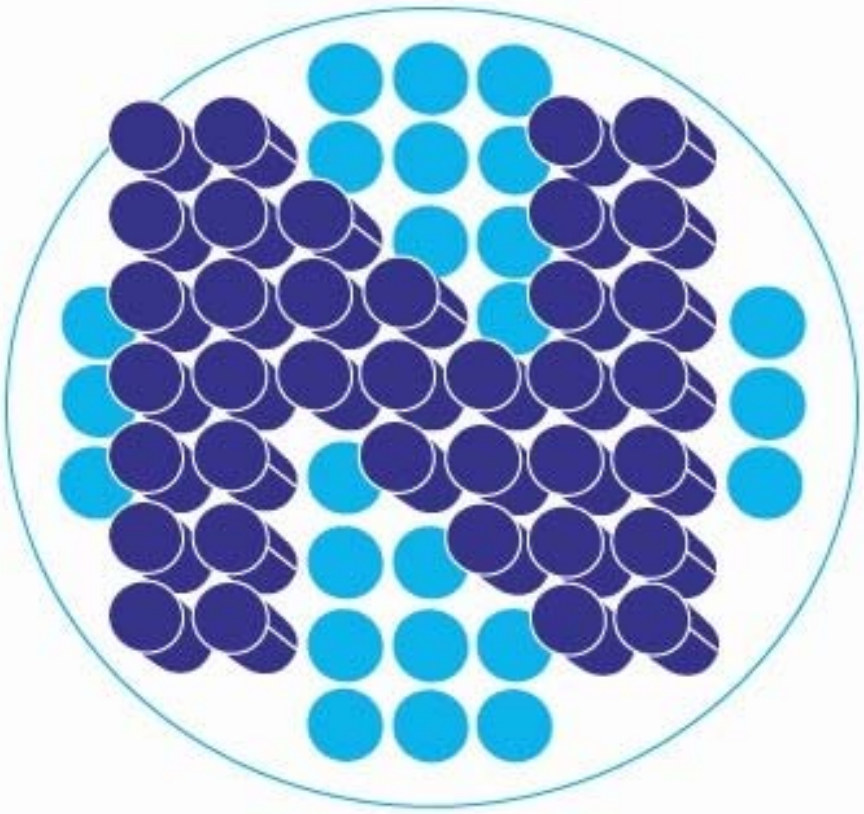
ANNUAL REPORT, 2004



U N E N E

University Network of Excellence in Nuclear Engineering

Réseau D'Excellence Universitaire en Génie Nucléaire

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University Network of Excellence in Nuclear Engineering
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CORPORATE PROFILE

University Network of Excellence in Nuclear Engineering (UNENE) is a not-for-profit Corporation incorporated by the Government of Canada with Letters Patent issued on July 22, 2002. The Head Office of the Corporation is located at the Department of Engineering Physics, Faculty of Engineering, McMaster University, 1280, Main Street West, Hamilton, ON, L8S 4L7.

UNENE is a unique industry - university alliance. Its current members are:
Atomic Energy of Canada Ltd. (AECL)
Bruce Power (BP)
Ontario Power Generation (OPG)
CANDU Owners Group (COG)
Canadian Nuclear Safety Commission (CNSC)
Nuclear Safety Solutions (NSS)
McMaster University
Queen's University
University of Toronto
University of Ontario Institute of Technology (UOIT)
University of Waterloo
The University of Western Ontario
Ecole Polytechnique and
University of New Brunswick

UNENE was launched to ensure that Canadian nuclear industry would continue to have a dependable supply of highly qualified and skilled professionals to meet its current obligations and emerging challenges. To this end, industry is investing significant funds in selected universities and is contributing in kind to enable the universities to acquire and retain the highest quality of teaching and research professoriate. The industry is also assisting the universities in developing relevant research programs, attracting bright students, educating and training them to pursue safe and efficient use of nuclear technology. The universities secure additional funds from Natural Science and Engineering Research Council (NSERC) of Canada, and elsewhere, to match investments made by the nuclear industry.

CHAIRMAN'S MESSAGE

Mo Elbestawi

Universities, as the hallmark institutions of higher learning, are all about providing the best environment for bright minds to become fully empowered to meet the societal challenges that lie ahead. In short, universities have Highly Qualified Personnel (HQP) as their primary outcome. To this end, the establishment and maintenance of a supportive educational and research environment is key.

The availability of reasonably priced, reliable energy underpins modern society and, indeed, was and is instrumental to Ontario's industrial growth and health. Nuclear energy is a substantial component of Ontario's energy supply (roughly 50% or so). To a lesser degree, but still significantly so, New Brunswick and Quebec also rely on nuclear energy for infrastructure stability. The geographical location of Canada's nuclear departments at universities reflects this nuclear energy installation distribution. Further, the low population density (relative to world averages) means that each nuclear department has only a minimal faculty complement. This, plus the large fluctuation in the demand for new nuclear hires in the last 20 years has meant that, at any given time, the number of students in program across all degree levels is relatively small. This makes the matching of HQP supply and demand particularly troublesome.

To compound these difficulties, we are now starting to feel the effects of the so-called Expertise Gap created by high hiring rates in the 1960's and 1970's, followed by a relative dearth of hiring since then. The gap exists on all levels (College, Bachelor's, Master's and Doctoral).

The foundation of the solution to the problems posed by this situation is clearly for universities and industry to collaborate on two main fronts:

(1) adding new HQP to the mix
(2) providing additional educational opportunities to professionals already in the workforce.

To this end, UNENE or its members have already established 5 of the 6 planned new Industry Research Chairs at McMaster, Queen's, Toronto, Waterloo and Western with the 6th Chair to follow at UOIT. These Chairs open up new and exciting research possibilities, dramatically strengthen the existing nuclear programs at these universities, and vault the production rate of HQP to previously unattainable levels. UNENE has also created a joint course-based Master's degree program. This program will provide a measurable help to the professional development activities ongoing within industry since it not only directly raises the expertise levels of the current workforce, it aids in workforce retention by addressing issues of employee satisfaction and career growth.

As Chair of the Board of Directors over the past several years, it has been my pleasure to be part of these new developments. I look forward to supporting UNENE in the years ahead as it meets the future head on.

VICE-CHAIRMAN'S MESSAGE

Emad Elsayed

Maintaining a qualified, well-trained, and competent workforce is a critical element in the safe and efficient operation of nuclear power plants. The Canadian nuclear industry is facing a significant challenge over the next five to ten years due to its workforce demographics and the potential for a substantial loss of its core expertise and knowledge. This is further compounded by the fact that, over the past two decades, the nuclear industry has not been hiring many new graduates and has not invested much in university-based education and research. Consequently, there was a justifiable concern that there would be an insufficient supply of nuclear engineers and scientists to meet the current and future demand of the industry.

In order to address this potentially serious gap, the nuclear industry has placed a high priority on establishing and maintaining meaningful and active partnerships with colleges and universities. The University Network of Excellence in Nuclear Engineering (UNENE) has been a leading example of these partnerships. The UNENE industry representatives have committed a significant level of funding and other support to ensure that the primary objectives of this partnership are successfully met, namely:

- To provide a sustainable supply of qualified staff to meet current and future industry needs;
- To promote university-based research in topics of significance to the nuclear industry; and,
- To create a stronger, wider base of nuclear expertise for industry and public consultations.

As described in this Annual Report, the UNENE organization has made significant progress towards establishing its research and education programs. It is the collective responsibility of all participants in this unique partnership to ensure that the practical focus of this initiative is maintained, and that the benefits to the nuclear industry as a whole are sustained in the long term.

CORPORATE GOVERNANCE

Membership of UNENE is available to Canadian universities, corporations, associations, government agencies or other entities. The Board of Directors and the Voting Members of UNENE approve an application for admission. Membership of UNENE is of two categories namely: Voting Members and Non-Voting Members. Each such Member, that is a corporation, nominates a representative in the dealings of UNENE.

Only those entities that fulfill the Annual Membership Fee and fund a significant portion of the overall UNENE Program and those universities that host UNENE funded Industry Research Chairs are eligible to become Voting Members. The current Voting Members of UNENE are Atomic Energy of Canada Ltd., Bruce Power, Ontario Power Generation, McMaster University, Queen's University, University of Toronto, University of Ontario Institute of Technology, University of Waterloo and The University of Western Ontario.

Entities that are committed to UNENE objectives and as a minimum pay the Annual Membership Fee and universities that participate in research and teaching of UNENE programs may become Non-Voting Members if they apply and when the Board of Directors and Voting Members of UNENE approve their applications. Currently, CANDU Owners Group, Canadian Nuclear Safety Commission, Nuclear Safety Solutions, Ecole Polytechnique and University of New Brunswick are Non-Voting Members of UNENE.

UNENE Board of Directors, with each Voting Member represented by one Director, manages the property and business of UNENE. Each Voting Member nominates one Director for a renewable two-year term. The Directors representing Voting Members from universities elect the Board Chair; and the Directors representing industry Voting Members elect the Board Vice-Chair. The term of office of both the Chair and the Vice-Chair is two years. Effective September 2004, Dr. Tom Harris has assumed the position of Chair succeeding Dr. Mo Elbestawi and Ms. Beth Medhurst has replaced Dr. Emad Elsayed as the Vice-Chair of the UNENE Board of Directors.

The Board of Directors sets policies and procedures not defined in the By-Laws of UNENE. It functions through two standing committees, the membership of which are drawn from the organizations of Members of UNENE

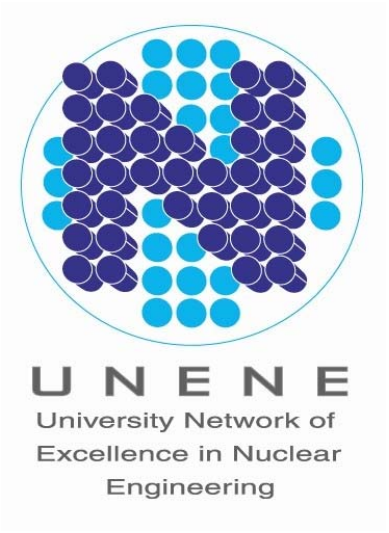
- Education Advisory Committee (EAC)
- Research Advisory Committee (RAC)

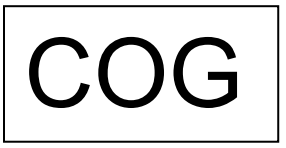
For administrative functions, the UNENE Board of Directors appoints President and CEO, Secretary/Treasurer and Course Coordinator as officers of the UNENE, each for two-year term. Current officers of UNENE are:

- Dr. Mohan Mathur, President and CEO
- Dr. Bill Garland, Secretary, Treasurer and Program Director succeeding Dr. David Jackson effective April 2004

The financial year of UNENE is from April 1 to March 31 of the succeeding calendar year.

THE UNENE NETWORK





Canadian Nuclear Safety Commission
Commission canadienne de sûreté nucléaire

VISION AND STRATEGIC OBJECTIVES

Vision:
"An outstanding and effective university-industry-government partnership promoting university-based education and research in nuclear engineering".

Mission:
UNENE is committed to blend the strengths of industry and university and secure government assistance to deliver relevant nuclear engineering educational and research programs, and train highly skilled human resources for the current and future needs of Canada. The strengthened university-based UNENE expertise will be accessible to public, government and industry.

Objectives:
Nuclear industry, universities and governments in Canada have elected to work together to ensure that Canada continues to be among world leaders in peaceful and safe application of nuclear technology. UNENE concentrates its efforts to ensure that, in sufficient numbers, bright candidates are attracted, educated and trained as engineers and scientists to advance the state of the art in nuclear technology and find innovative solutions for challenges faced by industry.

In specific terms, UNENE has three distinct objectives:

1. Enhance the supply of highly qualified graduates in nuclear engineering and technology
2. Reinvigorate university-based research and development in nuclear engineering and technology focusing primarily on mid to longer term research
3. Create a group of respected, university-based, nuclear experts for public and industry consultation

PRESIDENT'S REPORT

Mohan Mathur

Nuclear power generation is and will continue to be an important option for electricity production in Canada and worldwide. A dependable supply of intelligent, educated, qualified and highly skilled people to ensure safe and reliable operation of power plants is a critical factor for the continuing success of the nuclear industry. After an intense design and build activity of power stations in 60s and 70s that employed a large number of nuclear professionals, the demand for new professionals tapered off leading to stagnant employee pools and decay in university programs and supporting infrastructure.

Fortunately, several years ago the Canadian nuclear industry recognized this situation and embarked upon a unique vision to invest in and create an active partnership with a select group of prominent Canadian universities that were interested in building or strengthening their nuclear engineering education and research programs. Each participating university agreed to create and strengthen nuclear research expertise in an area of strategic importance to its mission and one that complemented other universities. The universities also agreed to deliver joint graduate programs to ensure that working professionals registered as students at one university will have unhindered access to expertise and facilities at another partner university. Therefore, to nurture the vision of active collaboration among nuclear industry and universities in Canada, in year 2002, the University Network of Excellence in Nuclear Engineering (UNENE) took birth.

UNENE received the following funds towards the first phase of its operation that will continue until the completion of the first set of five-year terms of the five NSERC-UNENE Industrial Research Chairs.

Ontario Power Generation	$4.5M
Bruce Power	$1.5M
Atomic Energy of Canada Ltd.	$1.5M
Total	$7.5M

In addition, CNSC and NSS are contributing $30,000 annually.

The overall financial impact by UNENE is significantly larger than that represented by the above direct funds. To fulfill the UNENE mission, OPG and COG each contributed $500,000 towards the NSERC-OPG-COG Industry Research Chair at Queen's University prior to the incorporation of UNENE. Each participating university makes cash and in-kind contributions through space, access to computing, library, administration and other research infrastructure. Current total cash commitment from universities is $810,000. Industry makes in-kind contributions through equipment, software, e-material, and supervision time. Current equipment, materials and software support from industry to universities is in excess of $297,000.

UNENE is very appreciative of the Natural Science and Engineering Research Council (NSERC) for accepting its comprehensive vision to create a university network of excellence in nuclear engineering and, on a selective case-by-case basis, invest in it through its Industry Research Chair (IRC) and Collaborative Research and Development

(CRD) grants. During the first phase of UNENE operation, host universities may receive in excess of $7.12M from NSERC funds matching the industry contributions.

The following expenses, incurred by UNENE member organizations but not billed to UNENE, constitute in kind contributions:

- Approximately $2.8 M overhead cost of research to be conducted at the universities;
- Cost of about one man-year per year time of experts, legal advisors and senior executives participating in UNENE activities;
- Travel expenses of members, directors, committee members and advisors incurred on UNENE business; and
- Cost of hosting meetings at members' premises.

When one adds the costs of these in-kind contributions to the cash contributions in support of UNENE programs, the overall impact of the UNENE programs for its first phase of operation exceeds $20.7M. This constitutes a significant leveraging of invested funds by industry. Furthermore, since the university-based research incorporates training of graduate students for conducting independent research investigations, the graduate research assistants cost a fraction of the amount if full-time research employees conducted the research.

In order to attract and educate bright students and augment the nuclear research profile at each university, in the first phase of UNENE operation, the industry agreed to invest 6 million dollars to build a critical mass of researchers, in selected areas, by creating 6 new Senior Industry Research Chairs (IRC) supported by junior Chairs in partner universities. On their part, the participating universities are committed to creating new tenured or tenure-track positions for the Chairs and provide them the needed space and access to other university infrastructure. Through an active collaboration among Chairs, other researchers and industry, UNENE has become a truly effective network.

The following Industrial Research Chairs are now in place to ensure that nuclear research and development promoted by UNENE is truly a multidisciplinary and synergistic effort:

- Dr. Rick Holt, (Feb. 2002) and Dr. M. Daymond (July 2004) "Nuclear Materials", Department of Mechanical and Materials Engineering, Queen's University
- Dr. Jin Jiang, (Sept.2003), "Control, Instrumentation and Electrical Systems of Nuclear Power Plants", Department of Electrical and Computer Engineering, The University of Western Ontario
- Dr. John Luxat, (May 2004), "Nuclear Safety Analysis", Department of Engineering Physics, McMaster University
- Dr. Roger Newman, (June 2004), "Nano-Engineering of Alloys for Nuclear Power Systems", Department of Chemical Engineering and Applied Chemistry, University of Toronto
- Dr. Mahesh Pandey, (Sept. 2004), "Risk-Based Life Cycle Management of Engineering Systems" Department of Civil Engineering, University of Waterloo

At this stage, searches for a suitable candidate for Industrial Research Chair in "Health Physics and Environmental Safety", to be set up at UOIT, and junior Chairs at Western, McMaster, Waterloo and UOIT are in progress.

In addition to funding Industry Research Chairs, UNENE set aside one million dollars to support about 11 research projects, of interest to industry, proposed by existing faculty members at any Canadian university. This investment in research is eligible for matching grants from the NSERC under Collaborative Research and Development (CRD) grant program. Indeed, research assistantships to graduate students conducting nuclear research and receiving training to conduct independent investigations forms a significant part of each grant. As of now, the UNENE Board, as described in the RAC Report, has approved three projects, each for $90,000 over three years. The proponents of these projects have submitted applications requesting matching NSERC CRD grants.

In order to train highly qualified personnel (HQP) for nuclear industry and fulfill one of the principal objectives of UNENE, two different initiatives are in use:

1. *Create nuclear specialists by pursuing doctoral and masters degrees, and/or working as research associates or postdoctoral fellows under the supervision of professors funded by UNENE and NSERC:*
   During its first phase of operation, UNENE expects to train 30 doctoral, 91 masters and 15 postdoctoral candidates. It is off to a good start. Considering that three of the five Industry Chairs started their terms only in 2004, at the time of writing this report, 10 doctoral, 16 masters and 10 postdoctoral candidates are already working with Industry Chairs.

2. *Sponsor current and newly hired employees to complete a course-based Master of Engineering (M. Eng.) in Nuclear Engineering degree through part-time studies:*
   Currently, McMaster, Waterloo and Western are jointly offering a course-based M. Eng. Degree Program in Nuclear Engineering, accredited by Ontario Council of Graduate Studies (OCGS), with 27 candidates registered. In the near future the student enrollment may increase significantly because of the program receiving full accreditation. From this program, on an average, 10 students may graduate each year. Queen's, Toronto and UOIT are shortly expected to join in the offering of the program.

Dr. Tom Brzustowski, President NSERC, while announcing Dr. Jin Jiang's appointment as the NSERC-UNENE Chair at Western, said: "….the development of a strong nuclear engineering research program, combined with training of students, will definitely be of benefit to Western, Canada's nuclear power industry, Canada's economy and ultimately the environment, since nuclear power produces no greenhouse gases…". He recognized that the UNENE activities are very timely and represent an excellent example of industry-university collaboration. The UNENE initiative is indeed a successful model for similar initiatives worldwide.

EXTERNAL RELATIONSHIPS

Mohan Mathur

UNENE represents Canada as a founding member and actively participates in World Nuclear University (WNU) affairs. The World Nuclear University (WNU) was established on September 4, 2003, to promote nuclear education and training, safeguard quality standards internationally and enhance the mobility of nuclear professionals worldwide. World Nuclear Association (WNA), World Association of Nuclear Operators (WANO), International Atomic Energy Agency (IAEA) and OECD Nuclear Energy Agency (NEA) are founding supporters of WNU. Dr. Hans Blix is its Chancellor and Mr. Zack Pate chairs its Governing Board. Currently, 23 countries are members of WNU. UNENE's role in WNU is significant as its officers and members serve on the WNU Academic Council, Resource Committee, and provide chair and membership of several Working Groups of WNU.

UNENE also maintains an active liaison with Canadian Nuclear Association (CNA) and Canadian Nuclear Society (CNS).

Founding members and officers of World Nuclear University at its inauguration, 2003

EDUCATIONAL ACTIVITIES

Bill Garland, David Blenkinsop

Education and training of highly qualified personnel (HQP) is one of the principal objectives of UNENE. This objective is fulfilled through graduate level education and training at participating universities. While prospective employees for nuclear industry pursue full-time studies or research assistantships at UNENE funded universities, a new Master of Engineering (M.Eng.) degree program in Nuclear Engineering, jointly offered by member universities has been established with strong UNENE support. This program received accreditation from the Ontario Council of Graduate Studies (OCGS) after a site visit and review by an international team of experts. The program is for the professional development and qualification upgrading of the current and newly recruited employees of nuclear industry. Therefore, it employs a flexible delivery format for educational courses that is suitable for part-time studies. In order to deliver a full breadth of nuclear engineering courses, the program exploits professorial expertise residing at participating universities and draws specialist guest lecturers from UNENE industry members. The Education Advisory Committee (EAC) of UNENE controls the curriculum matters, whereas the Program Director appointed by UNENE is responsible for enrollment, logistics, instructor selection, accounting and liaison work with universities.

Students at Pickering Nuclear Station attending UN 0801 Nuclear Power Plant Systems and Operations course

UN0803 Nuclear Reactor Safety Design Class

Report of the Educational Advisory Committee (EAC)

Jin Jiang

The Educational Advisory Committee (EAC) of UNENE met frequently since its first meeting on June 25, 2002. The Mandate of EAC is to advise the UNENE Board on education related issues, including setting up and offering a new M. Eng. Degree in Nuclear Engineering, admission standards, accreditation, course selection and delivery effectiveness and soliciting students for the program.

The Committee consists of one representative from each UNENE member. Jin Jiang chaired the committee from August 2002 to August 2004. David Blenkinsop is the current Chair. David Blenkinsop was the Vice-Chair of the committee from April 2003 until August 2004. The current Vice-Chair is George Bereznai. The Program Director, Bill Garland, is also a member of the committee.

The Committee membership comprises:

McMaster University	John Luxat
Queen's University	Brian Surgenor
University of Toronto	Roger Newman
UOIT	George Bereznai (Vice Chair)
University of Waterloo	Mahesh Pandey
University of Western Ontario	Jin Jiang
Ontario Power Generation	Alan Carmichael
Bruce Power	David Blenkinsop (Chair)
AECL	Basma Shalaby
CNSC	Magda Rizk
COG	Malcolm Lightfoot
University of New Brunswick	Derek Lister
Ecole Polytechnique	Jean Koclas
Program Director	Bill Garland
UNENE (ex-officio)	Mohan Mathur

The committee recommended setting up a new, Masters level degree program that is course-based and suitable for part-time studies to upgrade nuclear knowledge of current employees and those recruited afresh by the nuclear industry. It was also recommended that collective expertise resident at UNENE member universities augmented by guest lectures from industry experts be fully utilized in offering courses for this degree program. Anticipating its accreditation, admission of students and program delivery started in 2003. The Master of Engineering (M. Eng.) Degree Program in Nuclear Engineering, initially jointly offered by McMaster, Waterloo and Western received approval and accreditation from the Ontario Council on Graduate Studies (OCGS) on December 21, 2004. In the near future, Queen's, Toronto and UOIT would be joining the initial group of universities for jointly offering this program. Candidates eligible for admission into the graduate program of a participant university enroll in the M.Eng. Degree Program and complete 10 term courses of which 2 may be replaced by a major engineering project to earn their Degree. The Education Advisory Committee recommends curriculum, course content and potential instructors. Also, it assists the Program Director in making arrangements for technical visits and selection of course delivery sites at member organizations.

Since almost all targeted students are current employees from Canadian nuclear industries, the course delivery uses a flexible format to suit students and the instructors without jeopardizing the quality. The courses are invariably in concentrated modular format including several extended weekends. The Durham College Power Centre, Whitby, offers smart classroom and is easily accessible from Highway 401, therefore, it is the preferred location for course delivery.

Current offerings include the following courses:

UN 0801 Nuclear Power Plant Systems and Operations
UN 0802 Reactor Physics
UN 0803 Nuclear Reactor Safety Design
UN 0804 Reactor Thermal-hydraulics
UN 0805 Radiation Health Risks and Benefits
UN 0603 Project Management for Nuclear Engineers

In addition to the technical courses, a number of soft skill and management courses will form the curriculum. In the near future, the curriculum redesign will lead to regrouping of courses in a compulsory core and electives. Core courses will constitute annual offerings whereas the electives may be available every two years.

Detailed teaching evaluations, conducted at the end of each course, provide opportunities for quality control. Examination of evaluation feedback assists the Committee in assessing the quality of teaching, and the teaching faculty in incorporating changes for improving the next offering and enhancing the students' learning experience. The committee also recommends adoption of latest computer and web-based course delivery tools to facilitate the interaction between students and instructors.

Currently, there are 27 students registered in the program, this number will grow because of the official approval and accreditation of the program by OCGS.

The EAC nominated Lee Rehorn, graduate student at the University of Western Ontario, to attend the 19th World Energy Congress in Sydney, Australia from Sept 5th to 9th 2004.

RESEARCH ACTIVITIES

Kazem Rassouli, Mohan Mathur

UNENE Research activities have two components. The major component is the research conducted by NSERC-UNENE Industry Research Chairs and their respective research teams. The second component is the research conducted through other university professors and their research teams and funded by UNENE with additional support from NSERC through its Collaborative Research and Development (CRD) grants. While the newly established Industry Research Chairs (IRC) are off to a good start with their NSERC research programs, the UNENE non-Chair research is in its infancy. More than 30 research students and associates are engaged in various CANDU research projects under the IRC programs and a wide network of research and industrial establishments has been established. On the non-Chair research front, UNENE selected and committed funds to three projects in 2004, subject to the condition that the proponents acquire matching funds from NSERC CRD grants. The proponents have submitted their CRD applications to NSERC. More than 30 new project titles, in various areas of CANDU technology, have been submitted for consideration in the 2005-06 UNENE non-Chair research program.

Below are the brief reports of the six NSERC-UNENE Industry Research Chairs.

1. Report on the NSERC-OPG-COG-Nu-Tech Industry Research Chair program in Nuclear Materials at Queen's University

Rick Holt

Summary

Since its establishment on February 1, 2002 with the appointment of Prof. R.A. Holt as the chair holder, the NSERC-OPG-COG -Nu-Tech Industry Research Chair program in Nuclear Materials at Queen's University has made exciting progress.

Research Group

An excellent new faculty member, Professor Mark Daymond is the Associate Chair. He started on July 1, 2004. A postdoctoral fellow, Pingshun Zhao worked with the group from February 2003 until Sept 2004. His work resulted in two publications. A new postdoctoral fellow, Richard Zhang started on January 1, 2005. Sydney Aldridge, the former president and CEO of Nu-Tech Precision Metals, who retired in February 2004 has joined the group as a part-time research associate. There are eight research students.

Three students, registered for Ph.D, are investigating "Anisotropic Creep of Zr-2.5Nb"; "Plasticity of Zirconium Alloys"; and "Modeling Deformation of Zirconium Alloys". In addition there are five M.Sc. students who are researching "Texture Development in Zr-2.5Nb"; "Multiaxial Creep of Zr-2.5Nb"; "Effect of Texture on Hydride Orientation in Zr-2.5Nb"; "Radiation Damage in Magnesium"; and "Stress Analysis in Ni Alloys".

Research Facilities

Queen's University has renovated Rooms 119 and 116 in Nicol Hall and the Seminar Room in Jackson Hall. All the major equipment for the program has now been purchased (approximate cost = $250,000). This includes furnaces for creep testing, creep metrology, specimen preparation and specimen manipulation equipment, office

computers data acquisition and control computers, upgrades to the Philips CM 20 Electron Microscope and an Electron Back-Scattering Diffraction (EBSD) camera and software attached to the LEO Field Emission Gun Scanning Electron Microscope (SEM) that belongs to the Physics Department (Dr. K. Robbie).

Interaction with Industry Sponsors

Dr. Holt continues a strong interaction with the industry sponsors as an external consultant for AECL, Bruce Power and New Brunswick Power, a reviewer and a member of the COG Fuel Channels Technical Committee and the COG Fuel Channel Deformation Working Group. He also served on the organizing committee and as a session chair for the 6th COG Fuel Channels Seminar, Nov. 14-16, 2004. He collaborates with AECL and Nu-Tech precision metals on a number of research topics. One of his M.Sc. students spent the summer working on her research topic at Chalk River Laboratories with Dr. M.Griffiths. Prof. Holt, Prof. Daymond and seven of the students attended the COG Fuel Channels Seminar and four of the students made poster presentations on their work.

Collaborations

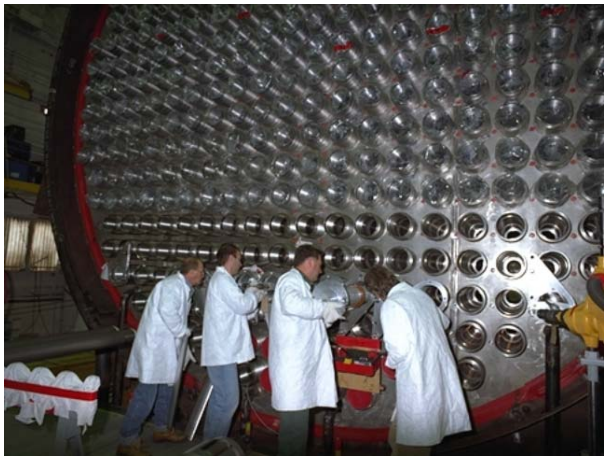
The Chair-holders collaborate within Queen's University, and with McGill University, the Royal Military College of Canada, the National Research Council of Canada, Pennsylvania State University, Los Alamos National Laboratories, the Polytechnical University of Hong Kong, the University of Manchester Institute of Science and Technology and the Open University. Agreements are in place to use facilities at Chalk River Laboratories (NRC), at Rutherford Laboratories (UK) and at Los Alamos National Laboratory (US),

Research Results

Research results have been published in six papers, and have been reported in seven oral presentations, four poster-presentations and two reports. Three more written papers are in preparation and two papers, for presentation at The Metallurgical Society Conference in San Francisco in 2005 February, are accepted.

Teaching

Interest in nuclear materials is high, with a Senior/Graduate level course offered in 2002, 2003 and 2004. Thirty students have taken or audited the course. Several graduated students actively sought employment in the nuclear industry. Two students from the course have joined the Nuclear Materials program as post-graduate students. One graduate has full-time job at Chalk River Laboratories and another is a consultant to OPG at Wardrup Engineering.



2. Report on NSERC- UNENE Industry Research Chair in Control, Instrumentation and Electrical Systems at The University of Western Ontario

Jin Jiang

Introduction

Dr. Jin Jiang was appointed the Senior IRC on September 1, 2003. Search for a Junior faculty member to assist Dr. Jiang is in progress.

Dr. Tom Brzustowski, President NSERC, congratulating Dr. Jiang at his Chair announcement

The main goals of the IRC research program are:

- to assist Canadian nuclear industries to find solutions to the pressing issues relating to the nuclear power plant control and instrumentation through fundamental and applied research,
- to train highly qualified personnel in the field of instrumentation and controls in nuclear power plants to meet the need of Canada's nuclear industry in the near future, and
- to investigate the potential applications of latest control and computer technologies to refurbish an existing plant or to design new ones. Three major issues facing nuclear industries have formed the core for this research program. They are safety, availability, and competitiveness.

To achieve the above objectives, the proposed research program focuses on the following major research topics:

- Smart condition monitor for in-core neutron flux detectors;
- Early fault detector for instrument power supplies;
- A probabilistic based safety-centered scheduler for maintenance decisions;
- Novel distributed control architectures and field-device configurations for nuclear plants;
- Control system issues involved in load-following mode of operation; and
- Detailed models of critical components in nuclear power plant training simulator to make it suitable for engineering investigations.

The potential impacts of this research program are to provide industries with well-trained, qualified engineers and scientists, and to develop new techniques to improve the safety and operational efficiency of the nuclear power plants.

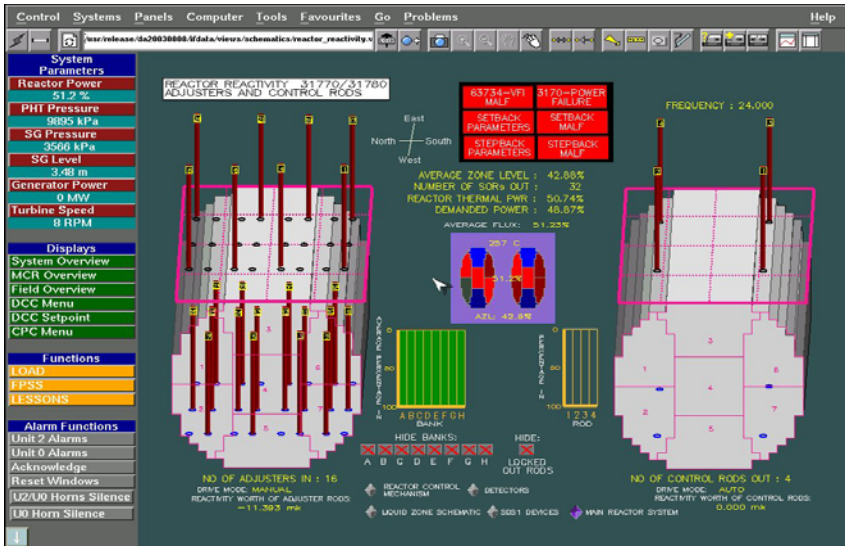
Research Group

While the search for a junior faculty member to support the Chair is on, Dr. Xinhong Huang has started in a Research Associate position. In addition, five students are pursuing M.E.Sc. and two students are pursuing Ph.D Degrees. The Masters Degree students are investigating fault detection techniques; distributed control systems; probabilistic maintenance scheduler; and simulator modeling improvements. The

Doctoral degree students are researching load-following controllers and reliability-centered maintenance.

Research Facilities

Ontario Power Generation has provided a run-time version of the Darlington and Pickering Nuclear Power Plant Simulators. Evaluation of several different Distributed Control Systems (DCS) is progressing the results of which will help in acquiring such a system to support the proposed research. The University of Western Ontario has provided research space in the new Thompson Engineering Building.



Interaction with Industry

Active liaison exists with experts from OPG, Bruce Power and AECL. In addition, control system manufacturers such as HFC Control, Invensys (Triconex), Honeywell, Siemens, and Emerson are contacted for their participation in research.

Publications

[1] Carlos O'Donell and Jin Jiang, 'A framework for evaluating distributed control systems in nuclear power plants,' CNS Sixth International Conference on Simulation Methods in Nuclear Engineering, Montreal, Quebec, Canada, October 12-15, 2004.

[2] Lixuan Lu and Jin Jiang, 'Probabilistic safety assessment for instrumentation and control systems in nuclear power plants: An overview,' Journal of Nuclear Science and Technology, Vol. 41, No. 3, pp. 323-330, March, 2004.

[3] Lixuan Lu and Jin Jiang, 'A risk-informed on-line test and maintenance framework for redundant instrumentation and control systems in nuclear power plants,' Proc. of 12th International Conference on Nuclear Engineering (ICONE12), Arlington, Virginia USA, 25–29, 2004.

[4] Lixuan Lu and Jin Jiang, 'Probabilistic safety assessment for instrumentation and control systems in nuclear power plants: A literature survey,' Proc. of 11th International Conference on Nuclear Engineering (ICONE11-36458), Tokyo, Japan, April 20 -23, 2003.

[5] Yang Yang, Jin Jiang, and Eric S. Moran, 'Standardization of CANDU simulator upgrade,' Proc. of 11th International Conference on Nuclear Engineering (ICONE 11-36417), Tokyo, Japan, April 20 -23, 2003.

3. NSERC/UNENE Industrial Research Chair in Nuclear Safety Analysis McMaster University

John Luxat

Summary
The NSERC/UNENE Industrial Research Chair in Nuclear Safety Analysis with emphasis on thermal-hydraulics was established at McMaster University in May, 2004 with the appointment of Dr. John C. Luxat as the chair holder. In the ensuing eight months, significant and rapid progress to establish the research program has taken place; it should further accelerate in the first part of 2005.

Overview
The outcome of the proposed research is of critical importance to industry in improving safe operation and competitiveness of nuclear power generation. The research will improve quantification of safety margins, help regain operating margins of nuclear generating units, improve the quality, efficiency and cost effectiveness of nuclear safety analysis and support the development of advanced CANDU reactor designs. This will contribute to improving the safety, reliability and competitiveness of nuclear power as an environmentally beneficial contributor to Canada's energy supply and will enhance the competitiveness of Canadian nuclear technology in global markets.

Research Group
The search for an Associate Chair, likely to join in 2005, is progressing well. Basel Ismail, a post-doctoral fellow, hired in August 2004, is assisting the Chair in establishing the experimental research program in heat transfer relevant to nuclear safety. Three graduate students, pursuing M.Sc. degrees, are working in the area of best estimate and uncertainty methods in nuclear safety analysis. Their projects are:

- *Functional Approximations for Nuclear Fuel Transient Thermal Behaviour in Best-Estimate and Uncertainty Analysis*
  Best Estimate and Uncertainty Analysis is a probabilistic approach to quantifying safety margins. In order to evaluate integrated uncertainty it is necessary to develop a means to interpolate and extrapolate detailed computer simulation results over a range of parameters. The approach under consideration involves developing lower order approximation models using system dynamics concepts. This project will consider specific application to the thermal response of nuclear fuel elements with time-dependent power and thermal-hydraulic boundary conditions.

- *Uncertainty in CANDU Lattice Cell Parameters and their Impact on Reactor Core Flux and Power*
  Reactor lattice cell codes provide the basic cross-sections and other cell-averaged parameters used as inputs to a reactor core physics model. This project will study the various sources of uncertainty in lattice cell calculations and establish bounds on the resultant uncertainty in neutron flux and power. The approach can be either analytical or computational or a combination of both.

- *Functional Approximations for Reactor Space-time Kinetic Transients in Best-Estimate and Uncertainty Analysis*
  Best Estimate and Uncertainty Analysis is a probabilistic approach to quantifying safety margins. In order to evaluate integrated uncertainty it is necessary to

develop a means to interpolate and extrapolate detailed computer simulation results over a range of parameters. The approach under consideration involves developing lower order approximation models using system dynamics concepts. This project will consider specific application to reactor space-time kinetics.

One Ph.D. candidate is taking courses as well as conducting literature search to arrive at a suitable topic of research for his thesis.

Research Facilities

In late November, a cluster of three rooms, in the John Hodgins Engineering Building, became available for the research group. A Linux computer cluster will be set up in one of the rooms to allow easy access for the members of the research group. Additional space for setting up a heat transfer experimental research facility is on request.

Interactions with Industry and Collaborations

The chair-holder has maintained strong interaction with industrial sponsor organizations and UNENE Associate Member organizations, acting as an external consultant and technical reviewer to Ontario Power Generation, Bruce Power, AECL, CANDU Owners Group (COG) and Nuclear Safety Solutions (NSS) Ltd. In addition, the chair-holder is a member of the COG Safety & Licensing Technical Committee, acting as an advisory resource.

Efforts are under way to establish effective collaborations with industry. These include negotiating access to source code and date for OPG legacy nuclear safety analysis codes, currently in the process of finalizing the agreement. Access to these codes will greatly facilitate the research work in nuclear safety analysis methods. Research collaboration with AECL, Chalk River (Brock Sanderson) in the area of heat transfer aspects of fuel channel integrity are in the early stages of development.

The Chair was the Executive Chairman of the organizing committee for the 2004 Canadian Nuclear Society (CNS) Annual Conference, held June 6-9, 2004 in Toronto, and will serve in the same role for the 2005 CNS Annual Conference. He was a member of the Technical Program Committee and Session Chair for the Embedded International Topical Meeting on Best Estimate Methods in Nuclear Installations held in Washington DC in conjunction with the American Nuclear Society Winter Meeting from November 14-18, 2004.

Publications

J.C.Luxat, “Analytical Evaluation of Probabilistic Safety Margins”, Proc. 25th Canadian Nuclear Society Annual Conference, Toronto, Ontario, June 2004

4. NSERC-UNENE Senior Industrial Research Chair in Nano-Engineering of Alloys for Nuclear Power Systems at University of Toronto

Roger C. Newman

Summary

Prof. Roger Newman joined as the NSERC-UNENE Chair in Nano-Engineering of Alloys for Nuclear Power Systems in the Department of Chemical Engineering and Applied Chemistry on June 1, 2004. The formal announcement of the Chair by NSERC took place on on October 13, 2004. Ken Petrunik, Chief Operating Officer of AECL, gave a public lecture at the announcement ceremony. In a relatively short time, the chair holder has made impressive progress in establishing his research.

Background

Corrosion prediction and control are ever-present concerns in nuclear power generation, and cannot be achieved reliably and cheaply without a deeper scientific understanding of the mechanisms involved. Accordingly, the research program will address corrosion mechanisms from the atomistic to the component level. The materials involved are mainly nickel base alloys used in steam generators, with some work on carbon steel in the context of CANDU feeder degradation. Model alloys are also being used, to idealize or simulate particular processes that occur on small length scales in engineering alloys. The extensive experience of corrosion mechanisms in a wide range of metallic materials, from aluminum alloys to stainless steels to noble metal alloys, will provide with novel and useful insights into the behavior of nuclear-industry materials. Such insights will lead naturally to improvements in corrosion prediction and control. Novel surface modification technologies with applications in a variety of industries will also probably arise from the research.

Research Facilities

The procurement of laboratory equipment and supplies is largely complete with the exception of major items: an atomic force microscope system, a dynamic mechanical testing system with autoclave, and an electrochemical autoclave ordered from CFI and OIT grants. These facilities should be in place by April 2005. These equipments are.

Research Group

The following people have joined the research group:
Dr. Anatolie Carcea – Research Associate, electrochemist, joined 6/04
Dr. Thomas Bannon* – Postdoctoral Fellow, electrochemist, joined 7/04
Dr. Deepashri Nage – Postdoctoral Fellow, corrosion engineer, arriving 1/05
In addition, three students have enrolled for MASc degrees, one for Ph.D. degree and completing his undergraduate degree. These students are researching the following topics:
Ph.D.: Stress corrosion cracking mechanisms in reducing hot water
MASc:

- Mechanism of lead effect on corrosion and stress corrosion of nickel base alloys
- *Stability of localized corrosion of Ni base alloys in the presence of non-chloride anions
- *Applications of nanoporous metals
- *These projects and people are supported from funds derived from other sources; however, the research is aligned with the UNENE project.*

Undergraduate Thesis: Effect of γ irradiation on corrosivity of ion-exchange resins towards steel

Undergraduate teaching

The chair holder taught introductory nuclear physics and basic reactor concepts in one half of the Nuclear Engineering 4th year Chemical Engineering elective course. Twenty five students attended this course.

In addition, a one-hour version of the introductory nuclear physics course, was delivered to a group of interested staff and students in the School of Materials, University of Manchester, December 2004.

Interaction with Industry and Collaborations

One formal meeting of Industry Advisory Group for the Chair took place on November 5 2004 at the university. All UNENE sponsors were present. An internet news-group scheme is set up to facilitate frequent technical exchanges, informal advice and brainstorming amongst this group and other interested technical colleagues.

The chair holder and his Ph.D. student visited AECL, Chalk Rive, to initiate industrial liaison with Dr. Mike Wright on feeder cracking. Dr. Carcea, having finished his initial duties related to the establishment of the laboratory, has begun his personal research work as well as helping to supervise the graduate students; in the New Year, he will be conducting a program of visits to familiarize him with the industrial context.

Continuing supervision of students in the UK

Useful scientific output continues to come from projects initiated in Manchester. These include research on stress corrosion of Alloy 690 and of stainless steel, as well as non-nuclear projects such as the development of new hydrogen sensors.

Conference and workshops

- Attended the Gordon Research Conference on Aqueous Corrosion in New London, as invited Discussion Leader, New Hampshire, July 2004.
- Delivered a plenary lecture, EICM-2 (Environment Induced Cracking of Metals), Banff, September 2004.
- Attended the Electrochemical Society Fall Meeting, October 2004, in Honolulu to receive the H.H. Uhlig Award of the Corrosion Division, and delivered an award lecture.
- Delivered an invited talk at the NACE Northern Region Conference, Toronto, November 2004.
- Attended the COG Workshop on Feeder Integrity, December 2004.
- Attended a seminar: titanium effects in Candu coolant at OPG, on joint work with Halden:

Networking and Academic Visits

Seminars were delivered at the University of Alberta, Edmonton (Chemical and Materials Engineering), the University of Virginia (Materials Science and Engineering), Sandia National Lab, and Arizona State University, Tempe (Mechanical and Aerospace Engineering). Visited Dr. John Colligon of Manchester Metropolitan University, to discuss provision of sputter-deposited materials for the research program; UWO and discussed collaboration with colleagues (Shoesmith, McIntyre); and held discussions on possible future collaboration with Dr. Andrew Sherry, the new Director of the BNFL Materials Performance Centre in Manchester.

5. NSERC-UNENE Industrial Research Chair in Risk-Based Life Cycle Management, University of Waterloo

Mahesh D. Pandey

Summary
The NSERC-UNENE Chair at the University of Waterloo started recently with the appointment of Prof. Mahesh Pandey on September 1, 2004. It is in its initial phase of recruiting students and post-doctoral research fellows. An intensive interaction with industry sponsors, OPG, BP and AECL, has taken place since the initiation of the program.

Introduction
The primary goal of the chair program is to advance research in the area of life-cycle management (LCM) of nuclear power plant systems and renewal of energy infrastructure as a whole. Life-cycle management is a comprehensive integration of safety, aging of plant components and business management decisions to optimize the operation, maintenance and service life of systems, structures and components.
The specific goals of the research program are:

- to advance the fundamental understanding of the probabilistic risk analysis techniques that are relevant to estimating reliability and remaining life of systems, structures and components that affect the plant life;
- to develop methods, tools, and models for optimizing inspection, rehabilitation and replacement strategies that would result in safe and economic life cycle performance of systems, structures and components;
- to develop a general, plant-level risk management model that integrates engineering risk analysis with business and operational risk management issues.

Research Group
Research Associate: Dr. Mikko Jyrkama
Visiting Researchers: Professor Niels Lind, University of Victoria (Adj. Professor)
Graduate Students: Presently, 3 doctoral students are working in the Chair program on the topics listed below:.

- Extreme Value Estimation Applied to Structural Reliability Analysis
- Risk-Based Approach to Life-Cycle Performance Optimization
- Risk-Based Health Monitoring Systems for Nuclear Power Plants

Research Facilities
The offices of the NSERC-UNENE chair program are located in the Institute for Risk Research (IRR) at the University of Waterloo. The Institute for Risk Research was established in 1982 to conduct research on risk management and to establish a knowledge base to assist Canadian governments, public organizations and industry in risk management decisions and policies.

The Institute for Risk Research provides ample office space for the entire research team as well as room for visiting scholars and experts from industry. The IRR also has its own conference room, and houses an extensive library of risk related literature. The research team can also make full use of the IRR secretarial staff and related infrastructure.

The research program is extensively involved with numerical risk analysis and simulation, requiring high performance computing facilities. In addition to administrative

assistance, the Department of Civil Engineering provides technical support for computing resources. Depending on the needs of the research program, the chair and his research team will have full access to well equipped engineering laboratories at the University of Waterloo.

Interaction with Industry and Collaborations

A series of meetings have taken place with industry partners to develop specific industrial applications of the research undertaken in the Chair program. This discussion with industry will continue in the coming months. So far, consultation with industry has resulted in the following list of research projects. Some of the projects have already been started.

Reliability Analysis using PLIM Data

- Estimation of the life-time distribution of an asset using inspection and surveillance data (Analysis of feeder cracking data – AECL)
- A model for preparing the optimum schedule of component (asset) replacement (Replacement of feeders – AECL)
- Optimization of sample size for inspections required to support the condition assessment of an asset
- Derivation of measures of information and extreme value estimation from small samples
- Bayesian analysis of inspection data

Probabilistic Modelling of Deterioration Processes

- Theoretical modelling of sampling and temporal uncertainty associated with ARDMs (e.g., cracks, creeps, fatigue, corrosion, FAC)
- Estimation of risk and costs over an operating interval of an asset – to determine a cost-effective approach to inspection, maintenance, refurbishment and replacement work
- Probabilistic modelling of feeder thinning (FAC) process using the available inspection data – objective is to establish a risk-based criterion for the feeder replacement

Risk-Based Health Monitoring System

Develop Health Monitoring Technology that will

- provide automated monitoring & trending with navigational aids to compare to past performance;
- alarm on out-of-spec condition with navigational aids to offending parameters and related displays;
- provide function- and problem-based displays of plant data to facilitate diagnostics;
- prepare health reports to plant personnel, management and regulatory authority; and
- integrate plant data with models for prediction and analysis for use as an advisory to plant staff.

AECL has suggested to apply the risk-based modelling to ChemAND and ThermAND health monitoring programs

Cost-Benefit Analysis of Risk Management Programs

- Socio-economic analysis of costs and benefits of nuclear risk management programs (e.g. Impact of feeder integrity issue to public risk)
- Impact of C-14 emissions from CANDU reactors

Mathematical Analysis and Computation Tools Development

- Ongoing research & development of mathematical and computational methods to support a wide variety of research projects related to probabilistic analysis and optimization

Teaching

The chair-holder has offered a graduate course in Engineering Risk and Reliability Analysis to the graduate students at the University of Waterloo. This course has drawn significant attention from the students, as evidenced by the fact that 43 students attended the course this term.

This course material is divided and typed up in a modular format for its delivery to the UNENE M.Eng. program in May - June 2005. A set of interactive computer programs are being developed as educational aids. The industry partners have also expressed interest in organizing this course for their staff on as per need basis.

Meetings and Presentations to Industry

- Meeting with AECL working group on feeder pipe cracking: Presented a lecture on "Probabilistic Assessment Capability for Feeder Pipe Cracking"
- Discussion about research collaboration with NSS.
- Attended COG workshop to learn about problems regarding feeder integrity, and to establish contacts in the nuclear industry.
- COG Nuclear Asset Management Discovery Meetin

Report of the Research Advisory Committee(RAC)

Dr. Rick Holt and Dr. Kazem Rassouli

The Research Advisory Committee of UNENE met several times subsequent to its inaugural meeting on August 16, 2002. The committee membership comprises:

McMaster University	Marilyn Lightstone (02-04), John Luxat
Queen's University	Rick Holt (Chair 02-04)
University of Toronto	Greg Evans (02-04), Roger Newman
U. of Ont. Inst. of Tech	George Bereznai
University of Waterloo	Mahesh Pandey, Vice Chair 04-
University of Western Ontario	Jin Jiang
University of New Brunswick	Derek Lister
Ecole Polytechnique	Jean Koklas
Ontario Power Generation	John Baron (02-03) Kazem Rassouli, Chair
CNSC	Philip Webster (02-04) Bev Ecroyd
Bruce Power	Marv Gold (02-03), Robert Chun
AECL	Wayne Inch (02-03) Bob Speranzini
COG	Malcolm Lightfoot (02-04) Frank Doyle
UNENE (ex-officio)	David Jackson (02-04)
	Mohan Mathur

Rick Holt chaired the committee from August 2002 to August 2004. Kazem Rassouli is the current Chair. He was Vice-Chair from April 2003 until August 2004 Mahesh Pandey is the current Vice-Chair of RAC.

The main work of the committee has been:

1. Developing a revised mandate of UNENE research programs
2. Devising a protocol to identify research requirements, and to solicit, evaluate, select and manage non-chair UNENE funded research projects.
3. Developing a list of industry approved research topics
4. Soliciting and evaluating proposals
5. Recommendations of funding to the Board of Directors

The Committee identified six research topics in 2004 and solicited proposals. It received four proposals, ranked these and recommended funding for three to the Board of Directors. The successful proponents have applied for NSERC Collaborative Research and Development (CRD) grants. The research topics and proponents are:

- *Measurement of Near-surface Residual Stress in CANDU Feeder Pipes using Magnetic Non-destructive Evaluation Techniques* –
  Lnyann Clapham, Queen's University

- *D_2O Isotope Effects on Hydrolysis and Ionization Equilibria in High Temperature Water* –
  Peter Tremaine, University of Guelph

- *Mathematical Modelling of Inter-sub-channel Thermal Mixing* –
  Marilyn Lightstone, McMaster University.

UNENE has committed $30,000 per year for each project for three years. New proposals are sought for selecting 4 new projects starting 2005.

AUDITOR"S REPORT

Grant Thornton LLP
Chartered Accountants
Management Consultants

Auditors' Report

To the Directors of the University Network
of Excellence in Nuclear Engineering

We have audited the balance sheet of the University Network of Excellence in Nuclear Engineering as at March 31, 2004 and the statements of operations and cash flows for the year then ended. These financial statements are the responsibility of the corporation's management. Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with Canadian generally accepted auditing standards. Those standards require that we plan and perform an audit to obtain reasonable assurance whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation.

In our opinion, these financial statements present fairly, in all material respects, the financial position of the corporation as at March 31, 2004 and the results of its operations and the changes in its financial position for the year then ended in accordance with Canadian generally accepted accounting principles.

Grant Thornton LLP

Hamilton, Ontario
June 4, 2004

Grant Thornton LLP
Chartered Accountants

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C

Grant Thornton LLP
Chartered Accountants
Management Consultants

Auditors' Report

To the Directors of the University Network
of Excellence in Nuclear Engineering

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We have audited the balance sheet of the University Network of Excellence in Nuclear Engineering as at March 31, 2004 and the statements of operations and cash flows for the year then ended. These financial statements are the responsibility of the corporation's management. Our responsibility is to express an opinion on these financial statements based on our audit.

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Grant Thornton LLP

Hamilton, Ontario
June 4, 2004

Grant Thornton LLP
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University Network of Excellence in Nuclear Engineering
Statement of Operations

Year ended March 31	2004	8 Months 2003
Revenue		
Grants	$ 593,371	$ 160,000
Interest income	3,413	833
Total revenue	596,784	160,833
Expenditures		
Administration fees	137,790	28,000
Bank charges	39	36
Depreciation	6,467	3,233
Insurance	4,261	3,567
Office	29,419	6,069
Professional fees	25,742	6,420
Program preparation	20,000	30,000
Program co-ordination	-	70,000
Research expense	116,667	-
Total expenditures	340,405	147,325
Excess of revenue over expenditures	$ 256,379	$ 13,508
Operating surplus, beginning of year	$ 13,508	$ -
Excess of revenue over expenditures	256,379	13,508
Operating surplus, end of year	$ 269,887	$ 13,508

See accompanying notes to the financial statements.

Grant Thornton

University Network of Excellence in Nuclear Engineering
Balance Sheet

March 31	2004	2003
Assets		
Current		
Cash	$ 585,075	$ 323,666
Receivables	2,708	1,276
	587,783	324,942
Capital assets (Note 3)	9,700	16,167
	$ 597,483	$ 341,109
Liabilities		
Current		
Accruals	$ 133,367	$ -
Deferred grants (Note 2)	194,229	327,601
	327,596	327,601
Equity		
Surplus	269,887	13,508
	$ 597,483	$ 341,109

_____ Director _____ Director

See accompanying notes to the financial statements.

University Network of Excellence in Nuclear Engineering
Statement of Cash Flows

Year ended March 31	2004	8 Months 2003
Increase in cash and cash equivalents		
Operating		
Net surplus	$ 256,379	$ 13,506
Depreciation	6,467	3,233
	262,846	16,741
Change in non-cash operating		
Receivables	(1,432)	(1,276)
Accruals	133,367	-
	394,781	15,465
Financing		
Decrease in deferred grants	(133,372)	327,600
Investing		
Purchase of capital assets	-	(19,400)
Net increase in cash and cash equivalents	261,409	323,666
Cash and cash equivalents, beginning of year	323,666	-
Cash and cash equivalents, end of year	$ 585,075	$ 323,666

See accompanying notes to the financial statements.

Grant Thornton

University Network of Excellence in Nuclear Engineering
Notes to the Financial Statements
March 31, 2004

1. Nature of operations

The company is an alliance of universities, nuclear power utilities, research and regulatory agencies for the support and development of nuclear education, research and development capability in Canadian universities.

2. Summary of significant accounting policies

Revenues and expenditures

Revenues and expenditures are recorded according to the accrual basis of accounting.

Depreciation

Rates of depreciation applied to write-off the cost of equipment over their estimated lives on a straight line basis are as follows:

Computer equipment	3 years
Website	3 years

One-half of the annual rates are used in the year of acquisition.

Grants

Grant revenue is recognized in accordance with the periodic amounts invoiced to the grantors. Any excess funds received have been deferred and will be recognized in accordance with the company's invoicing to the grantors.

Cash and cash equivalents

Cash and cash equivalents consists of balances with chartered banks and funds held by a Canadian University on behalf of the organization.

Use of estimates

In preparing the organization's financial statements, management is required to make estimates and assumptions that affect the reported amounts of assets and liabilities, the disclosure of contingent assets and liabilities at the date of the financial statements and reported amounts of revenue and expenses during the period. Actual results could differ from these estimates.

University Network of Excellence in Nuclear Engineering
Notes to the Financial Statements
March 31, 2004

3. Capital assets

	Cost	Accumulated Depreciation	2004 Net Book Value	2003 Net Book Value
Computer equipment	$ 3,321	$ 1,660	$ 1,661	$ 2,767
Website	16,079	8,040	8,039	13,400
	$ 19,400	$ 9,700	$ 9,700	$ 16,167

CONSOLIDATED FINANCIAL STATEMENTS

Bill Garland and Jim Findlater

Income/Expense
01/01/2002 Through 31/12/2004 (in Canadian Dollars) (Cash Basis)

Category Description	01/01/2002-31/12/2002	01/01/2003-31/12/2003	01/01/2004-31/12/2004	OVERALL TOTAL
INCOME				
Interest Inc	189.40	2,888.44	1,845.84	4,923.68
MembershipDues	30,000.00	30,000.00	30,000.00	90,000.00
FROM AECL Invoices	0.00	146,511.50	200,000.00	346,511.50
FROM BP Invoices	321,000.00	0.00	200,000.00	521,000.00
FROM NSS Invoices	0.00	0.00	30,000.00	30,000.00
FROM OPG Invoices	0.00	450,020.50	600,000.00	1,050,020.50
TOTAL INCOME	351,189.40	629,420.44	1,061,845.84	2,042,455.68
EXPENSES				
Admin	134,299.19	168,119.64	96,960.69	399,379.52
Bank Charge	68.65	81.25	41.25	191.15
Education	0.00	20,000.00	0.00	20,000.00
GST	0.00	22,066.45	-2,708.53	19,357.92
Legal-Prof Fees	0.00	30.00	0.00	30.00
Research	0.00	0.00	858,747.00	858,747.00
TOTAL EXPENSES	134,367.84	210,297.34	953,040.41	1,297,705.59
OVERALL TOTAL	216,821.56	419,123.10	108,805.43	744,750.09

Itemized Categories
1/1/2004 through 31/12/2004 (in Canadian Dollars) (Cash Basis)

09/11/2004 Page 1

Cat/Sub	Date	Account	Num	Description	Memo	Cl	Amount
INCOME							
Interest Inc							
	31/01/...	UNENE b...		Bank Interest		R	487.59
	29/02/...	UNENE b...		Bank Interest		R	370.90
	31/03/...	UNENE b...		Bank Interest		R	309.53
	30/04/...	UNENE b...		Bank Interest		R	200.33
	31/05/...	UNENE b...		Bank Interest		R	170.10
	30/06/...	UNENE b...		Bank Interest		R	156.40
	31/07/...	UNENE b...		Bank Interest		R	150.99
TOTAL Interest Inc							1,845.84
MembershipDues							
CNSC							
	01/01/...	Mac Holdi...		CNSC Membership Dues			30,000.00
TOTAL CNSC							30,000.00
NSS							
	23/05/...	NSS Invoi...		NSS Membership Dues		c	30,000.00
TOTAL NSS							30,000.00
TOTAL MembershipD...							60,000.00
TOTAL INCOME							**61,845.84**
EXPENSES							
Admin							
Advertizing							
	11/03/...	UNENE b...		CNA Advertizing		R	-3,440.05
	03/05/...	UNENE b...		CNS Advertizing		R	-1,444.50
TOTAL Advertizing							-4,884.55
Course Coord.							
	30/01/...	UNENE b...		David Jackson ???		R	-16,050.00
TOTAL Course Coord.							-16,050.00
Financial							
	06/01/...	UNENE b...		James Findlater - Accoun...		R	-4,280.00
	10/04/...	UNENE b...		James Findlater - Accoun...		R	-4,280.00
	11/06/...	UNENE b...		Grant Thornton Auditor		R	-3,210.00
	06/07/...	UNENE b...		James Findlater - Accoun...2004/5		R	-4,280.00
	03/08/...	UNENE b...		Grant Thornton Auditor		R	-3,477.50
TOTAL Financial							-19,527.50
Meetings							
	30/10/...	UNENE b...		Windermere Manor BOD meeting and r...			-443.16
TOTAL Meetings							-443.16
Office							
	31/03/...	Mac Holdi...		Telephone			-48.58
TOTAL Office							-48.58
President							
	16/01/...	UNENE b...		Mohan Mathur ???		R	-10,700.00
	31/03/...	UNENE b...		Mohan Mathur ???		R	-10,700.00
	07/06/...	UNENE b...		Mohan Mathur ???		R	-10,700.00
	02/07/...	UNENE b...		Mohan Mathur		R	-10,700.00
TOTAL President							-42,800.00

Itemized Categories

01/01/2004 Through 31/12/2004 (in Canadian Dollars) (Cash Basis)

Cat/Sub	Date	Account	Num	Description	Memo	Cl	Amount
Travel							
	06/07/...	Mac Holdi...		Travel Expenses (Garland)	Course travel		-396.95
	13/08/...	Mac Holdi...		Travel Expenses (Garland)	stations		-873.53
	16/01/...	UNENE b...		Mohan Mathur - Travel		R	-2,110.65
	05/02/...	UNENE b...		Derek Lister meeting		R	-1,099.58
	31/03/...	UNENE b...		Mohan Mathur - Travel		R	-763.15
	02/07/...	UNENE b...		Mohan Mathur - Travel		R	-3,384.78
	13/10/...	UNENE b...		S/T Travel Claim Chalk River,	Western		-975.03
TOTAL Travel							-9,603.67
Web							
	06/01/...	UNENE b...		iUpload		R	-181.90
	26/01/...	UNENE b...		Challe Design		R	-936.25
	26/01/...	UNENE b...		Challe Design		R	-842.63
	26/01/...	UNENE b...		Challe Design		R	-561.75
	29/02/...	UNENE b...		iUpload		R	-181.90
	31/03/...	UNENE b...		iUpload		R	-181.90
	21/05/...	UNENE b...		iUpload		R	-107.00
	23/06/...	UNENE b...		IUpload	June 2004	R	-545.70
	23/06/...	UNENE b...		iUpload -	Cancel for Feb	R	181.90
	23/06/...	UNENE b...		iUpload -	Cancel for Mar	R	181.90
	13/07/...	UNENE b...		iUpload		R	-214.00
	09/08/...	UNENE b...		iUpload		R	-107.00
	20/10/...	UNENE b...		iUpload	October 2004		-107.00
TOTAL Web							-3,603.23
TOTAL Admin							-96,960.69
Bank Charge							
	31/01/...	UNENE b...		Bank S/C		R	-2.40
	29/02/...	UNENE b...		Bank S/C		R	-3.20
	31/03/...	UNENE b...		Bank S/C		R	-2.40
	30/04/...	UNENE b...		Bank S/C		R	-3.20
	31/05/...	UNENE b...		Bank S/C		R	-2.10
	30/06/...	UNENE b...		Bank S/C		R	-2.40
	30/06/...	UNENE b...		Bank S/C ???		R	-22.00
	31/07/...	UNENE b...		Bank S/C		R	-3.55
TOTAL Bank Charge							-41.25
GST							
	26/07/...	UNENE b...		Gov of Canada - Receiver...	refund	R	2,708.53
TOTAL GST							2,708.53
Research							
McMaster							
	12/08/...	UNENE b...		McMaster, May 1, - Oct 31, 04		R	-66,975.00
	01/10/...	UNENE b...		McMaster, Nov 1, - Apr 30, 04		R	-66,975.00
TOTAL McMaster							-133,950.00
Toronto							
	01/10/...	UNENE b...		Toronto Jun 1, - Oct 31, 04		R	-154,065.00
	01/12/...	UNENE b...		Toronto Nov 1, - Apr 30, 04		R	-154,065.00
TOTAL Toronto							-308,130.00

Itemized Categories

01/01/2004 Through 31/12/2004 (in Canadian Dollars) (Cash Basis)

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Cat/Sub	Date	Account	Num	Description	Memo	Cl	Amount
Waterloo							
	01/10/...	UNENE b...		Waterloo Sept 1, - Feb28,			-100,000.00
TOTAL Waterloo							-100,000.00
Western							
	03/05/...	UNENE b...		Western, Sept 1, 2003 - Sept. 04		R	-216,667.00
	01/10/...	UNENE b...		Western Oct 1, 2004 - Mar 31, 05		R	-100,000.00
TOTAL Western							-316,667.00
TOTAL Research							-858,747.00
TOTAL EXPENSES							**-953,040.41**
TRANSFERS							
Mac Admin							
	31/10/...	Mac Holdi...	TXFR	S/T Expenses Q1			-10,000.00
	31/10/...	Mac Holdi...	TXFR	Course Coordinator Q1			-5,000.00
	31/12/...	Mac Holdi...	TXFR	S/T Expenses Q2			-10,000.00
	31/12/...	Mac Holdi...	TXFR	Course Coordinator Q2			-5,000.00
TOTAL Mac Admin							-30,000.00
Mac Holding Acct							
	31/10/...	Mac Admin		S/T Expenses Q1			10,000.00
	31/10/...	Mac Admin		Course Coordinator Q1			5,000.00
	31/12/...	Mac Admin		S/T Expenses Q2			10,000.00
	31/12/...	Mac Admin		Course Coordinator Q2			5,000.00
TOTAL Mac Holding ...							30,000.00
UNENE bank acct							
	30/10/...	AECL Inv...		AECL Membership Dues			-200,000.00
	21/05/...	BP Invoices		Bruce Power Membership,paid too much			-200,000.00
	23/05/...	NSS Invoi...		NSS Membership Dues		c	-30,000.00
	28/09/...	OPG Invoi...		OPG Membership Dues			-600,000.00
TOTAL UNENE bank ...							-1,030,000.00
AECL Invoices							
	30/10/...	UNENE b...		AECL Membership Dues			200,000.00
TOTAL AECL Invoices							200,000.00
BP Invoices							
	21/05/...	UNENE b...		Bruce Power Membership, paid too much			200,000.00
TOTAL BP Invoices							200,000.00
NSS Invoices							
	23/05/...	UNENE b...		NSS Membership Dues		R	30,000.00
TOTAL NSS Invoices							30,000.00
OPG Invoices							
	28/09/...	UNENE b...		OPG Membership Dues invoiced			600,000.00
TOTAL OPG Invoices							600,000.00
TOTAL TRANSFERS							0.00
Balance Forward							
Mac Admin							
	12/09/...	Mac Admin		Opening Balance		R	0.00
TOTAL Mac Admin							0.00
Sales Tax							
	12/09/...	*Sales Tax*		Opening Balance			0.00
TOTAL *Sales Tax*							0.00
TOTAL Balance Forw...							0.00
OVERALL TOTAL							**-891,194.57**

BOARD OF DIRECTORS AND OFFICERS

Voting Members and Directors

Mo Elbestawi,
Chair, 2002-04
McMaster

Emad Elsayed
Vice Chair,
2002-04
OPG

Tom Harris Chair,
2004-
Queen's

Paul Spekkens
2004-
OPG

Beth Medhurst,
Vice Chair,
2004-
AECL

Tas
Venetsanopoulas
Toronto

Adel Sedra
Waterloo

Steve
McDougall
Bruce Power

George
Bereznai
UOIT

Franco Berruti
Western

Non-Voting Members

Jean Koclas
Ecole
Polytechnique

Brian MacTavish
COG

Cheryl Nelson
CNSC

Derek Lister
UNB

John
McKinnon
NSS

Jin Jiang
Chair EAC
2002-04
Western

David
Blenkinsop
Chair, EAC
2004-
Bruce Power

George
Bereznai
Vice Chair, EAC
2002-
UOIT

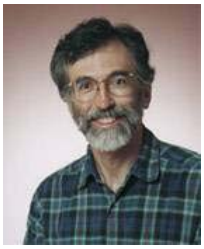
Rick Holt
Chair, RAC
2002-04
Queen's

Kazem
Rassouli
Chair, RAC
2002-
OPG

Mahesh Pandey
Vice Chair, RAC
2002-
Waterloo

Officers and Staff

Mohan Mathur
President and
CEO



Bill Garland
Secretary/
Treasurer,
Program
Director
McMaster

Jim Findlater
Accountant

Lori
Admin. Asst.
McMaster