THE AMERICAN CHEMICAL SOCIETY'S DIVISION OF NUCLER CHEMISTRY AND TECHNOLOGY'S SUMMER SCHOOLS IN NUCLEAR AND RADIOCHEMISTRY

J. R. Peterson, University of Tennessee (USA)

ABSTRACT

A successful educational program (lecture and laboratory) for advanced undergraduate students to study the fundamentals of nuclear and radiochemistry (including radiological safety) and to make them aware of the many challenges and career opportunities in the nuclear science arena is described. The story of its founding in 1984 at San Jose State University in California is summarized, along with that of the establishment in 1989 of a second site at Brookhaven National Laboratory on New York's Long Island. Funding from the U.S. Department of Energy supports 24 fellowships for participation in the simultaneous, intensive, six-week summer schools. Students are provided transportation to and from the school site, room and board for the entire session, text and reference books, laboratory supplies, and tuition for six units of transferable college credit through the American Chemical Society accredited chemistry programs at San Jose State University or the State University of New York at Stony Brook. Each school site identifies its Outstanding Student, and these two are rewarded with an expense-paid trip to the fall national meeting of the American Chemical Society. Graduates of the summer school are given assistance in the following year(s) to join a nuclear science research project at a university or national laboratory, and also, in their applications to graduate or professional school. This program contributes positively toward the established national need of having young, dynamic, trained personnel entering the workforce and establishing careers in academia, government laboratories and facilities, nuclear medicine and radiopharmaceuticals, the nuclear power industry, nuclear waste disposal and management, site remediation, etc.

INTRODUCTION

Following a brief recounting of the founding of the summer school(s), a discussion of the benefits accruing to the participants is presented. The major benefit to the diverse field of nuclear science in terms of generating fresh talent and trained personnel is then mentioned. A more complete description of the actions taken by the National Director in preparing for operation of the 2001 summer schools is presented, along with some pertinent data relative to class status, gender, major, and academic affiliation from the last four summer school classes (1997-2000). The main purpose of this document is to acquaint the reader more thoroughly with this ongoing, educational, outreach project of the Division of Nuclear Chemistry and Technology (DNCT) of the American Chemical Society (ACS) and to solicit cooperation in making potential student applicants aware of its existence.

FOUNDING OF THE SUMMER SCHOOL(S) (1)

In Fall 1977 an *ad hoc* Committee on Training of Nuclear and Radiochemists was appointed by the Chair-Elect of the ACS's DNCT to conduct a national survey on the current status of training of nuclear and radiochemists. This action followed concerns expressed by

DNCT members that the vigor and magnitude of academic training in nuclear and radiochemistry were declining due to shrinkage in faculty, students, and research funding. Some conclusions in the committee's report, presented to DNCT in Spring 1978, were:

1. Graduate student population in nuclear and radiochemistry is decreasing. 68 Ph.D. degrees were awarded in 1976, in stark contrast with the 30 Ph.D. degrees expected to be awarded in the 1980-81 academic year, based on the number of students currently in the pipeline at the time of the survey. This represents a decrease of 56%! Reasons offered included less student interest in the nuclear field, decreased funding for research positions, and lack of access to the new accelerators.

2. The lower number of Ph.D. degrees in nuclear and radiochemistry being awarded is inadequate over the short term (5 y) and could be in serious imbalance with the national need by 1988.

The committee suggested two avenues to address these issues:

1. Add young faculty in nuclear and radiochemistry.

2. Provide assurance of adequate research funding in nuclear and radiochemistry by federal agencies. Such funding was considered only marginal in 1978 for the current level of faculty and student population and quite inadequate for any growth in the field.

It was with this background and in this climate that one member of DNCT took on the task, almost single handedly, to garner support for operation of an undergraduate summer school in nuclear and radiochemistry. Dr. Patricia A. Baisden of the Lawrence Livermore National Laboratory (LLNL) first had to convince the DNCT Chairs that this educational outreach project was doable by the DNCT. She also sold the idea to the Committee on Nuclear and Radiochemistry of the National Research Council (NRC) and won over their Staff Officer and Committee Chair to participate directly in the school's operation. This result gave the proposed program added prestige. Dr. Baisden then had to convince the ACS that running such a summer school was an activity in which one of its divisions could and should be involved. The agreement was that she would handle all the operational details and provide the ACS with the required financial and progress reports for sending on to the financial sponsor, in return for ACS's handling of the financial grant with no overhead charges.

With an administrative infrastructure finally in place in 1983, Dr. Baisden approached the San Jose State University (SJSU) in nearby San Jose, CA, to take advantage of their existing Nuclear Science Facility, experienced faculty members, being a school without a Ph.D. program in chemistry (DNCT members wanted to avoid any graduate student recruiting advantage by the host institution), ability to offer college credit, location near a variety of nuclear facilities, and LLNL upper management's willingness to provide released time for LLNL employees who would participate in the summer school operation. In addition LLNL agreed to provide the design and printing of color posters advertising the summer school and invitations to many of the summer school's guest lecturers to present seminars at LLNL while in the area (thus defraying travel costs otherwise chargeable to the summer school).

The initial proposal for the six-week Undergraduate Summer School in Nuclear and Radiochemistry was submitted to the U.S. Department of Energy, Office of Basic Energy Sciences, and funded with the comment that it addressed an important national need and was a solidly conceived program. Dr. Baisden continually solicited involvement of DNCT members through service on committees to select the students, to give guest lectures at the summer school, to evaluate the curriculum, to survey student response to the summer school for course improvement, to assist with the location of summer research opportunities for the summer school graduates, to help with compiling information about graduate school programs in nuclear science, etc. She served as National Director of the summer schools through the 1992 schools.

Prior to that, however, in February 1988, an NRC workshop to address the training requirements needed for chemists who work in nuclear medicine, the nuclear power industry, the various laboratories and facilities of the U.S. Department of Energy (DOE), and related areas of nuclear science and technology was convened in Washington, DC. Some of the findings issued in the report of that workshop (2), published by the National Academy Press, were:

1. Based on a survey made in late 1987, there was a 60% decrease in radiochemical faculty between 1978 and 1987.

2. The same survey noted a 57% decrease in nuclear and radiochemical courses offered in Ph.D.-granting departments.

3. A clear and growing need for scientists thoroughly trained in radiochemistry was found.

4. The minimum training requirement was defined as a core lecture course plus hands-on laboratory experience in nuclear and radiochemistry.

The interested reader is referred to Appendix E of the workshop report (2) to see the details of the six categories of nuclear and radiochemical research interests used in collecting the survey data. It is also noteworthy to recall the societal impact of two events that occurred between the surveys of 1987 and 1978, i.e., the nuclear reactor accidents at Three Mile Island (1979) and Chernobyl (1986). These events, and the public perception of them, undoubtedly played a role in the decreases noted in the number of faculty and graduate students pursuing nuclear and radiochemical research. The key point to be made here for the purposes of the present paper is that one of the specific recommendations included in the subject report (2) was to establish a second undergraduate summer school in nuclear and radiochemistry at an eastern site. This speaks to validating the success of the SJSU summer school within just four years of operation, and to its satisfying the minimum training requirement (item 4. above).

Actually in August 1987, Dr. Seymour Katcoff of the Brookhaven National Laboratory (BNL) had already discussed with Dr. Baisden the possibility of a second summer school to be held at BNL. After the strong recommendation of the NRC workshop report (2) for a second summer school, he solicited the support and cooperation of other nuclear chemists at BNL and the BNL Chemistry Department Chair, requesting laboratory space, a lecture hall, and permission to use some equipment. Permission was granted, but not without some apprehension that such a program might interfere with the normal BNL research programs. Eventually BNL

administration approved on-site housing for the summer school students and some off-site instructional staff, and the BNL Office of Educational Programs offered to sponsor social events for the students. As it turned out the 1988 Chair of DNCT was on the chemistry faculty of nearby State University of New York at Stony Brook (SUNY-Stony Brook), and he secured academic affiliation of the summer school with SUNY-Stony Brook, enabling the awarding of college credit for the course. A senior nuclear chemist at Rensselaer Polytechnic Institute (RPI) with experience in teaching nuclear and radiochemical laboratory courses agreed to assist with the laboratory portion of the course. Laboratory equipment not available at BNL was borrowed from RPI and nuclear instrument companies, like Canberra.

Dr. Baisden applied for, and received, the necessary funding from DOE to support a second summer school. Dr. Katcoff was named Director of the BNL summer school and also served as a part-time instructor to their first class in summer 1989. The other main lecturers came from Clark University, SUNY-Stony Brook, RPI, and the BNL staff.

PARTICIPANT BENEFITS

Students are provided transportation to and from the school site, room and board for the entire six-week session, text and reference books, laboratory supplies, and tuition for six units of transferable college credit through the ACS-accredited chemistry programs at SJSU or SUNY-Stony Brook. The instructional program consists of lectures and laboratory exercises that cover the fundamentals of nuclear theory and radioactive decay, radiochemistry, nuclear instrumentation, radiological safety, and applications in research, medicine, and industry. Guest lecturers and seminar speakers cover their own specialties and broaden the students' exposure to the various aspects of nuclear science. Emphasis in recent years has been placed on making the students more aware of the many challenges and career opportunities available, as well as the needs for personnel at various degree levels to work in the universities, national laboratories, nuclear power industry, medical facilities, and in environmental clean-up, site remediation, and waste disposal and management activities. Both summer schools employ field trips to nearby nuclear facilities as well to show the students first-hand some potential work environments and to facilitate their interaction with nuclear science practitioners. In addition there are some planned social and cultural events for the students.

Graduates of the summer schools are given Student memberships in DNCT for the remainder of their class year plus the next full calendar year, so that they receive the regular divisional newsletter and information about activities, events, conferences, networking possibilities, etc. within its purview. They are also given considerable personal assistance in the following year(s) to join a nuclear science research project at a university or national laboratory and in their applications to graduate or professional school. In addition each student is provided with a compilation of graduate programs in nuclear science to aid in their selection of additional education and training. Building on the knowledge gained during the summer school, they are strongly encouraged to pursue another hands-on activity in some aspect of nuclear science that interests them during a following term or summer. Keeping them involved with nuclear science increases the chances that they will continue their education and training toward a career in some aspect of it. This is aided by the networking that naturally occurs and the continued mentoring, advice, and encouragement from the summer school staff.

Each school site identifies its Outstanding Student from that year's class, and these two students are rewarded with an expense-paid trip to the fall national meeting of the ACS. They are encouraged to attend the scientific sessions, participate in the society's programs for undergraduates, and network with the chemists and nuclear scientists in attendance. They are each introduced to the DNCT membership at the regular divisional Business Meeting and given the opportunity to speak about their experience at the summer school and how it might affect their future education and career plans.

NUCLEAR SCIENCE BENEFITS

This undergraduate summer school program, an admitted recruiting mechanism, has been successful in attracting students into at least considering further education and training in some aspect of the nuclear sciences, if not actually pursuing it and becoming a nuclear science practitioner themselves. Actually a reasonable number of the summer school graduates, now almost 350 in total, have gone on into careers in nuclear science and medicine. More, however, have furthered their education in other fields of science and technology, but with a greater understanding and appreciation of nuclear and radiochemistry. The resulting academicians, physicians, researchers, and industrial scientists will be, at any rate, better informed citizens, having been made aware of the many benefits of nuclear science, as well as some of its challenges, by their participation in the ACS Summer Schools in Nuclear and Radiochemistry.

THE 2001 SUMMER SCHOOLS: June 18 - July 27

Recruiting for the 2001 summer schools already began at the spring 2000 national meeting of the ACS, because of its traditional heavy draw of undergraduate student participants. Flyers (see Fig. 1) announcing the availability of fellowships are made available at the ACS Student Affiliates hospitality lounge, the undergraduate research poster sessions, and at appropriate chemical education sessions, where it is anticipated that college/university faculty will pick up one and take it back to their institution and share the information with their students. Preferred candidates (must be US citizens or resident aliens) are those students who will be entering their senior year in the fall of 2001 and who have completed at least two years of chemistry, one year of physics, and one year of calculus. In actual fact the class status at the time of application for the last four years (1997-2000) of summer school classes, the stated major(s), and the academic institution applied from are summarized in Table I to represent the variety accepted in these categories. Also the gender breakdown is given in Table I to make note of the general increase in female participants over the recent years, to where they were the major group in 1999 and 2000. Flyers are sent to all regional ACS meetings for distribution in a like manner.

NUCLEAR & RADIOCHEMISTRY UNDERGRADUATE FELLOWSHIPS:

Summer Schools

San Jose State University, San Jose, California and Brookhaven National Laboratory, Upton, Long Island, New York

June 18 through July 27 2001

The Division of Nuclear Chemistry and Technology of the American Chemical Society (ACS) is sponsoring two **INTENSIVE** six-week Summer Schools in Nuclear and Radiochemistry for undergraduates. Funding is provided by the U.S. Department of Energy.

AWARDS

Fellowships include transportation to and from the Summer School, housing, food, books, laboratory supplies, and tuition. Six units of transferable college credit will be awarded through the ACS accredited chemistry programs at San Jose State University or the State University of New York at Stony Brook.

QUALIFICATIONS

Candidates should be undergraduates who will be entering their junior or senior year in the fall of 2001. They should have completed at least two years of chemistry, one year of physics, and one year of calculus. Preference will be given to entering seniors. Applicants must be U.S. citizens or resident aliens.

SELECTION

The Summer Schools will be limited to 12 students at each site. Announcement of awards will be made in early spring 2001.

COURSE DESCRIPTION

The course will consist of both lecture and laboratory work on the fundamentals of nuclear science and applications to related fields. In addition to the formal instruction, the course will include a Guest Lecture Series and tours of nearby research centers at universities and National Laboratories. There will also be a special nuclear medicine symposium. Thus the student will meet and interact with prominent research scientists working in nuclear and radiochemistry, nuclear medicine, and related fields.

FUTURE RESEARCH OPPORTUNITIES

Participants in the 2001 Summer Schools will be encouraged to join a research project during the following summer at a university or federal research institution. Considerable personal assistance will be provided to secure summer positions and admission to Ph.D. and M.D. programs at leading universities.

For more information and application forms contact:

Dr. Joseph R. Peterson, Director
Summer Schools in Nuclear and Radiochemistry
Department of Chemistry
University of Tennessee
Knoxville, TN 37996-1600

Tel: 865-974-3434, Fax: 865-974-3454
Email: JOEPETE@UTK.EDU

Completed applications must be received no later than February 1, 2001.

More information and downloadable forms at URL http://www.cofc.edu/~nuclear/nukess.html

Fig. 1. Recruiting flyer for the 2001 Summer Schools in Nuclear and Radiochemistry

Table I. Summer School Class Statistics for Last Four Years*

Year	2000	1999	1998	1997
Class	5 seniors 14 seniors 5 sophomores	4 seniors 19 juniors 1 sophomore	7 seniors 14 juniors 3 sophomores	8 seniors 12 juniors 4 sophomores
Gender	8 males 16 females	11 males 13 females	15 males 9 females	13 males 11 females
Majors	Chemistry [15] Biochem [1] Physics [2] Kinesiology [1] Chem/Biology [1] Chem/Math [3] Chem/Religion [1]	Chemistry [15] Biochem [3] Biology [1] Chem/Math [1] Chem/Biosciences [1] Chem/Life Sciences [1] Chem/Spanish [1] Biophysics/Music [1]	Chemistry [15] Chem Eng [2] Chem/Physics [2] Chem/Biology [2] Chem/Math [1] Chem/Communication Arts [1] Chem/Math/Eng [1]	Chemistry [14] Biochem [2] Chem Eng [2] Eng Physics [1] Phys Sci Educ [1] Chem/Biology [1] Chem/Geology [1] Chem/Math [1] Chem/Physics [1]
Academic Institutions	Belmont Coll Bradley U Cal State U-Sacramento Chatham Coll Coll of New Jersey Eastern Michigan U Grove City Coll Johns Hopkins U Lock Haven U Marist Coll Northwestern U San Jose State U SUNY-Stony Brook Tennessee Technol U Towson U U California-Davis [2] U Dallas U Iowa [2] U Missouri-Columbia U Puerto Rico-Mayaguez U Wisconsin-Parkside Washington State U	American River Coll Coll of New Jersey Coll of William and Mary Dartmouth Coll Fairfield U Hope Coll Indiana State U Kean U Mount Holyoke Coll New Mexico Inst of Mining and Technol Oklahoma City U Old Dominion U Quincy U St. Mary's U Southern Utah U SUNY-Binghamton [2] Texas A & M U U Alabama U Delaware U Puerto Rico-Mayaguez U Tennessee-Knoxville Walla Walla Coll Washington State U	Adrian Coll Cal State U-Fresno Clark U Colby Coll Coll of New Jersey Coll of St. Elizabeth Frostburg State U Georgetown Coll Harding U Michigan State U [2] New Jersey Inst of Technol Shepherd Coll US Naval Academy U California-Davis U California-San Diego U Kentucky U Massachusetts-Lowell U Mobile U Nebraska-Lincoln [2] U Puerto Rico-Mayaguez U Tennessee-Knoxville Worcester State Coll	American River Coll Colby Coll East Carolina U Eastern Michigan U Framingham State Coll Kean Coll of New Jersey Maryville Coll Middlebury Coll Niagara U Saint Cloud State U St. Mary's U Tennessee Technol U [2] US Naval Academy U California-Davis U California-Irvine U California-Santa Barbara U California-Santa Cruz [2] U Maryland-Baltimore County U Rhode Island U Texas-Dallas Wayne State Coll Wilkes Coll

* Data taken from the student applications

A mailing to all faculty advisors of the ACS Student Affiliate chapters is made in October each year, as well as to each DNCT member, to encourage them to talk up the summer school and encourage application to enter the competition for a fellowship. The ACS Summer Schools in Nuclear and Radiochemistry are registered as an ongoing program in many Career Services and Internships Offices at academic institutions throughout the U.S.A. and also with the Experiential Programs in Chemistry (EpiC) of the ACS. Potential applicants can download the application and personal reference forms from the DNCT website [http://www.cofc.edu/~nuclear/nukess.html] or contact the National Director for an application packet.

Completed applications are due to the National Director on February 1, 2001. A complete application consists of the application form, two personal reference forms, an official transcript, and verification of the reported SAT/ACT scores (copy of the official report is most often supplied). The applicant writes two paragraphs on the back of the application form, one describing his/her interests in, and how he/she would benefit from, this program, and the second, describing his/her educational and career goals. Completed files are copied and sent in mid-February to the Student Selection Committee (recently consisting of the three persons in the DNCT Chair succession) who rank order the applicants for the National Director to make fellowship offers until all 24 are awarded. Usually this is accomplished within the top 30 applicants and by the end of March. Some awardees turn down the offer when they discover that they will not leave the program with money in their pocket. Others accept instead paying research positions or other opportunities for which they have competed.

Upon establishing the class lists for each school site, the National Director writes a draft press release for each student and sends it to him/her. He encourages them to add a picture, if possible, and send it to both their school and hometown newspapers. A significant number of these gets published, which provides visibility for the summer school program and the student participants. Travel arrangements are made by the National Director to get each student from his hometown or college/university site to the assigned school site (the applicants are given the opportunity to indicate their site preference, if any) by air on the day before the summer schools begin (June 17, 2001) and back again on the day after the summer schools end (July 28, 2001). Electronic mail communications have greatly facilitated these necessary operations and the extensive question raising and answering that goes on between the National Director and the applicants and then continuing with the selected students. In the late spring the students start communicating with their respective Site Directors to learn of the local arrangements and other particulars for their summer school site.

At any time the students can question, or complain to, the National Director, but the usual practice is for the National Director to visit each site toward the end of the session and meet with the students in the absence of the local school staff to hear student complaints and/or suggestions for course improvements. Through surveys of the students by the respective school staffs, they can evaluate aspects of their individual programs, determine the usefulness of field trips, measure the effectiveness of the guest lecturers, seminar speakers, course books and materials, living accommodations, etc. Updating

both computer facilities and laboratory equipment have been frequent requests that the two Site Directors have addressed with unexpended monies toward the end of each summer school fiscal year. Thus, the program is a continually evolving one, changing with the needs and desires of the student clientele. Also there is more emphasis now on discussing graduate school and career opportunities, varied career paths, jobs at various degree levels, etc. Current students are very interested in the details of the more practical aspects of life as a nuclear scientist, and not just in understanding the technical aspects of nuclear science. Because we are trying to recruit them into the field, it behooves us to address their requests for information.

CONCLUSION

Having graduated almost 350 students from the ACS Summer Schools in Nuclear and Radiochemistry through 17 years of continuous operation, this program has contributed significantly to recruiting young, dynamic, trained personnel into the diversity of the nuclear arena, be it in academia, government laboratories and facilities, medicine, pharmaceuticals, the nuclear power industry, environmental clean-up and waste disposal and management activities, etc. The continuing national need for such personnel assures the near-term future operation of the ACS Summer Schools in Nuclear and Radiochemistry.

ACKNOWLEDGEMENT

This project is sponsored by the Division of Chemical Sciences, Geosciences, and Biosciences, Office of Basic Energy Sciences, U.S. Department of Energy, under grant number DE-FG02-95ER14520 with the American Chemical Society in Washington, DC.

REFERENCES

1. J.R. PETERSON, "The American Chemical Society's Division of Nuclear Chemistry and Technology's summer schools in nuclear and radiochemistry," *J. Radioanal. Nucl. Chem.* **219**, 231 (1997).

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