INL researcher Justin Coleman plays a number of roles in an international effort to manage risk from external hazards at nuclear power plants, an effort that relies heavily on scientific modeling.

Shaking Things Up: Idaho Researcher Integrates National Efforts to Improve Seismic Risk Analysis

By Casey O'Donnell, *INL Nuclear Science & Technology intern*

An earthquake can strike at any time or place around the globe.

Yet earthquakes don't occur with equal frequency everywhere on Earth. Some areas shoulder more risk for frequent and damaging earthquakes, while others rarely experience a tremor. These varying levels of seismic risk capture the attention of nuclear power plant designers and owners, who must take these data into account when evaluating plant safety. To capitalize on the most advanced tools available, the modern nuclear industry turns with increasing frequency to modeling and simulation capabilities.

Justin Coleman, a researcher at Idaho National Laboratory, plays a number of roles in an international effort to manage risk from external hazards at nuclear power plants, an effort that relies heavily on scientific modeling. Coleman is integrally involved in more than six projects, all of which, he said, "tie into the risk portfolio" and involve modeling. His initial research on seismic modeling at INL was funded by a Laboratory Directed Research and Development grant.

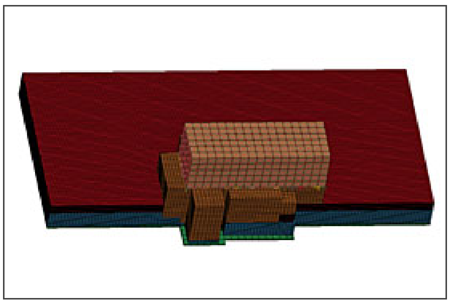
In his various roles, Coleman models the effect of seismic shock on nuclear power plant emergency systems, studies the transportation of used nuclear fuel, and authors language for nuclear power plant seismic design and analysis standards. These standards are used by industry when designing nuclear power plants.

"About 40 to 50 percent of what I do is purely technical work: developing and testing models," Coleman explained. "The rest is growing the business of seismic risk research, participating on national committees, and serving as an integrator of a number of different research and development projects."

Coleman's role as a project integrator demands a lot of his attention. He oversees a collaboration of seismic researchers from laboratories, industry and academia, using their data to develop a standard methodology for the evaluation of seismic risk at a nuclear power plant site.

"A methodology is like a recipe," Coleman said. "Ideally, you follow the recipe correctly and you get a good result. My job is to create a ‘recipe' that details how to evaluate seismic risk."

But his job isn't nearly as simple as baking a batch of cookies. He leads collaboration among a number of sources across the country, including University of Buffalo; University of California, Davis; seismic industry experts; Los Alamos National Laboratory; and INL. As the project integrator, Coleman determines what research needs to be done, as well as why and how it should be accomplished. He conveys these needs to various project researchers, who conduct physical experiments, run models and accumulate data. He ties everything together to create an acceptable methodology that will be useful to DOE and industry.



Coleman is developing a modeling method that considers different types of interactions between the soil and the structure of the nuclear power plant during a seismic event.

Following a set methodology to evaluate seismic risk isn't a new concept in the nuclear industry. Federal regulations mandate that nuclear power plants implement multiple layers of safety to prepare for even extremely unlikely occurrences. All U.S. plants are equipped with safety features capable of withstanding even higher degrees of seismic activity than the expected base risk for the plant site. A number of established methods exist to evaluate this base seismic risk and ensure the continuous preparedness of the nation's nuclear power plant fleet.

However, the method Coleman is developing stands out from its peers in that it considers different types of interactions between the soil and the structure of the nuclear power plant during a seismic event. These types of interactions may better predict the effect of larger earthquakes.

"Current methods for this type of evaluation rely on linear analyses, which correspond to low-level seismic shaking, or a smaller earthquake," he said. "To predict the effect of larger earthquakes, you need to use a method based on nonlinear analysis. It has fewer restrictions, so it gives a better representation of what would actually happen if there were a big earthquake."

This nonlinear methodology is "about 70 percent developed," Coleman explained. Once completed, it will stand alongside other methods that predict the response of a nuclear power plant to a wide variety of scenarios, including flooding or the loss of off-site power. Together, these methodologies would provide both government agencies and the nuclear energy industry with a comprehensive way to evaluate the risks faced by specific nuclear power plants. Plant owners can use the results to determine how to enhance the safety of their nuclear power plants.

For example, one option to mitigate seismic risk at a nuclear power plant site is to install a seismic isolation system. Lead-centered pods of alternating steel and rubber layers could be built into the ground at sites facing higher seismic risk to absorb much of an earthquake's energy. Such a system would reduce overall shifting of the plant. An advanced model of a plant's seismic risk profile would allow the designer or owner to make an informed decision about whether to install seismic isolators.

"Following accurate methodologies when evaluating risk is important because it shows plant owners where to focus their attention," Coleman said. "If a plant is at very low risk from seismic activity, then the owner can focus on reducing risks that are more pressing. That ensures the best use of time and money and enhances the safety of the plant."

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