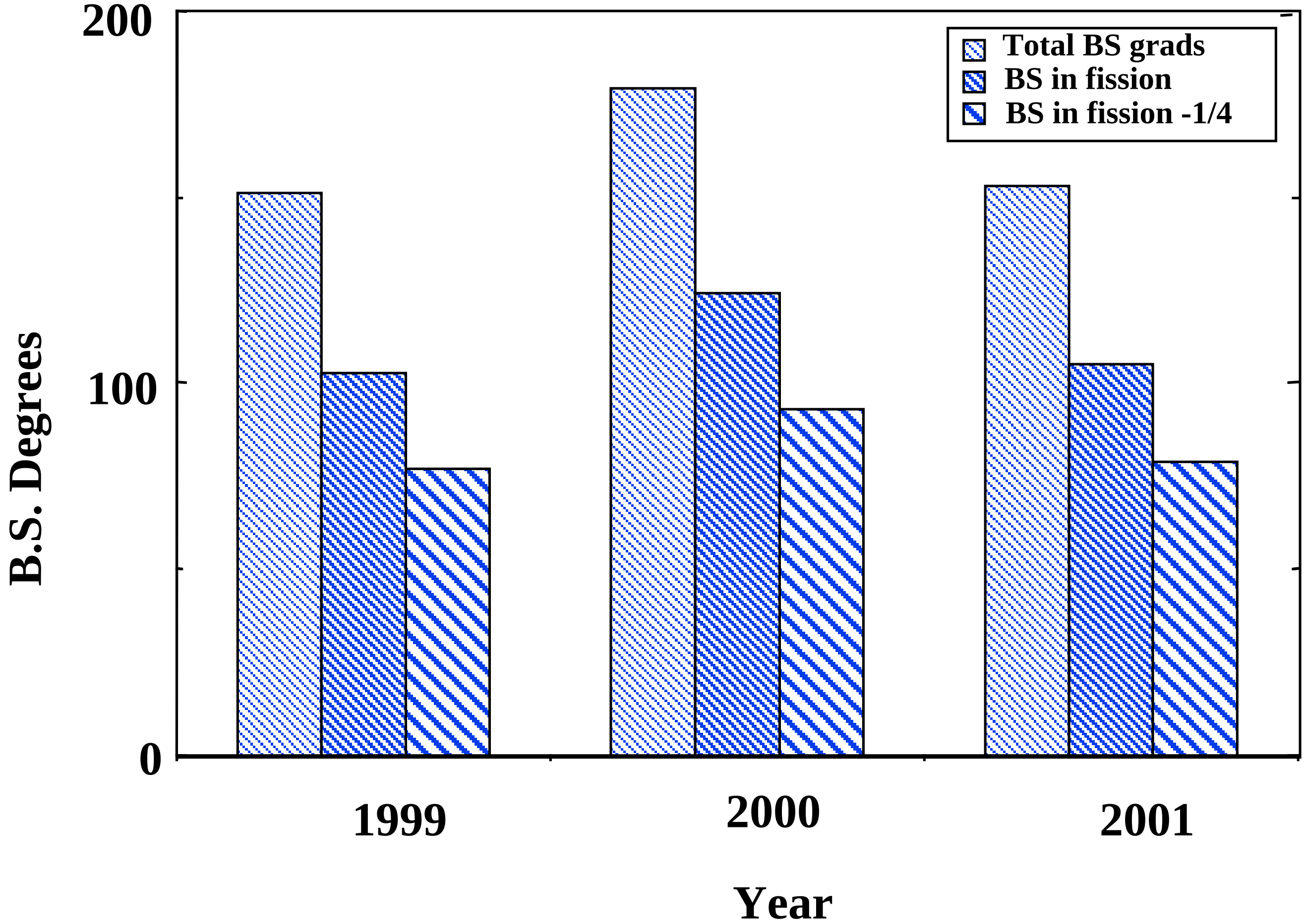

Figure 1. Expected number of B.S. degrees in nuclear engineering for the period 1999-2001.

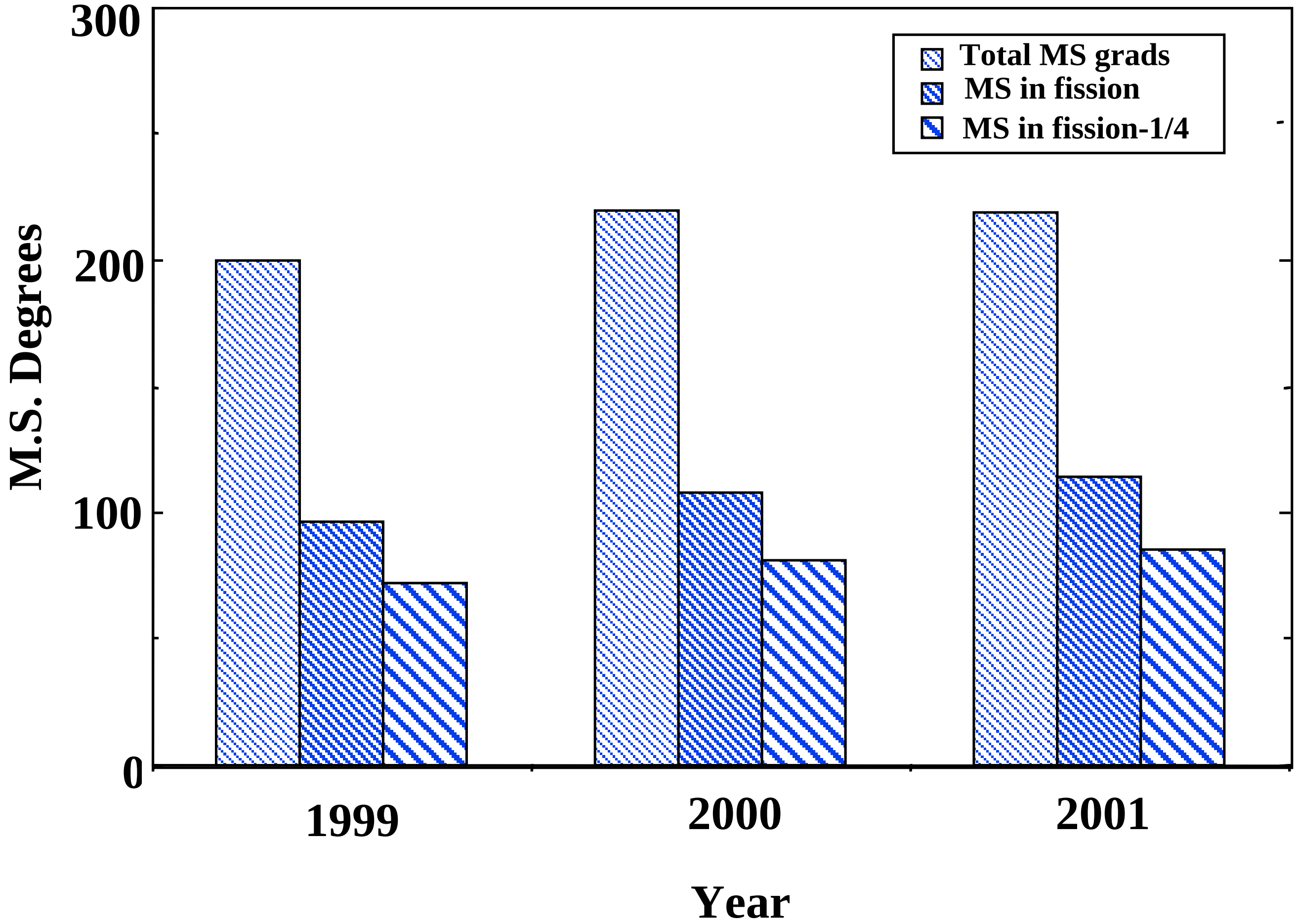

Figure 2. Expected number of M.S. degrees in nuclear engineering for the period 1999-2001.

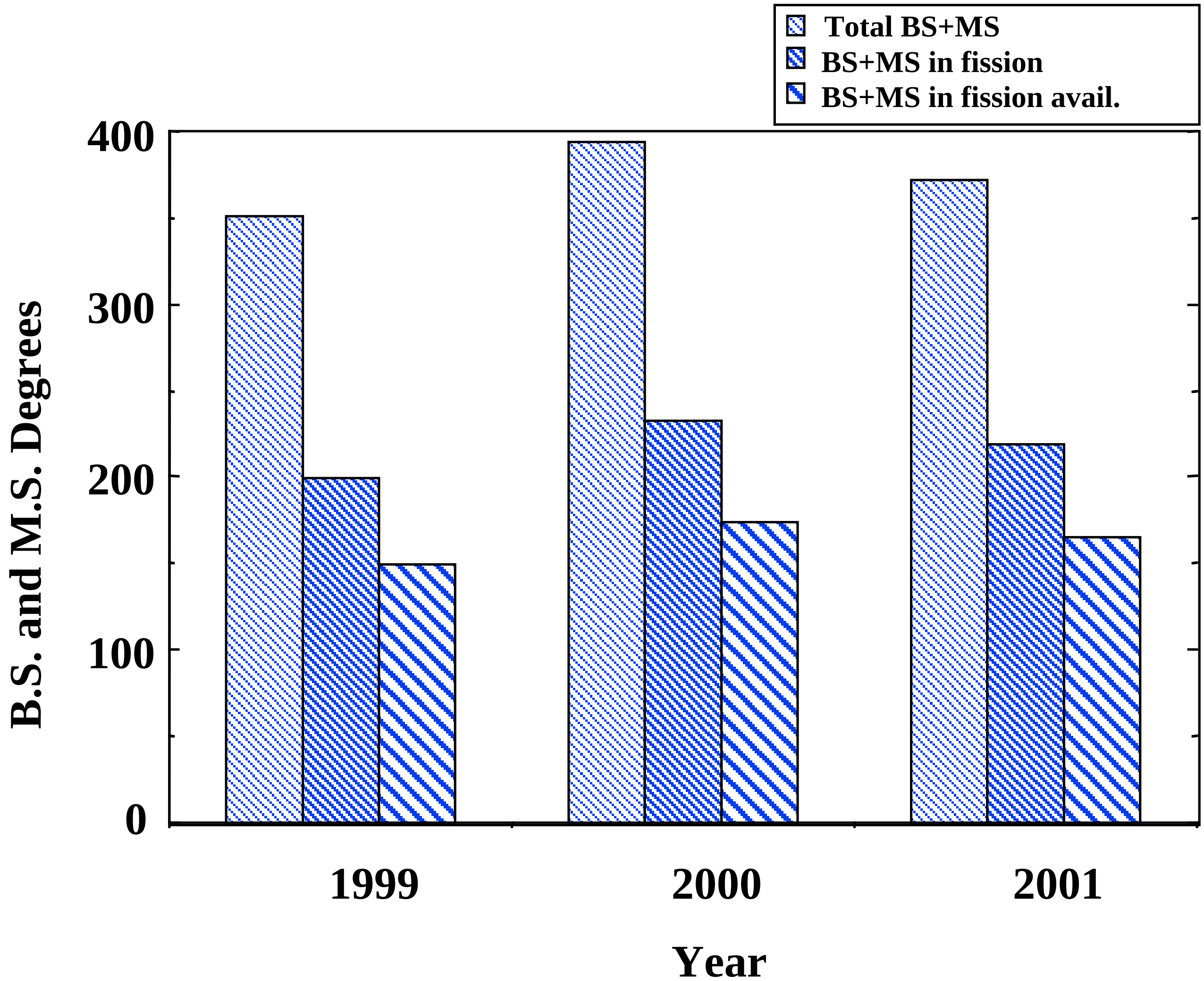

Figure 3. Expected number of B.S. and M.S. degrees in nuclear engineering for the period 1999-2001.

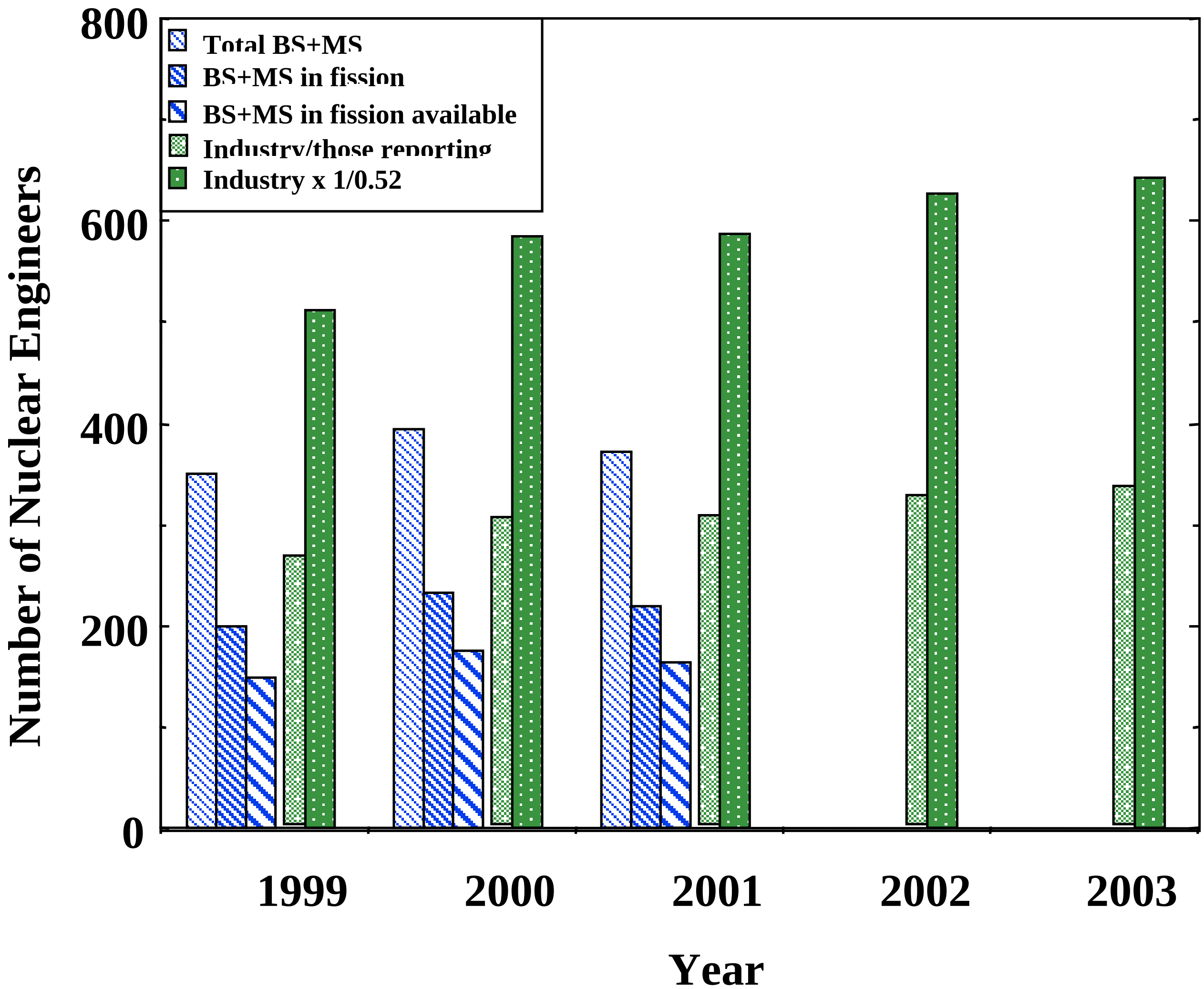

Figure 4. Expected number of B.S. and M.S. graduates in nuclear engineering between 1999 and 2001, and the expected demand for these graduates for the period 1999-2003.

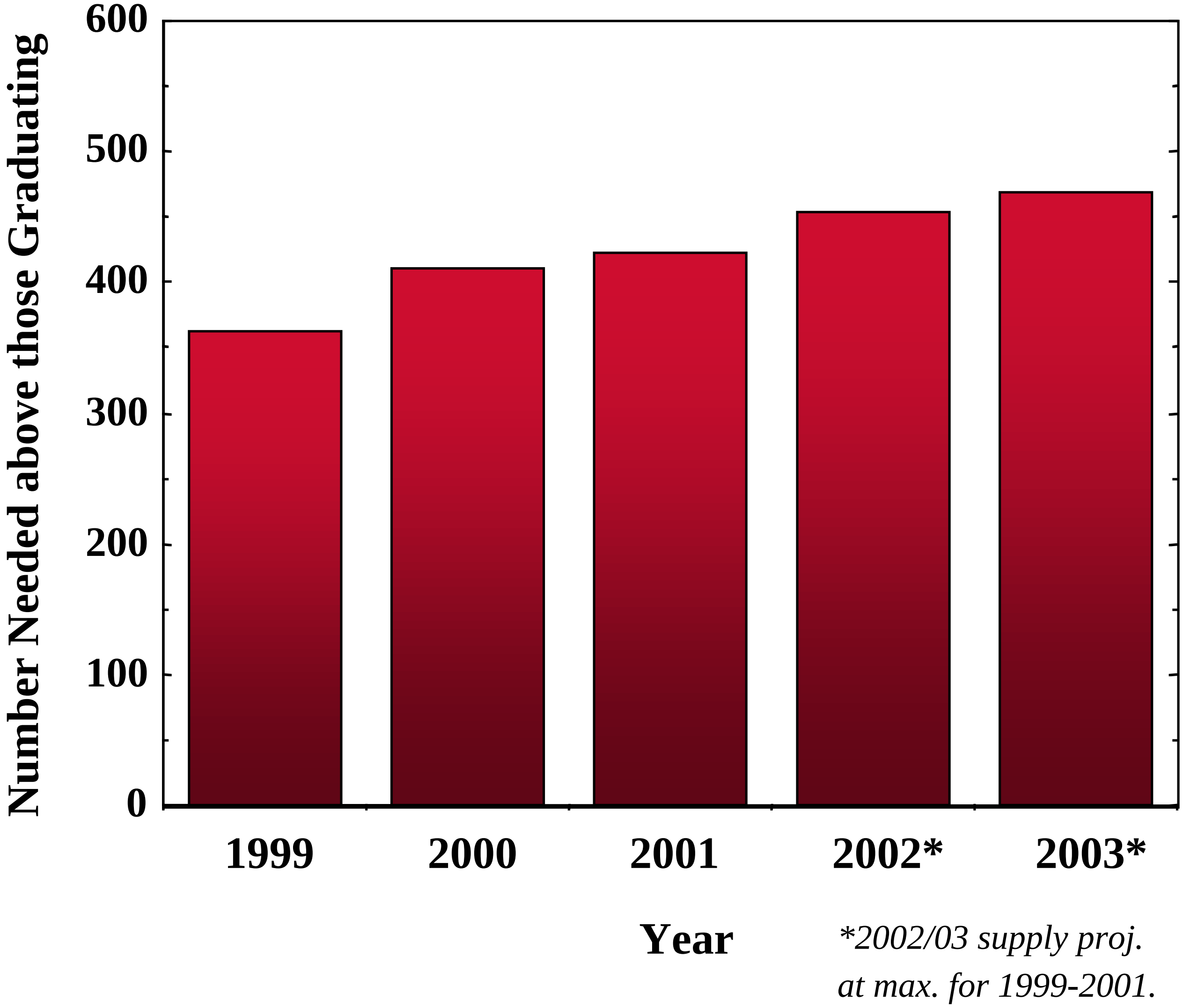

Figure 5. Expected excess demand for B.S. and M.S. graduates in nuclear engineering for the period 1999-2003.

SURVEY QUESTIONNNAIRES

For Nuclear Engineering Academic Departments

The purpose of survey is to find out as much as possible about the supply and demand of nuclear engineering degreed individuals. There appears to have been a sharp increase in the demand for graduates with nuclear engineering degrees and there also appears to be a greater demand than there is a supply. These questions, along with a complementary survey sent to industry, are designed to determine if this supply-demand gap is real and if so, how it is likely to evolve in the coming years.

1. Number of undergraduates in your nuclear engineering program?

- No. seniors
- No. juniors
- No. sophomores
- No. freshmen

2. What year (Freshman, Sophomore, Junior) is your "entering" class in nuclear engineering?

3. How many do you expect to graduate with a BS in nuclear engineering in the following academic years?

- 98/99
- 99/00
- 00/01

4. For each of these academic years, what fraction of your graduates would you say are interested in nuclear engineering rather than radiological sciences, where nuclear engineering is defined as that sub-discipline that deals with the nuclear fuel cycle (power generation, propulsion, fuel characterization and disposal).

5. Repeat questions 1, 3 and 4 for MS degree students.

For Industry

The purpose of survey is to find out as much as possible about the supply and demand of nuclear engineering degreed individuals. Indications are that there appears to have been a sharp increase in the demand for graduates with nuclear engineering degrees and there also appears to be a greater demand than there is a supply. These questions, along with a complementary survey sent to universities, are designed to determine if this supply-demand gap is real and if so, how it is likely to evolve in the coming years.

1. Does your organization employ engineers holding a BS and MS in nuclear engineering?

2. Roughly how many nuclear engineering degree holders does it employ?

3. How many engineers do you employ in total?

For the following questions, base your answers on the following description of a nuclear engineer: an engineer that deals with reactor physics, reactor engineering, reactor safety, fuel management, handling and disposal or radiological health engineering (health physics), or any part of the nuclear fuel cycle.

4. How many openings did you have for nuclear engineers in the past year?

5. How many of these openings did you fill with nuclear engineering graduates?

6. Do you anticipate hiring nuclear engineers in the next 5 years? If so, how many do you anticipate hiring in each of the upcoming years? (1999-2003) Please provide an estimate.

7. Have the type of tasks assigned to nuclear engineers today changed from that over the past several years?

8. What are the major tasks for nuclear engineers today?

9. Have you had difficulty finding nuclear engineers to fill your positions?

10. Do you hire nuclear engineers out of school or do you require a minimum number of years in the discipline?

11. Do you hire non-nuclear engineers that either have some knowledge of nuclear engineering (e.g. an minor in the subject) or that you expect to train to function in an nuclear engineering position?

Responses from University Survey (2 pages)

Institution	Q1 Number of students enrolled				Q2 Entering Class	Q3 B.S. degrees expected		
	Senior	Junior	Soph.	Fresh.		98/99	99/00	00/01
Air Force Tech.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U. of Cal., Berkeley	9	13	6	7	Freshman	4	4	4
U. of Cincinnati	5	2	0	0	N/A	5	2	0
Cornell University	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
University of Florida	7	8	4	8	Junior	7	8	10
Georgia Tech.	10	3	7	6	Fresh/Soph	10	6	8
Idaho State Univ.	0	2	N/A		Junior	0	2	N/A
U. of Illinois	9	12	4	14	Freshman	9	12	4
Kansas State Univ.	6	2	1	4	Junior	5	3	1
Louisiana State U.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U. of Maryland	N/A	4	2	1	Freshman	0	1	3
Mass. Inst. of Tech.	8	10	6	N/A	Sophmore	6	12	6
U. Mass.-Lowell	4	3	N/A	N/A	Junior	3	3	2
U. of Michigan	13	10	15	N/A	Sophmore	7	13	15
U. of Missouri-Col.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
U. of Missouri-Rolla	13	6	4	6	Sophmore	7	10	6
N.C. State	19	14	2	9	Sophmore	9	18	9
U. of New Mexico	2	3	3	N/A	Sophmore	2	3	3
Ohio State University	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oregon State U.	17	11	10	14	Freshman	12	13	12
Penn State University	11	13	N/A	N/A	N/A	8	10	10
Purdue University	9	8	14	24	Sophmore	8	9	9
Rensselaer Poly.	15	24	20	6	Freshman	15	24	20
U. of Tennessee	7	6	5	12	Sophmore	7	6	8
Texas A&M Univ.	20	8	13	11	Freshman	20	8	13
U. of Texas at Austin	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
University of Utah	6	4	N/A	N/A	Junior	4	3	N/A
U. of Wisconsin	10	12	2	N/A	Sophmore	3	9	10
Total	**200**	**178**	**118**	**122**		**151**	**179**	**153**
Average						**103**	**124**	**105**

Q4 %B.S. Grads Interested in N.E.			Q1 M.S. Cand.	Q3 M.S. degrees expected			Q4 %M.S. Grads Interested in N.E.		
98/99	**99/00**	**00/01**		**98/99**	**99/00**	**00/01**	**98/99**	**99/00**	**00/01**
N/A	N/A	N/A	12	9	3	6	N/A	N/A	N/A
50	50	50	27	7	7	7	50	50	50
60	50	N/A	15	5	6	6	50	50	50
N/A	N/A	N/A	0	0	1	1	N/A	50	50
80	80	80	25	18	18	18	40	40	40
100	80	75	37	16	18	16	30	40	30
N/A	100	N/A	9	0	3	2	100	100	67
75	75	75	23	11	7	5	83	81	80
3	1	1	0	0	0	2	0	0	100
N/A	N/A	N/A	21	2	6	8	0	17	33
N/A	100	50	12	4	3	3	75	67	67
80	35	50	61	11	10	10	55	50	50
100	100	100	6	1	3	3	100	100	100
60	70	70	23	16	15	15	35	35	35
N/A	N/A	N/A	30	5	6	7	25	25	30
60	60	60	6	2	5	5	60	60	60
30	50	30	14	5	9	8	20	10	25
50	100	90	28	13	12	12	40	33	33
N/A	N/A	N/A	20	7	4	7	4	2	4
63	59	82	14	6	7	6	72	66	85
90	90	90	14	10	12	12	80	80	70
100	100	100	19	4	14	8	100	100	100
75	75	75	15	7	8	9	50	50	50
90	50	50	30	10	10	10	50	50	50
75	63	85	30	16	14	16	50	64	63
N/A	N/A	N/A	24	0	8	2	0	0	0
25	33		5	3	2	3	33	50	33
100	100	90	25	12	9	12	50	50	50
68	**69**	**69**	**545**	**200**	**220**	**219**	**48**	**49**	**52**
				96	**108**	**114**			

Responses from Industry Survey (6 pages)

Organization	Q1 Employ NEs?	Q2 How many?	Q3 Total engin. empl
ABB Combustible Engineering Nuclear Power	Yes	95	500
Argonne National Laboratory	Yes	85	500
Arizona Public Service Co. - Palo Verde Nuclear Sta.	Yes	N/A	308
Baltimore Gas & Electric - Calvert Cliffs Nuclear Sta.	Yes	30	120
Bechtel	Yes	120	8300
Bettis Atomic Power Laboratory	Yes	100	1600
Black & Veatch	Yes	40	5000
BNFL, Inc.	Yes	10	100
Boston Edison Co.	Yes	10	250
Carolina P&P	Yes	25	187
Central Power & Light Co.	Yes	2	N/A
Clinton Power Station, Illinois Power Co.	Yes	12	160
Commonwealth Edison	Yes	150	1500
Consumers Energy - Palisades Nuclear Plant	Yes	30	300
Detroit Edison - Fermi 2	Yes	37	192
Duke Energy (NC)	Yes	114	958
Excel Services Corp.	Yes	75	85
First Energy Corp./Davis-Besse Nuclear Station	Yes	34	108
First Energy Corp./Perry Nuclear Station	Yes	17	133
Florida Power & Light Co.	Yes	300	300
Flour-Daniel Hanford, Inc.	Yes	45	1093
Framatome Technologies	Yes	117	487
General Atomics	Yes	76	432
Hayward Tyler Inc.	No	0	8
Idaho National Engineering & Environmental Lab	Yes	120	1800
JUPITER Corp.	Yes	6	24
Jacobs Engineering Group	Yes	12	8000
KAPL, Inc.	Yes	90	1400
Lawrence Livermore Nuclear Laboratory	Yes	58	1057
Maine Yankee Atomic Power Co.	Yes	1	6
MDM Engineering Corp.	Yes	5	150
Morrison Knudson Corp.	Yes	10	1000
MPR Associates, Inc.	Yes	9	93
NAC Int'l	Yes	27	52
National Nuclear Corp.	No	N/A	4
NES	Yes	10	25

North Atlantic Energy Service - Seabrook Station	Yes	10	100
Northeast Utilities	Yes	120	475
Northern States Power Co.	Yes	25	150
Nuclear Energy Institute	Yes	15	20
Nuclear Placement Services, Inc.	Yes	4	15
NUKEM Nuclear Technologies	No	0	6
NUMANCO, LLC	Yes	6	15
Oak Ridge National Laboratory	Yes	156	680
Ohio Edison, Co.	Yes	50	500
Omaha Public Power District	Yes	10	100
Overly Door Co. Nuclear Service	No	0	20
PaR Systems, Inc.	Yes	2	40
Parsons Corp.	Yes	30	6000
PECO Nuclear	Yes	50	300
Private Fuel Storage LLC	Yes	25	140
Proto-Power Corp.	Yes	4	119
Raytheon Nuclear Inc.	Yes	50	500
Reef Industries, Inc.	No	2	N/A
Rochester Gas & Elec.	Yes	5	55
Rocky Flats Environmental Technology	Yes	10	25
Rosemount Nuclear Instruments, Inc.	Yes	12	12
Sargent & Lundy	Yes	60	1100
Scientech, Inc.	Yes	150	500
Siemens Power Corp.	Yes	70	150
Southern California Edison	Yes	10	90
STP Nuclear Operating Co.	Yes	N/A	158
Tekton Resources	Yes	30	150
Tennessee Valley Authority	Yes	28	N/A
TradeTech, L.L.C.	No	0	0
TU Electric/CPSES	Yes	30	180
Union Electric Co. - Callaway Nuclear Plant	Yes	12	190
USHRC, Region II	Yes	20	100
USNRC, Region IV	Yes	8	125
Vermont Yankee Nuclear Power Corp.	Yes	10	120
Westinghouse Electric Co.	Yes	100	2000
Westinghouse Safety Mgmt. Solutions	Yes	50	175
West Valley Nuclear Services Co.	Yes	9	178
Wisconsin Electric - Point Beach Nuclear Plant	Yes	16	117
Wisconsin Public Service Corp.	Yes	20	80
H.L. Yoh, LLC (formerly NPS Energy Services)	Yes	15	1000
TOTALS	**70Y/6N**	**3096**	**51917**

(shaded Co's or non-nucl: responses are "N/A" or "0")

Q4 # N.E. openings in '98	Q5 # filled by N.E. grads	Q6 Hire N.E.s within 5 years	Planned number of hires				
			1999	2000	2001	2002	2003
7	7	Yes	3	5	5	6	7
11	12	Yes	10	10	10	10	10
3	3	Yes	N/A	N/A	N/A	N/A	N/A
5	5	Yes	1	2	2	2	2
2	1	Yes	5	5	5	5	5
8	4	Yes	10	8	6	10	12
10	8	Yes	10	5	0	0	0
20	2	Yes	20	10	5	5	5
2	2	Yes	0	2	1	1	0
3	3	Yes	1	2	4	3	2
2	2	No	0	0	0	0	0
2	0	Yes	2	1	2	1	2
9	9	Yes	2	2	2	2	2
2	2	Yes	1	2	1	1	1
2	1	Yes	1	0	2	0	1
0	0	Yes	4	4	4	4	4
15	15	Yes	10	20	20	20	20
2	1	Yes	2	1	1	1	1
3	3	Yes	N/A	1	1	1	1
5	5	Yes	2	2	2	9	9
3	3	Yes	2	4	1	3	2
66	33	Yes	7	10	7	7	7
3	1	N/A	N/A	N/A	N/A	N/A	N/A
0	0	No	0	0	0	0	0
10	2	Yes	10	7	10	15	12
2	2	Yes	2	2	2	2	2
5	0	Yes	5	15	20	10	10
8	8	Yes	8	10	7	7	7
0	0	Yes	3	3	3	3	3
0	0	No	0	0	0	0	0
200	N/A	Yes	1	3	5	10	20
5	5	Yes	2	2	2	2	2
2	0	Yes	1	2	1	2	1
5	5	Yes	2	2	2	1	1
0	N/A	Yes	0	1	0	0	0
2	2	Yes	3	5	5	7	7
2	1	Yes	2	1	1	1	1

31	14	Yes	1	2	1	2	1
5	5	Yes	4	4	4	4	4
3	3	Yes	N/A	N/A	N/A	N/A	N/A
12	8	Yes	4	5	5	7	8
0	0	No	0	0	0	0	0
6	6	Yes	6	10	10	15	15
5	5	Yes	3	3	3	3	3
10	5	Yes	10	10	10	10	10
3	2	Yes	0	1	0	1	1
0	N/A	No	0	0	0	0	0
0	0	No	0	0	0	0	0
8	8	Yes	6	8	8	10	10
N/A	10	Yes	25	25	25	25	25
0	N/A	Yes	0	0	1	4	0
2	2	Yes	3	3	2	2	2
5	5	Yes	2	5	7	N/A	N/A
0	N/A	No	0	0	0	0	0
0	N/A	No	0	0	0	0	0
0	0	No	0	0	0	0	0
2	0	Yes	1	0	1	0	1
2	2	Yes	1	2	2	2	2
5	5	Yes	2	7	12	15	18
20	15	Yes	10	5	5	5	5
65	10	No	0	0	0	0	0
0	0	No	0	0	0	0	0
20	20	Yes	25	30	35	40	45
16	1	Yes	20	20	20	20	20
0	0	No	0	0	0	0	0
5	5	Yes	0	1	1	0	1
3	3	Yes	1	0	1	0	1
5	0	Yes	0	2	5	5	5
3	0	Yes	0	2	2	2	2
2	0	Yes	1	2	0	0	0
6	6	Yes	6	6	6	6	6
10	10	Yes	5	5	5	5	5
1	0	Yes	0	2	2	2	2
4	4	Yes	2	3	2	3	2
18	5	Yes	1	2	1	2	1
10	10	Yes	15	15	20	20	20
713	**316**	**60Y/6N**	**286**	**329**	**335**	**361**	**374**

Q7 Have N.E. tasks changed?	Q9 Recruiting difficulties?	Q10 Hire upon graduation?	Min. post-grad. Work required?	Q11 Hire non-N.E.s for N.E. positions?
Yes	Yes	Yes	Yes	Yes
Yes	No	Yes	N/A	No
No	Yes	Yes	N/A	No
No	Yes	Yes	N/A	Yes
No	No	Yes	N/A	Yes
Yes	Yes	Yes	No	Yes
No	Yes	No	Yes	Yes
Yes	Yes	Yes	N/A	Yes
Yes	Yes	Yes	N/A	Yes
No	No	Yes	Yes	No
No	No	Yes	N/A	Yes
No	No	Yes	No	No
No	N/A	Yes	N/A	No
Yes	Yes	Yes	N/A	Yes
Yes	No	Yes	N/A	Yes
No	Yes	Yes	N/A	Yes
N/A	No	No	Yes	No
No	Yes	Yes	N/A	Yes
N/A	Yes	Yes	No	Yes
Yes	Yes	No	Yes	Yes
Yes	Yes	Yes	N/A	Yes
No	Yes	Yes	N/A	Yes
Yes	Yes	No	Yes	Yes
N/A	N/A	N/A	N/A	N/A
Yes	No	Yes	N/A	Yes
No	No	Yes	N/A	Yes
Yes	Yes	No	No	Yes
No	Yes	Yes	N/A	Yes
No	Yes	Yes	Yes	No
N/A	N/A	N/A	N/A	N/A
Yes	Yes	No	Yes	Yes
Yes	No	No	No	Yes
Yes	Yes	Yes	N/A	Yes
No	No	N/A	N/A	No
No	Yes	No	Yes	Yes
No	N/A	Yes	N/A	Yes
No	No	Yes	N/A	No
No	Yes	Yes	N/A	No

N/A	Yes	Yes	N/A	No
No	Yes	No	Yes	No
No	No	Yes	N/A	Yes
No	No	No	No	No
No	No	No	No	Yes
No	No	No	Yes	Yes
Yes	Yes	Yes	N/A	Yes
No	Yes	Yes	N/A	Yes
N/A	N/A	N/A	N/A	N/A
No	No	No	Yes	Yes
Yes	No	Yes	N/A	Yes
No	Yes	Yes	N/A	Yes
Yes	N/A	Yes	N/A	No
Yes	Yes	Yes	N/A	Yes
Yes	Yes	Yes	N/A	No
N/A	N/A	N/A	N/A	No
Yes	No	Yes	N/A	Yes
N/A	No	Yes	N/A	Yes
Yes	Yes	Yes	N/A	Yes
Yes	Yes	Yes	N/A	Yes
Yes	No	N/A	Yes	Yes
No	Yes	Yes	N/A	Yes
No	No	Yes	N/A	No
No	No	No	N/A	No
Yes	Yes	No	Yes	Yes
Yes	Yes	Yes	N/A	Yes
No	N/A	N/A	N/A	N/A
No	Yes	Yes	N/A	Yes
No	No	Yes	N/A	Yes
No	Yes	Yes	N/A	Yes
No	Yes	Yes	N/A	Yes
Yes	No	No	Yes	No
No	Yes	Yes	N/A	Yes
Yes	Yes	Yes	N/A	Yes
No	Yes	Yes	N/A	Yes
No	No	Yes	N/A	No
No	Yes	Yes	N/A	Yes
No	No	No	Yes	Yes
28Y/37N	**40Y/26N**	**52Y/15N**	**15Y/6N**	**51Y/18N**

Complete List of All Organizations Surveyed

ABB Combustion Engineering Nuclear Power
ADLPIPE
AIL Systems, Inc.
Allied Signal Federal Mfg, Kansas City, MO
Allient-IES Utilities
Altran Corporation
American Union Electric Co./ Calloway Plant
Ames Laboratory
ANATECH Corporation
Argonne National Laboratory
Arizona Public Service Co. / Phoenix
Arizona Public Service Co. - Palo Verde Nuclear Generating Station
Atlantic Group, The
Babcock & Wilcox Co.
Baltimore Gas & Electric - Calvert Cliffs Nuclear Power Plant
Bartlett Nuclear, Inc.
Bechtel
Bechtel Bettis Atomic Power Laboratory
Bigge Crane & Rigging Company
Black & Veatch
Boston Edison Co.
Brackett Green USA, Inc.
British Nuclear Fuel Limited, Inc.
Brookhaven National Laboratory
Burns & Roe Enterprises, Inc.
Calvert Cliffs Nuclear Power Plant
Canberra Industries
Carolina P&L
Central Power & Light Co.
Central Research Laboratories
Clean Energy Technologies, Inc.
Clinton Power Station, Illinois Power Co.
Cogema, Inc.
Commonwealth Edison
Consolidated Edison Company of New York
Consumers Energy - Palisades Nuclear Plant
Detroit Edison - Fermi 2
Dubose National Energy Services
Duke Energy Power Services (Houston, TX)
Duke Energy (NC)
Dusquesne Light Company
Eagle-Picher Industries, Inc.
Enercon Services, Inc.
Energy Options, Inc.

Entergy Operations, Inc.
Epicor, Inc.
Excel Services Corp.
First Energy Nuclear Operating Co., Akron, OH
First Energy Corp./Davis-Besse Nuclear Power Station
First Energy Corp./Perry Nuclear Station
Florida Power Corporation Nuclear Operations
Florida Power & Light Co.
Fluor-Daniel Hanford, Inc.
Framatome Technologies
General Atomics
General Physics Corporation
General Electric - Nuclear Energy
G. E. Reuter Stokes, Inc.
GPU Nuclear, Inc.
Hayward Tyler Inc.
Herguth Laboratories
ICF Kaiser International, Inc.
Idaho National Engineering & Environmental Laboratory
Indiana Michigan Power Company / DC Cook Nuc. Plant
International Access Corporation
Jacobs Engineering Group
Jefferson Laboratory, Newport News, Va
Joseph Oat Corporation
JUPITER Corp.
Kansas City Power & Light
Knolls Atomic Power Laboratory
Kinemetrics, Inc.
Lawrence Berkeley National Laboratory
Lawrence Livermore Nuclear Laboratory
LND, Inc.
Los Alamos National Laboratory
Maine Yankee Atomic Power Co.
MCEC, Inc.
MDM Engineering Corp.
McDermott International, Inc.
Mega-tech Services, Inc.
MGP Instruments, Inc.
Morrison Knudson Corp.
MPR Associates, Inc.
NAC Int'l
National Nuclear Corp.
Nebraska Public Power District
NES
New York Power Authority
Niagra Mohawk Power

North Atlantic Energy Service - Seabrook Station
Northeast Utilities
Northern States Power Co.
NRE, Inc. Oak Ridge, TN
Nuclear Energy Institute
Nuclear Generation Group
Nuclear Placement Services, Inc.
Nuclear Research Corporation
Nucon International, Inc.
NUKEM Nuclear Technologies
NUMANCO, LLC
NUMATEC, Inc.
Numerical Applications, Inc.
Oak Ridge National Laboratory
Ohio Edison, Co.
Omaha Public Power District
Overly Door Co. Nuclear Service
Pacific Gas & Electric / Diablo Canyon
Pantex Plant
PaR Systems, Inc.
Parsons Corp.
PECO Nuclear
PE Safety Management Solutions
Pennsylvania Power and Light Company
Private Fuel Storage LLC
Proto-Power Corp.
Public Service Electric and Gas Company
PX Engineering Co., Inc.
R & D Staffing
Raytheon Nuclear Inc.
R. Brooks Associations, Inc.
Reef Industries, Inc.
Rochester Gas & Elec.
Rocky Flats Environmental Technology
Rockwell International Corporation
Rosemount Nuclear Instruments, Inc.
Sargent & Lundy
Savannah River
Science Applications Intl. Corp.
Scientech, Inc.
S. G. Pinney & Associates, Inc.
Siemens Power Corp.
Sierra Nuclear Corporation
Southern California Edison
South Carolina Elec. & Gas/V.C. Summer Nuclear Station
Southern Nuclear Operating Company

Stone & Webster Engineering Corporation
Studsvik Scandpower, Inc.
STP Nuclear Operating Co.
Technical Associates
Technologies Group, The
Tekton Resources
Tenera, Inc.
Tennessee Valley Authority
TradeTech, L.L.C.
TRW Professional & Technical Services
TU Electric/CPSES
Union Electric Company
Union Electric Co. - Callaway Nuclear Plant
United Controls International
U.S. Enrichment Corporation
USHRC, Region II (Atlanta)
USNRC King of Prussia, AP
USNRC, Region IV (Texas)
Vermont Yankee Nuclear Power Corp.
Victoreen, Inc.
Virginia Power
Washington Public Power Supply System
Westinghouse Electric Co.
Westinghouse Safety Mgmt. Solutions
West Valley Nuclear Services Co.
Wisconsin Electric - Point Beach Nuclear Plant
Wisconsin Public Service Corp.
Wolf Creek Nuclear Operating Corp.
Wright Industries, Inc.
Wyle Laboratories
H.L. Yoh, LLC (formerly NPS Energy Services)
Y-12, Plant, Oak Ridge, TN

normal = responded (70)
normal+shaded = responded, doesn't hire NEs (6)
bold = established contact - didn't respond (69)
bold+italic = didn't establish contact, didn't respond (23)
total = 168

Responses to Industry Survey Question 8

ABB Combustion Engineering Nuclear Power, Inc.: New power plant reload, loading pattern setting, preparation of reload design report, preparation of reload start-up constants, analysis of special excore nuclear conditions, evolving plant life time conditions

American Union Electric – Calloway Plant: No response

Argonne National Laboratory: Yes, less research, more routine analysis and project work**.**

Arizona Public Service Co. – Palo Verde Nuclear Generating Station: Palo Verde is currently reducing staff, through attrition. Therefore, we do not have plans for hiring outside the organization, unless necessary.

Calvert Cliffs Nuclear Power Plant: See other commercial nuclear plant descriptions – they will be the same.

Bechtel: While the tasks assigned to our nuclear engineers are basically the same as in the past, there have been changes in the types of projects, to which they are assigned. For example, Bechtel's workload has increased in remediation, steam generator replacement, and decommissioning.

Bettis Atomic Power Laboratory: Increased emphasis on waste shipping and handling. Reactor design, performance analysis, shielding, instruction, criticality analysis, shipping analysis, director calculations, plant response analysis, decay heat calculations, plant reactivity analysis.

Black & Veatch: design, radiation shielding, involvement in all discipline areas of nuclear design (nuclear, electrical, control, structural, licensing, etc.)

BNFL: waste management, waste disposal, fuel transport, radiological control, licensing.

Boston Edison Company: core design, reactor engineering (reactivity management), reactor physics analyses, disposal of high and low level nuclear wastes.

Carolina Power & Light – Nuclear Generating Group: core design, contract mgm for fuel purchase/fabrication, core performance monitoring, safety evaluations, risk assessment.

Central Power & Light Co.: general, performance management oversight of CPL's nuclear power asset specifications, monitor nuclear plant operations.

Clinton Power Station – Illinois Power Co.: Design & analyze fuel (fuel physics/thermal hydraulic) potential plant events, plan & execute fuel depletion within licensed & design limits, advice to plant operators on fuel issues, coordinate procurement of fuel components & services, licensing analysis track core component lifetimes & replacement etc.

Colorado Flats Environmental Technology: Criticality safety

Commonwealth Edison: as described in the statement preceding question 4.

Consumers Energy – Palisades Nuclear Plant: Nuclear engineers are now expected to have the diversity to fill system engineering and design engineering roles and often asked to license as senior reactor operators.

Detroit Edison – Fermi 2: Have to be multi-disciplined for efficiency. Currently, personnel with nuclear engineering degrees are functioning in performance and system engineering, licensing, maintenance, and operations.

Duke Energy, North Carolina: Major tasks are reactor physics calculations such as core design, incore detector monitoring calcs, physics measurements reports and plant maneuvering analyses; safety analysis calculations, such as plant transient and accident simulation, containment calculations, reactor protective system setpoints, and hydraulic simulations; probabilistic risk calculations such as reliability of systems, source term for severe accidents, and risk calculations; fuel management analyses, such as fuel cycle economics, uranium/enrichment/fabrication procurement, fuel cycle legislation, spent fuel storage technology, spent fuel inventory, criticality analysis and long-term spent fuel storage strategy; thermal-hydraulic calculations such as critical heat flux, departure from nuclear boiling, fuel assembly rod strain and pressurization, and core thermal-hydraulics; radiological engineering such as health physics, offsite dose calculations, and shielding calculations; reactor engineering such as core monitoring, critical positions, and fuel handling.

Excel Services Corp.: No response

FirstEnergy Corp./Davis-Besse Nuclear Power Station: core design and analysis, thermal hydraulic accident and transient analysis, design basis information

FirstEnergy Corp./Perry Nuclear Station:

1. Technical guidance for the receipt, handling and operation of nuclear fuel, including guidance for all reactivity changes
2. Technical oversight and direction of the nuclear fuel design.
3. Performance of reactor physics and thermodynamics calculations in support of plant operations.
4. Resolution of nuclear engineering related technical issues.
5. Performance of probabilistic safety assessments (PSA) in support of plant operations, maintenance, modifications and license amendments.

Nuclear engineers are also assigned to more generic and management fields, such as Operations Manager, System Engineer, etc.

Florida Power & Light Co.: Fuel management, safety analysis, economic evaluation of core designs.

Flour-Daniel Hanford, Inc.: The Hanford site has changed missions from production to environmental restoration. All disciplines have been affected.

Framatome Technologies: Shielding/criticality evaluation, reload core configuration; reactor core behavior, fluid dynamics, thermal hydraulic code work, mechanical/fluid system design, safety assessments

General Atomics: Used to be more development of proto-type nuclear equipment and vessels. Now only repair work or clean up.

Hayward Tyler, Inc.: No response

Idaho National Engineering and Environmental Laboratory: INEEL now has more computational focus and less focus on large experimental programs. We also have a substantial international focus that requires travel. As a national laboratory, we still require a breadth of academic backgrounds to carry out our programs. However, we will look more strongly to new hires over the next 5 years in emerging technologies (like PRA) and to fit program needs (like nuclear fuels and materials, waste management, environmental).

Jacobs Engineering Group: Spent fuel management, criticality safety, rad safety

JUPITER Corp.: Review new reactor designs; prepare papers on nuclear science and technology issues and programs; review of testing and safety analysis programs; facility inspections/assessments.

KAPL, Inc.: Core neutronics (design & analysis), criticality, testing, nuclear methods and shielding (design, analysis, and methods). To a lesser extent core T/H, core mechanical, reactor safety studies, core structural analysis, core operations, and nuclear materials.

Lawrence Livermore Nuclear Laboratory: Nuclear Test Engineers

Maine Yankee Atomic Power Co.: No response. They are in the process of decommissioning, which is to be completed by 2003.

MDM Engineering Corp.: more efficiency related – no const. Or s/u.

Morrison Knudson Corp.: Activation analysis, criticality safety, etc.

MPR Associates, Inc.: Nuclear plant support, nuclear design problem solving, fuel design and improvement, shielding.

NAC International: criticality control, shielding design, radiation protection, fuel assembly design, core reload design, isotope production, research reactor operation

National Nuclear Corporation: Our business is in health physics instruments therefore, the primary task of our engineers is to conceive, design and implement new instruments that address changing needs of the marketplace.

NES: Rad surveys; site release (MARSIMS) analyses, field D&D, operating reactor support; nuclear fuel handling system design; nuclear tools/fixtures design; inservice inspection.

North Atlantic Energy Service – Seabrook Station: No response

Northeast Utilities: core design, reload coordination, nuclear fuel design/fabrication/performance monitoring, fuel economics and contract administration.

Northern States Power Co.: Both – nuclear engineers usually enter NSP through the nuclear energy engineering department (fuel design) and then migrate to plant operation, etc. **Essentially what you have described in the prelude to question 4. Plus they go to plant operation, engineering (other than nuclear), finance area, etc.**

Nuclear Energy Institute: safety, security, regulatory matters

Nuclear Placement Services, Inc.: Tasks vary greatly

NUKEM Nuclear Technologies: No response – they don't hire nuclear engineers.

NUMANCO LLC: radiological health engineering associated with dose assessments, shielding calculations and remediation activities.

Oak Ridge National Laboratory: Operations (for experienced BS/MS engineers). Computational physics & engineering, engineering technologies R&D, and instrumentation & controls for PhD. Level engineers.

Ohio Edison Co.: less analytical

Omaha Public Power District:

1. Core design & reload analysis
2. Transient analysis & setpoints
3. Core performance tracking
4. Reactor engineer
5. Radiological consequences analysis
6. Health physics

Overly Door Co.: No response- they don't hire nuclear engineers.

PAR Systems, Inc.: We use primarily mechanical engineers to do the type of design work necessary.

Parsons Corp.: Risk assessment, design, fuel management, handling and disposal of rod waste

PECO Nuclear: No response

Private Fuel Storage, LLC: Our direct staff will oversee final loading or permanent storage containers at each plant site. As these will be MPC, it will be the final inspection this fuel will ever have.

Proto-Power Corporation: Most relate to operational efficiencies, maintenance improvement performance, design documentation for modifications, radiological monitoring, systems performance

Raytheon Nuclear Inc.: Engineering work analysis and work management.

Reef Industries, Inc.: No response – they don't hire nuclear engineers.

Rochester Gas and Electric: fuel analysis/modeling, reactivity manipulation, modifications to installed equipment

Rosemount Nuclear Instrument, Inc.: develop new qualified instrumentation to replace outmoded designs over twenty years old.

Sargent and Lundy: Fire Protection systems in nuclear power plants, radiological analysis, licensing issues resolution, spent fuel storage, decommissioning activities

Scientech, Inc.: major computer analysis and PC based interface. More licensing and technical writing/analysis in English understandable to regulators.

Siemens Power Corporation: Nuclear fuel/core design, nuclear safety analyses, methodology development for fuel assembly/core, design and safety analyses

Southern California Edison: No response

STP Nuclear Operating Co.:

1. Perform engineering calculations
2. Determine plant licensing and design basis
3. Prepare technical assessments and reports
4. Provide independent technical reviews
5. Develop computer models for analysis activities

Tekton Resources: Fuel management, health safety, reactor safety, decommissioning, fire safety, life extension

TVA Nuclear: More operations oriented.

Tradetech, LLC: No response – don't hire nuclear engineers.

TU Electric: Core design, reload safety evaluation, PRA, radiological evaluations, fuel & core performance, power assertion testing nuclear fuel procurement.

USHRC, Region II: No response

USNRC, Region IV: Inspection and regulation of the commercial nuclear power industry, the use of special nuclear material, and the use of nuclear material in the field of medicine, This can encompass any, or all, of the area identified in the definition provided on the bottom of page 1.

Vermont Yankee Engineering: RE plant support, design basis support for plant operability assessments, oversight of NSSS vendor analyses.

Westinghouse Electric Co.: Core analysis, core design, radiation engineering and analysis, systems analysis, accident analysis.

West Valley Nuclear Services Co.: Evaluates monitoring program to protect personnel from radiation hazards. Perform basic operation and maintenance of radiological protection equipment for programs such as dosimetry, whole body counting, and respiratory protection. Evaluates and interprets current and proposed regulations and assists in compliance.

Wisconsin Electric: Reactor engineering, probability safety analysis, fuels, radiological engineering.

H.L. Yoh, LLC (NPS Energy Services, Inc./): Fuel analysis, radiation shielding analysis,

Wisconsin Public Service Corp.: creative problem solving, keep technology equipment/components current, monitor new designs.

Westinghouse Safety Management Solutions: Radiation shielding, criticality safety.