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SRNL's Lessons Learned from the University of Nevada Reno™ Nuclear Packaging Internships – 19464

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ABSTRACT

The U.S. Department of Energy's Packaging Certification Program (DOE PCP) and the University of Nevada, Reno (UNR) Mechanical Engineering Department have developed an accredited, graduate level nuclear packaging certificate. The mission is to ensure that the DOE staff and users of PCP services are knowledgeable and competent in packaging and transportation activities. Since 2008, the Savannah River National Laboratory (SRNL) has been teaching two classes for the DOE PCP Packaging University. This paper introduces a recently added third class, where SRNL provided Site Supervisors, targeted toward engineering interns.

As part of ensuring a future workforce, the Packaging Technology and Transportation Engineering Group (PT&TE) at SRNL normally employs two to three summer interns each year. The internships provide SRNL innovative high-performing employees carrying-out valuable research and supporting work related to package certification. It also provides SRNL the opportunity to bring in perspective engineers on a "trial-basis." The interns benefit by learning valuable career skills and gaining exposure to a broad-based career field in the field of packaging.

As part of the job specific training, the summer interns are provided an overview of package design, testing, and certification. This includes package operations, containment vessel leak testing, and Safety Analyses Reports in Packaging (SARP) preparation. Two years ago, SRNL recognized the efficiency of using the SRNL-taught courses for the summer interns working in SRNL PT&TE. SRNL requested that UNR allow the PT&TE two summer interns, who were rising college juniors, to enroll in the SRNL-taught courses for graduate credit. UNR agreed and allowed the interns to enroll under a special admission status.

Since that time, UNR developed a new class within the Graduate Certificate in Nuclear Packaging (GCNP), for the summer intern research work. This new class offers a formalized framework for the summer interns to conduct research, while ensuring that the research is performed in a rigor consistent with an accredited college level setting. Last summer, the SRNL PT&TE had three summer interns − all participating in the new course, UNR ME-699 Nuclear Packaging Summer Internship − with each earning three graduate credits from UNR in mechanical engineering.

This paper provides a brief overview of the DOE PCP Packaging University/ UNR GCNP, a discussion of SRNL's use of summer interns as a tool to recruit and train the future workforce, and lessons learned from having last year's three SRNL PPT&TE summer interns enroll in the UNR Packaging Internship Class.

INTRODUCTION

DOE Packaging University and Graduate Certificate in Nuclear Packaging

The DOE PCP packaging and transportation mission has three objectives: 1) develop the systems and

technologies to ensure packaging and transportation activities are safe, economical, efficient, secure, and meet applicable regulatory requirements; 2) resolve packaging and transportation issues safely, economically, and promptly; and, 3) develop, manage and coordinate policies and procedures for packaging and transportation activities for DOE materials, including hazardous materials (particularly radioactive), substances and wastes. The PCP sponsors many training courses to ensure that the DOE staff and users of PCP services are knowledgeable and competent in performing their activities.

In 2013, the PCP and the University of Nevada, Reno (UNR) Mechanical Engineering Department developed an accredited graduate-level nuclear packaging certificate. The Graduate Certificate in Nuclear Packaging (GCNP) provides a curriculum in packaging of nuclear and other radioactive materials. The GCNP complements UNR's graduate programs in Mechanical Engineering and Materials Engineering but has been considered more applied-knowledge-based than research-based. The general admission requirements to the graduate certificate program are either an earned baccalaureate degree in mechanical, materials, nuclear or closely-related engineering fields, or a baccalaureate degree and background in project management related to packaging nuclear and other radioactive materials. The GCNP and its courses are approved by the Northwest Commission on Colleges and Universities (NWCCU), Redmond, WA [1].

The purposes for developing the GCNP were twofold: (1) to encourage students to complete a curriculum in packaging safety and security of nuclear and other radioactive materials that has both depth and breadth, and (2) to provide a graduate-level curriculum designed to give students an advantage when seeking employment or advancement in the area of radioactive material packaging and transportation, or related fields [1].

The curriculum for the certificate currently comprises nine courses that were developed and offered on a regular basis for DOE PCP by the Argonne (ANL), Lawrence Livermore (LLNL), Oak Ridge (ORNL), Sandia (SNL), and Savannah River (SRNL) National Laboratories. The courses are assigned the following UNR Mechanical Engineering (ME) course numbers [1]:

ME 690 Radiation and Nuclear Criticality Analysis of RAM Packages, 1 credit (offered at ORNL)
ME 691 ASME Pressure Vessel Code for Nuclear Transport and Storage, 1 credit (at ANL or UNR)
ME 692 QA for Radioactive Material Packaging, 1 credit (offered at ANL or UNR)
ME 694D Nuclear and Other Radioactive Materials Transport Security - Domestic, 1 credit (offered at ANL or UNR)
ME 694I Nuclear and Other Radioactive Materials Transport Security - International, 1 credit offered at ANL or UNR)
ME 695 SARP Review and Confirmatory Analysis, 2 credits (offered only at LLNL)
ME 696 Management of SARP Preparation, 1 credit (offered only at SRNL)
ME 697 Radioactive Material Package Operations and Leak Testing, 1 credit (offered only at SRNL)
ME 698 Thermal Modeling and Testing of RAM Packages, 1 credit (offered only at SNL)
ME 699 Nuclear Packaging Internships, 3 credits (offered at commercial or government nuclear facilities)

Students who enroll in these courses receive UNR graduate credit when they meet the following requirements: (1) gain appropriate type of admission to UNR, (2) enroll in the UNR course and pay tuition, and (3) earn a passing grade in the course. These credits may be applied toward graduate degrees at UNR or any other university that accepts that credit. An earned C grade or better in a class, allows the student to use the credits toward UNR's 9-credit GCNP. To earn the certificate, students must complete ME courses 691, 692, and 695. They must also take five additional elective credits from the previous list.

Finally, to earn the GCNP, students must earn least a B average in the courses [1].

Even if not enrolled in the GNCP, the credits earned can be applied toward any other university that accepts that credit.

SRNL and Packaging Internships

In recent years, the Savannah River Site (SRS) and specifically SRNL have recognized advantages for its internship programs and the program has grown. In fact, since 2014, SRS has steadily increased its number of interns by 100%, last year reaching and overall number of approximately 180 internships. Of those, approximately 157 were site summer interns, with about 50 working for SRNL. In addition, minority student participation increased from 19.3% in FY16 to 26.3% in FY17.

Although playing a small part in the overall SRS internship program, SRNL's PT&TE reliance on the use interns has grown. In 2016, one intern supported the group, in 2017 the number increased to two, in 2018 the number increased to three. The current plans for 2019 are again to have three interns.

A large part of the work the packaging group performs is associated with package design and certification; therefore, interns perform work and research in associated areas. To ensure the work is both challenging and rewarding, the PT&TE interns work with their SRNL Site Supervisor to develop at least one conference-worthy paper. As part of ensuring that the interns are adequately trained for performing this work and conducting research, a significant amount of up-front introductory training is required. Two years ago, SRNL recognized that the introductory training and the two PCP/UNR courses contained much of the same content. After some discussion within the group, it was concluded that PCP University /UNR courses taught by SRNL would provide a more consistent training to the interns. SRNL PT&TE then requested UNR to allow the Packaging Group's two interns, who were rising college juniors, to enroll to the SRNL-taught courses, and hence also obtain graduate credit. UNR agreed and allowed the interns to enroll under a special admission process. The first summer, the interns participated in the two, single-credit courses taught by SRNL: SARP Preparation and Leak Testing. This last year, a new class, ME-699 Nuclear Packaging Summer Internship was offered, enabling interns to perform valuable real-life nuclear packaging research while earning three graduate credits in mechanical engineering from UNR. With a willing SRNL Site Supervisors and SRNL's forecasted workload, the interns performed valuable research supporting the development of a new radioactive material Type B package for transportation.

DESCRIPTION

Packaging Internship Course

ME 699, Nuclear Packaging Internships course was developed by PCP University and UNR and approved by the University and DOE authorities in the spring/early summer of 2018. The course description is supervised independent use of engineering skills for professional project planning, performance, and communications at a National Laboratory or DOE Site. Satisfactory completion of the course requires that the students demonstrate the following capabilities [2]:

1. Identify, formulate, and solve engineering problems.
2. Explain professional and ethical responsibility and identify professional and ethical issues.
3. Communicate effectively.
4. Demonstrate the understanding of the impact of engineering solutions in a global, economic, environmental, and social context.

5. Explain the need for, and an ability to, engage in life-long learning.
6. Identify and analyze contemporary issues.

The student intern is required to collaborate with a site supervisor and a UNR Faculty Member to create a formal internship proposal that includes the following items [2]:

(a) Project title, goals, and expected outcomes
(b) Work schedule including gathering initial background information and reading assignments, midterm report, final report, and important milestones.
(c) Requirements of the final report which must include assessing achievement of all course student learning outcomes
(d) Resources that are being committed by the internship site and UNR to complete the work
(e) A plan to address contingencies, such as the site supervisor leaving the internship site, or reduced resources.

The student intern is required to conduct the planned work primarily at the internship site. Participating in meetings and other activities of the organization is an important part of the internship. The student intern must spend at least 120 hours at the internship site. Midway through the internship, the student intern is required to produce a mid-term report describing progress toward the internship milestones and goals. Important issues that may arise and limit the project success, and any necessary revisions to the plan to address those issues, including changing the project goals, must be included in the mid-term report. The mid-term report is graded by the UNR-approved faculty member with input from the Site Supervisor. At the end of the project, the student must produce a final report. This report may be a presentation, a written report, or both, as specified in the internship proposal.

Grading is based on the intern's compliance with the internship proposal and any revised plan, and the assessed quality of the completed assignment. The final report is graded by the UNR-approved faculty member with input from the Site Supervisor [2].

DISCUSSION

Research Topics Chosen by Students

The three interns during the summer of 2018 supported the development of the Model 9982 Shipping Package, a new nuclear material package that SRNL is developing for DOE. Each intern was given a choice of associated research topics from which to pick.

One of the interns investigated closure mechanism concepts for the 9982 Containment Vessel (CV) lid. The intern’s concept utilized a twist-and-lock sealing mechanism to reduce the time needed for assembly/disassembly and improve the ease of use for operations personnel. The CV lid closure, shown in Figure 1, comprised two main components, a locking tab ring and a disc spring (which includes the spring shaft) [3].

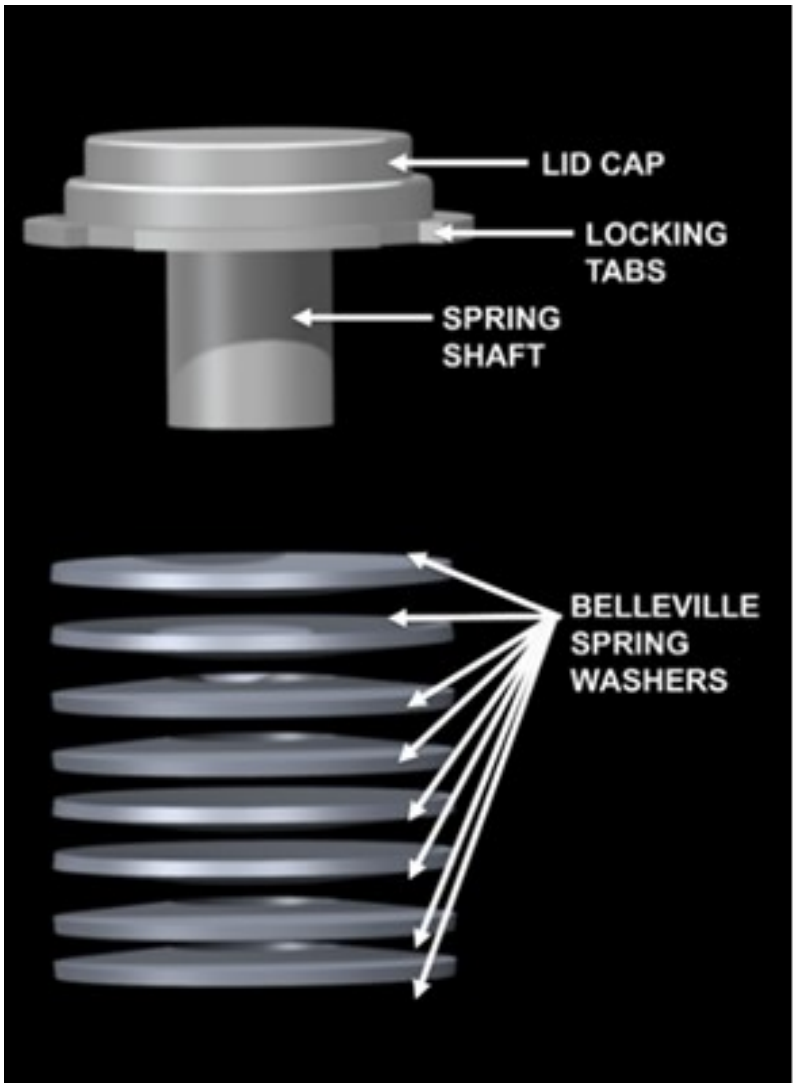

Fig. 1. CV Lid Closure (Assembly)

The other two interns investigated energy-absorbing structural components to provide impact protection to the contents. The interns focused their work on stainless steel honeycomb structures, specifically the static and dynamic crush strengths. Although not commonly used in radioactive material packaging, stainless steel honeycomb structures are ideal energy absorbers due to the high strength-to-weight ratios, predictable material properties, and nearly constant crush-deflection curves. The advantages of stainless steel construction over a traditional aluminum honeycomb are (1) higher temperature capabilities, and (2) the alleviation of the adhesive materials required to bond aluminum sheets. Stainless steel honeycomb offers the possibility of bonding individual sheets via spot welds.

One of these two interns performed physical crush testing as part of an effort to understand and quantify the differences in the static and dynamic crush strengths of the 304-stainless steel hexagonal honeycomb. Figure 2 shows an example of one of the crushed honeycomb structures. This work allowed a data set of test crush strengths to be cataloged along with the cell size, material yield and tensile strengths and impact velocity.

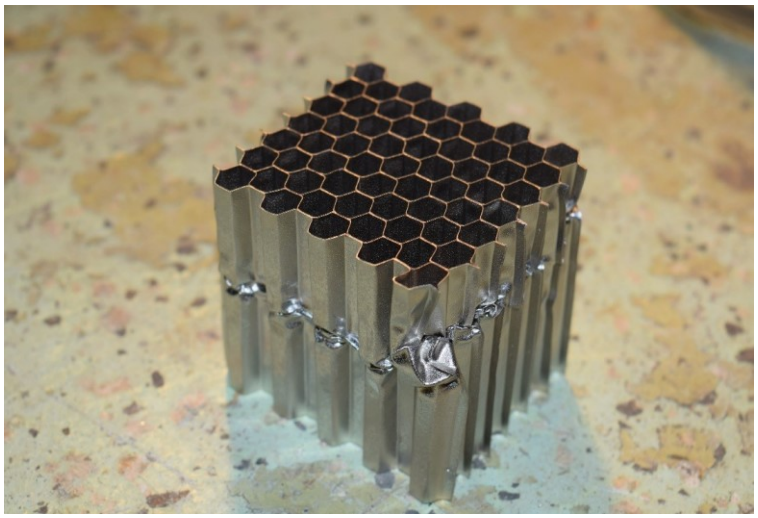

Fig. 2. Crushed Honeycomb Structure

The other intern used ABAQUS® software to perform Finite Element Analysis (FEA) analysis to estimate the crush strength of various 304 stainless steel honeycomb structures. The models simulated a drop test where a 22.6 kg plate lands flat on a honeycomb stainless steel structure from a height of 9.1 meters (Figure 3). The intern's work focused on selection of end boundary conditions and sheet bonding modeling, and dynamic strength enhancement required for FEA to match actual test data. Pictures of the results of the model versus test specimens are shown in Figure 4.

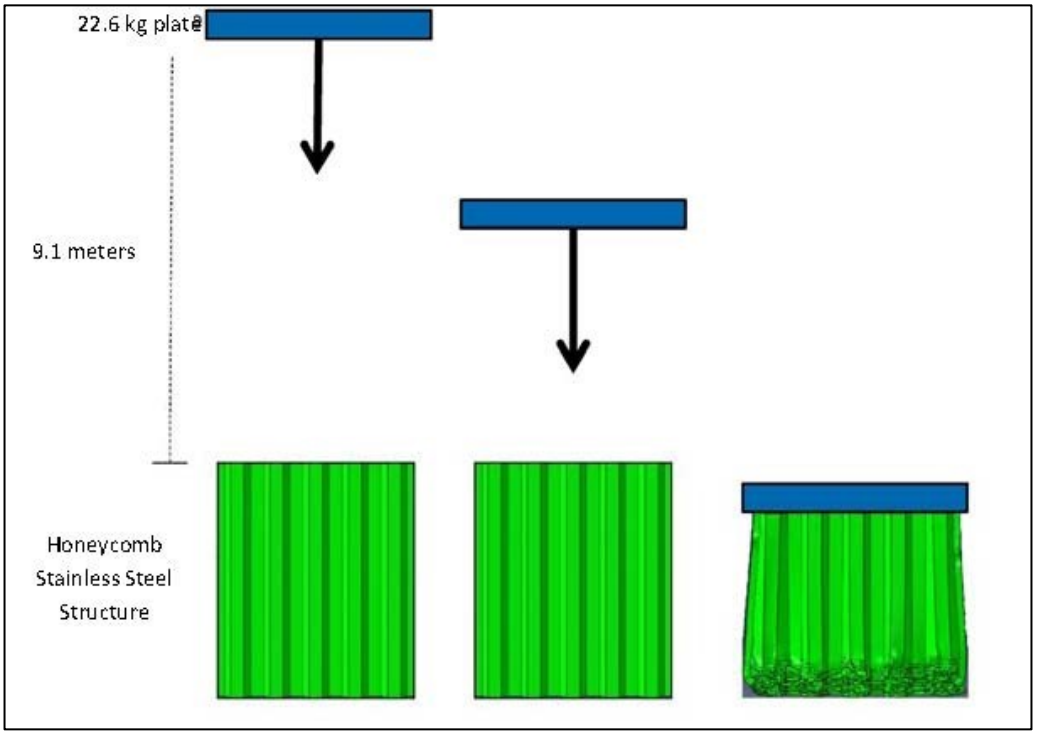

Fig. 3. Drop Test Illustration

Pictures of the modelled deformation results versus test specimens are shown in Figure 4.

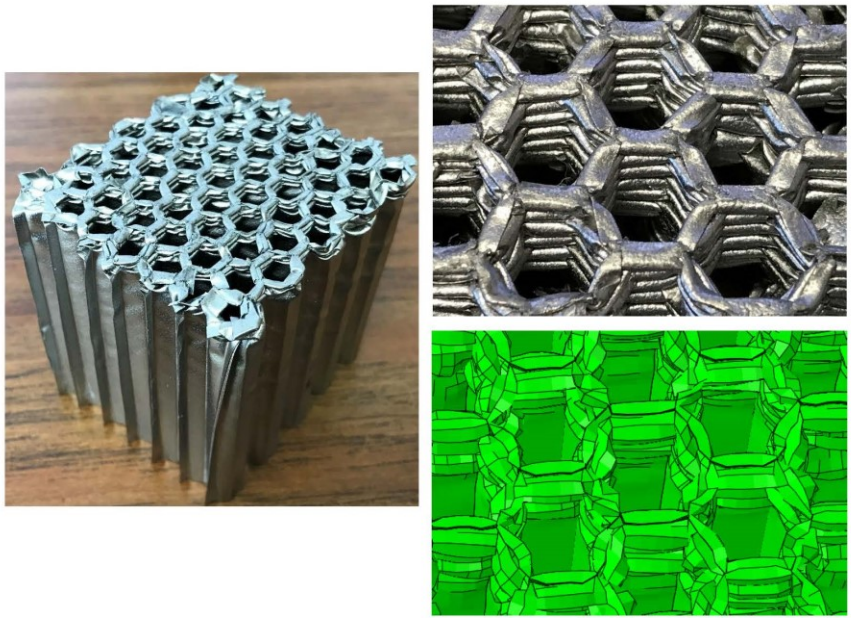

Fig. 4. Comparison of Modelled Deformation vs Test

Site Supervisor Strategies

SRNL and UNR worked closely to ensure the interns experienced a real work environment, with real work environment issues, problems and deadlines. Interns were responsible for developing and maintaining schedules of their work using the SRNL work schedule process. Requirements on the length of the (mid-term and final) research reports were based on expectations mirroring those of a new engineering employee. Interns were expected to determine the scope of the research, and how much effort to apply in developing the reports. Interns were also expected to accomplish the work using the SRNL systems and procedures. As part of learning the SRNL systems, interns had to determine the appropriate documentation system for saving the documents, as well as to how to submit and ensure their papers being sent to UNR and conference papers were first approved for off-site release.

Research Proposals

Each of the interns developed and submitted their research proposals. All were reviewed by the Site Supervisors and approved by the UNR Mechanical Engineering Chair, with only minor comments. As previously stated the topics were: 1) using a spring-loaded lid on a radioactive material package containment vessel; 2) testing stainless steel honeycomb; and 3) modelling the deformation of a stainless-steel honeycomb.

Research Reports and Posters

The SRNL Site Supervisors invested heavily in the interns, ensuring each intern felt like they owned all

aspects of their research projects. Each of the interns developed their research and submitted their midterm reports and final reports. In addition to the UNR requirements, the interns also had to develop an SRNL intern summer poster for their research. The interns were also strongly encouraged to develop and submit at least one conference paper.

Issues and Lessons Learned

Schedule

Complicating completion of the steel honeycomb testing, was the fact that SRNL was under a stop-work order for at least half of the internship period, therefore detailed contingency plans were developed, with float and durations monitored by the intern, daily. Eventually the stop work was relaxed and removed, enabling the intern's testing to proceed, and complete the research on time.

Administration

Because the internship -based course was new, the SRNL Site Supervisors, UNR, and the interns had to develop and address a significant amount of administrative paperwork work.

Each student had to submit registration to UNR requesting special status, then register and pay the UNR course fees. As the course was considered a "prerequisite" by an SRNL customer for the interns to support the 9982 project, the course was eligible for tuition reimbursement by SRS. However, the SRS site policy manual does not allow summer interns (i.e., limited service employees) to be tuition reimbursed [6]. Therefore, reimbursement using an alternate process had to be undertaken. Specifically, each intern had to complete an SRS Travel Expense Report 2 (with no travel), with significant amount of time spent by the Site Supervisors explaining to various SRS reimbursement accountants and auditors that the training was required for the interns to perform their jobs (i.e., the UNR graduate credit earned was only an added benefit for completing the class, and even without the credit, the intern would need to enroll in the course). Ultimately, nine weeks into the 10-week class, the interns were reimbursed, but only after the SRNL Controller/Finance as well as the SRNL Accountant concurred with the SRNL Site Supervisor's justification. Currently, a statement of work is being developed, where there will be a contract between SRNL and UNR, in which SRNL will be invoiced for all appropriate UNR fees. With the potential to seemingly violate the SRS tuition reimbursement policy removed, the process will hopefully be greatly simplified, and reimbursements should occur in a much timelier manner. This planned contract should also enable the registration process to be greatly simplified for other interns, as well as students registering for PCP courses taught by SRNL.

Early on, around the time the interns started the UNR enrollment process, UNR informed SRNL that an Organization Agreement had to be approved between each national laboratory hosting interns and UNR. Although most of requirements imposed on the national laboratories were designed to protect the students, the students were already beginning their internship. As such, SRNL legal counsel would likely not have adequate time to review the agreement before the students would be completing their internship. Thankfully, after a few discussions with UNR, UNR rescinded this requirement.

CONCLUSION

Ultimately, the paper-work issues did not stop the SRNL interns. With the need for SRNL to sign the Organization Agreement rescinded, the interns were able to enroll and participate in the course. Eventually the interns were reimbursed by SRNL. Future plans for a contract between SRNL and UNR are expected to decrease SRNL reimbursement time, as well as to simplify the overall registration process for the internship course as well as for the two PCP University courses that SRNL teaches.

The Site Supervisors worked hard to empower the interns, or at least make the interns feel like they owned their own research. The interns were treated like first-year engineers and were responsible for determining the best ways to manage and accomplish their research and work. The expectations used by the SRNL Site Supervisors was that the proposals, mid-term research report, and final research report would look and feel like any other SRNL research report, that a first-year engineer would be expected to write. That is, the interns would use all SRNL tools, systems and processes, just like a real employee, to create a product like that of a first-year engineer at SRNL.

Despite an SRNL safety pause during the internship, all of the research, even the testing of the 304-stainless steel honeycomb was completed on time. The research is proving to be very valuable, and well worth the additional paperwork and time invested by the SRNL Site Supervisors.

Although the Belleville spring washers will not be used for the 9982 CV lid, the concept will likely be considered for future applications. Much of the research proved very valuable and as such the 304-stainless steel honeycomb material is being used to provide optimized overpack impact absorption in the 9982. The model developed is being used to support the 9982 crush and impact structural evaluations.

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