Nuclear Safety Research at the University of Maryland

Research on nuclear energy started at the University of Maryland just after World War II, when the peacetime applications of nuclear fission seemed like a path to prosperity. The intervening decades have been a complicated rise and fall for nuclear technology. The proliferation of nuclear power plants and nuclear weapons was followed by controversial accidents and regulation. Today, nuclear power is considered one of the best available alternatives to carbon-fueled electricity, but there are still concerns about its safety and security. University of Maryland engineers are looking for ways to make nuclear power a safe and sustainable source of energy.

Mohamad Al-Sheikhly examines the changing chemistry of irradiated materials and finds safe ways to use spent nuclear fuel.

Kenneth Kiger examines changes in the boron/water mix of nuclear coolant systems to help prevent overheating.

Marino di Marzo studies nuclear accidents to determine how specific safety measures might have prevented these accidents or mitigated their consequences.

Mohammad Modarres tests simulations of the safety systems created for new nuclear reactor designs both to ensure that they will work and to prevent nuclear disasters.

Ali Mosleh creates systems that analyze the risks involved in the use of nuclear energy.

Understanding and Using Radiation

The ionizing radiation produced by radioactive materials changes the chemical properties of substances. Mohamad Al-Sheikhly, director of the University of Maryland's Biophysical and Polymer Radiation Laboratory, examines the changing chemistry of irradiated materials and also helps scientists figure out how to neutralize environmental damage resulting from radiation.

One of Al-Sheikhly's recent projects offers a better and safer way to dispose of nuclear waste; he uses it to remove other pollutants from the environment. Al-Sheikhly uses the ionizing radiation of spent nuclear fuel to create electron-beam decontamination systems. These systems can cleanse an area of industrial pollutants, such as polychlorinated biphenyls (PCBs).

In 2005, Al-Sheikhly was named president of the Council on Ionizing Radiation Management and Standards (CIRMS), a group of experts who ensure that ionizing radiation is produced and used safely.

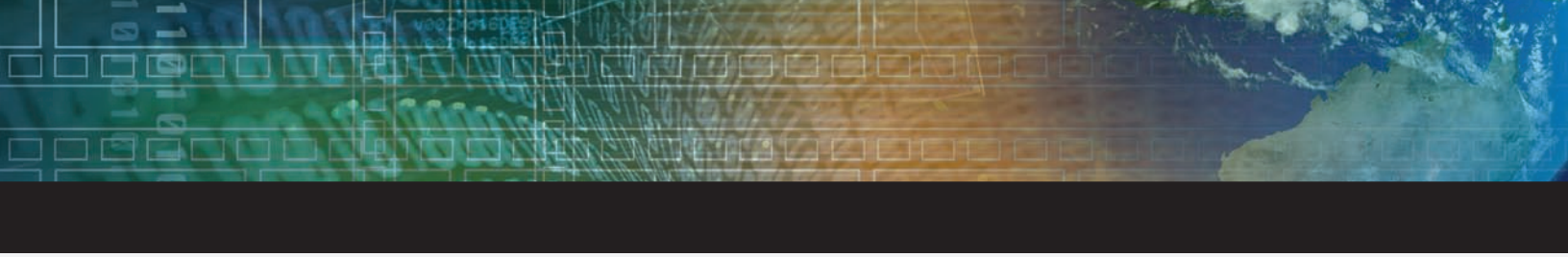
Mohamad I. Al-Sheikhly mohamad@umd.edu http://www.mse.umd.edu/facstaff/alsheikhly.html

Safer Coolant Systems

Pressurized water reactors (PWR) use plain water mixed with boron to sustain a steady nuclear reaction and generate power. However, the balance between these elements must be precise to start with and remain consistent to regulate the heat safely. Kenneth Kiger examines this dynamic system to figure out when and how variations in the water-boron mix cause accidents.

Kiger and his team have built a transparent model of the internal workings of a PWR downcomer, which allows them to see the mixing process normally hidden inside a reactor. They can now watch as water with too much or too little boron flows through their model. Laser induced fluorescence (LIF) and laser doppler velocimetry (LDV) help them to measure the flow and composition of the liquid mix and to track variations over time. Kiger's research can aid in the development of safety systems that prevent the power surges and possible disasters that can occur when reactors are not cooled properly.

Kenneth T. Kiger kkiger@umd.edu http://www.glue.umd.edu/~kkiger/index.html



Safety Systems Make Safe Power Plants

Regardless of how careful nuclear engineers are in designing and building nuclear plants, accidents happen. Parts break. Systems fail. Marino di Marzo, chair of Fire Protection Engineering, has spent decades examining a particular kind of system failure. Specifically, he studies what happens when nuclear systems leak. For example, di Marzo has simulated small-break loss-of-coolant accidents to determine how large a leak needs to be to result in a core meltdown. This work, which started after the Three-Mile Island accident, led to the creation of the UMCP 2x4 Integral Loop Facility. This facility helps researchers examine the frequency and severity of boron-dilution events that can lead to nuclear disasters.

Di Marzo has also studied the ways in which cooling systems and sprinklers can be used to prevent serious damage during accidents in thermal power plants. His study of dropwise evaporative cooling is now applied to the modeling of fire sprinkler thermal response systems in plants built around the world.

Recently, di Marzo participated in the Department of Energy's Nuclear Energy Research Initiative and the Department of Defense's Next Generation Fire Suppression Technology Program.

Marino di Marzo marino@umd.edu http://www.enme.umd.edu/facstaff/facprofiles/dimarzo.html

Assessing Risk for Future Safety

Upgrading our nuclear energy infrastructure to meet modern energy demands is not an easy task. Most of the nuclear plants in the U.S. have been in continuous use for decades, and people are often resistant to new plants opening near their communities. Mohammad Modarres, director of the nuclear engineering program at Maryland, helps assess the safety of upgrading older plants and building new ones.

With over 30 years experience in nuclear safety analysis and risk assessment, Modarres constructs models of new designs for passive reactor cooling systems. He uses these models to determine if the systems will work as expected, what might go wrong, when it might go wrong, and what damage could be done if a system fails. Modarres and his team are often the last line of assessment before these new nuclear cooling systems are put into place.

Outside the lab, Modarres works with the Nuclear Regulatory Commission and consults on newly proposed nuclear reactor sites across the country. Modarres determines if more reactors can be built safely on existing sites and if new sites can host reactors without adversely affecting the people, soil, and water systems of the surrounding area.

Modarres is a fellow at the American Nuclear Society and received a special citation from the Food and Drug Administration in 2004 for Contributions to Risk Assessment Methods.

Mohammad Modarres modarres@umd.edu http://www.enre.umd.edu/faculty/modarres/

Improving Nuclear Safety with Hardware AND Software

Human error has played a role in many nuclear accidents. Ali Mosleh, professor of mechanical engineering, has designed more than 10 major risk and reliability analysis programs that help reduce the fallible, human factor in nuclear power operations. His programs are used widely in government and industry to assess risk and monitor safety. When used in concert with traditional nuclear plant safety systems, Mosleh's systems significantly reduce the likelihood of accidents, regardless of the cause.

Like Modarres, Mosleh consults with the Nuclear Regulatory Commission. He is also one of eleven members of the U.S. Nuclear Waste Technical Review Board. This independent federal agency provides scientific and technical oversight of the Department of Energy's program for managing and disposing of high-level radioactive waste and spent nuclear fuel.

Ali Mosleh mosleh@umd.edu http://www.enme.umd.edu/facstaff/fac-profiles/mosleh.html