**Proposal from the Faculty of Energy Systems and Nuclear Science for**

**Graduate Diplomas in Nuclear Technology**

In addition to graduate degrees, OCGS establishes guidelines for, appraises and approves proposals for 4 different types of graduate diplomas. The four options are defined on the following page.

The Faculty of Energy Systems and Nuclear Science wishes to submit a proposal for a suite of six Type 4 Graduate Diplomas in Nuclear Technology based on areas of sub-specialization within the fields of Nuclear Power and Radiological and Health Physics. The proposed programs have been designed to accommodate the needs of personnel working in the nuclear industry to upgrade their knowledge and skills, to position themselves for transfer and/or advancement within their industry and to promote an orientation toward lifelong learning. Over the course of their careers, students may choose to complete a number of these diplomas.

The six diplomas are as follows:

1. Graduate Diploma in Nuclear Technology - Fuel, Materials and Chemistry
2. Graduate Diploma in Nuclear Technology - Reactor Systems
3. Graduate Diploma in Nuclear Technology - Operation and Maintenance
4. Graduate Diploma in Nuclear Technology - Safety, Licensing and Regulatory Affairs
5. Graduate Diploma in Nuclear Technology - Health Physics
6. Graduate Diploma in Nuclear Technology - Radiological Applications

To earn a diploma, students will be required to complete 4 courses relevant to one of the six areas of sub-specialization and approved by the Graduate Program Director. Each diploma has a set of defined courses relevant to the area of sub-specialization. In addition, there are number of non-specialist courses common to all diploma programs. These courses are senior undergraduate and graduate courses currently offered by UOIT's Faculty of Energy Systems and Nuclear Science and Faculty of Engineering and Applied Science.

Because the rationale, admission and diploma requirements, core faculty and model for administration and delivery are common to all six diplomas, the proposal will be provided to OCGS as one single package.

McMaster University is currently offering a graduate diploma in Nuclear Technology but it offers only one area of specialization. (McMaster does not have a stand-alone graduate degree in Nuclear Engineering.) McMaster's program has been endorsed by a number of organizations in the nuclear industry for its personnel. Dr. Bereznai has presented his proposal to industrial representatives and they have indicated that they strongly support the intent and format of the proposed model.

These are UOIT's first diploma submissions.

**Excerpts from OCGS By-laws - Graduate diplomas**

OCGS has defined four types of graduate diplomas. Types 1 and 2 are not stand alone qualifications and, therefore, the standards that apply to them are those of their parent program(s). Inasmuch as types 3 and 4 graduate diplomas are stand-alone graduate credentials, some evidence is required that they provide education more advanced than that achieved at the undergraduate level although "research" in its strictest sense is not required. It is incumbent on the proposer to demonstrate that the program is indeed offered at the graduate level and leads to the development of some basic analytical/interpretive skills.

**TYPES OF GRADUATE DIPLOMAS**

**Type 1 graduate diploma**: The diploma awarded when a candidate admitted to a master's program leaves the program after completing a certain proportion of the requirements. Students are not admitted directly to these graduate diplomas. Several MBA programs offer this possibility to students who have successfully completed 10 of the 20 required courses. These do not require separate funding approval, but when new, do require standard appraisal and, thereafter, periodic appraisal. The appraisal for these programs is described below.

**Type 2 graduate diploma**: The diploma offered in conjunction with a master's (or doctoral) degree, the admission to which requires that the candidate be already admitted to the master's (or doctoral) degree. This represents an additional, usually interdisciplinary, qualification. These do not require separate funding approval, but when new, do require standard appraisal and, thereafter, periodic appraisal. The appraisal for these programs is described below.

**Type 3 graduate diploma**: The stand-alone diploma, not additional to a master's or doctoral degree, and to which students are admitted directly. When new, these require standard appraisal and, thereafter, periodic appraisal. Such programs are appraised according to the Procedures for Standard or Periodic Appraisal (see Section 10 and 11). MTCU funding approval must be sought as for master's degrees if the university wishes to count the students toward its BIU entitlement.

**Type 4 graduate diploma**: The sub-specialization within an existing program. These programs are stand-alone, direct-entry diplomas designed to suit the needs of a particular clientele or market (i.e., not additional to the master's or doctoral program, as Type 2) developed by a unit already offering a master's (and sometimes a doctoral) program. Such programs are often offered on a full-cost recovery basis. If the university wishes to count the students towards its BIU entitlement, and if the program is specific11 rather than generic12, MTCU funding approval must be sought. The appraisal of Type 4 graduate diploma programs is outlined in the section entitled *Guidelines for the Appraisal of Sub-specializations,* Section 21.
Approved: OCGS September 19, 1997.

## PROPOSAL FOR GRADUATE DIPLOMAS IN NUCLEAR TECHNOLOGY

### 1. FOCUS OF AND RATIONALE FOR THE PROGRAM

The nuclear industry requires highly qualified personnel who possess a sound and up-to-date understanding of the technical and professional practices that govern the safe and reliable operation of nuclear power plants and supporting facilities. With the planned expansion of nuclear power for electricity production and the expected reduction of the work force of Canada's nuclear industry through retirements in the next two decades, increased efforts to both attract and prepare new employees and to continuously upgrade the skills of existing personnel become even more critical.

The Graduate Diplomas in Nuclear Technology (with a range of sub-specializations) has been designed to accommodate the needs of personnel working in the nuclear industry to upgrade their knowledge and skills, to position themselves for transfer and/or advancement within their industry and to promote an orientation toward lifelong learning.

With undergraduate and graduate degree programs in Nuclear Engineering, UOIT offers a wide range of relevant courses from which students can design a program in a specialized area related to the fields of Nuclear Power or Radiological and Health Physics. As graduates change jobs and advance in their careers, they may want to gain a second or third diploma, as part of the expected life-long learning in our knowledge economy.

### 2. PROGRAM REQUIREMENTS AND COURSE LIST

To gain a nuclear technology graduate diploma in a given sub-specialty, a student must complete four courses as defined below, and not previously taken at UOIT or at another university with a comparable program. The student must select the specialist program he or she wishes to obtain at the time of registration. Any changes to this choice, and to the selection of courses which are designed to achieve the intent of the specific sub-specialty, must be approved by the graduate program director. It should be noted that any one course can only be counted towards one diploma, and that transfer credits are not permitted.

a. Complete a minimum of two courses from the sub-specialty, including at least one NUCL course.
b. Complete no more than one course from another sub-specialty and/or up to two courses from the Non-Specialist Common courses.
c. There must be a minimum of two NUCL courses completed. (Note: All NUCL courses must be at the 5000 level.)
d. Subject to the approval of the Graduate Program Director, one graduate course may be taken that is not listed for the Diploma in Nuclear Program, (i.e. from graduate a program offered by other UOIT faculties).

These four courses must be completed within a three year period with a minimum passing grade of B- for each course.

The majority of the listed courses will be available every year, and a minority of the courses will be available once every two years.

Courses are to be selected from the following list. These courses are already offered as part of the fourth and final year of the BEng (Honours) in Nuclear Engineering (4000 level) or the MASc/MEng in Nuclear Engineering (5000 level).

## SUB-SPECIALIZATIONS IN THE FIELD OF NUCLEAR POWER

### 1. Fuel, Materials and Chemistry

NUCL 5080G Advanced Topics in Environmental Degradation of Materials
NUCL 5220G Fuel Management in Nuclear Reactors
NUCL 5300G Advanced Topics in Radioactive Waste Management
NUCL 5450G Advanced Material Analysis
ENGR 4510G Nuclear Plant Chemistry
ENGR 4610G Corrosion for Engineers
ENGR 4620G Radioactive Waste Management Design
ENGR 4680G Nuclear Materials
ENGR 4810G Nuclear Fuel Cycles

### 2. Reactor Systems

NUCL 5200G Reactor Physics
NUCL 5210G Advanced Reactor Physics
NUCL 5215G Advanced Reactor Engineering
NUCL 5230G Advanced Nuclear Thermalhydraulics
NUCL 5240G Heat Transfer in Nuclear Reactor Applications
NUCL 5290G Advances in Nuclear Power Plant Systems
ENGR 5122G Computational Fluid Dynamics
ENGR 4700G Nuclear Plant Design and Simulation
ENGR 4730G Reactor Control
ENGR 4780G Nuclear Reactor Design

### 3. Operation and Maintenance

NUCL 5100G Nuclear Plant Systems and Operation
NUCL 5250G Power Plant Thermodynamics
NUCL 5270G I&C and Electrical Systems
NUCL 5280G Advanced Reactor Control and Protection
ENGR 5121G Advanced Turbo Machinery
ENGR 5740G User Interface Design
ENGR 5910G Embedded Real-Time Control Systems
ENGR 5920G Analysis and Control of Nonlinear Systems

ENGR 5930G Adaptive Control
ENGR 5940G Intelligent Control Systems
ENGR 5960G Power System Operations, Analysis and Planning
ENGR 4670G Shielding Design

4. Safety, Licensing and Regulatory Affairs

NUCL 5050G Applied Risk Analysis
NUCL 5070G Environmental Modelling
NUCL 5090G Occupational Health and Safety
NUCL 5260G Reactor Containment Systems
NUCL 5310G Regulatory Affairs and Licensing Concepts
NUCL 5430G Advanced Dosimetry
NUCL 5440G Advanced Radiation Biophysics and Microdosimetry
ENGR 4520G Nuclear Plant Safety Design
ENGR 4660G Risk Analysis Methods
RADI 4220G Radiation Biophysics and Dosimetry
RADI 4550G Radiation Detection and Measurement

SUB-SPECIALIZATIONS IN THE FIELD OF RADIOLOGICAL AND HEALTH PHYSICS

5. Health Physics

NUCL 5070G Environmental Modelling
NUCL 5090G Occupational Health and Safety
NUCL 5300G Advanced Topics in Radioactive Waste Management
NUCL 5430G Advanced Dosimetry
NUCL 5440G Advanced Radiation Biophysics and Microdosimetry
ENGR 4620G Radioactive Waste Management Design
ENGR 4670G Shielding Design
RADI 4220G Radiation Biophysics and Dosimetry
RADI 4550G Radiation Detection and Measurement

6. Radiological Applications

NUCL 5400G Advanced Radiation Science
NUCL 5410G Physics of Radiation Therapy
NUCL 5460G Industrial Radiography
NUCL 5470G Nuclear Forensic Analysis
RADI 4430G Industrial Applications of Radiation Techniques
RADI 4440G Radioisotopes and Radiation Machines

NON-SPECIALIST COURSES COMMON TO ALL DIPLOMA PROGRAMS

NUCL 5010G Project Management for Nuclear Engineers
NUCL 5020G Mathematical Methods in Nuclear Applications
NUCL 5030G Transport Theory
NUCL 5040G Monte Carlo Methods
NUCL 5060G Nuclear Concepts for Engineers and Scientists
NUCL 5065G Thermalhydraulics Concepts for Engineers and Scientists
NUCL 5420G Aerosol Mechanics
ENGR 5010G Advanced Optimization
MCSC 6210G Advanced Topics in Mathematical Modelling
MCSC 6120G Numerical Methods for Ordinary Differential Equations
MCSC 6230G Advanced Topics in High-Performance Computing

## 3. FACULTY

The core faculty group who will teach in these programs are:

Dr. George Bereznai – Professor and Dean of the Faculty of Energy Systems and Nuclear Science
Dr. Anthony Waker – Professor
Dr. Glenn Harvel – Associate Professor
Dr. Brian Ikeda – Associate Professor
Dr. Igor Pioro – Associate Professor
Dr. Edward Waller – Associate Professor
Dr. Matthew Kaye – Assistant Professor
Dr. Lixuan Lu – Assistant Professor
Dr. Rachid Machrafi – Assistant Professor
Dr. Eleodor Nichita – Assistant Professor

In addition, the Faculty has seven part-time definite term complementary academic instructors, sessional lecturers and adjunct professors who are eligible to participate in the teaching of graduate courses and likely to participate in the delivery of the diploma programs.

Dr. Mike Dymarski – Sessional Lecturer
Dr. Reza Ghafouri – Definite Term Complementary Academic Instructor
Dr. Ali Keshavarz – Definite Term Complementary Academic Instructor
Dr. Daniel Meneley – Adjunct Professor
Dr. Barry Neil – Definite Term Complementary Academic Instructor
Dr. Benjamin Rouben – Adjunct Professor
Mr. Peter Schwanke – Sessional Lecturer

Most of these core and complementary professors were included in the original MASc/MEng in Nuclear Engineering program proposal. Their CVs were provided as

Volume II of that submission. Drs. Kaye and Machrafi are new core faculty and their CVs are attached.

## 4.1 ADMISSION REQUIREMENTS

The following are the minimum admission requirements for the parent MASc/MEng program in Nuclear Engineering upon which this diploma is based:

- Completion of an undergraduate science or engineering degree from a Canadian university, or its equivalent from a recognized institution.

- Overall academic standing of at least a B (GPA = 3.0 on a 4.0/4.3 scale), with a minimum B in the last two full-time years (four semesters) of undergraduate work or equivalent, although a B+ is preferred for MASc applicants. Submission of one certified copy of each previous undergraduate and graduate transcript directly from the granting institute is required. It is the student's responsibility to provide a certified English translation of the transcript if the original is in another language. Applicants may be required to submit a brief description of the courses listed on their official transcripts or provide a copy of the relevant calendar where they are listed.

- A minimum of two letters of reference from persons having direct knowledge of the applicant's academic competence. Academic references are preferred; however professional references will be accepted. Letters of reference should come from individuals under whom the applicant has worked closely or studied. The quality of the letters will be assessed by the Graduate Committee of the Faculty of Energy Systems and Nuclear Science to make sure relevant requirements have been met.

- Proof of English proficiency is needed from those applicants whose first language is not English.

- As part of the application form, students are expected to provide a one-page Statement of Interest outlining their objectives in undertaking graduate study. Applicants may describe career aspirations/plans, specific research interests (if known), and experience relevant to their interests. If a potential thesis supervisor has been contacted, he/she must be identified in the Statement of Interest.

- Close technical contact with a faculty member is an essential part of graduate education in engineering and science. Prior to being accepted into the program, MASc students must find a professor who specializes in the applicant's desired area of research and is willing to act as a supervisor. In the event the MASc student cannot find a project supervisor, the student must transfer into the MEng-Course option.

**Language Requirements**

All applicants are required to give evidence of their oral and written proficiency in English. This requirement can be satisfied with one of the following criteria:

i) The student's mother tongue or first language is English.

ii) The student has studied full-time for at least three years (or equivalent in part-time studies) in a secondary school or university where the language of instruction and examination was English.

iii) The student has achieved the required proficiency on one of the tests in English language acceptable to the University of Ontario Institute of Technology: TOEFL (computer based) 220 or TOEFL (paper based) 560 or IELTS 7 or MELAB 85 or CAEL 60.

## 4.2 AMENDMENTS AND/OR ADDITIONS TO ADMISSION REQUIREMENTS FOR THE GRADUATE DIPLOMA PROGRAM

- Applicants must hold a baccalaureate degree in the fields of engineering, science or mathematics with a grade point average of B- (GPA = 2.7 on a 4.0/4.3 scale), i.e. one grade below that for entry into a MEng degree program. In the case of mature students who do not meet the MASc/MEng academic requirements, consideration will be given to specialized education, training and experience relevant to the chosen field of diploma studies, as long as the applicants are deemed to have satisfactory preparation to succeed in the program. The Graduate Program Director, upon the recommendation of the Faculty's Graduate Admissions Committee, will make admission recommendations to the Office of Graduate Studies.

- As the target group is professionals working in the industry, all applications will be reviewed on a case-by-case basis, with special attention given to the nature and duration of the applicant's work experience and the letters of reference from individuals who can validate and attest to the quality of the applicant's professional experiences and skills.

- As students applying to the Graduate Diploma Program in Nuclear Technology are not required to prepare a thesis or major project, they are not required to prepare a statement of interest or find a supervisor. Their program advisor will be the Graduate Program Director of the Faculty of Energy Systems and Nuclear Science.

## 5. IMPACT OF DIPLOMA ON PARENT PROGRAM

Because the diploma programs are subsets of an existing program at UOIT, students in the diploma programs will be taking the same courses at the same time as undergraduate and graduate students in UOIT's Nuclear Engineering programs. For this reason, there should be no need for additional courses to be scheduled or faculty assigned to accommodate the diploma cohort. Depending on the number of students enrolled in the diploma programs and the courses selected at a given time, it may be necessary to assign additional teaching assistants to undergraduate courses. The enrollment in graduate level courses is sufficiently low that such accommodations will not be necessary.

At the current time, at least half of the courses offered by the Faculty of Energy Systems and Nuclear Science for graduate studies are scheduled after 4 pm in order to accommodate the needs of professionals in industry enrolled on a part-time basis to upgrade their qualifications. In addition, all the courses use technology that gives students the option of face-to-face, on-line or hybrid (i.e. a combination of face-to-face and on-line) delivery options.

While candidates for the diploma programs may be admitted with lower academic grade point averages, they will still be expected to maintain the minimum academic standing level of B- in the course as the graduate students in the parent program. Hence, there will be no impact on the quality of the courses or course delivery.

## 6. MODE OF DELIVERY

As noted above, students have the option of participating in face-to-face, on-line or hybrid course delivery models. The on-line components allow students to participate in lectures synchronously and/or work through the course material asynchronously. It is expected that many, if not all, courses will be available to students, optionally, in a complete online format.

## 7. ADMINISTRATIVE ARRANGEMENTS

The diploma programs will be included as part of the Faculty's Graduate Program Director portfolio.