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Author(s): Kippen, Karen E.

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MPA Materials Matter

INSIDE

Los Alamos NATIONAL LABORATORY EST. 1943

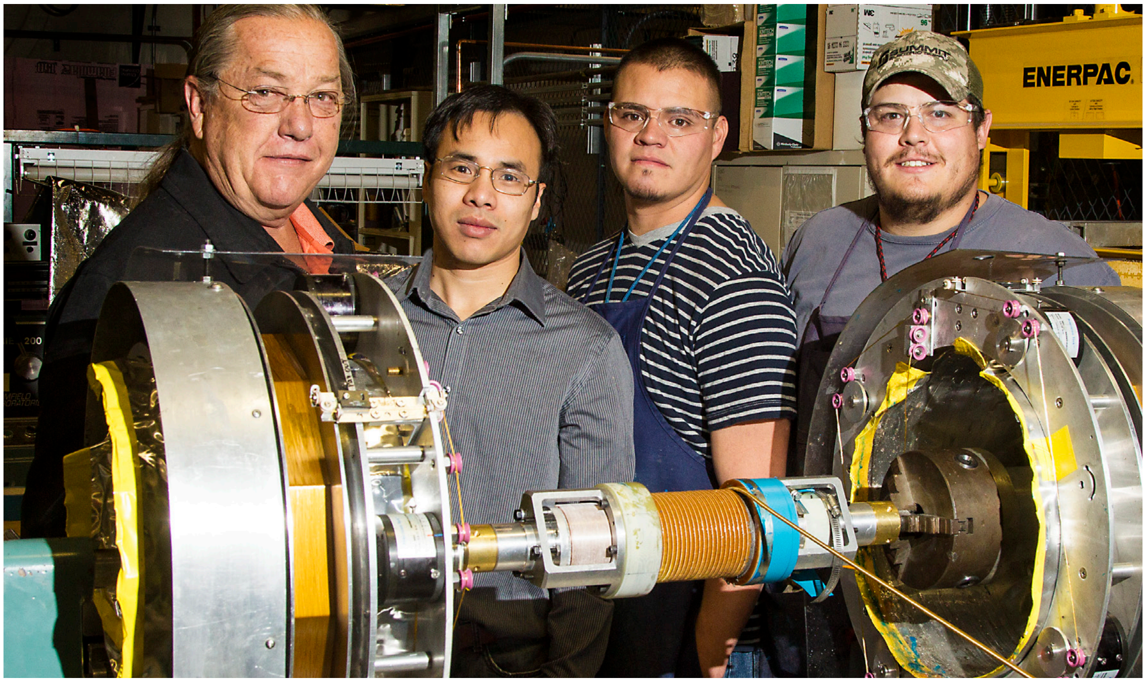


Photo by Richard Robinson, IRM-CAS

The Pulsed Magnet Development team (left to right) are Dave Sattler (Applied Engineering Technology-1, AET-1), Doan Nguyen, Jason Lucero, and James Michel (Condensed Matter & Magnet Science, MPA-CMMS).

Doan Nguyen

Rolling out ultrahigh field magnets that cool faster and last longer

By Diana Del Mauro, ADEPS Communications

Doan Nguyen and his team at Los Alamos National Laboratory's Pulsed Field Facility are building a magnet that will create precise and repeatable nondestructive high magnetic fields for researchers visiting from around the world. The technicians wrap a high-tech fiber—which looks like silky locks of golden hair but is three times stronger than steel—around the conductor for electrical insulation. They've used the fiber for years, but now the application is optimized for improved performance.

"Better, stronger conductors and reinforcement materials, along with innovative designs, are always needed for better, higher field magnets," Nguyen said.

"It's a great opportunity for me to explore my creativity for solving physics and engineering challenges in powerful magnet systems."

Nguyen, the new leader of the Pulsed Magnet Design team at the National High Magnetic Field Laboratory's Pulsed Field Facility (NHMFL-PFF), recently redesigned the 65 tesla user magnet and 100 tesla insert magnet.

"He's a genius," said Jon Betts, head of the NHMFL-PFF user program. "Doan's skillset has really helped us, and he always shares everything with us. I really love working with him."

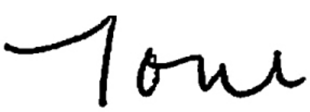
continued on page 4

From Toni's desk . . .

We have had a rough start to 2014 with the cuts in the LDRD program and the recent news about the loss of BES funding for the Lujan Center. I would like to thank all LDRD PIs for their patience in working with MPA leadership to navigate this changing LDRD landscape. We are hopeful that there will be a better solution to this issue in FY15. In terms of the Lujan Center news, Laboratory senior management is working with various stakeholders to determine the optimal path for LANSCE in the future and will communicate the outcome to the Laboratory as soon as all of the implications are understood.

On a more positive note, MPA-11 has received beneficial occupancy for the ~6,000 square feet of laboratory space in the former MSL infill. MPA-11 personnel are now fully engaged in making this lab fully operational, with programmatic work expected to begin in the near future.

"As the Laboratory and our directorate, ADEPS, are in the midst of strategic planning, I thought it would be beneficial to describe MPA Division's S&T priorities."



As the Laboratory and our directorate, ADEPS, are in the midst of strategic planning, I thought it would be beneficial to describe MPA Division's S&T priorities. The priorities derive from MPA's vision statement: "MPA Division will enable the development of new technologies that solve pressing national energy and security challenges by exploring and exploiting materials and their properties, developing practical applications of materials, and providing world-class user facilities." I believe these are consistent with the Laboratory goals and ADEPS priorities, especially the Materials for the Future Pillar. We should all realize, however, that these priorities will (and should) evolve with time.

Materials Physics and Applications Division's Strategic S&T Priorities

1) Realization of LANL's Materials Strategy: Discovering the principles for control of materials functionality focusing on emergent phenomena, defects and interfaces, and extreme environments.

2) Support of S&T underpinning MPA's stewardship of the national user facilities, CINT and NHMFL:
   a. Foundational condensed matter physics and nanoscience.
   b. Novel techniques and diagnostic capabilities enabling the discovery and characterization of (emergent) phenomena, especially for nanoscience and for materials physics in high magnetic fields.
   c. Materials science and engineering in pursuit of 150 T pulsed magnetic fields.

3) Forefront S&T in support of materials for clean energy and industrial partnerships:
   a. Hydrogen-based energy technologies, expanding scope to address stationary and portable applications and high-temperature fuel cells.
   b. Energy storage and grid S&T.
   c. Novel materials and structures for photovoltaic devices and solid-state lighting.
   d. Materials for separations technologies.
   e. Materials and energy science underpinning the mission of DOE-BES.
   f. Sensor technologies, especially for fossil energy production and utilization.

continued on page 6

From Kristin's desk . . .

As the newest member of the CINT management team, I'm happy to have an opportunity to introduce myself. I've been the Deputy Group Leader of MPA-CINT since December, and I'm really enjoying getting to know the MPA staff! I'm an inorganic chemist by training—I did my graduate work on the photophysics of transition metal-polypyridyl complexes—then did one postdoctoral fellowship in the United States Senate, followed by another, at LANL, characterizing the vibrational spectra of live cells. In 2000, I was offered a staff position in the Global Security PAD, designing systems to detect aerosolized biological threat agents. The system we designed is now operating in more than 30 cities nationwide, 24 hours a day, under the Department of Homeland Security's BioWatch program. My current technical work is focused on improving the early detection of biological threat agents, and understanding how the natural environment plays a role in bioagent fate and transport.

> *"I am looking forward to finding new ways to bridge homeland security and defense work with the research and capabilities here in MPA."*

It's really nice to be back in an experimental facility, and I am incredibly impressed by both the people and the capabilities in MPA. I applied for the job in MPA-CINT because I'd heard this was a really good place to work, and I've been delighted to find that's true. You are really fortunate to work with an incredible group of staff.

I am looking forward to finding new ways to bridge homeland security and defense work with the research and capabilities here in MPA. In the past decade, I've spent a lot of time with homeland security and defense sponsors, as well as federal, state, and local stakeholders, such as local public health officials and first responders. I've seen firsthand how LANL's science contributes to national security, but I've also observed a tremendous gap between where we are today and where we would like to be. I am constantly frustrated by the inability of current technology to address some of our very real problems. In many cases, this is due to our lack of understanding of fundamental phenomena; for example, interactions between surfaces and threat agents in complex environments. I believe that MPA can help with those problems. In recent months, there has also been increasing interest from the defense community in novel, functional materials for defense or homeland security applications, like surfaces that are easier to decontaminate following an attack, or fabrics or coatings that autonomously detect and signal the presence of a threat agent. I believe MPA can play an important role in the development of these materials.

I'm still coming up to speed on the amazing variety of work done here, and would love to learn more about the work you do. If you're in the CINT Gateway, my office is 1119; please stop by and introduce yourself!

Deputy CINT Center Leader Kristin M. Omberg

Nguyen cont.

By optimizing the use of reinforcement and insulation materials in magnets and creating techniques for fine-tuning quality control, the team has significantly improved the magnets' lifetime, maximizing the number of experiments they can endure before failing. "One small weak spot inside a magnet could limit its operation and lifetime," Nguyen said.

With these changes, the team is approaching its goal to increase a magnet's lifetime from a few hundred shots to 1,000 full-energy shots.

NHMFL-PFF, the only pulsed magnetic field user program in the United States, holds the world record for the strongest magnetic field ever delivered by a nondestructive magnet. Each year about 150 condensed matter physics researchers visit the facility to place their experiments inside the hollow core of a magnet and collect data during a burst of energy that lasts fractions of a second. That's what it takes to detect hidden phenomena, such as superconductivity and magnetic-field-induced phase transitions.

Between experiments, a magnet must cool from 400 Kelvin to 75 Kelvin, its base temperature when enveloped in liquid nitrogen. The team's greatest achievement—a new cooling technology—cuts the cooling time from 2.5 hours to 45 minutes without decreasing the stability and robustness of magnets. "I've gotten very positive feedback from users as they now can do many more experiments per day," Nguyen said.

Before joining the NHMFL-PFF team in 2012, Nguyen's research focused on applied superconductivity and he even devised small superconducting magnets, under 1 tesla, as a member the Laboratory's Superconducting Technology Center. His expertise in electromagnetic simulations and physics made him a promising addition at the magnet lab. "It's a great opportunity for me to explore my creativity for solving physics and engineering challenges in powerful magnet systems," he said.

Nguyen has shown himself to be a divergent thinker and a collaborative problem-solver.

"In some cases, the magnet design seems to be working very well in computer simulations, but the requirements are very challenging to meet in real life when the magnet is in production," he said. "Luckily, we have a creative, highly experienced magnet design and production team who always tries to provide clever solutions every day."

Nguyen will need every ounce of cleverness in the future as his team pursues a grand challenge: masterminding a 150 tesla nondestructive magnet.

Feeling the force of magnets

At the age of 13, Nguyen entered an exclusive boarding school for mathematics in Vietnam, and during high school he won medals in National Physics Olympiads. During college he grew interested in electromagnetism and high magnetic field science, which prompted him to move to the United States for graduate school. After receiving a PhD in physics from Florida State University and working briefly at a NHMFL campus there, he joined Los Alamos as a postdoctoral associate in 2007, becoming a staff scientist in 2009.

"Finally, I ended up here building strong, strong magnets," he said, smiling, in his office.

Doan Nguyen's favorite experiment

Who: With my former mentor, Steve Ashworth, and two collaborators from the École Polytechnique de Montréal in Canada

What: Magnetic materials are commonly used in superconducting systems. We developed an advanced finite element model to accurately calculate ac loss and electromagnetic dynamics in a combined system of superconductors and ferromagnetic materials. The calculation model has been used extensively to predict the ac loss and optimize the design of superconducting devices, such as superconducting cables, fault current limiter, and superconducting coils.

When: 2010

Where: Superconductivity Technology Center, Los Alamos

How: We developed a model capable of taking into account the magnetic field dependences of permeability and ferromagnetic loss of the magnetic materials.

The "a-ha moment:" Our simulation model showed that with appropriate arrangement we can eliminate most of the hysteretic loss contribution from the ferromagnetic material. More importantly, the ferromagnetic materials, in some cases, can help pull the magnetic field out of the superconductors and therefore help reduce the ac loss in superconducting materials.

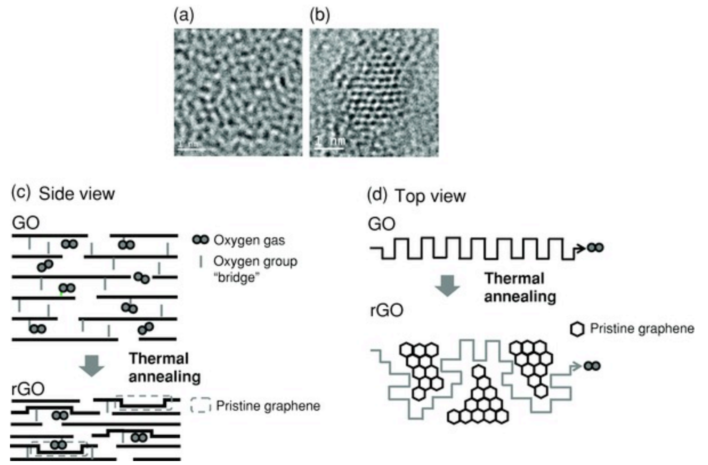
Building reduced graphene oxide thin films as ultrabarriers for organic electronics

Gas barrier films are crucial to a wide range of products used in food packaging, ship coatings, water/gas purification, and electronic device packaging. In 2010, the global market for gas barrier films involving the packaging industry was $130 billion and is expected to grow to $171 billion by 2016, according to a SmithersPira report. Development of high performance gas and moisture barrier films is therefore of significant importance.

In *Advanced Energy Materials*, Materials Synthesis and Integrated Devices (MPA-11) scientists working with collaborators from Rutgers University, Georgia Institute of Technology, and Tohoku University (Japan) report that properly stacking atomically thin sheets of carbon, specifically graphene oxide, leads to bulk thin films that prevent oxygen/moisture penetration better than current commercially available polymer-chain based barrier films. The results provide a new route for the design and preparation of high-performance and solution-processable gas/moisture barriers, with potential application to a wide range of encapsulation technologies.

Taking advantage of the unique properties of graphene, which prevents even the smallest atoms of hydrogen to pass due to its close-packed hexagonal structure, they developed a scalable chemical route to produce the reduced graphene oxide material, which is then filtered to form thin films. The researchers applied their barrier films to working organic photovoltaic devices (OPVs) and monitored device performance over time. OPVs were chosen due to their high sensitivity to environmental conditions (i.e., oxygen and moisture levels). The new films made by this process resulted in substantial improvements in OPV lifetime relative to devices without a barrier layer as well as devices encapsulated by commercially available polymer-chain-based barrier films.

Reference: “Reduced Graphene Oxide Thin Films as Ultrabarriers for Organic Electronics,” *Advanced Energy Materials*, DOI: 10.1002/aenm.201300986. Los Alamos authors include Hisato Yamaguchi (MPA-11, and Rutgers University), Wanyi Nie, Gautam Gupta, and Aditya Mohite (all MPA-11). The Los Alamos portion of the research was funded by the Laboratory Directed Research and Development (LDRD)



Structural properties of GO/rGO barrier layers. HRTEM image of GO a) before and b) after annealing. Restoration of hexagonal atomic structure in the form of a graphene nanoisland can be observed after annealing. Scale bars = 1 nm. c) Schematics of side view showing oxygen gas permeating through GO (top) and rGO (bottom). For the case of GO, oxygen molecules permeate through the interlayer due to presence of oxygen functional groups acting as “bridges.” On the other hand, pristine graphene nanoislands created by removal of oxygen group “bridges” clog permeation paths (dashed boxes), increasing the diffusion length as illustrated in top view (d). Possible permeation paths of the oxygen are indicated by the black and gray arrows for GO and rGO, respectively.

Director’s Postdoctoral Fellowship. The work supports the Laboratory’s Energy Security mission and Materials for the Future science pillar.

Technical contact: Aditya Mohite

Celebrating service

Congratulations to the following MPA Division employees celebrating a service anniversary recently:

Darrell Roybal, MPA-CMMS .... 20 years
Dmitry Yarotski, MPA-CINT .... 15 years
Nan Li, MPA-CINT .... 5 years

MPA Materials Matter

Materials Physics and Applications

Published by the Experimental Physical Sciences Directorate

To submit news items or for more information, contact Karen Kippen, ADEPS Communications, at 505-606-1822 or kkippen@lanl.gov.

To read past issues see www.lanl.gov/orgs/mpa/materialsmatter.shtml.

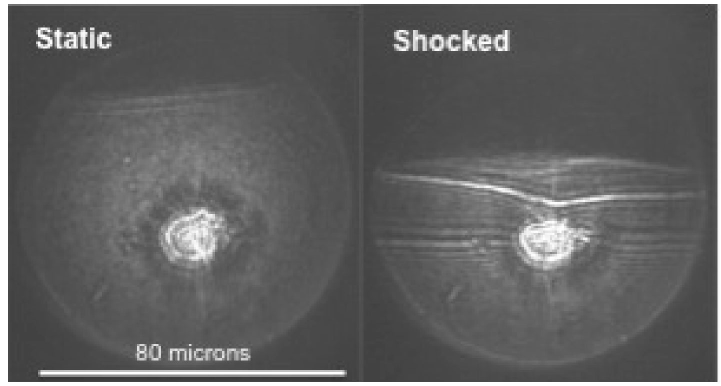
Los Alamos NATIONAL LABORATORY EST.1943

First in situ x-ray images of void collapse pave way for better models of explosives

While creating the first-ever images of explosives using an x-ray free electron laser in California, Los Alamos researchers and collaborators demonstrated a crucial diagnostic for studying how voids affect explosives under shock loading. This in situ data is the first experimental step toward developing next-generation, physically based mesoscale models with predictive capability for high explosives and supports the out-year goals of LANL's predictive capability framework (PCF).

The heat generated when small voids in high explosives collapse is postulated to be one of the mechanisms for formation of "hot spots," which lead to shock-induced reaction and detonation initiation. In this study, the researchers used the x-ray free electron laser at SLAC National Accelerator Laboratory's Linac Coherent Light Source (LCLS), the world's most powerful x-ray laser, to dynamically image the collapse of 10 µm diameter voids in single crystals of the explosive pentaerythritol tetranitrate (PETN) and to simultaneously measure x-ray diffraction to study high rate crystalline mechanics.

Next steps include analyzing the x-ray images and comparing them to current simulations of the shock wave interactions, plastic flow and jetting during void collapse. In situ shocked x-ray diffraction data will also be analyzed to extract previously unattainable equation-of-state information. Demonstrating the extent of mission relevant information that can be extracted from in situ experiments like these is important and timely for the Laboratory's proposed signature science facility, Matter-Radiation Interactions in Extremes (MaRIE).



Dynamic x-ray images of void collapse in shocked PETN. The void (bright spot in the center of the image) is collapsing as the shock wave (seen as horizontal lines) passes through it, travelling downward from the edge of the sample (top).

The research team includes Richard Sandberg, Quinn McCulloch, Ricardo Martinez (Center for Integrated Nanotechnologies, MPA-CINT), Cindy Bolme, Kyle Ramos, Virginia "Tate" Hamilton, Tim Pierce, Shawn McGrane, Kathryn Brown, Margo Greenfield (Shock and Detonation Physics, WX-9), John Barber (Physics and Chemistry of Materials, T-1), and Jacob Sutton (Metallurgy, MST-6), with collaborators from LaTrobe University (Australia), TU-Dresden, and SLAC-LCLS/MEC.

Science Campaign 2: Dynamic Materials Properties (LANL Program Manager Rick Martineau) and Science Campaigns Capabilities funded the work, which supports the Lab's Stockpile Stewardship mission and the Materials for the Future pillar.

Technical contact: Richard Sandberg

Toni's Desk: "Materials Physics and Applications Division's Strategic S&T Priorities" cont.

4) Advanced S&T supporting LANL's weapons physics/ stockpile stewardship mission:
   a. Actinide science.
   b. Novel diagnostics for small-scale and integrated dynamic experiments and for advanced manufacturing.
   c. Materials physics and chemistry in support of stockpile safety and surety.
   d. Advanced and additive manufacturing, especially utilizing nanoscience and/or connecting to applied energy customers.

5) Basic and applied materials physics for global security:
   a. Integrated nanotechnology for GS, including multifunctional materials, energy harvesting, advanced photonics, and novel materials for sensors.
   b. Novel diagnostics and sensors, especially those relevant to other mission areas.

MPA Division Leader Toni Taylor

Jia selected as a new Materials Research Society Fellow

Quanxi Jia has been honored as a 2014 fellow of the Materials Research Society (MRS) for his "pioneering contributions to the development of high-temperature superconducting-coated conductors and for advancing the processing and application of multifunctional metal-oxide materials."

At CINT, jointly operated by Sandia and Los Alamos National Laboratories, Jia is the thrust leader of Nanoscale Electronics and Mechanics. He specializes in the synthesis of nanostructured materials, multifunctional materials, and thin films, the development and fabrication of high-temperature superconducting films, and the exploration of novel solid-state microelectronic devices based on semiconductor and multifunctional materials. He has conducted pioneering research in such fields as high-temperature superconducting coated conductors, novel techniques to grow thin films of electronic materials, and monolithic integration of complex metal-oxide thin films for novel devices. Some of his important contributions include the development of multilayer architectures to enhance the supercurrent-carrying capability in thick superconducting films, of polymer-assisted deposition to grow a wide range of electronic materials, and of integration of metal-oxide materials with complementary functionalities for electronic devices.

Jia is a fellow of Los Alamos National Laboratory, the American Association for the Advancement of Science, the American Ceramic Society, and the American Physical Society. He is the recipient of the 2005 Asian-American Engineer of the Year Award, a Federal Laboratory Consortium for Technology Transfer Award for Excellence in Technology Transfer, and two R&D 100 Awards. He has authored/co-authored more than 400 refereed journal articles and been awarded 46 United States patents in electronic materials and devices. He is the co-editor-in-chief of *Materials Research Letters* and a member of the editorial boards of *Journal of Semiconductors* and *Transactions on Electrical & Electronic Materials*.

MRS is an organization with more than 16,000 materials researchers from academia, industry, and government that promotes the advancement of interdisciplinary materials research to improve the quality of life. The MRS Fellow program recognizes outstanding members whose sustained and distinguished contributions to the advancement of materials research are internationally recognized. The number of new fellows selected annually is capped at 0.2% of the current total MRS membership.

Technical contact: Quanxi Jia

Crooker honored as Optical Society of America Fellow

Scott Crooker (MPA-CMMS) has been chosen as a 2014 fellow of the Optical Society of America (OSA). He was recognized for "the development and application of magneto-optical spectroscopies to colloidal quantum dots and to electron spin transport and noise in semiconductors."

The 71 new OSA Fellows were selected based on their overall impact on optics, as gauged through specific scientific, engineering, and technological contributions, significant publications or patents related to optics, technical leadership in the field, and service to OSA and the global optics community. "The distinction of OSA Fellow signifies members who are at the top of the optics and photonics profession," said OSA President Donna Strickland in a news release.

Crooker holds a Ph.D. in physics from the University of California, Santa Barbara. He joined the Laboratory in 1998 as a Director's Postdoctoral Fellow at the National High Magnetic Field Laboratory (NHMFL) and became a staff member in 2000. At the NHMFL, Crooker focuses on the development of ultra-sensitive optical techniques to measure the static and dynamic properties of electron spins and magnetization in semiconductor materials and colloidal nanocrystals. Crooker is a fellow of the American Physical Society and a recipient of the 2007 Laboratory Fellows' Prize for Research.

Founded in 1916, the OSA has more than 18,000 members and produces publications and conference papers on the science of light and its applications. The number of fellows, who are nominated by other society members, is restricted to 10% of the total OSA membership. Crooker is only the fifth LANL employee to receive the honor of American Optical Society Fellow.

Technical contact: Scott Crooker

HeadsUP!

Taking charge of electricity usage

The UI-FOD has provided information on electricity usage in ADEPS buildings. While ADEPS staff share many of these buildings with folks from other directorates, the data is, nonetheless, revealing. We also note that in buildings with experimental areas, it is not surprising that all forms of energy usage may vary, sometimes greatly, from quarter-to-quarter and year-to-year.

As can be seen in the data, ADEPS electricity usage increased 5% from FY12 to FY13. Electrical usage has a significant monetary and environmental impact to our bottom line.

Please remember to turn off/unplug equipment when not in use, lower room thermostats in the winter at nights and when common areas (conference rooms) are unattended, and turn off office and common area lights if you are the last one out. Lastly, always look for energy-efficient alternatives when they do not affect mission delivery.

A good adage to follow: “If you do it at home (shut off lights and lower thermostats at nights and vacations), then why not do it at work too?” Take responsibility for protecting and sustaining our environment! Thank You.

Your ADEPS EMS (Environmental Management System) POCs are:

Steve Glick - Physics
Jim Coy – MST
Susie Duran – MPA
Frances Aull – LANSCE

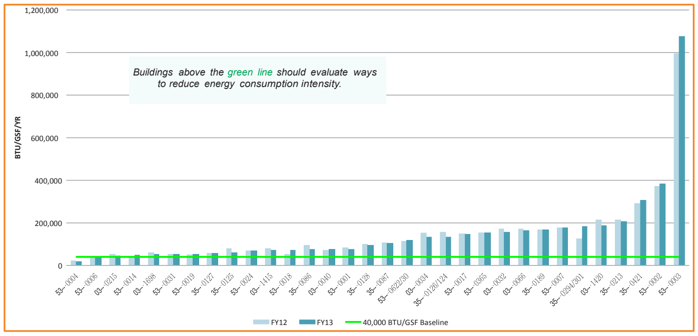
RAD Electricity Report

Fiscal Year Comparison – FY13 vs FY12

Account Number: RAD ADEPS

Billing Period: FY13

ADEPS Building Energy Efficiency – FY12 vs FY13

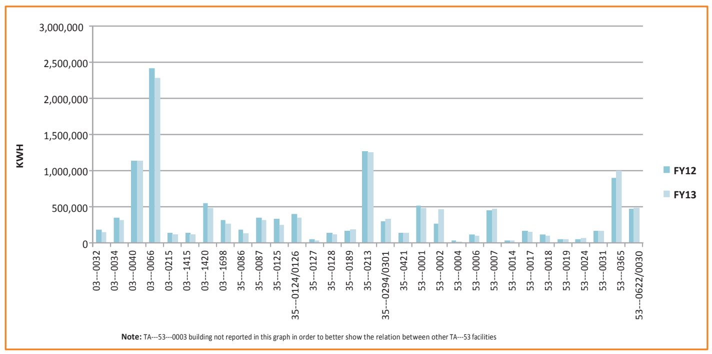


Building Energy Efficiency Comparison

This chart compares the energy efficiency of your RAD’s buildings this year with FY12.

*Energy efficiency can be measured by energy intensity—which for an office building is total energy use over time in relation to floor area, counting gas as well as electricity. The **green line** marks DOE’s standard for an efficient building: no more than 40,000 Btu/GSF per year or 10,000 Btu/GSF per quarter.*

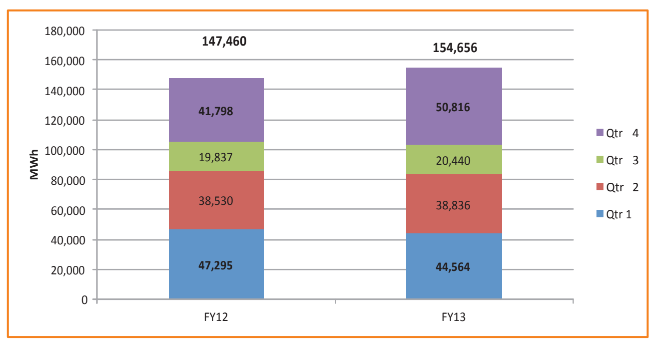
ADEPS Building Electricity Use – Quarter 4 – FY12 vs FY13



Building Electricity Use Comparison

Electrical consumption by your RAD’s buildings this quarter compared to the same quarter in FY12

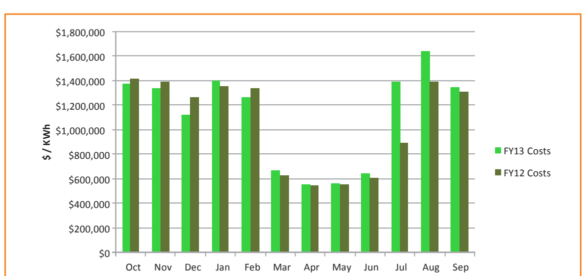
ADEPS Quarterly Electricity Use – FY12 vs FY13



Quarterly Electricity Use Comparison

Quarterly electricity use in megawatt-hours (MWh) for all metered facilities in your RAD during FY12 and FY12

ADEPS Electricity Costs by Month – FY12 vs FY13



Estimated cost of $0.086 per KWh

Individual Action Steps

- **Unplug unnecessary electronics.**
- **Turn your monitor and the lights off when you leave for a meeting or the day.**
- **Put your computer to sleep or in power down mode when you’re not using it.**

We hope this information helps you better understand and make better choices about your RAD’s use of electricity.

Questions? Need more information? Go to umetering@lanl.gov

ADEPS Environmental Action Plan for FY14

Environmental management will always be an ongoing effort. Our 2014 Environmental Action Plan addresses our impact on the environment, and outlines steps we can take to reduce our impact and decrease the potential for and severity of any environmental damage.

In keeping with the three-pronged approach established in the recent past, we have focused upon three objectives: Clean the Past; Control the Present; and Create a Sustainable Future. These objectives parallel the LANL institutional objectives, with the targets fine-tuned to fit our Directorate's needs.

Clean the Past: Reduce Environmental Risks from Historical Operations, Legacy and Excess Materials, and Other Conditions Associated with Activities No Longer a Part of Current Operations.

Target 1: Focused inventory on out-of-date peroxide formers to ensure proper testing and potential disposal pathways.
Target 2: Reduce ADEPS surplus equipment, salvaging or recycling wherever appropriate; inventory and work to minimize use of transportainer storage units; reduce total volume of chemical containers; properly disposition unwanted/unneeded office and lab items; properly disposition legacy records and documents.

- Action 1: Reduce, Salvage and Recycle
- Action 2: Transportainer Inventory, Clean-out, and Removal
- Action 3: MST Clean-out of 03-35 (Contingent on available funding)
- Action 4: MST Clean-out of 03-169 (Contingent on available funding)

Control the Present: Control and Reduce Environmental Risks from Current, Ongoing Operations, Missions, and Work Scope.

Target 1: Managers will conduct at least one environmentally-focused MOV in each quarter
Target 2: Perform annual chemical inventories (90% of ChemLog entries inventoried)
Target 3: Communicate environmental objectives to the Directorate
Note: all three targets are assessed on an annual basis.

Create a Sustainable Future: Reduce or Eliminate the Use of SF6 Green House Gas (GHG) by Recycle/Reuse or Replacement Activities.

Target 1: SF6 reduction, elimination, and/or reclamation of this egregious GHG is an institutional environmental goal via the LANL SSP (Site Sustainability Plan).

We need you to turn off lights in offices, conference rooms, hallways, and labs when not in use. Get that leaking faucet/toilet/urinal fixed (contact your Facilities Coordinator). Turn off computer peripherals when not in use. Alter your purchasing habits–Purchase GREEN. Use the blue and green recycling bins. Share chemicals, minimize chemical inventories, purchase safer alternatives, recycle and dispose properly. Salvage all unnecessary or unused (and not needed) equipment. Nominate a deserving colleague for a P2 Award!!

Document, record, and report all significant environmental actions that you take that positively affect the environment. Remember, if it's not recorded, it didn't happen. Please send your environmental action updates to your Division's EAP contact (MPA: Susie Duran at susiew@lanl.gov; MST: Jim Coy at jcoy@lanl.gov; LANSCE: Frances Aull at aull@lanl.gov; P: Steve Glick at sglick@lanl.gov). This will ensure that our Directorate continues to get the recognition it deserves for our environmental efforts.

The plan in greater detail can be found at hsrasweb.lanl.gov/emsdb/print_plan.asp?id=351.

Spring snow, White Rock Canyon