

# Annual Report Calendar Year 2003

## Nuclear Science and Technology Group Harry Reid Center for Environmental Studies

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### INTRODUCTION

The Nuclear Science and Technology Group (NSTG) is a division of the Harry Reid Center for Environmental Studies (HRC) at the University of Nevada, Las Vegas (UNLV). The NSTG's students and staff conduct research and communicate information regarding aspects of nuclear science and technology that are of interest to the community and sponsoring organizations. The NSTG was formed in 2000 as an offshoot of a U.S. Department of Energy (DOE) cooperative agreement with UNLV that established in 1995 the Nevada Risk Assessment/Management Program (NRAMP), a broad program in environmental risk assessment and management of the nuclear weapons testing legacy in Nevada. Upon its completion on April 30, 2000, NRAMP had distributed 80 reports; produced 44 refereed published papers and articles; gave 42 invited presentations; and, conducted stakeholder working groups, focus groups, and continuing education classes and seminars as part of its risk assessment/management program. Further details are contained in the NRAMP *Final Technical Report* (June 2000).

Researchers who have contributed to NSTG products in calendar year 2003 as principal staff, authors, and/or collaborators (not including the campus-wide Advanced Accelerator Applications/Transmutation Research Program that is administered by NSTG staff):

Donald H. Baepler, Ph.D.	Biology and Ornithology
Denis Beller, Ph.D.	Nuclear Engineering
Gary S. Cerefice, Ph.D.	Nuclear Engineering and Actinide Chemistry
Kenneth R. Czerwinski, Ph. D.	Actinide and Analytical Chemistry
Jeanette Daniels	Analytical Chemistry and Laboratory Coordination
Anthony E. Hechanova, Ph.D.	Nuclear Engineering and Health Physics
Carter D. Hull, Ph.D.	Radiogeochemistry and Nuclear Instrumentation (Associate)
Kathleen Lauckner	Stakeholder Interaction
Longzhou Ma, Ph.D.	Materials Science and Engineering

#### Students:

Amanda Brandt	Graduate Student, Water Resource Management
Dean Curtis	Physics Department
Steve Curtis	Graduate Student, Health Physics Department
David Edwards	Health Physics Department
Demian Gitnacht	Health Physics Department
John Knoten	Civil and Environmental Engineering, Webmaster
Joseph Lloren	Undergraduate Studies
Kondala Rao Mantri	Graduate Student, Transportation Research Center
Mosese Ohia	Undergraduate Studies

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Jennifer Petchsaiprasert	Chemistry Department
Kristen Stetzenbach	Graduate Student, Communications Department
Jeff Stutz	Graduate Student, Health Physics Department
Erica Summers	Psychology Department
Diana Switaj	Education Department
Richard Turner	Health Physics Department

### PROJECTS

#### 1. Information Management: NSTG Websites and Libraries

The Nuclear Science and Technology Group provides avenues for communication and maintains archives through websites and libraries. The NSTG website was established in 2000 and was maintained by a student webmaster John Knoten in 2003. The following websites are currently located on the HRC server except for the YMEP site:

- NSTG Home Page: <http://nstg.nevada.edu>
- Transmutation Research Program website: <http://aaa.nevada.edu>
- Waste Management Research Project website: <http://wmrp.nevada.edu>
- Pahrump Nuclear Waste and Environmental Advisory Board website:  
<http://nstg.nevada.edu/PAHRUMP.html>
- Actinide Research Group website: <http://nstg.nevada.edu/actinide/profile.htm>
- High Temperature Heat Exchanger Program website:  
<http://nstg.nevada.edu/heatexchangers.html>
- Support to Yucca Mountain Education Project website: <http://www.library.unlv.edu/yucca/>

The websites serve as the main vehicle for information dissemination and contains information about the NSTG and its research projects including distributed reports, presentation slides, pictures and movie clips from activities, and links to related sites. As identified above, the NSTG also hosts the UNLV Transmutation Research Program website, the International Youth Nuclear Congress Waste Management Research Project website, and the Pahrump Nuclear Waste Advisory Board website. The NSTG website is a valuable asset and serves communication needs of research collaborators and stakeholders.

The NSTG maintains and updates an extensive library that was established in 1995 with the Nevada Risk Assessment/Management Program. The library currently contains about 2000 documents related to nuclear science and technology. In addition to the main library located in room HRC 401, a smaller Transmutation Research Program Library located in room HRC 415 and exhaustive Ecological Bibliography are maintained by the NSTG. These libraries are open to community and databases are provided on request.

## **2. Experimental Facilities**

### **2.1 Radiation Detection Laboratory**

The NSTG opened a new Radiation Detection Laboratory (RDL) in 2001. The RDL is approved for use of radioactive materials at UNLV. Drs. Cerefice, Czerwinski, and Hull are approved Users of radioactive material at UNLV, and can supervise work in the laboratory. The RDL has several counting instruments such as a state of the art alpha spectrometry system, low background alpha/beta proportional counting instruments, calibrated radiation sources, a Liquid Scintillation Counting system, and a High Purity Germanium (HPGe) gamma ray spectrometry detector.

NSTG students and staff perform routine maintenance on the Radiation Detection Laboratory to satisfy Radiation Safety Office and Environmental Health & Safety requirements.

### **2.2 Transmission Electron Microscopy User Facility**

The NSTG is developing a Transmission Electron Microscopy (TEM) user facility to allow researchers to examine materials down to the atomic level (approximately 1 to 2 angstrom resolution, 0.1 to 0.2 nm), obtaining not only images of the materials, but also determine the elemental and molecular chemistry of the sample. This custom designed user laboratory will allow UNLV researchers access to the cutting edge in materials and imaging technology. The centerpiece of the user facility is the TECNAI-F30-SUPER-TWIN series TEM for the facility. This highly versatile tool is used to explore in-depth structure within the microscopic world in disciplines spanning life sciences and materials science. This acquisition institutes tremendous scientific advancement for research at UNLV and within the research community.

In 2003, the remodeling of the space at the HRC was completed, and the installation of the basic system was completed. The installation of the remote operation system, along with other upgrades, is expected to be completed in early 2004, along with the modifications to the facility to reduce the magnetic and acoustic fields in the instrument room. Once complete, the user facility will be fully operational and available to the scientific community at UNLV and nation-wide.

In support of this facility, the NSTG, through the Transmutation Research Program, supported the expansion of the SEM sample preparation facility (in TECH 121) to provide the specialized equipment necessary to prepare samples for TEM analysis. The primary facility modifications were completed in 2003, along with the purchasing process for the sample processing equipment. The final equipment is expected to be delivered and installed in early 2004, after which the facility, which has been re-named the Electron Microscopy Sample Preparation User Facility, will be available to support both the TEM User Facility and the Electron Microprobe and Imaging Laboratory (EMIL).

### **2.3 Inductively Coupled Plasma - Atomic Emission Spectroscopy User Facility**

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Inductively Coupled Plasma - Atomic Emission Spectroscopy (ICP-AES) is one of the fundamental analytical techniques for physical chemistry, allowing researchers to rapidly, easily, and affordably determine elemental concentrations of most elements down to the parts per billion level. This facility will also host a pyrolysis unit, allowing the direct measurement of the composition of any sample that can be vaporized at temperatures up to 2000 °C.

In 2003, the purchasing process for the instrument was completed, and the system was delivered. The facility (MSM 172) is being remodeled to support the installation of the ICP-AES. The design and planning for the retrofit was completed in late 2003, and the construction work will be combined with the construction for the Actinide Chemistry lab project. The facility is expected to be available to UNLV researchers by mid to late 2004.

### 2.4 Actinide Chemistry Laboratory

In 2003, a room at the HRC was procured for the Actinide Chemistry Laboratory. The planning and design of the facility was completed in 2003. The renovation of the facility is planned for 2004, and is expected to be complete by mid to late 2004. The facility was designed to allow the use of significant activity of actinides for experiments (up to 1 gram plutonium per experiment), and is designed to meet all the UNLV OSHA, EH&S, and RSO requirements for such a facility.

### 2.5 Molten Metal Thermohydraulics Facility (Interim)

In 2003, space was procured by the Transmutation Research Program for the temporary installation of the TC-1 complex, or “Lead-Bismuth loop” in the Engineering Building (TBE B-129). The electrical and mechanical modifications to the facility required to allow the installation of the TC-1 were completed, and the loop was set into place at the end of the summer. Researchers from the Institute for Physics and Power Engineering (IPPE) in Obninsk, RU, visited UNLV to begin the installation process in late 2003. The installation process is expected to take more than a year, with the goal of having the system available for the prototyping campaign in late 2005.

### **3. Risk Assessment Activities**

The NSTG continued work on two research projects in 2003 dealing with issues related to the DOE National Nuclear Security Administration Nevada Operations Office (NNSA/NV) environmental management program as part of the purview of the Nevada Test Site (NTS) Risk Assessment grant. NSTG staff met with DOE-EM on July 25 to discuss these new research projects. One on depleted uranium disposal at the NTS and another on using RADTRAN or other state-of-the-art codes for performing stakeholder-driven transportation risk assessments. Both concepts were approved and two graduate students were hired and have started their research with their ultimate goal being M.S. degrees.

#### **3.1. Depleted Uranium Disposal at the Nevada Test Site**

A DOE-commissioned study recommended the Nevada Test Site (NTS) as the preferred location for depleted uranium (DU) disposal. Currently, the NTS operates two low-level radioactive waste management sites in Area 3 (Yucca Flat) and Area 5 (Frenchman Flat), and has accepted depleted uranium in several forms in the past. Legislation and infrastructure presently in place at the NTS supports the creation of additional uranium disposal sites. Given its arid climate, large capacity volume, and experience with DU disposal, it is possible that existing NTS low-level waste management sites could be expanded to accept large volumes of depleted uranium.

To assess the performance of a depleted uranium disposal cell, the GOLDSIM modeling suite is being used to create a performance model for a hypothetical disposal unit at the Nevada Test Site, particularly in the Area 5 radioactive waste management site (Area 3 may also be examined in the future). Emphasis is placed on developing a conceptual, dose-based model with interchangeable components for ease of transferability and multi-party use, promoting compatibility with existing research in the field. Such a model should be easily integrated into the current modeling efforts for the Area 5 waste management site (e.g., the Probabilistic Evaluation Group project). Components of this model can also be adapted to examine the thorium waste disposal cell in Area 5, which should pose similar (albeit lesser) risks and challenges as the DU disposal facilities.

The first area of focus involves identification of physical parameters affecting uranium disposal and transport. The second area concentrates on model development and building, including incorporation of existing modeling approaches as applicable. The model will provide a valuable tool for site engineers, designers, and decision makers by providing a test-bed for disposal site design components, links to dose-based standards through the employment of receptor modules, and potential for integration with current Area 5 groundwater flow modeling efforts.

The model for the DU is intended to evaluate if the facility would meet the current requirements for low-level radioactive waste management (10CFR60). This model will then be used to examine the

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variables affecting the safety of DU disposal at the NTS, as well as provide a basis for evaluating design changes and performing cost-benefit analyses in advance of siting these facilities.

### 3.2 Transportation of Radioactive Waste

In 2002, NSTG staff met with UNLV's Transportation Research Center and developed a detailed proposal outlining the stakeholder-driven transportation risk assessment project. The proposal was reviewed by a major stakeholder group, the Pahrump Nuclear Waste and Environmental Advisory Board (PNWEAB, see Section 7.1) and approved. Students and staff are conducting an in depth literature review on transportation accidents and incidents to support the project and respond to PNWEAB inquiries. In particular, statistics pertaining to hazardous materials transportation accidents for years 1993-2001 were collected, as well as radioactive material transportation accidents.

The potential risks and impacts of transporting low-level radioactive waste (LLW) to the NTS is a concern to the residents of Nevada and to those residing along these shipment routes in Nevada and the main foci of the project. The routes used to transport LLW traverse towns and cities. In doing so, trucks with LLW pass within short distances of homes, schools, hospitals, nursing homes, factories, and business establishments. Risks and consequences could be severe when trucks containing LLW are involved in a crash. The NSTG is developing tools to address questions related to public health and safety. Examples of such questions are the following:

- How much exposure to radiation could affect public health and safety?
- How might risks associated with a route be assessed?
- What impact might a major crash involving a truck with low-level radioactive waste material have on the local area?
- Can a tool be developed to help stakeholders evaluate the level of safety and efficiency in the transport of low-level radioactive waste material?

The purpose of this research project is to address concerns of the stakeholders such as the Pahrump Nuclear Waste and Environmental Advisory Board by identifying the extent of the problem, determining transportation alternatives, and developing a tool to support local efforts in providing for the safe transportation of radioactive wastes.

The objectives of the project are to: (1) Identify the extent of the type and amount of LLW shipments, and potential LLW transportation routes; (2) Identify on-link and off-link characterization measures which may be used to quantify the "risks and consequences" involved in transporting LLW to the NTS, and (3) Develop a tool to evaluate consequences of transporting LLW to the NTS along highway routes in Nevada.

## 4. Transmutation Research Program

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NSTG staff are the principal administrators of the UNLV Transmutation Research Program (TRP) established on March 6, 2001 as the then-named Advanced Accelerator Applications University Participation Program. The UNLV program was supported by a \$3.8 million grant in FY03 from DOE-NE as a core component of the new national transmutation of radioactive waste program led by Los Alamos and Argonne National Laboratories. Complete and detailed information about the UNLV TRP can be found on their website at <http://aaa.nevada.edu> or by referring to the program's quarterly reports (located on the website) and the Year 2 annual report (published August 2003). This information (such as deliverables, milestones, and schedules) is not repeated in this document.

The UNLV TRP is a major component of the NSTG and the funding source for the TEM and ICP-AES facilities at the HRC (see Sections 2.2 and 2.3, above). The UNLV TRP also sponsors information management, new academic program development, and appropriate stakeholder activities.

### **5. International Youth Nuclear Congress (IYNC)**

The International Youth Nuclear Congress was organized by a new generation of professionals in the nuclear field from different countries to: develop new approaches to communicate benefits of nuclear power as part of a balanced energy mix; promote further use of nuclear science and technology for the welfare of humankind; transfer knowledge from the current generation of leading scientists to the next generation; and, encourage the creation of a global network among young professionals. The primary purpose of the IYNC is to transfer knowledge from the current generation of leading nuclear scientists and engineers to the next generation.

The NSTG Group Leader was appointed as the lead of the International Youth Nuclear Congress (IYNC) Waste Management Research Project (WMRP). A website has been set up at <http://wmp.nevada.edu> on the HRC server to facilitate communications. As of December 31, 17 countries have appointed representatives to the WMRP (two more additions are pending approval). Two major deliverables were developed in 2002. First, a series of radioactive waste management fact sheets are being prepared by each participating country. Twelve countries have submitted fact sheets (Armenia, Bulgaria, Iran, Korea, Lithuania, Slovenia, Sweden, Switzerland, Romania, Russia, United Kingdom, and U.S.). The NSTG staff prepared the U.S. Fact Sheet. The second deliverable is a radioactive waste management opinion poll to be conducted on nuclear science and engineering students and young professionals. Both deliverables were presented at the IYNC conference in Daejeon, Korea held April 15 to 19, 2002 (IYNC 2002).

The NSTG Group Leader presented an oral paper at IYNC 2002. The name of the presentation was "Waste Management Research Project" and it was awarded best presentation of the session. The full paper was published in the IYNC 2002 Congress Proceedings. In addition, the NSTG staff edited the Youth Department of the Russian Nuclear Society English-edition of their Nuclear Cities Tour brochure that was distributed at IYNC 2002.

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After the Waste Management Research Project presentation at IYNC 2002, representatives from Japan and France (two of the major countries not yet participating) gave their assurance that they will participate in the ongoing project. NSTG staff continues to coordinate the project and maintain and update the website at <http://wmrp.nevada.edu>.

NSTG staff attended the IYNC 2004 first organizational meeting in Washington, DC, November 16, 2002. The technical area on waste management was designed by the NSTG staff. IYNC 2004 is scheduled for Toronto, Canada in April 2004.

### **6. Highly-Involved Stakeholder Groups**

The NSTG plays an active role in providing support to highly involved stakeholder groups dealing with issues related to the DOE National Nuclear Security Administration Nevada Operations Office (NNSA/NV) environmental management program as part of the purview of the Nevada Test Site (NTS) Risk Assessment grant. In 2003, the NSTG staff were principal participants in the Pahrump Nuclear Waste and Environmental Advisory Board and the UNLV Yucca Mountain Education Project. The NSTG staff also developed and coordinated a lecture series on nuclear waste and related issues for Mesquite, NV.

#### **6.1 Pahrump Nuclear Waste and Environmental Advisory Board (PNWEAB)**

The NSTG provides technical and material support to the Nuclear Waste Advisory Board of the Town of Pahrump in Nye County, Nevada. Anthony Hechanova is the PNWEAB's Consultant Emeritus from the University of Nevada, Las Vegas, a position appointed by the Town Board of Pahrump. In addition to hosting the PNWEAB website and attending monthly meetings in Pahrump, the NSTG sponsored and staffed the Board's outreach booth at the Pahrump Earth Day Festival (April 12, 2003) and at the annual Pahrump Harvest Festival (October 3 to 5, 2003). The group also conducted and reported on several projects commissioned by the PNWEAB.

#### **6.2 Yucca Mountain Education Project (YMEP)**

The Yucca Mountain Education Project is a multidisciplinary effort by interested UNLV faculty and staff to create a balanced information resource for the general public on the subject of the proposed Yucca Mountain high-level radioactive waste disposal site. The ultimate goal of the project is to present the positive and negative aspects of the proposed waste site so that the general public can make informed political decisions. NSTG researchers Anthony Hechanova and Kathy Lauckner are founding members of the YMEP and helped to coordinate the lecture series that will begin in spring term 2001.

On April 10, 2003, NSTG students and staff hosted a presentation by Brian Sandoval, Nevada Attorney General, entitled "Where Do We Go From Here: The Legal Aspects Facing Yucca Mountain."

## **7. Stakeholder Outreach and Educational Activities**

The NSTG plays an active role in providing an avenue for public involvement dealing with issues related to the DOE National Nuclear Security Administration Nevada Operations Office (NNSA/NV) environmental management program as part of the purview of the Nevada Test Site (NTS) Risk Assessment grant. In 2003, the NSTG staff were actively involved in stakeholder outreach and educational activities. This section reviews the activities of 2003.

### **7.1 Workshops and Conferences**

NSTG staff participated in the national American Nuclear Society on the Accelerator Applications Committee and the Public Information Committee at the ANS Summer Meeting in San Diego, June 2-4, 2003 and at the Winter Meeting in New Orleans, LA, November 17-20, 2003.

The NSTG Group Leader was a Session Organizer at the 9<sup>th</sup> International Conference on Environmental Remediation and Radioactive Waste Management held in Oxford, UK, September 21-25, 2003 (ICEM03) for the Major Institutional Issues in Environmental Management Track Session on “Technical and Public Acceptance Criteria for Disposal or for Clearance.”

The NSTG staff coordinated the UNLV participation at the American Nuclear Society Student Conference held at UC Berkeley, April 3-5, 2003.

NTSG staff attended conference of Microscopy and Microanalysis 2003, San Antonio, Texas, from August 3-7, 2003, and presented a paper regarding TEM sample preparation technology. During presentation, the new facilities such as TEM and upcoming TEM sample preparation lab in UNLV, and NTSG organization and mission were highlighted.

NTSG staff published three papers regarding high temperature crack growth of Ni-based superalloy, and SEM and TEM analysis of this issue in a top rank international journal in materials science, Scripta Materialia.

NTSG staff submitted a paper regarding TEM sample preparation technology to a top rank international journal in microscopy field, Micron, and this paper has been accepted. Paper will be published in 2004.

### **7.2 UNLV Research and Academic Support**

NSTG staff consulted on the development of academic programs in the fields of radiochemistry and nuclear engineering with the Colleges of Sciences and Engineering. The program proposal to the board of regents for the proposed Masters of Science Degree Program in Materials and Nuclear Engineering was prepared in 2003. The proposal was approved by the internal UNLV committees,

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and is expected to be presented to the Board of Regents in 2004. The staff also assisted the development of the Radiochemistry Ph.D. program, which was also approved by the internal UNLV committees and is expected to be presented to the Board of Regents in early 2004.

NTSG staff developed and taught an undergraduate course on radiochemistry (CHE 312, "Introduction to Radiochemistry").

NSTG staff participated as members of the UNLV Radiation Safety Advisory Committee.

In addition, NSTG staff visited or were visited by the following academic and research institutions to investigate collaborations with UNLV academic and research programs:

- Nevada Test Site, August 29 and November 19.
- Argonne National Laboratory, Chemistry Group, March 6 and June 30.
- Massachusetts Institute of Technology and Seoul National University, June 6.
- Khlopin Radium Institute (St. Petersburg, RU), July 14 through 18 and October 9 through 17
- Institute for Physics and Power Engineering (Obninsk, RU) November 19 through December 5.
- Idaho State University and the Idaho Accelerator Center, January 15,

### 8.3 Invited Seminars

NSTG staff developed a seminar series course on Radioactive Waste for Charles Horne, Mayor, City of Mesquite. The seminar series will seek participation from local government officials in the rural communities and is to start in January 2003.

NSTG staff presented the following invited seminars in 2003:

- "Nuclear Waste and Nevada", Graduate Seminar, Department of Nuclear Engineering, University of Illinois, Urbana-Champaign. March 18, 2003.
- "Waste Management Strategies", Presentation (part of Mesquite Lecture Series). March 19, 2003.
- "UNLV Transmutation Research Program: Recent Highlights and Future Directions". Presentation. Advanced Fuel Cycle Initiative Semi-Annual Technical Review. Albuquerque, NM. August 28, 2003.

### 8.4 Outreach in the Community

NSTG staff interviewed on UNLVView regarding radioactive waste management and transportation in April.

NSTG staff was interviewed by Bill Nye ("Bill Nye, the Science Guy", PBS) as part of the Nuclear Power Episode for the Eyes of Nye television series under development for PBS on May 5 regarding

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radioactive waste management and nuclear power.

NTSG Staff attended meetings of the NRC, DOE, UNLV, ASME, and other miscellaneous meetings.