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Progress Toward a Graduate Certificate Program in Radiation Protection

A Report to the USTUR Scientific Advisory Committee

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September 7, 2012

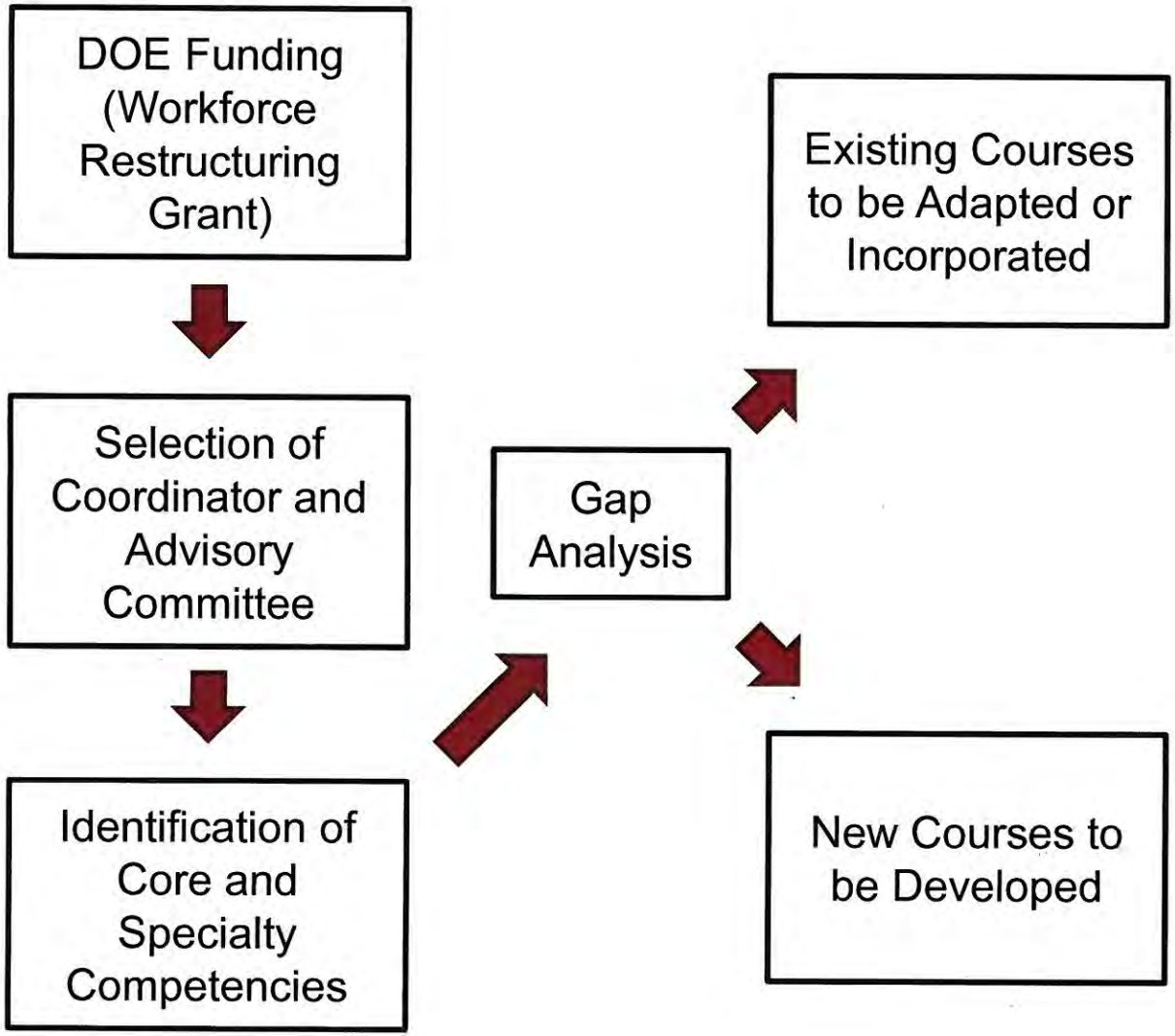
What is a Graduate Certificate Program?

- A new element in today's graduate studies, for those desiring organized graduate study, who don't have the time to pursue a master's degree
- Must be admitted to the graduate school in the certificate program
- Complete 12 credits
  - A "gate-keeper" course (required of all students)
  - 3 three credit courses from a short list of electives, centered around a defined field of knowledge

Graduate Certificate Program (cont.)

- Undergraduates may take courses with permission of the instructor but can not earn the certificate
- Unlike a new master's degree program, is possible to create de novo in today's financial climate

The Process Used



- Introduction to Radiological Science
- Radiation Biology

- Uses of Radiation and Radiological Material and Their Regulation
- Radiation Instrumentation
- Environmental and Internal Dosimetry

Advisory Committee

Person	Credentials	Employer	Specializations/Job
Wane Glines	M.S. Radiological Science	DOE	Senior Technical Advisor for Radiological Controls
Robin Hill	Ph.D..	PNNL	External Dosimetry & Internal Dosimetry, Exposure
Warnick Kernan	Ph.D., CHP	PNNL	Applied Research on Radiation Detection
Jay MacLellan	CHP	PNNL	Medical Physics, Academics, Internal Dosimetry,
Bruce Napier	CHP, NCRP	PNNL	Dose Reconstruction, Environmental Computer
Dick Pratt	Ph. D., Vice Chancellor	WSU/TC	Academics, Biology
Paul Stansbury	Ph.D., CHP	Dade Moeller	Academics, Operational Health Physics under NRC License, Applied Health Physics Research
Dan Strom	Ph.D., CHP, NCRP	PNNL	Academics, Campus RSO, and Many Other
Sergei Tolmachev	Ph.D.	WSU/TC	Manages and Researches in the U.S. Trans-and Uranium Registries
David Waite	Ph.D., CHP	Dade Moeller	Academics, Waste Management, and Many Other Specializations

Timeline

Spring 2011	DOE commits to providing funding
Fall 2011	Coordinator appointed; Advisory Committee selected and has 1st mtg.; Competencies determined
Spring 2012	Gap analysis completed; new courses designed; poster paper presented at Health Physics Society annual meeting
Fall 2012	Proposed program submitted to faculty committees for approval; courses developed
Spring 2013	New courses finished; program publicity begun
Fall 2013	Students admitted; first courses taught

Core Competencies

	Health Effects of Radiation	**Radiological Physics**	Ubiquitous Background Radiation	Uses of Radiation and Radioactive Material	**Radiation Quantities and Units**	**Instruments to Measure Radiation Quantities**	Exponential Equation	Regulations and Standards and History of Radiation Protection
Intro to Radioplogical Science	I S	I S	I	I R	I R	I R	I R	I
Radiation Instrumentation		R	R	R	R	S	R	
Uses and Regulation of Radiation	R	R		S	R	R	R	
Environmental and Internal Dosimetry	R	R	R	R	R		R	
Radiation Biology	R	R			R		R	

KEY	
I	introduce
R	reinforce
S	specialize

Bold Core Competencies should be emphasized

Specialty Competencies (Electives)

	External Dosimetry	Internal Dosimetry	Fuel Cycle	Structure and Function of Radiation Protection Programs	Radiochemistry	Environmental Dose Calculations	Dose Assessment and Emergency Preparedness and Response
Intro to Radioplogical Science	I	I	I	I R		I	
Radiation Instrumentation	R	R					
Uses and Regulation of Radiation	R	R	S	S		R	
Environmental and Internal Dosimetry		S	R	R		R S	R
Radiation Biology					R		

Mentioned Topics

	ALARA	Public Relations	Shielding Calculations	Donning and Doffing Protective Equipment	Calibrating Instruments	Calibrating Sources and Machines	Gamma Spectroscopy	Special Aspects of Radiation Protection in a DOE Environment
Intro to Radioplogical Science	I R	I	I				I	
Radiation Instrumentation					I	I	S	
Uses and Regulation of Radiation		R					R	I
Environmental and Internal Dosimetry			R					

Details on Courses

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Description of Revised Course
Introduction to Radiological Science

Purpose of Revision

ESRP-406 will become the "gatekeeper course" for the new Graduate Certificate Program in Radiation Protection. It will be a required course for all those earning the certificate, but will also be available to undergraduate students with permission of the instructor. The revised course will be 3 credits.

Week	Lecture Title	Lecture Subjects
1	Radiation--What is it?	Binding Energy, Types of Radiation, Interactions of Radiation with Matter
2	Radiation, A Little Won't Kill You	Radiation Quantities and Units, Health Effects of High Doses
3	Radiation--It's Everywhere	Ubiquitous Background Radiation, Half-life and Exponential Decay
4	The Scary Thing about Radiation	Chemical and Biological Effects of Radiation, Health Effects of Low Doses of Radiation
5	(Scary continued)	More on Biological Effects, Psychological Effects
6	Radiation--You Can't See It	Radiation Detection
7	Radiation--It's Used in Lots of Places	Uses of Radiation in Medicine, Medical and Industrial Radiography
8	(more uses of radiation and radioactive material)	Nuclear Fuel Cycle, Tracer Studies
9	10 Principles and 10 Commandments of Radiation Protection	10 Principles and 10 Commandments of RP, Radiation Protection in the Workplace, Personal Radiation Protection
10	When Radioactive Material Gets Loose	Environmental Radiation Calculations, Emergency Preparedness
11	So Radiation Interacts with My Body?	External dosimetry, Internal Dosimetry
12	Radiation Forensics and Other Methods	Gamma Ray Spectrometry, Shielding Calculations
13	The Sociology of Radiation and Things Radioactive	An Introduction to How the World and Society Control Radiation, Radioactive Material, and Radiation Exposure (and the history)
14	Making Electricity with Nuclear Material	Thermionic generators, Criticality, Nuclear Reactor Fundamentals
15	There Have Been (and Will Be) Radiological and Nuclear Accidents	Comparison and Contrast of the Three-Mile Island, Chornobyl, and Fukashima Reactor Accicednts, Non-reactor Fatal Accidents

Radiation Biology
4 credits (3 lecture +1 lab)

Description: Effects of ionizing radiation at the molecular, cellular, organ and organism level. Prereq Introduction to Radiological Physics (ES/RP 406) or one course each in biology and radiological physics

Textbook: Various

Lab Module	Laboratory Topic	Endpoint	Experiment Setup
1	Statistical analysis of survival data	N/A	Computer lab
2	Cell survival curves	Clonogenic survival	Plates will be analyzed and discussed. Plates plated and irradiated previously will be fixed stained and scored
3	Data analysis		Cells plated and irradiated previously will be fixed stained and scored. Survival data will be collected, plotted, and statistically analyzed.
4	Dose response curve	Micronuclei	Cells plated and irradiated previously will be fixed and stained for micronuclei. Micronuclei will be scored.
5	Labs groups choice	Micronuclei	Another set of cells plated and irradiated previously for micronuclei will be fixed and stained.
6	Dose calculations and Radiation quality	N/A	Dose calculations will be done illustrating the effects of radiation quality, uptake schedule, and biokinetics.
7	DNA damage	gH2AX	Cells plated previous week and fixed, stained and scored for gH2AX.
8	Lab groups choice	gH2AX	Previous experiment continued.
9	Dose rate	N/A	Computer lab
10	EXTRA	N/A	Extra lab time will be available for students to get help with data analysis.
11	Group presentations	N/A	Each group will give a 15 minute presentation.

Radiation Instrumentation
3 credits (2 lecture & 1 lab)

Textbook: *Radiation Detection and Measurement, 3rd Ed.*, Glenn F. Knoll

Week	Lecture Subjects	Lab Activities
1	Course Introduction; Review of Interactions of Radiation with Matter; Review of Radiological Quantities and Units	Internet Sources for Radiological Data and Information. Advance Excel™ Computational Techniques
2	Ion Chamber	Ion Chamber Operating Characteristics
3	Attenuation and Efficiency and Other Factors That Affect Radiological Measurements	Demonstrating 1/d^2; Measuring Attenuation
4	Geiger-Mueller Counter	GM Usage including plateau and saturation
5	Statistic of Radiological Counting; Chi-Squared Test	Performing chi-squared and other tests
6	Proportional Counter and Applications of Gas-Filled Detectors	Using a proportional counter
7	Thermoluminescent and Optically-Stimulated Luminescent Dosimeters	Measurements with TLD crystals
8	NaI Spectrometry	Single and multichannel analysis
9	High Resolution Gamma Ray Spectrometry	Using HPGe detector and interpreting typical environmental measurements
10	Gamma Ray Spectrometry Continued	More gamma spectrometry measurements
11	Liquid Scintillation; Mass Spectrometry for Low Specific Activity Radionuclides	Preparing samples and using an LSC; Preparing Samples for Mass Spectrometry
12	Alpha and Beta Spectrometry	Using solid state detectors
13	Neutron Detectors	Analysis of neutron detection data acquired by others
14	Microwaves and Lasers	Microwave interferometer and "measuring the wavelength of light with a ruler"
15	Old Technology and New Technology for Radiation Measurements	Cloud chamber demonstration

Environmental and Internal Dosimetry
3 credits (2 lecture & 1 lab)

Week	Lecture Subjects	Lab Activities
1	Course Introduction; Review of Absorbed Dose, Dose Equivalent, and Related Topics	WSU Computer Use Policies; Install software on students' laptops, as desired; Share URLs for on-line software and useful websites
2	Internally Incorporated Radionuclides: Pathways, Levels, Health Effects, and Medical Treatment	More web resources for Health Physics. Advance use of Excel™
3	Biokinetic Models for Internal Dosimetry: Internal Dosimetry Made Simple	Dose calculation by hand: ICPR 30
4	Biokinetic Models for Internal Dosimetry: Internal Dosimetry Made Simple (cont.)	Computer codes for Internal Dosimetry (Freely available codes: DCAL, RadBox,
5	Biokinetic Models for Internal Dosimetry: Differing Dosimetric Models: ICRP 26/30; ICRP 60/66/68/72; ICRP 103 (et.al.); Differing Biokinetic Parameter "Models": ICRP 23 v ICRP 89	PopTools & Commercially available codes: LUDEP, IMBA Professional Plus)
6	Internal Dosimetry Monitoring Bioassay and Radiobiological Data	
7	Quality Assurance/Quality Control and Decision Levels in Internal Dosimetry	Separation Methods/Alpha spectrometry technique/ Visit USTUR Laboratory
8	Radiopharmaceutical Dosimetry: Medical Internal Radiation Dose (MIRD) Concept. Computational Phantoms for Radiation Protection, Imaging and Radiotherapy	Nuclear Medicine Internal Dose Codes: MIRDOSE and OLINDA/EXM
9	Conceptual Models of Exposure &; Exposure Scenarios; Atmospheric Transport: the Atmosphere, Stability Concepts, Data, the Gaussian Model; the Affect of Sampling and Data Quality on Environmental Dose Calculations	Install HOTSPOT; evaluate simple Gaussian results for an acute release
10	Atmospheric Transport (cont.): Deposition Processes, Puff Models, Other Types of Transport Models, their Applicability and Reliability; the Concept of 95^{th} Percentile Meteorology	Apply HOTSPOT for an extended case, including 95^{th} percentile met
11	Surface Water Transport: Water Movement in Rivers, Lakes, Estuaries, and Oceans; Complex Surface Water Models, Including Sedimentation	Install GENII; develop a complete surface water scenario
12	Aquatic Food Chains; Fresh v Salt Water: Fish, Mollusks, Crustaceans, Water Plants, Marine Mammals; Terrestrial Food Chains. Deposition/retention, Root Uptake, Translocation in Plants, Seasonality, Animal Products.	Apply GENII to a chronic atmospheric release, combine with a chronic marine case
13	Groundwater Transport: Types of Models for Vadose and Saturated Zones; Resuspension, "Special Radionuclides" Tritium, Carbon-14, etc.	Install RESRAD. Develop an initial soil contamination scenario
14	Equilibrium v Dynamic Models; Uncertainty Analysis in Environmental Predictions; Summary of Various RESRAD Codes and Other Env. Codes (CAP-88)	Use RESRAD to simulate groundwater transport to an exposed reference
15	Sources of Radioepidemiolgical Data, Development of Risk Estimates, and Probability of Causation	Use NIOSH Interactive RadioEpidemiological Program (IREP) to compute PC for various example cases

Uses of Radiation and Radioactive Material and Their Regulation (3 credits)

Textbook: TBD

Week	Lecture Subjects The Use	Its Regulation or Mitigation
1	Radiation and Radioactive Materials--the Difference, Brief Review of Radiological Physics, Overview of the Pervasive Uses of Radiation and Radioactive Material in the Current Civilized World	Role of International and National Standard-setting Organizations; US Regulatory History, i.e., Advisory Committee on X-Ray and Radium Protection → Manhattan Project → AEC → ERDA/NRC → DOE/NRC
2	Nuclear Weapons 101 (their design and their effects)	Nuclear Phobia: What Are Its Components and How Can It be Dealt With, DOE (NNSA) and DoD
3	Industrial Uses: Irradiating Materials, including Food Irradiation, Review of Absorbed Dose	The Nuclear Regulatory Commission, and an Outline of Its Regs and Guidance Documents
4	Naturally Occurring Radiological Material, Uses of Isotopic Information for History or Understanding of Geochemical Processes	The States and EPA; UMTRCA, FUSRAP, & the CRCPD recommendations
5	Industrial Uses: Radiological Issues and Applications in Oil Companies, Al Plants, Paper Mills, Food Processors, Grain Elevators, Pipeline Companies, and Conventional Power Plants	The NRC's Inspection Program, The Function of Regions
6	Analytical Uses: X-Ray Fluorescence Analysis; Radiological Uses & Methods in Law Enforcement and Homeland Security	Federal Radiation Council, CRCPD, CIRRPIC, & ISCORS
7	Medical: Diagnostic X Rays	The Role of FDA
8	Medical : Radiation Therapy	TBD
9	Medical: Nuclear Medicine, CT, and PET	Transportation Regulations
10	Scientific: Uses of Radioactive Tracers	10CFR35
11	Nuclear Fuel Cycle: Uranium Mining and Enrichment	40CFR190
12	Nuclear Fuel Cycle: Power Reactors and Research Reactors	10CFR50
13	Nuclear Fuel Cycle: Current Plans and Practices for Waste Disposal; of DOE's Environmental Restoration & Legacy Management Missions	10CFR20 & 10CFR835; current waste disposal "situation": NWPA, WIPP, Yucca Mountain, Blue Ribbon Committee, & other
14	Nuclear Fuel Cycle: The Potential Benefits and Hazards of Nuclear Fuel Reprocessing	TBD
15	Current Events in All Things Radiological	Nuclear "Fingerprints"--Gamma Ray Spectrometry

Summary

- A graduate certificate program in radiation protection is being developed at Washington State University (WSU) Tri-Cities. Graduates of the program will be qualified to assist radiation safety professionals in protecting workers, the public, and the environment from hazards associated with ionizing radiation and radioactive materials and wastes, including those at the local U.S. Department of Energy Hanford site.
- The program will require that students be admitted to graduate school and complete 12 hours of graduate course work—a required course and 3 from among a small number of electives.
  - Teaching courses and admitting students is targeted to begin in the fall of 2013.
- A 10-person academic advisory committee of local radiation protection professionals, who have a mix of academic and professional backgrounds, oversees the development of the program.

Summary (cont.)

- Advisory committee has met several times, starting with the task of specifying what should the graduates of this program be able to do.
  - Balloting first as individuals and then coming to a consensus, the committee identified 8 core competencies and 7 specialty competencies.
  - The core competencies, expected of all students, were health effects of radiation, radiological physics, ubiquitous background radiation, uses of radiation and radioactive materials, radiation quantities and units, instruments to measure them, regulations and standards, and the exponential equation.
  - The specialty or elective competencies included internal and external dosimetry, fuel cycle, structure and function of radiation protection programs, radiochemistry, dose assessment and environmental dose calculation, and emergency preparedness and response.
  - Existing courses are being modified and new courses developed that will impart to the graduates the needed mix of skills and knowledge.