INOVATIONS IN NUCLEAR INFRASTRUCTURE AND EDUCATION (INIE) CONSORTIA – CURRENT STATUS

Presented at the Americas Nuclear Energy Symposium
Miami, FL October 4, 2004

Robert A. Fjeld
Clemson University

John Gutteridge
U. S. Department of Energy

Craig Williamson
South Carolina Universities Research and Education Foundation
THE PROBLEM

- Declining number of operating university research/training reactors
  - University reactors: 62 in 1979, 27 in 2001
- Dwindling student population in nuclear engineering
  - BS: 1800 in 1979; 550 in 1999
  - MS: 900 in 1979; 250 in 1999
  - PhD: 600 in 1979; 190 in 2001
- Closing or loss of identity of university nuclear engineering programs
- Looming shortage of nuclear engineering graduates
- Threat of additional reactor closures
THE RESPONSE

• **NERAC task force report:** “The Future of Nuclear Engineering Programs and University Research and Training Reactors,” (1999-2000) headed by Michael Corradini, confirmed that:
  - University nuclear engineering in the U.S. was in jeopardy
  - Reactors were rapidly decreasing
  - All this was in sharp contrast to the increasing need for experts trained in nuclear science
  - University reactors are an important part of undergraduate and graduate education

• **An outgrowth of this was the NERAC Task Force on University Research Reactors headed by Robert Long**
  - Several recommendations were made including the provision for Federal funding in FY 2002 to initiate a competitive peer-reviewed process for the establishment of geographically distributed regional university research/training reactor user facilities
Innovations in Nuclear Infrastructure and Education – INIE

- Established by DOE’s Office of Nuclear Energy, Science, and Technology
- Objective: To strengthen the Nation’s university nuclear engineering education programs through innovative use of the university research and training reactors and encouraging strategic partnerships between the universities, the DOE national laboratories, and U.S. industry, i.e.
  - Educational Innovations
  - Infrastructure Enhancements
  - Research Innovations
- To be achieved through regional consortia
IMPLEMENTATION

• December 2001: Solicitation
• June 2002: Awards Announced
  – Four consortia (14 institutions) - $5.5M
  – Big-10, New England, Southwest, West
  – Funded in late 2002
• Oct 2003 – Two additional consortia (13 institutions)
  – Midwest, Southeast
• 2003/2004 – Six additional institutions (TOTAL - 33)
• Consortium of Big-10 University Research and Training Reactors: “Big-10” - PSU, PU, UIUC, UW, OSU (Yr 2), UM (Yr 3)
• New England Consortium: “New England” - MIT, RINSC, UM Lowell (Yr 2)
• Southwest Consortium of Research Reactors: “Southwest” - TAMU, UTexas, UNM
• Western Nuclear Science Alliance – WNSA: “West” – OSU, UCD, WSU, UCB, ISU, Reed College (Yr 3), UC Irvine (Yr 3)
• Midwest Nuclear Science and Engineering Consortium: “Midwest” – MU, UMR, UMKC, LSTC, PURR, Tuskegee
• Multi-University Southeast INIE Consortium – MUSIC: “Southeast” – NCSU, UMD, GaTech, UTenn, AFRRI, SCSU, UF, USC
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Big-10</td>
<td>$1.97M</td>
<td>$1.97M</td>
<td>$2.17M</td>
</tr>
<tr>
<td>New England</td>
<td>$1.1M</td>
<td>$1.1M</td>
<td>$1.15M</td>
</tr>
<tr>
<td>Southwest</td>
<td>$1.05M</td>
<td>$1.05M</td>
<td>$1.15M</td>
</tr>
<tr>
<td>West</td>
<td>$1.3M</td>
<td>$1.3M</td>
<td>$1.4M</td>
</tr>
<tr>
<td>Midwest</td>
<td>-</td>
<td>$0.6M</td>
<td>$1.4M</td>
</tr>
<tr>
<td>Southeast</td>
<td>-</td>
<td>$0.4M</td>
<td>$1.46M</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$5.5M</strong></td>
<td><strong>$6.5M</strong></td>
<td><strong>$8.8M</strong></td>
</tr>
</tbody>
</table>
GENERAL ACTIVITIES
EDUCATIONAL INNOVATIONS

- Distance Learning (All)
- UG Scholarships (All)
- Graduate Assistantships (All)
- Outreach (Big-10, Midwest, West)
- New Nuclear Degrees/Options (Midwest)
- Intra-consortium Collaboration (Midwest, Southeast, Southwest, West)
- Inter-consortium Collaboration (All)
GENERAL ACTIVITIES
INFRASTRUCTURE ENHANCEMENTS

- Beam port (All)
- Laboratory Upgrades (Southeast, Southwest, West)
- NAA/PGNAA (Big-10, Midwest, Southwest)
- Reactor Systems (Big-10, New England)
- Distance Learning Hardware (Midwest, Southeast, Southwest)
- Neutron Imaging (Big-10, New England, Southeast, West)
- Neutron Capture Therapy (New England, Southeast)
- Positron Source (Southeast, Southwest)
- Cold Neutron Source (Southeast, Southwest)
- Advanced Materials Test Facility (New England)
- Post-docs (Midwest, New England, Southeast, Southwest)
GENERAL ACTIVITIES
RESEARCH INITIATIVES

- Research Seed Money (Big-10, Midwest, Southwest, West)
- Neutron Scattering (Midwest, Southeast)
- Neutron Science (Big-10, New England, Southeast)
- Mini-grant Program (Big-10)
- Virtual Research and Training Reactor (Big-10)
Big-10 Minigrant Program

• Objective: To broaden participation of researchers, educators and students in nuclear science and technology by providing access to Big-10 facilities

• Year 2
  – 40 proposals, 16 awards: $1000 - $25000
  – 7 high schools, 4 universities, 1 industry

• Sampling of Projects
  – Nuclear science laboratories (various HS)
  – Neutron radiography analysis of lawn mower blades (HS)
  – Heavy metals in urban and rural areas near Johannesburg (HS)
  – Cell survival experiments for boron neutron capture therapy (Univ)

• http://www.mne.psu.edu/minigrant/governance.html
WNSA ("West") Summer Institute

• Idea for a summer course in a highly specialized area emerged at WNSA partners meeting in October 2003
• “Nonproliferation Instrumentation and Measurements” offered in Idaho Falls in July 2004
  – 5 day course
  – Instructors from ANL-W, INEEL, PNNL, LLNL, LANL
  – Lectures, tours, hands-on detection
  – 18 students (13 from WNSA institutions)
• Basis for INIE Summer Institute
  – Course available to students from all consortia
  – Proposals due October 29
Southwest Intra-Consortium Collaboration: Remote Delivery of Reactor Labs

- **Delayed Neutron Lab: TAMU to UTexas (Spring 2003)**
  - INIE funds used to enhance delayed neutron counting system at TAMU
  - Lab performed at TAMU with remote delivery (audio) to students at UTexas. Data provided in almost real time to students at UTexas.

- **Neutron Radiography: UTexas to TAMU (Spring 2004)**
  - INIE funds used to purchase video equipment at UTexas
  - Students physically located at TAMU conducted neutron radiography lab at UTexas.
  - Audio and video feeds plus TAMU students rotated object being examined.
Research Facility Upgrades at NCSU

• Research Facility Upgrades under INIE
  – Advanced Neutron Imaging System (phase contrast)
  – Ultracold Neutron Source (one of three in world)
  – Intense Positron Source (proof of principle experiment to support large NSF instrumentation proposal)
  – Neutron Diffraction (system moved from U Michigan)

• Effect on University Support
  – Upgrades will permit cutting edge research. University administration now views reactor as state-of-the-art research tool rather than expensive teaching tool
Neutron Capture Therapy Research (New England)

- National NCT User Facility at MIT
  - Brookhaven reactor was national user facility for NCT research before it was shut down
  - INIE funds have permitted MIT to develop infrastructure to fill void
- Gd NCT Research at RINSC
  - Important project because it benefits biomedical/health industry in RI
Radiation Protection Technician Degree Program

- Two-year associate degree in nuclear technology at Linn State Technical College (MO)
  - Technical training for Callaway Nuclear Plant and other organizations
  - First class Fall 2004
  - Collaborative effort among INIE ($45K), Linn State ($67K) and AmerenUE ($8.5K)
  - INIE support critical
INIE at TWO YEARS

• Educational Innovations
  – Distance learning
  – Intra-consortium cooperation and collaboration
  – INIE Nuclear Science Institute

• Infrastructure Enhancements
  – Reactor systems and beam ports
  – Teaching laboratories
  – Research facilities
  – Technical support personnel

• Research Initiatives
  – New research applications
  – Neutron science
  – Reactor computations
IMPACT OF INIE

• Helping to revitalize nuclear engineering education
  – Student interest
  – Faculty enthusiasm
  – University administrative support

• Facilitating intra- and inter- University cooperation
  – Remote delivery of lectures and labs
  – Sharing of facilities

• Providing seed money for research initiatives
  – Large return on investment

• Leveraging of INIE funds
  – Synergism when INIE funds are leveraged w/ NEER, NERI, REAP, NSF, university, industry, etc.