

Graduate Certificate in Nuclear Packaging at the University of Nevada, Reno

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ABSTRACT

In 2015, the University of Nevada, Reno (UNR) Mechanical Engineering (ME) Department began offering a 9-credit, regionally accredited Graduate Certificate in Nuclear Packaging (GCNP). The certificate's program educational objectives are to provide the necessary applied knowledge and skills that mechanical, material, or nuclear engineers require to be successful as nuclear packaging system designers, analysts, reviewers and users. This includes knowing how to apply required quality assurance methods, regulations, and design goals. It also includes gaining added depth in those required topics, and/or a breadth beyond those topics, to support the certificate holder to excel in the nuclear packaging industry. The GCNP courses draw heavily on nuclear packaging safety content that experts at Argonne, Lawrence Livermore, Oak Ridge, Sandia and Savannah River National Laboratories developed and taught over the past 20 years with support from the US Department of Energy (DOE) Packaging and Certification Program (PCP). The national laboratories continue to teach the required GCNP courses, which present the essential information, and several elective courses. UNR offers some elective courses. This paper describes the current GCNP curriculum. It also describes the ongoing efforts to (a) administer the program, (b) assess and improve it, including establishing an advisory council, (c) develop new courses, (d) publicize it to potential students and their employers, (e) offer a summer program, and (f) establish a related Graduate Certificate in Transportation Security and Safeguards.

INTRODUCTION

Industries and governments use nuclear and other radioactive materials for large-scale production of electricity without greenhouse gas generation, defense, advanced medical treatments, food sterilization, and sophisticated measurement technologies. In order to benefit from these uses, nuclear materials packaging, which protects public health and the environment during storage, transfer, transport, and disposal, must be developed, manufactured, inspected, and maintained. Before a package may be used, a regulatory authority must certify its design based on Safety Analysis Report for Packaging (SARP), which demonstrates that the package will provide containment, shielding and sub-criticality of its contents under normal and hypothetical accident conditions [1].

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The SARP describes the package design, as well as structural, thermal, containment, shielding and criticality evaluations. It also describes the package operating procedures, acceptance tests and maintenance, and packaging-specific quality assurance requirements. Regulators issue a Certificate of Compliance (CoC) for the packaging design based on the SARP. Package operators must follow the operating procedures, acceptance tests and maintenance, and quality assurance information described in the SARP and other specific Conditions of Approvals in the CoC.

Package designers, analysts and operators require specialized training and skills. For many years, the Department of Energy (DOE) Packaging Certification Program (PCP) has supported Argonne, Lawrence Livermore, Oak Ridge, Sandia, and Savannah River National Laboratories to offer 3 to 10 day courses that provide these skills. Experienced content experts developed these courses, in accordance with DOE standards [2]. Domestic and international professionals from government agencies, industries, and national labs have attended these courses.

GRADUATE CERTIFICATE IN NUCLEAR PACKAGING

In 2013, the University of Nevada, Reno (UNR) began developing a 9-credit, accredited Graduate Certificate in Nuclear Packaging (GCNP) with support from the DOE PCP. The national laboratory courses are the basis of the GCNP content. This *academic* program is designed to:

- a) Provide applied-knowledge that supplements research-based graduate programs in Mechanical, Materials, and Nuclear Engineering;
- b) Increase the number and preparedness of engineers who are able to serve organizations that design and operate radioactive materials packaging (which is especially important now since a significant fraction of these engineers is retiring); and
- c) Serve as a program that organizations can use to train new packaging engineers.

UNR is a natural host for this academic program since it has conducted externally funded research in nuclear packaging safety since 1993.

The GCNP program educational objectives are to provide the necessary applied knowledge and skills that mechanical, material, or nuclear engineers require to be successful as nuclear packaging designers, analysts and users. Packaging engineers must be familiar with relevant Federal Codes of Regulation for transport and storage packages, using a graded approach for their structures, systems and components (SSCs), in accordance with their importance to safety. They must know how to apply the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code related to nuclear packaging, since it is the foundation for design and analysis calculations. Packaging engineers must be able to employ Quality Assurance methods to assure that manufacturers and users enact the specified package design and operating procedures. Finally, package designers and analysts must have deep expertise in at least one of the SARP technical areas, or possess necessary management skills. They must also have general knowledge of all the other technical areas, to assure that the overall system meets its needed design expectations. User of packages must know how to precisely enact all Operating Procedures, Acceptance Tests and Maintenance, and Quality Assurance practices prescribed in the SARP.

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The admission requirements for the GCNP is an earned baccalaureate degree in mechanical, materials, or nuclear engineering or a closely-related field, or a baccalaureate degree and background in project management related to nuclear and radioactive materials packaging. To create courses that are acceptable to the UNR Mechanical Engineering (ME) graduate program, the coordinators of the laboratory courses tailored the content into courses that required roughly 45 or 90 hours of student involvement. The University assigned these courses, respectively, one or two graduate credits. The course coordinators then rigorously formalized the student learning outcomes and grading procedures in the resulting courses. The UNR ME Department then requested and received approvals from the University Course and Curriculum Committee hierarchy. Finally, the Department applied for and received approval from the Northwest Commission of Colleges and Universities (NWCCU), a regional accreditation body. The coordinating instructors of each course applied for and received UNR adjunct professor status.

This process resulted in the following nine national laboratory courses that are currently part of the GCNP curriculum, using the Nuclear Packaging (NP) prefix [3]:

1. NP 600 (formerly ME 691) American Society of Mechanical Engineers (ASME) Pressure Vessel Code for Nuclear Transport and Storage, 1 credit, offered at Argonne National Laboratory
2. NP 601 (formerly ME 692) Quality Assurance (QA) for Radioactive Material Packaging and Storage Casks, 1 credit, offered at Argonne National Laboratory
3. NP 602 (formerly ME 695) SARP Review and Confirmatory Analysis, 2 credits, offered at Lawrence Livermore National Laboratory
4. NP 603 (formerly ME 696) Management of Safety Analysis Report for Packaging (SARP) Preparation, 1 credit, offered at Savannah River National Laboratory
5. NP 605 (formerly ME 698) Thermal Modeling and Testing of RAM Packages
6. NP 607 (formerly ME 690) Radiation and Nuclear Criticality Analysis of RAM
7. NP 608 (formerly ME 697) Radioactive Material Package Operations and Leak Testing, 1 credit, offered at Savannah River National Laboratory
8. NP 610 (formerly ME 694D) Nuclear and Other Radioactive Materials Transport Security, 1 credits, offered at Argonne National Laboratory
9. NP 611 (formerly ME 694I) Nuclear and Other Radioactive Materials Transport Security, 1 credits, offered at Argonne National Laboratory

In addition the following six 3-credit courses, offered by the ME and Materials Science and Engineering (MSE) programs at UNR, are part of the curriculum.

10. ME 675 Introduction to Combustion,
11. MSE 601 Corrosion of Metals
12. MSE 665 Nuclear Power Fundamentals,
13. MSE 666 Nuclear Fuel Cycle,
14. MSE 667 Radiation Detection and Measurement, and
15. MSE 668 Nuclear Materials.

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Finally, student may take the following internship course at national laboratory, nuclear industry or government sites [4]

16. NP 640 (formerly ME 699) Nuclear Packaging Internships, 3 credits

The 9-credit GCNP curriculum requires student to complete three required courses, NP 600, NP 601 and NP 602. The content of these courses are foundational to all designers, analysts and users of nuclear packaging. These courses comprise four credits and are all offered by the national laboratories. Student must take five additional elective credits from the remaining national laboratory, UNR or internship courses. These courses add depth, breadth and/or professionalism to the required content.

In order to earn UNR mechanical engineering graduate credit in a class, a student must gain admission to UNR, pay UNR tuition and fees (in addition to any fees collected by the national laboratory), and earn a passing grade based on class assignments and a final exam. The student may then use the course toward selected graduate degrees at UNR, or at other universities that accept them. To use a course toward the GCNP, the student must earn a C grade or better, and complete the certificate curriculum in 6 years or less, with an average grade point average (weighted based on course credits) of B or better. The UNR Course and Curriculum hierarchy and the NWCCU approved the GCNP curriculum in 2015.

STATUS and ONGOING WORK

At the current time, 54 students have enrolled in the GCNP Program, and taken at least one course. The first student completed the Certificate in December 2016 [5]. The UNR ME Department is currently working, with support from the DOE PCP, to perform the following tasks:

- Administer the GCNP Program. This includes answering student questions, granting student admissions, tracking student grades and progress toward completion, and awarding certificates upon completion.
- Publicize the GCNP program to potential students and employers. This included conducting of a three-hour workshop, entitled “The Application of the ASME Code and QA Principles to Packaging and Casks for Transportation and Storage of Radioactive Materials, Spent Nuclear Fuel and High-Level Waste,” at the 2019 WM Symposia, Phoenix, Arizona, on March 3, 2019. This workshop summarized the content of NP 600 and NP 601 for sixteen registered, domestic and international WM attendees.
- Perform research to develop an assessment and continuous improvement process for the GCNP program. This includes soliciting, analyzing and drawing conclusions from students and their employers.
- Work with site supervisors to conduct and evaluate nuclear packaging internships (NP 640). In summer 2018, six university undergraduate and graduate students from UNR, Texas A&M, Virginia Tech, Missouri University of Science and Technology, and the University of South Carolina, Aiken performed internships, supervised by staff at Argonne and Savannah River National Laboratories, and at Orano.

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- Establish a GCNP Industrial/Governmental Advisory Council. The objectives of the Council are to (1) Evaluate curriculum information, as well as student and employer survey data, (2) Assess the relevance and effectiveness the GCNP courses in achieving the GCNP educational objectives, and (3) suggest programmatic improvements. The Council members consist of high-level packaging managers and employers from industry and government, some of whom may have experience or interests in hiring packaging engineers, certificate holders, and/or using the certificate program to train new employees.
- Work with national laboratory content experts to develop and gain UNR approval for the following two new 1-credit national laboratory elective courses.
- 17. NP 620, Fundamentals of Nuclear Security, 1 credit, being developed by Sandia National Laboratories
 18. NP 630, Fundamentals of Nuclear Safeguards, 1 credit, being developed by Oak Ridge National Laboratory
- Conduct a summer program at UNR. Content experts from Argonne National Laboratory will present two courses, NP 600 and NP 601 during consecutive weeks, June 3-7, and June 10-14, 2019 at UNR's Redfield campus. This will be a convenient way for students to earn two of the four required GCNP credits.
- Establish a new 9-credit Graduate Certificate in Transportation Security and Safeguards (GCTSS). Security and safeguards of nuclear and radioactive materials must be maintained at all times during their life cycle, especially during transportation. Packaging is central to this effort. The new certificate will take advantage of courses that UNR and the national labs have established for the GCNP. The new GCTSS required courses will incorporate fundamentals of nuclear security, and fundamentals of nuclear safeguards, in addition to international and/or US domestic transport security, and the ASME Pressure Vessel Code for nuclear transport and storage courses. To achieve this, the following courses, which present essential information and skills, are required for the GCTSS: NP 600, NP 620, NP 630, and either NP 610 or NP 611. Three of these courses are already part of the GCNP program. The GCTSS curriculum will also require 5 credits of electives, from a family of courses and the nuclear packaging internship.

REFERENCES

1. DOE Order 460.1D, *Hazardous Materials Packaging and Transportation Safety*, Dec. 20, 2016.
2. *Department of Energy Training Program Handbook: A Systematic Approach to Training*, Department of Energy, Washington, D.C. (1994).
3. RAMPAC, "Packaging University," Office for Environmental Management (2016).
4. Greiner, M., Liu, Y.Y., and Shuler, J., 2018, "Practical Experience Integration into the Univ. of NV, Reno Nuclear Packaging Graduate Certificate," WM2018 Conference, March 18 – 27, 2018, Phoenix, Arizona, USA.

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5. American Nuclear Society, Nuclear News: Education, Training & Workforce, “University of Nevada First-of-its-Kind Program Awards Certificate to First Graduate,” April 2017.

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