Public Interest Report

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FAS HOUSING TECHNOLOGY

FAS has constructed a demo house in Turkey and played a key role in building conferences inTurkey and Azerbaijan. These initiatives are expanding the use of structural insulated panels.

More on page 3.

A RESPONSE TO KATRINA

In 2005, Hurricane Katrina spawned the largest natural disaster in U. S. History. Unfortunately the pace of construction cannot keep up with the demand for housing. The Alternative Housing Pilot Program (AHPP) is providing an opportunity to explore innovative solutions post disaster.

Read more on page 5.

WOES FOR THREE DOE PROGRAMS

The *Stockpile Stewardship Program: Fifteen Years On* reviews the status of three expensive devices developed to maintain the nuclear stockpile. The report describes how each experiment is supposed to work and identifies problems that have been encountered.

To learn more, *go to page 7.*

About FAS

The Federation of American Scientists (FAS), founded on 8 December, 1945 as the Federation of Atomic Scientists by Manhattan Project scientists, works to ensure that advances in science are used to build a secure, rewarding, environmentally sustainable future for all people by conducting research and advocacy on science public policy issues. Current weapons nonproliferation issues range from nuclear disarmament to biological and chemical weapons control to monitoring conventional arms sales and space policy. FAS also promotes learning technologies and limits on government secrecy. FAS is a tax-exempt, tax-deductible 501(c)3 organization.

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PRESIDENT'S MESSAGE

The Future of the Building Industry

The building industry has managed to dodge the innovation in materials, design, assembly methods, and quality control management that has revolutionized most other manufacturing businesses in the U.S. Automobiles are expected to use advanced composites to increase safety and performance, and we are used to the idea that there are more than 50 microprocessors in a car controlling everything from the windows to fuel injection. But there's very little on a modern construction site that would surprise your grandfather.

The sluggish rate of innovation in construction makes it difficult to imagine how we can provide safe, comfortable, affordable housing for the 7 billion people on the globe without placing unacceptable burdens on world resources. Comfort and safety are basic essentials in a good life, which should be reflected in our homes and work. However, at least a third of the world's population still lives in primitive conditions -- 2 billion people have little or no electricity.

Wars, earthquakes, floods, and other calamities create new housing demands and often lead to enormous camps where displaced persons are forced to live in primitive structures for years. Often tents are the only affordable shelter. Despite our position as a global leader, the U.S. is scarcely an exception. The victims of the Katrina and Rita hurricanes are still cramped into unhealthy travel trailers two years later as states try to provide acceptable temporary and permanent shelter for them. Unfortunately, technological innovation that has led to productivity, growth, and cost reduction in other manufactured products has not had a similar impact on housing, and these problems continue to grow.

Secondly, construction quality has an enormous influence on safety when buildings face strong winds, earthquakes, and fires. Millions of people in Turkey, Iran, Afghanistan, Pakistan, and neighboring countries live in structures that will collapse in a major earthquake. And again, the U.S. is not exempt from this problem, as many areas in the U.S., including much of California, the central Mississippi River Valley, and Charleston, South Carolina, are in high-risk earthquake zones. In addition, a large fraction of the world's population lives in coastal cities that face huge risks from hurricanes and typhoons. In the U.S. there's been a dangerous collision between coastal cities and an insurance industry increasingly adverse to underwriting structures exposed to hurricanes. With structural insecurity spread throughout the global building stock, the building industry needs to adapt to address these dangerous realities.

Finally, the quality of construction has an enormous impact on world use of resources and energy, with a corresponding impact on global climate change. In the U.S., buildings use nearly 70 percent of electricity. While developing countries typically use much more electricity in industry, they move rapidly toward excessive U.S. consumption patterns as their wealth grows. According to recent Lawrence Berkeley Lab studies, energy used for air conditioning, refrigerators, lighting and other building energy use represents more than a quarter of all energy use in China and electricity use in buildings. Building demand for electricity is increasing at twice the national rate of electric demand. Rapid construction of residential and commercial structures is driving the enormous increases in demand for cement and steel – which dominates Chinese industrial energy use. Few of these new buildings provide adequate insulation or meet China's own standards for efficient appliances. Technology should allow homes and commercial buildings to operate at enormously reduced levels of energy use, and new materials should drive down the energy costs of construction.

There are good reasons to believe that construction can benefit from the advances that have driven huge increases in quality and cuts in cost in other industries – improvements driven by sophisticated understanding of materials, advanced computer controlled design and testing, and management methods that provide quality at all stages of production. Several of the articles in this issue explore some of the opportunities. While seemingly unspectacular, these advances in the field of construction turn out to be essential for meeting our hopes for a secure and sustainable future economy.

[1] *http://www.globescan.com/news_archives/bbcusop/*

Hy Kelly

FAS Housing Technology Project Reaches Turkey and Azerbaijan

By John Milhone

The FAS initiative to improve the quality of housing worldwide has led to construction of a demonstration house in Turkey and key roles in building conferences in Turkey and Azerbaijan. The conferences have generated plans to transfer the FAS-initiative on energy-efficient, earthquake-resistant buildings to these countries.

The broad FAS goal has been to use the talents of scientists and engineers to introduce new products and designs into the international building industry—an industry with a poor track record for innovation both at home and abroad. The more focused goal is to expand the use and performance of structural insulated panels (SIPs).

SIPs are a sandwich with a core of insulation, such as expanded polystyrene (EPS), between cement or wood facings. SIPs have the potential for increasing energy efficiency, improving structural strength, and providing resistance to mold and mildew—all at competitive prices. Invented more than 50 years ago by Dow Chemical Co., SIPs remain a tiny share of the new housing market, an oversight FAS sought to change when it recognized the seismic performance of ThermaSAVE panels, manufactured by H. H. (Hoot) Haddock in Florence, Alabama. A two-story ThermaSAVE unit survived the most severe earthquake simulation possible on a laboratory shake table—a performance captured by the Discovery Channel.

Turkey

The performance caught the attention of energy colleagues who recognized the potential of the advanced panels in Turkey, where

more than 90% of the land is in active seismic zones. (See: "U.S.-Turkey Connections") In 2005, the FAS arranged for meetings between Haddock and Metin Lokmanhekim and Haluk Sur, senior executives of Ihlas Holding A.S., a leading Turkey construction company. The FAS, Haddock and Ihlas agreed on plans to transfer the ThermaSAVE panel technology to Turkey. The plans included:

- Construction of a demonstration house in Turkey using ThermaSAVE panels,
- Shipment of additional panels to Turkey for a series of performance tests at Istanbul Technical University (ITU), and
- Cooperation in gaining certification of the SIPs for widespread use in buildings throughout Turkey.

In December, 2005, I traveled to Turkey for FAS and the U.S. Department of Energy to move these plans forward through meetings with Ihlas and other business leaders, Turkey government officials, and university researchers.

The trip was encouraging. Ihlas selected a showcase location for the demonstration house at the highest point in its upscale 675-unit Güzeksehir development on a hill overlooking the Sea of Mamara, southwest of Istanbul. The demonstration will replicate the design of the Lale (tulip) model, a two-story, 277.5 square meter villa—one of the five models in the development. A road is being built along the edge of the development so those visiting the demonstration villa won't drive through the development. Ihlas is planning a 350-unit addition to the development and, depending upon the results of the demonstration, the SIP panels could be used in the addition. The Turkey government officials were interested in cooperative efforts to improve energy efficiency and provided information about the seismic code requirements. ITU has a large, impressive seismic testing laboratory and the Middle East Technical University in Ankara also has a seismic test laboratory. Both expressed interest in evaluating the performance of the SIPs.

The demonstration villa was completed this summer, thanks—importantly—to the persistence and skill of the Ihlas construction team. Many of the ThermaSAVE panels were badly damaged during shipment from Florence to Istanbul. There were other problems. It was

a learning experience. But learning occurred and the inherent advantages of SIPs were recognized—their energy efficiency, strength, light weight, versatility, and potential ease of construction.

In parallel with the demonstration, the FAS and our Turkish partners cooperated on a broadening set of issues. Haluk Sur, in addition to his Ihlas position, was the 2006 chairman of the Association of Real Estate Investment Companies (GYODER), which attracted some 1,000 real estate leaders from Turkey, the region and the world to its annual conference on May 2-3, 2006, in Istanbul. Rosenfeld was a keynote speaker, championing California's building energy efficiency leadership. Lokmanhekim moderated a panel that included Henry Kelly, Charles Washington, DOE senior policy analyst, and myself. We gained a chance to sell the cost-effectiveness of advanced technologies to an important audience.

We earned a reprise when we were invited to speak at the May 10-11, 2007, Turkey Forum—an annual gathering of Turkey's political and economic leaders. Henry Kelly gave a keynote address on Global Warming. Lokmanhekim moderated a panel on energy efficiency. Joe Hagerman, Director of the FAS Housing Technology Project, described its expanding activities. Prof. Dr. Khalid Mosalam, University of California-Berkeley, described advanced seismic simulation research. I made a presentation prepared by Rosenfeld and me on the reshaping of the U.S. and California energy and environmental programs.

Azerbaijan

The FAS kept the U.S. DOE and State Department informed about these activities in Turkey and DOE recognized that energy-efficient, earthquake-resistant housing was also a high priority in a key country in the Caucasus region—Azerbaijan. A backwater republic of the USSR, since the end of the Cold War, Azerbaijan has emerged as a pivotal country in the new "Great Game" over the oil and natural gas resources of Central Asia. A major Western goal was achieved with the construction of the Baku-Tiblisi-Ceyhan (BTC) pipeline that brings oil from the Caspian region through Azerbaijan, Georgia and Turkey to a port on the Mediterranean and to world markets. DOE Secretary Samuel Bodman spoke at the May 25, 2005, ceremony in Baku commemorating the loading of first oil into the pipeline. While oil and natural gas interests are dominant, the U.S. Government also supports a broader dialogue on democracy and human rights. This was shown when Bodman—at the BTC ceremony—announced the U.S. plans to support a workshop in Baku on energy efficient building technologies.

The workshop, initially planned for last fall, was postponed to July 16-17, 2007, at the request of Azerbaijan. Meanwhile, the agenda was expanded to cover a broad set of topics that Azerbaijan sees as important to its long-term economic, social and political future: energy efficiency for all residential and commercial buildings, seismic building codes, implementation and enforcement, banking and mortgage reforms, industrial energy efficiency, renewable energy, and research and development. Attended by 100 participants, the workshop appeared to tap a yearning among government, private sector, university, and NGO leaders to hear and share ideas about Azerbaijan's future.

In this broad exchange, the potential contribution of SIPs received major attention because of their potential to address a major Azerbaijan problem—the nearly 1 million internally displaced persons (IDPs) among its population of 8 million. The IDPs are refugees from the dispute between Azerbaijan and Armenia and the 1991-1994 Nagorno-Karabakh War, who live in temporary housing

and tent cities across Azerbaijan. Permanent housing would signal that they could never expect to return to their homes. SIPs offer flexibility. They can be assembled and disassembled, like LEGO blocks, for either temporary or permanent housing, schools, health centers, and community buildings. David Gauthier, President, Winter Panel Corp., a leading U.S. manufacturer of SIPs, gave a well-received presentation on SIPs, emphasizing their use in different building sizes and designs, temporary or permanent use, and his international experience.

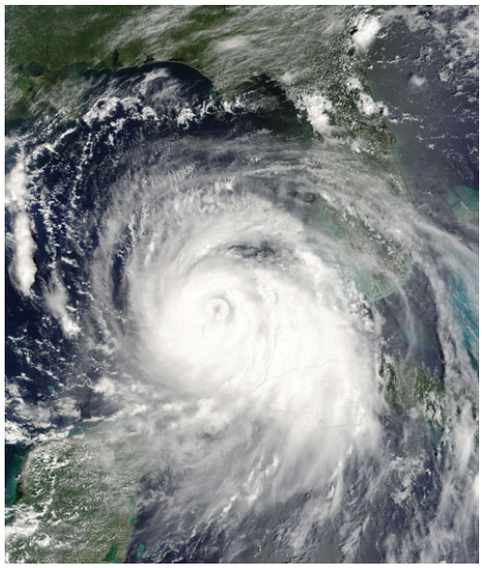
The Turkey contact also served us well. Haluk Sur made a presentation on the modernization of the Turkey banking and mortgage financing systems which have fueled the healthy economic growth of the country during the past five years—reforms that are urgently needed in Azerbaijan. Metin Lokmanhekim described the growth and use of building simulation tools to design energy-efficient and healthy buildings. William T. Holmes, Principal, Rutherford & Chekene, San Francisco, spoke on seismic building designs and standards. Dr. Stan Bull, Associate Director Science & Technology, National Renewable Energy Laboratory, and workshop Co-chair, and Ms.Christina Ward, ORNL, overviewed the recent developments in renewable energy. Robert Gemmer, DOE's Office of Industrial Technology, described the university-based Industrial Assessment Centers (IACs) as a potential model for Azerbaijan. Ms. Kimberly Grubb, ORNL, summarized the U.S. programs for visiting scientists. I reviewed U.S. and international building standards and "Green Building" resources. On each of these topics, Azerbaijani speakers also made presentations, making the sessions information sharing events, often with stimulating Q. and A. exchanges with the audience.

The major product of the workshop was a Roadmap approved at the final session. The effort was led by Ms. Kay Thompson, Senior Economist, Office of Russia & Eurasian Affairs, DOE, the leader of the U.S. delegation. The Roadmap calls for continuing cooperation to develop codes and standards for Azerbaijan with a primary focus on seismic standards, educate and train the human resources essential to implementing the codes and standards, upgrade living conditions for the IDPs, including the use of SIPs, and improve seismic mapping of the Baku area. The document also calls into consideration the creation of an Industrial Assessment Center in Azerbaijan and to cooperate in developing Azerbaijan's renewable energy resources. **FAS**

A Response to Katrina

The making of the largest, most efficient modular building order in US history.

By Joe Hagerman and Brian Doherty



In August of 2005, Hurricane Katrina spawned the largest natural disaster in our nation's history, decimating the housing stock of the Gulf Coast. In the following two months, Hurricanes Rita and Wilma further extended the housing crisis. Since then, non-profits throughout the country have worked nonstop to develop economical, fast, and basic solutions to the extensive and complex challenge of providing communities with low income and affordable housing.

Unfortunately, the pace of construction cannot keep up with the demand. The construction quality only marginally improves upon pre-Katrina levels, and non-profits are ultimately at odds with themselves as they are distanced from their core-competency, forced to act as contractors and home builders rather than working with families in crisis. This inability to effectively and timely deliver affordable housing has hampered the renewal of the coast from New Orleans, LA to Past Christian, MS to Bayou LaBatre, AL.

In late 2006 FEMA recognized that a new post hurricane housing paradigm needed development. FEMA realized that the complexity and extent of the gulf coast housing problems required solutions beyond their ordinary statutory authority. The U.S. Congress appropriated $400 million to the U.S. Department of Homeland Security (DHS) to support alternative housing pilot programs that would simultaneously provide both short and intermediate term housing solutions. Working with the state of Mississippi under this program, the Federation of American Scientists has used an innovative approach to develop two modular housing models that are safe, energy efficient, environmentally friendly, and despite the parameters of the program, can be used as long-term permanent housing.

The Alternative Housing Pilot Program and FAS's contribution

The Alternative Housing Pilot Program (AHPP) represents a one-time exception to FEMA's existing authority under the Robert T. Stafford Disaster Relief and Emergency Assistance Act, by providing an opportunity to explore, implement, and evaluate innovative approaches to housing solutions post disaster. At its core, the program is a research project giving FEMA the opportunity to examine new ideas, designs, and processes for housing.

Led by FAS Building Technologies Project Manager Joe Hagerman, Mississippi's proposal for the AHP program represents a new prototype to deliver housing solutions by leveraging the industrialized housing sector (modular and HUD-code manufacturers) and energy efficient, green technologies. At the core of the proposal are two model units that are built in factories under controlled environments, where assembly and construction is rigorous, optimized, and carefully regulated by full time inspectors. Aptly named the Mississippi Park Model and the Mississippi Cottage Model, these homes were heavily influenced by FAS's past successes in building technology research.

The Park Model and Mississippi Cottage were designed to address the shortcomings of the travel trailer and mobile homes used by FEMA following large-scale disasters. Design priorities included energy efficiency, minimal environmental impact, safety, durability, and the ability to provide immediate (short term) yet permanent (intermediate and long term) affordable housing.

The design of each of Mississippi's alternative housing units, like the designs originally offered by the New Urbanist Guild's Katrina Cottage concept, are based upon local architectural style, and are highly adaptable to regional specifics. Mississippi alternative housing units are built with multiple exterior applications, finishes, and colors to give neighborhoods a variety of looks. Each home is designed with adequate floor space, living area, and storage space to accommodate a typical Mississippi coastal family. Further specifications of the home make it comparable to the architecture, structural strength, and typical amenities of local site-built options yet the Mississippi units are stronger, more energy efficient, and more durable.

While both housing units were designed with these same basic ideals, they provide different options for families in need. The Park Model was originally created to address the seasonal needs of National Park Service employees working in remote areas and is regulated under ANSI A119.5. The Mississippi Park Model was designed to remain on a wheeled undercarriage permanently, allowing it to be deployed quickly and removed for redeployment as needed in future disaster events. The Park Model is limited to one-bedroom units with a multifunctional living area that can be used as a second sleeping space. The Park Model also incorporates numerous features to improve safety, livability, and durability over FEMA travel trailer standards. While similar in size to FEMA's travel trailers, the Park Model improves upon FEMA's design in energy efficiency (exceeding energy star standards by upwards of 10%), structural design (meeting International Residential Codes for 150mph winds), use of environmentally safe materials (no-VOC paints/adhesives and formaldehyde free materials), an open floor plan, reduced roof penetrations (to code minimums), the use of durable, rot, mold, and

moisture-resistant materials, and a front porch.

Intended for larger families and the disabled, the Mississippi Cottage was designed to meet International Residential Code. The two- and three-bedroom cottages include similar construction techniques and materials as those used in the Park Model, reaching the same high structural, energy, and safety standards. The cottages also offer conventional-sized kitchens, closets and bedrooms, further improving livability. In addition, the footprint of the Cottages was designed to allow for adequate wheelchair access, as required by Universal Federal Accessibility Standards. There is also a door in the utility area that also allows for alternative ramp entry if narrow-lot limitations apply. Unlike the Park Model, the Mississippi Cottage is placed on a wheeled undercarriage so it can be removed if the tenant chose to purchase the unit and make it a permanent residence.

While these significant improvements in energy efficiency and livability are laudable, what makes the Mississippi project so unique is how each model is dual certified as a HUD-Code and International Residential Code-Modular Unit. Dual certification gives the unit the ability for rapid, immediate, and universal deployment to any state without any regulatory hassles. International Residential Code Modular compliance is important for the structures to become part of the long-term housing stock – taking them off their steel frames and undercarriages (and losing their HUD-code designation at this time). Because the units are inspected as International Residential Code Modular for deployment in 150mph wind zones, they are inspected to the highest class or standards. Therefore, when the units are converted onto permanent foundations, the appropriate paperwork and certification of this in-plant inspection can be transferred to the appropriate State or regulatory agency for approval. This facet of the unit design allows the most regulatory flexibility, and maximizes the project's impact.

For example, while FEMA travel trailers serve disaster victims for approximately 2 years, Park Model units are estimated to have a useful life of 15 years, and Mississippi Cottage units are estimated to have a useful life of 30 years. This dual certification – a major goal crafted by FAS's participation in the project – significantly increases the projects ability to have an immediate and long term impact in the rebuilding process, and is an amazing advancement for emergency housing.

An Innovative process for modular housing...

In addition to providing high quality housing relief, the Mississippi AHP project has also been an innovative step for the modular housing industry. Historically, modular housing has been driven solely by a traditional product-to-customer model. The plant produces a product based on their internal research and manufacturing abilities and hires a third-party inspector to inspect the production line. FEMA traditionally has only purchased units off of a manufacturer's lot without clear, concise, and comprehensive specifications. Under the AHP program, the product is very specialized with the look and-feel and the material specifications. The AHP project focused on a research model to design, bid, prototype, and build units in mass as quickly as possible. This new model is extremely important to disaster housing because authorities, such as FEMA, can custom tailor a product to immediately meet their needs while maintaining a high quality in plant and to the end user through rigorous in plant inspections. The AHP project unfolded with five critical stages:

1. **Concept/Design Stage:** scientists, engineers, architects, and emergency responders met to complete a full set of engineering drawings for a specialized disaster housing product, designed with an approved Modular/HUD-code engineering firm operating as the engineer of record (the professional in charge of the project) .
2. **Bidding Stage:** The engineer of record advertised and put out for competitive bid the engineering drawings for the specialized disaster housing product;
3. **Prototyping Stage:** The engineer of record along with the scientists, architects, and emergency responders worked with each selected manufacturer to prototype both the quality and construction standards in which the manufacturer will be held. The first unit was retained at the manufacturing facility as the standard of quality. The engineer of record also reviewed and maintained all HUD-code documentation.
4. **Production Stage:** FEMA required a fulltime inspection by the owner's third party/engineer of record to maintain the specifications and integrity of all products shipped (i.e. checking specification, formaldehyde, and energy star compliancy in ALL units); and
5. **Delivery Stage:** Manufacturer will hold the units at their facility until needed by FEMA (to be shipped as just-in-time--delivery).

Effective disaster response does not just bring shelter to people. Rather, it must house people in a livable environment that can renew the local community. The Mississippi project manages to provide energy efficient, safe, livable housing for both immediate and permanent rebuilding through both the design of the units and the process by which the units are manufactured and ultimately procured. Its unique design approach also provides a successful model for the modular industry that can improve adaptability and make further relief efforts more case specific. Inspired by this resounding success, FAS will continue to work with FEMA and other agencies to pursue this and other innovative housing solutions post disaster in a continued effort to affect positive change through science and technology. **FAS**

Woes for Three DOE Programs, Report Finds

By Monica Amarelo

The three major components of the Stockpile Stewardship Program (SSP) at the Department of Energy are all seriously over budget and seriously behind schedule, according to a report issued today by the Federation of American Scientists (FAS).

The paper, The Stockpile Stewardship Program: Fifteen Years On, reviews the status of the experimental devices that support the SSP, describes how each experiment is supposed to work, and identifies the problems that have been encountered. SSP was developed because of concerns that over time a nuclear weapon's reliability could decline.

All of the expensive SSP experiments were initiated because of the cessation of nuclear testing, with the expectation that they would be essential to maintaining the nuclear stockpile," said Ivan Oelrich, vice president of strategic security at the Federation of American Scientists. "We understand nuclear weapons much better now than we did when we were testing. It is time to reevaluate which of these expensive experiments we still need. The DOE is even proposing to move away from stockpile stewardship to a reliable, replacement warhead, which could avoid the need for the SSP experiments altogether."

How essential is it for these megaprojects to continue?

The SSP supports three projects: the National Ignition Facility (NIF) to use laser beams to compress a hydrogen target to densities and pressures where fusion would occur; the Dual-Axis Radiographic Hydrodynamic Test (DARHT) Facility uses x-rays to follow the shape of sections of plutonium when they are compressed as they would be in the primary; and the Accelerated Strategic Computing Initiative (ASCI)—renamed Advanced Simulation and Computing (ASC) — to build supercomputers and associated software to use the information from other experiments to model nuclear warheads and predict their behavior.

The National Ignition Facility (NIF) should have been finished four years ago and was originally budgeted at just over one billion dollars. Now its first experiments are expected to occur in 2010 to a cost of more than another billion dollars to complete – greater than the original estimates of total cost.

"Based on unclassified sources, it appears that the connection between NIF and the current SSP is at best indirect," said Oelrich. "We believe that NIF could be ended without reducing the confidence in the existing nuclear stockpile."

Being able to model a nuclear weapon on a computer is one of the critical substitutes for nuclear testing. Although the Advanced Simulation and Computing (ASC) program has already made important contributions to understanding the behavior of nuclear weapons, it too has been plagued with problems. It is not at all clear when the ASC program will be "done." Construction on some computers was started but never completed while some computers suffered from low reliability because of their complexity. In many cases, Herculean hardware developments were not matched by development of software that could fully exploit the capabilities of these new machines. Even successes were short lived – the world's fastest computer today will be overtaken by some rival within months.

All of the SSP experiments, but NIF in particular, are promoted as a means to attract top new scientific talent to DOE and the SSP. Universities and industry are now at the cutting edge of scientific and technical advance. Even if NIF did contribute to this goal to some degree, it is far from being the most efficient means of applying those billions of dollars. Those funds could go directly to support university research of interest to DOE or to create smaller but scientifically more interesting experiments within the labs.

"Even without NIF, the United States can maintain its existing nuclear weapons without a return to testing," said Oelrich. **FAS**

FAS receives 4-star rating

For the fifth consecutive year, Charity Navigator awarded FAS four out of a possible four stars, indicating that FAS successfully manages its finances in an effective manner and assuring sponsors that their contributions are well-spent.

Charity Navigator, America's premier independent charity evaluator, works to advance a more efficient and responsive philanthropic marketplace by evaluating the financial health of America's largest charities.

FAS Has Moved

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