

demic paper developed for discussion among academia of the appropriate security levels at nuclear energy facilities." The author, NPPP graduate research assistant Lara Kirkham, didn't have access to confidential information that would be needed to make a complete assessment of plants' security, the NEI statement says; it adds that NPPP didn't explain how attackers might be able to move highly radioactive fuel contained in bundles weighing 360–540 kg from reactors, spent fuel storage pools, or multi-ton concrete dry casks.

Since 2001 the industry has spent more than \$2 billion for security upgrades, and the number of guards has increased by 60%, to a total of 9000. Every reactor design has been assessed for potential aircraft impacts, and no damage to reactor fuel and stored spent fuel would occur in the event of a crash, according to the NEI statement. Still, as Kuperman told reporters, the NRC only requires that new reactors be designed to withstand a deliberate 9/11-style airliner crash.

Robert Lewis, the NRC's director of preparedness and response, said the agency does require that nuclear plants guard against waterborne attacks. In a blog post, Lewis said the threat scenarios outlined in the NRC standards include an assault by one or more adversary forces attacking by land or water, truck bombs, boat bombs, insider threats, and cyberattacks. The NRC requires each plant to test its security force annually, and the agency itself tests the security forces at each plant every three years. The NRC works with the Federal Aviation Administration, the Department of Homeland Security, and the Department of Defense to guard against 9/11-type air attacks. Existing plants are required to implement measures similar to those for new reactors to mitigate the effects of an airplane crash, he added.

Sandia National Labs to help fix Sandy-damaged electrical grid

Energy secretary Ernest Moniz and New Jersey governor Chris Christie announced a partnership to design a smart microgrid system to keep public transportation in the Newark, Jersey City, and Hoboken areas running when the central grid goes down. Sandia National Laboratories, whose microgrid designs are in place at more than 20 US military bases, will design the microgrid for NJ Transit, the nation's third-largest public transportation sys-

Research reactors

The nation's three HEU-fueled, NRC-regulated research reactors, located at MIT, NIST, and the University of Missouri, are exempted from the NRC standards. Although there is too little HEU located at any of those reactors to fashion a simple gun-type nuclear device—the design used for the Little Boy bomb dropped on Hiroshima—Kuperman notes that a more sophisticated implosion-type weapon, which makes much more efficient use of fissile material, would require far less HEU. By various estimates, the amount of HEU needed to fashion a gun-type weapon is between 35 kg and 50 kg, but the mass necessary for a sophisticated implosion design could be as little as 9 kg. Thomas Cochran, a nuclear expert at the Natural Resources Defense Council, estimates that the weapons labs in the US, Russia, China, France, and the UK could build an implosion device with an explosive yield of 1 kt using just 3–4 kg of weapons-grade uranium (93% or greater ^{235}U).

The MIT reactor uses 8 kg of weapons-grade uranium annually; the University of Missouri reactor, 24 kg; and the NIST reactor, 13 kg, according to Kuperman's book *Nuclear Terrorism and Global Security: The Challenge of Phasing Out Highly Enriched Uranium* (Routledge, 2013). A program to develop low-enriched fuels for the three reactors and for two other HEU-fueled reactors operated by DOE has been delayed repeatedly. Kuperman says the conversions aren't expected to be completed until 2025. But a spokesman for DOE's Global Threat Reduction Initiative, which is responsible for developing the low-enriched fuels, said the reactors will be converted as soon as new fuels can be developed and qualified, which could take until 2030.

David Kramer

Cost Effective Solutions for Surface Analysis

MINICMA™
Electron Analyzer



LEED
Auger



individual instruments & complete systems

HREELS • UPS • LEED • UHV SYSTEMS
ION & ELECTRON GUNS • AES • TDS

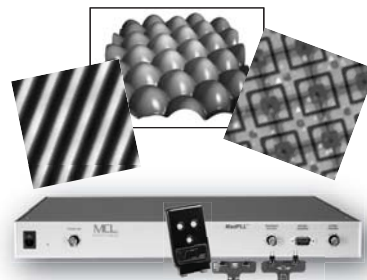


www.lktech.com
(812) 332-4449

Introducing MadPLL®

Instant AFM and NSOM—just add science.

MadPLL® includes software, digital PLL controller, probe and amplifier boards, and is fully compatible with Mad City Labs nanopositioning systems.



- Low cost imaging tool
- Automated control
- Integrated package
- Integrated z-axis control loop
- Suitable for resonant probes
- Build your own closed loop AFM!

MCL
MAD CITY LABS INC.

+1 608 298-0855
sales@madcitylabs.com
www.madcitylabs.com



New Jersey governor Chris Christie (left) and Energy secretary Ernest Moniz speak to reporters after signing an agreement for Sandia National Laboratories to design a microgrid for NJ Transit.

power between generation sites, facilities, and rail lines in Jersey City, Kearny, Secaucus, Hoboken, Harrison, and Newark. Railroad facilities and lines in those communities represent the most crucial and the most vulnerable corridor in the agency's rail system and, Moniz noted, are also a major emergency evacuation route for Manhattan.

"This first-of-its-kind electrical microgrid will supply highly reliable power during storms and help keep our public transportation systems running during times of natural disaster, which is critical not only to our economy but also emergency and evacuation-related activities," Christie said at the announcement. Moniz called the microgrid "a model for developing a 21st-century grid" that would potentially link more than 50 MW of existing distributed generation, such as solar and wind, in the area. In recovering from Sandy, he said, "We have to rebuild in a smart way, in a way that prepares the energy infrastructures not for the last storm but for the next storm, for the next possible major interruptions."

The project will make use of a quantitative risk-based assessment tool developed at Sandia to evaluate communities' regional energy needs and identify cost-effective solutions for an improved electric grid. Sandia-designed microgrids at military bases integrate distributed energy resources such as backup generators, local photovoltaic systems, small wind turbines, and energy storage into a local electrical distribution service area.

A key feature of a microgrid is the ability during a grid disturbance or outage to separate and isolate itself from the utility seamlessly with little or no disruption within the microgrid. Then,

when the utility grid returns to normal, the microgrid automatically resynchronizes and reconnects itself in an equally seamless fashion.

In a 26 August speech at Columbia University, Moniz said extreme events like Sandy "are likely harbingers of things to come; scenes that will likely be repeated as carbon emissions from human activity threaten to alter the climate consistent with the longstanding expectations of the climate science community."

David Kramer

news notes

Physics and astronomy rosters. The numbers of physics and astronomy degrees awarded in the US continue to climb. In the class of 2011–12, 6776 bachelor's degrees were awarded in physics, up 8% from the year before and 86% from a low in 1999; 1762 PhDs represented hikes of 4% from a year earlier and 62% over 2004.

The University of California, Berkeley, and the University of Washington each conferred 84 bachelor's degrees in physics; MIT was close behind with 83, and 10 other universities had physics bachelor's classes exceeding 50. At the PhD level MIT led the pack with 37 degrees.

Some 385 astronomy bachelor's degrees were awarded in 2011–12, double the number from a decade earlier. With 28 bachelor's degrees, the University of Colorado, Boulder, had the largest class. Astronomy PhDs have been steady at about 150 nationwide for the past five years. With 11, Johns Hopkins University was the only institution to reach double digits.

Two reports by the Statistical Research Center at the American Institute of Physics break down enrollment and degree data in physics and astronomy by state (see <http://www.aip.org/statistics/catalog.html>). **TF ■**

Recently on physics today online...



◀ Down to Earth

Rachel Berkowitz reports on research aimed at assessing the long-term feasibility of storing carbon dioxide in underground rock formations.

▶ Enterprise

A consultancy that sprang from wartime operations research continues to employ physicists to solve problems in naval warfare, energy use, and other sectors.



◀ The Dayside

In his blog, PHYSICS TODAY's online editor Charles Day writes about the desirability of a manned mission to Mars, Russia's past and present persecutions, a scientifically misleading blog post about radioactive tuna, and a newly reissued graphic novel about parallel universes.

▶ Points of View

Egyptian aeronautical engineer Basman elHadidi relates the political disorder in his home country to the chaotic fluids he studies in his lab.



www.physicstoday.org