

Descriptions of the Health Physics Program at The University of Tennessee

Larry Miller

52nd Annual Meeting of the Health Physics Society

Status of Academic Programs and Student Recruitment

July 10 , 2007



Overview of Presentation

- **Background**
- **Academic Programs in Health and Medical Physics**
- **Research Topics and Students Graduated**
- **Recruitment, Funding and Accreditation**
- **Distance Education**
- **Observations and Opinions**

Background

- **General interest for ORNL since early 1980's**
- **Departmental decision to establish a concentration of courses in December of 1987**
- **Academic program based on conversations with Jim Turner**
- **Classes offered at the ORAU facility from 1988 through 2001**
- **New enrollments were about 20 each year through the mid 90's**
- **Current HP class enrollments are about 10 to 15**

Academic Program in Health Physics

- **Radiation Protection**
(NE-551; Turner, Groer, Townsend)
- **Radiological Assessment and Dosimetry**
(NE-552; Cloutier, Miller)
- **Radiation Measurements Laboratory**
(NE-550; Frame, Simpson and Miller)
- **Radiation Biology**
(Special Topic, Byrne)

Some Special Topics Classes Offered (NE-597 and NE-621)

- **Radiation Biology (taught every two years by Byrne)**
- **Internal Dosimetry (taught several times by Eckerman, Miller)**
- **Radiation Risk Assessment (taught several times by Groer, NE-553)**
- **Radiological Characterization of Facilities Undergoing Decontamination and Decommissioning (Abelquist, Frame)**
- **Statistics for Health Physicists (Downing)**
- **Uncertainty Analysis (taught several times, Miller, Hoffman)**
- **Charged Particle Transport (taught several times, Townsend)**

Radiation Protection (NE 551)

- **Text**
 - **Anderson, Absorption of Ionizing Radiation, with Turner's book as a supplement**
- **Topics**
 - Fundamental radiation protection concepts and definitions
 - Physical interactions of heavy charged particles, electrons, photons and neutrons and mechanisms of energy loss
 - Chemical and biological effects of radiation
 - Current radiation protection standards and practices

Radiological Assessment and Dosimetry (NE-552)

- **Text**
 - **Till and Meyer**
- **Topics**
 - **Air, Water and Ground Transport of radionuclides**
 - **Food Chain Pathways**
 - **Internal and External Dosimetry**
 - **Special Case Radionuclides**
 - **Health Effects**
 - **Uncertainty Analysis**

Radiation Measurements Laboratory

(NE-550)

- **Text**
 - **Radiation Detection and Measurement, Knoll**
- **Topics**
 - **Review of Radiation Detection Physics**
 - **Statistical Methods and Uncertainty Analysis**
 - **Gas, Scintillation, and Solid State Detectors for Photons**
 - **Analysis of Spectra**
 - **Neutron Detectors**
 - **Spectral Unfolding**
 - **TLDs**

Courses in Medical Physics

- **Medical Physics I (NE 567)**
 - Uses of ionizing radiation in radiation therapy
 - Physics of interactions
 - Clinical applications
- **Medical Physics II (NE 568)**
 - Quality assurance
 - Treatment planning
 - Special treatment procedures
- **Medical Imaging (Special Topics Survey Course)**
 - Essentially all diagnostic methods are covered

Research and Students Graduated

- **Groer**
 - Radiation risk assessment
 - Graduated 22 M.S. and Ph.D. HP students through 2004
- **Townsend**
 - Space radiation, charged particle transport
 - Graduated 15 M.S. and 7 Ph.D. HP students through 2006
 - Five honors projects
- **Miller**
 - Radiological assessment, radiation detection
 - Graduated 54 M.S. and 9 Ph.D. HP students through 2006

Funding

- **During the mid 90's about 15 students were continuously supported through Oak Ridge**
- **Currently all Health Physics research is funded through space radiation protection related contracts**
- **Proposals for detector development are under review by the National Science Foundation and National Nuclear Security Administration for detector development**

Recruitment

- **Mailings are sent to all high schools in Tennessee and Ten Academic Common Market States**
- **Maintain an exchange program with other nuclear engineering departments**
- **Presentations to freshmen in the college of engineering at The University of Tennessee**

Accreditation

- **The undergraduate nuclear engineering program at The University of Tennessee is accredited**
- **It was decided that a separate accreditation for Health Physics required more effort than could be readily accommodated**

Distance Education at UTNE

- **Six Distance Education (DE) programs**
 - **M.S. in Nuclear Engineering (NE)**
 - **Certificate in Nuclear Criticality Safety**
 - **Certificate in Maintenance and Reliability Engineering**
 - **Colloquium Program**
 - **Nuclear Criticality Safety Short Course**
 - **Reliability and Maintainability**

M.S. in Nuclear Engineering With a Concentration in Health Physics

- **Distance M.S. program is identical to our on-campus M.S. program, but with fewer courses offered**
- **Thesis or Engineering Project M.S. degree requires eight 3-hour courses (24 hours)**
 - **Four NE courses**
 - **Two courses in math, statistics, or comp. science**
 - **Two more courses in NE or a related field**
- **Project plus 2 NE courses (30 hours)**
 - **The project option require 3 hours of research (33 total hours)**

M.S. in Nuclear Engineering (continued)

- **Sixteen distance courses are currently offered**
 - **Thirteen are synchronous (i.e., live and interactive in real time)**
 - **Three are asynchronous (web-based or on a CD)**
- **Admission: B.S. graduates in engineering, physics, chemistry, or mathematics: GPA of least 3.0/4.0**
- **Non-NE graduates must take at least one pre-requisite course, “Fundamentals of Nuclear and Radiological Engineering” without graduate credit**
 - **Available asynchronously each semester**
- **Students may begin in any semester**

M.S. in Nuclear Engineering

(continued)

- **Students come to campus at the end of their program to defend their work in a final oral examination**
 - **Oral exam covers all coursework and thesis or engineering practice project(s)**
- **M.S. requirements usually completed in six semesters**
 - **1 course per semester for four semesters**
 - **2 courses per semester for two semesters**
 - **Research or engineering practice project(s) are conducted during most semesters**
- **Pace could be slower or faster (student preference)**

Distance Technology

- **Most courses are delivered synchronously to student's computer using CENTRA software (Cyber Class), which is provided by the university**
 - **Cyber Class Interactivity: instructor to students, students to instructor, and student to student in real time**
 - **Each class is recorded and saved to accommodate working professionals who occasionally miss class**
- **Initially, NE instructors taught distance classes from their offices**
- **Currently, NE instructors use Smart Board 3000 and teach both local and distance students simultaneously from a regular classroom**

Observations and Opinions

- **Enrollment in Health Physics Classes is Relatively Strong (~15 each year in NE 551 and ~10 in NE 552)**
- **Current Funding for Health Physics is for Space Radiation Protection**
- **Funding in the Area of Homeland Security is a Realistic Opportunity**
- **Medical Physics Attracts More Students than HP**
- **Enrollments Have Been Relative Stable for About Five Years**

Extra Slides

- **Special Topics**

Special Topics: Charged Particle Transport

- **Text**
 - **Space Radiation Transport and Interactions (NASA RP 1257)**
- **Topics**
 - Boltzmann transport equation derivation for electrons and heavy charged particles (mesons, hydrogen, helium and heavier nuclei)
 - Deterministic methods: Perturbation expansion, Green's Function, numerical methods
 - Monte Carlo methods
 - Heavy charged particle interactions and event generators

Internal Dosimetry (Special Topic)

- **Basic Internal Dosimetry Concepts**
- **Anatomical Models**
- **Calculation of SEE**
- **Gastrointestinal Track Kinetics**
- **Respiratory Track Kinetics**
- **Biokinetics of Systemic Material**
- **RBD Software**
- **Bioassay Program at ORNL**
- **Radiation Transport for Internal Dosimetry**
- **Dose Assessment and Associated Software**
- **Radiation Transport for Internal Dosimetry**
- **Radiopharmaceutical Procedures**
- **Dosimetry of Bone Seekers**
- **Measurements of Internal Emitters**
- **Uncertainty Analysis**

Radiation Biology (Special Topic, Objectives)

- **Provide a foundation for the understanding of radiation effects upon biological systems.**
- **Discuss the use of radiation (brachytherapy, external beam, total body, electron mode, QA for radiation and others) in the treatment of cancerous tumors.**
- **Describe the use of agents that enhance radiation effects and/or protect cells from radiation damage.**
- **Reflect on current risk estimates for the development of leukemia/lymphoma and solid tumors.**
- **When necessary provide additional background in biochemistry, embryology, human anatomy, genetic and immunology for complete understanding of the subject.**
- **Aid students in preparation for future American Board of Radiology, ABR, examinations (if student are interested).**

Uncertainty Analysis (Special Topic)

- **Overview of Uncertainty Analysis & Fundamental Concepts**
- **Propagation of Variance & Least Squares**
- **The propagation and Analysis of Uncertainty, Chapter 8:Morgan,**
- **Generalized Least Squares**
- **Interpretation of the Variance-Covariance Matrix**
- **The Nature and Sources of Uncertainty, Chapter 4:Morgan**
- **Probability Distributions & Statistical Estimation, Chapter 5:Morgan**
- **Statistical Methods for Uncertainty Analysis**
- **Discussion of Numerical Experiments**
- **Description of Latin Hypercube Sampling Software & Crystal Ball**
- **Evaluation of Numerical Experiments**
- **The Value of Knowing How Little you Know, Chapter 12:Morgan**
- **Forward and Adjoint Methods Using Computer Calculus**
- **Deterministic Uncertainty Analysis**
- **Limit State Methodology**
- **Calibration Problems**
- **Bayesian Statistics for Uncertainty Analysis**

Facilities Undergoing Decontamination and Decommissioning (Special Topic)

- **MARSSIM Survey Design**
- **Decommissioning Overview**
- **Characterization**
- **Pathway Modeling**
- **DCGLs derivation, detection sensitivity**
- **Statistics (I and II),**
- **Background Reference Areas**
- **Final Status Surveys, Survey instrumentation**
- **Techniques and Experiences at Different D&D sites**