**Statement of Ned Sauthoff**
**Director, U.S. ITER Project Office**
**Oak Ridge National Laboratory**

**Before the**
**Subcommittee on Energy**
**Committee on Science, Space and Technology**
**U.S. House of Representatives**
**July 11, 2014**

# Hearing on Fusion Energy: The World's Most Complex Energy Project

Madame Chair, Ranking Member Swalwell, and Members of the Committee: Thank you for this opportunity to appear before you today.

My name is Ned Sauthoff. I am the Director of the U.S. ITER Project Office at the U.S. Department of Energy's Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee. It is an honor to provide this testimony on progress of the ITER international fusion project, challenges we are facing, and the vision for hydrogen fusion to become an attractive source of future U.S. energy.

## INTRODUCTION

The goal of ITER is to create and study a reactor-scale "burning plasma," the core of a magnetically-confined fusion power reactor. In such a system, the energy from fusion reactions "self-heats" the plasma. Fusion combines light elements such as hydrogen; in contrast, fission splits heavy elements such as uranium, exploiting Einstein's famous mass-energy equivalence principle $E = mc^2$. Both fusion and fission nuclear reactions produce about a million times more energy per pound of fuel than do chemical reactions, such as the burning of fossil fuel. ITER seeks to study the behavior of a reactor-scale system based on fusion of hydrogen into helium at the level of 500,000,000 watts of fusion power.

A reactor based on fusion has attractive characteristics:

1. Hydrogen fusion is fueled principally by common elements found in the Earth's oceans and crust: deuterium (a stable isotope of hydrogen) and lithium[1]—so ***fusion would be a virtually inexhaustible energy source.***
2. Fusion of the most-reactive hydrogen isotopes, deuterium and tritium, produces the inert gas helium and a neutron that in turn reacts with lithium to breed the tritium fuel; with proper selection of materials for reactor components, the neutron bombardment can produce waste with a lifetime comparable to that of a human —so ***fusion would produce neither greenhouse gases nor long-lived high-level radioactive waste***.
3. The amount of fuel in the reaction chamber is small and the fusion reaction itself shuts down if control is lost – so ***fusion has inherent safety advantages.***

These desirable characteristics have made fusion energy a long-standing quest. The scientific proof-of-principle for controlled fusion power using magnetic confinement was first demonstrated in the U.S. at Princeton's Tokamak Fusion Test Reactor in 1994, and then in Europe in 1997 at the Joint European Torus located near Oxford. Laboratories focused on the tokamak concept have grown

---

[1] Transmutation of lithium into tritium by a fusion-produced neutron is an integral aspect of the hydrogen-fusion closed fuel cycle.

worldwide, including major facilities in China, Europe, India, Japan, Korea, Russia and the U.S. and smaller facilities in many industrialized countries.

In the Summer of 2002, over 200 fusion scientists and engineers from around the world met to conclude and extensive investigation of options for the next major step in the U.S. and world magnetic-confinement fusion programs: the creation and study of a self-heated burning plasma. Burning plasma, much like that found in the Sun, remains hot because enough of the energy from the fusion reactions self-heats the plasma to overcome energy losses. Such a plasma would form the core of a fusion reactor that could burn forms of hydrogen plentiful enough to power civilization for thousands of years. A burning plasma facility using magnetic confinement fusion must be large like ITER so that the surface-like energy losses are less than the volume-heating, enabling the plasma to stay sufficiently hot.

One key challenge for fusion energy is confining the plasma so that fusion reactions can take place. While the Sun utilizes strong gravity to confine the plasma, gravity cannot be used as the confinement force on Earth; as a measure, the mass of the Sun is roughly 300,000 times that of the Earth. Further, we seek to produce an energy source that uses little land area. To meet this containment challenge, fusion scientists utilize a magnetic bottle configured in the shape of a toroid (doughnut), called a tokamak, to confine the hot ionized gas. The 2002-study's scientific and engineering teams assessed the research benefits of burning plasma studies, the scientific and technological feasibility, and the advantages and disadvantages of multiple approaches using the tokamak configuration, which confines the plasma in a doughnut-shaped (toroidal) shape. The tokamak formed the basis for the multiple magnetic confinement approaches because it offers the greatest opportunity to advance understanding of the dynamics associated with burning plasma in the near term, based on a consistent demonstrated performance history by tokamaks. While the tokamak may not be the optimum long-term fusion reactor configuration, the advances from such a tokamak-based burning plasma study would be applicable to virtually any future toroidal-confinement approach to fusion, due to the similarities of the toroidal physics.

The DOE's Fusion Energy Sciences Advisory Committee (FESAC) built upon these studies and technical assessments, and recommended creation and study of burning plasma as a next major step toward achievement of fusion energy.[2] Subsequently, the DOE commissioned the National Academies' National Research Council to conduct "an assessment of a program of burning plasma experiments and its role in magnetic fusion research." This assessment resulted in a report that recommended that the U.S. enter negotiations on the construction and operation of ITER.[3]

Similar studies were being conducted across fusion communities and governments worldwide, and negotiations on moving the ITER activity to construction began in 2003. The international consensus was, and remains, that the creation and study of self-heated "burning" plasma is a next major step in fusion energy research, and that ITER is the best path for that research. In 2006 and 2007, nations representing over half the world's population agreed to partner on design, construction, operation and decommissioning of an approximately 500,000,000-watt, industrial-scale fusion experimental system termed "ITER" (Latin for "the way").

---

[2] U.S. Department of Energy, Fusion Energy Sciences Advisory Committee, *A Plan for the Development of Fusion Energy*, DOE/SC-0074, Washington, D.C., 2003.

[3] U.S. National Academy of Sciences, Burning Plasma Assessment Committee, *Burning Plasma: Bringing a Star to Earth,* National Academies Press, ISBN 0-309-52766-X, Washington, D.C., 2004.

The international mission of ITER is to demonstrate the scientific and technological feasibility of fusion power for peaceful purposes. Associated burning plasma studies are to:

(1) produce and study the dynamics of a self-heated plasma wherein power released in the fusion reaction keeps the plasma hot;
(2) advance knowledge on the effects of high-energy particles on the stability and confinement of hot plasma; and
(3) advance understanding of a reactor-scale plasma.

Fusion research over the past decade has reinforced confidence that ITER can meet its mission and produce ~500 Megawatts of fusion thermal power with only ~50 Megawatts of external heating power absorbed by the plasma—a factor-of-10 "gain". The ITER project represents the frontier in magnetic-confinement fusion power generation, and will deliver an international scientific laboratory that studies burning plasmas and supporting technologies. It will advance scientific understanding of fusion plasmas, a key part of the foundational knowledge base for an attractive fusion power system in the 21st century.

The ITER international partnership enables the U.S. to gain access to 100% of the ITER results, to propose and execute experiments, and to share in the governance of the project while paying 9% of the cost (an advantage of 11 to 1).

Today's tokamak fusion research, underway on existing fusion facilities worldwide using international teams, is both answering key questions relevant to ITER and establishing the foundational teams and tools that will enable exploitation of ITER during its research phase. A strong U.S. fusion research program is essential because it both increases understanding and establishes the U.S. as a leader on ITER-related research topics, positioning the U.S. for strong participation in exploiting ITER for research.

## GLOBAL PROGRESS ON THE ITER PROJECT

The ITER project has made substantial progress with

- construction of buildings and infrastructure at the ITER site in southern France, mostly by the host Member, Europe, and
- fabrication of hardware components and subsystems, mostly by the ITER national teams. (For example, the U.S. budget supports the U.S. team designing and procuring assigned hardware from the U.S., contributing to the advancement of U.S. industrial capabilities, and providing high-tech U.S. jobs.)

In addition, the ITER team is now engaged in management reforms to improve the effectiveness of the integrated project team, which consists of the ITER Organization and seven national teams, known as Domestic Agencies. The U.S. DOE and the U.S. ITER Project Office are both actively engaged in these management reforms.

Preparation of the ITER site began in 2008 in St. Paul-lez-Durance, France, adjacent to the French Alternative Energies and Atomic Energy Commission (CEA) Cadarache site. On November 12, 2012, following two years of investigation and analysis performed in strict accordance with regulatory review procedures, the French Ministry of Environment issued a decree authorizing ITER to begin construction. The decree also established a binding contract between the French state and the ITER Organization as nuclear operator.

*ITER site, April 2014 [Photo: ITER Organization]*

- The **European Domestic Agency** is responsible for site construction and has made substantial progress on buildings and site infrastructure. Prime contracts have been placed and work is under way at the ITER site. Construction is proceeding on the tokamak complex, including the assembly, diagnostics, tritium and tokamak buildings, plus 12 support buildings that are beginning construction in 2014. Concrete pouring for the basement slab under the diagnostics building and the tritium building is nearly complete. Construction is expected to begin in the second half of 2014 on the assembly hall, site services building, electrical buildings, and walls of the tokamak complex. Also under construction is storage space for large near-term deliverables, including large drain tanks ready for shipment from the U.S. in 2014 as part of the U.S. contribution of the tokamak cooling water system. The EU Domestic Agency is also making manufacturing progress on magnet systems; radial plates for the toroidal field magnets are in fabrication and winding of the first production conductor has been completed.

*The tokamak complex at the ITER site, April 2014 [Photo: ITER Organization]*

- The **Chinese Domestic Agency** has completed two toroidal field conductors and five poloidal field conductors. Manufacturing equipment has already been commissioned for the correction coils and several prototypes have been produced for the feeder conductor.
- The **Indian Domestic Agency** is progressing on in-wall shielding components that will be captive inside the two walls of the vacuum vessel. Manufacturing of the cryostat base section has started and the cryostat fabrication workshop at the ITER site is complete.
- The **Japanese Domestic Agency** has work well under way on their toroidal field magnets plus toroidal field support structures, gyrotrons for heating systems, and conductor for the central solenoid. The Japanese conductor will be used by the U.S. to manufacture the central solenoid.
- The **Korean Domestic Agency** is also producing conductor for toroidal field magnets and fabricating two vacuum vessel sectors.
- The **Russian Domestic Agency** is fabricating multiple types of conductor for magnet systems, and has begun deliveries for both toroidal field coil conductor and poloidal field coil conductor.
- The **U.S. Domestic Agency** contributions are discussed in the next section.

In summary, progress is being made across the global partners, albeit in some cases slower than originally planned. Events ranging from earthquakes and heavy snow in Japan to technical challenges to budget constraints for several Member countries have had a ripple effect across the project, impacting some production schedules. The partners continue to work together and with the ITER Organization to identify the best approaches for coordinating interdependent manufacturing activities and accelerating the pace of work. Further information on the international aspects of the project is available at the ITER website: www.iter.org.

## U.S. PROGRESS ON THE ITER PROJECT

The **U.S. Domestic Agency** is responsible for delivering multiple hardware subsystems essential for ITER:

- Magnet Systems: Superconducting Toroidal Field Coil Conductor and fabrication of the Central Solenoid, to confine, shape and control the plasma inside the vacuum vessel
- Cooling Water System, to absorb and convect away the power output from operation of the tokamak
- Steady State Electrical Network, to supply the electricity needed for construction activities and operation of the non-pulsed parts of the entire plant
- Heating and Current Drive Systems (Electron Cyclotron and Ion Cyclotron Heating Transmission Lines), to deliver heating power to the plasma
- Pellet Injection, to fuel the plasma by injection of deuterium-tritium ice pellets
- Disruption Mitigation System, to reduce the impacts of plasma disruptions on the tokamak vacuum vessel, blankets, and other components
- Diagnostics, to provide the measurements necessary to control, evaluate and optimize plasma performance and to further the understanding of plasma physics
- Vacuum Auxiliary Systems and Roughing Pumps, to remove gases from the vacuum vessel, cryostat, and auxiliary vacuum chambers prior to and during operations
- Exhaust Processing System, to separate hydrogen isotopes from tokamak exhaust for isotope separation (by a European-supplied system) and re-injection of the hydrogen isotopes into the plasma.

The U.S. continues to be a strong and demanding partner in the ITER project, with contributions in fabrication, technical innovation, and management practices. The impact of U.S. contributions to ITER extends across the country, contributing to manufacturing and high technology industries, leading-edge research at universities and national laboratories, and U.S. readiness for fusion energy development.

More than 80% of the project total funding will be spent in the U.S. Through March 31, 2014, there have been over $616 million in purchase orders to U.S. industry and universities, and commitments to Department of Energy National Laboratories, in 40 states plus Washington, DC.

The R&D portion of the U.S. fabrication project effort is nearly complete (87%) and >70% (by value) of the U.S. hardware is in final design or beyond. Fabrication and delivery of hardware is underway. The U.S. schedule for these deliverables is driven by the international schedule, wherein the U.S. provides components that must be installed in the buildings as they are constructed, are needed to support construction activity such as site electrical power, or are needed by other Members for incorporation into their hardware.

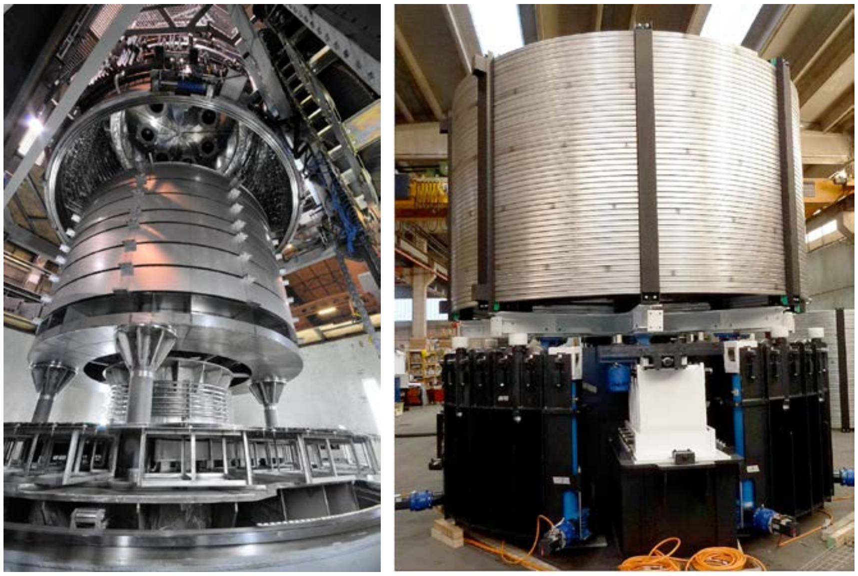
*An 800-meter sample toroidal field conductor was delivered to the EU in June 2014. Photo: U.S. ITER*

*Joseph Oat Corporation in Camden, NJ is completing fabrication of drain tanks. Photo: U.S. ITER*

*Laminated core of a high voltage substation transformer in fabrication for the steady state electrical network. Photo: Hyundai Heavy Industries*

- The U.S. completed fabrication of all 40 tons — over 4,000 miles — of superconducting strand, for the entire U.S. contribution of toroidal field coil conductor. The toroidal field conductor manufacturing process involves multiple vendors in four states: Superconducting strand was produced by Oxford Superconducting Technologies in Carteret, NJ and Luvata Waterbury, Inc. in Waterbury, CT; cabling of the strands is performed by New England Wire Technologies in Lisbon, NH; integration and jacketing of the cable into stainless steel conduit is performed by High Performance Magnetics in Tallahassee, FL. All of the manufacturing processes have been successfully developed by the U.S. project team and its contractors. An 800-meter sample conductor with copper, non-superconducting strands was fabricated and delivered to the EU winding facility in Italy in June 2014. A 100-meter superconducting conductor, using Oxford Superconducting Technologies strand, was shipped to the EU in June 2014.

- Other U.S. deliveries scheduled for 2014 include parts of the tokamak cooling water system and the steady state electrical network needed soon for the construction activities at the ITER site. Large-scale (up to ~61,000 gallon) drain tanks for the cooling water system are completing fabrication at the Joseph Oat Corporation in Camden, NJ, and will be ready for shipment to the ITER site by the end of 2014 for installation in the basement of the tokamak building. Components of the steady state electrical network will be delivered in 2014 to provide essential construction-site power; manufacturing is underway for high-voltage (HV) current transformers, HV potential transformers, and HV substation transformers and factory acceptance testing has been completed for HV surge arrestors.



*A heat treatment furnace (left) and de-spooler for the winding station (right) are part of the 11 workstations that are being installed at General Atomics' central solenoid module fabrication building in Poway, CA. Photos: General Atomics*

- The central solenoid is *the heart of ITER*—because its "beating" pulses the magnetic flux needed to initiate and sustain the plasma current. Weighing in at approximately 1,000 metric tons with a 5.5 Gigajoule stored energy capacity, the U.S.-supplied central solenoid will be the highest-stored-energy pulsed superconducting electromagnet ever produced.

  The U.S. is now preparing for central solenoid module fabrication, using superconductor supplied by Japan. A manufacturing building has been completed by General Atomics (GA) in Poway, CA and factory acceptance testing has been completed for the winding station, heat treatment furnace, insulation taping heads and air-bearing transfer cart. Ultimately, 11 tooling stations will be installed and utilized at GA for the fabrication of 7 modules. Winding of the mock-up module coil will begin this summer.

- The U.S. continues to advance design and prototype fabrication and testing for longer-term subsystems. For heating and current drive systems, the U.S. has already demonstrated operation of major ion cyclotron transmission line components at full power (6 Megawatts/line), and has developed prototype designs for 12 of the 14 required ion cyclotron transmission line components and 14 of the 16 electron cyclotron transmission line components. For fueling and disruption mitigation systems, the U.S. is developing the injectors required to provide continuous frozen pellets of gases that penetrate into the ITER plasma. These pellet injectors will also be used to reduce divertor-wall erosion from edge plasma- and power- flux to acceptable levels. The design and prototyping of early-delivery diagnostics — the residual gas analyzer and low field-side reflectometer — are on schedule. For vacuum and pumping systems, the U.S. has completed prototype fabrication of tritium-compatible screw pumps and roots pumps and is now testing these components. The tokamak exhaust processing is a late delivery item, but design is under way to solidify interfaces and support the ITER safety basis.

The U.S. is committed to delivering its commitments in the most cost effective manner and has achieved more than $225 million in cost avoidance by applying value engineering across its subsystems, including an innovative procurement arrangement with the ITER Organization for cooling water design and piping.

The engagement of U.S. industry with ITER has resulted in an expansion of technology-readiness across a number of sectors, including:

- Enhanced industrial capacity for production of high-performance superconducting cable;
- Advanced plasma diagnostic systems and high-power microwave transmission lines; and
- Industrial experience in complying with French nuclear pressure equipment regulations.

More information is available at the U.S. ITER website: www.usiter.org

## SCIENTIFIC, TECHNOLOGICAL AND MANAGEMENT CHALLENGES

As with any grand challenge in science and engineering, progress is paced by the magnitude of the scientific, technological, and management hurdles to be overcome and the technical, budgetary and management assets brought to bear on the challenges.

### *Scientific Challenges*

While ITER will be a large scientific endeavor that will enable understanding of the burning plasma state, science is no longer the constraining factor for ITER's design, fabrication and construction. The scientific basis for ITER is well established. As pointed out previously, scientific proof-of-principle for fusion power was demonstrated during the 1990s in both the U.S. and Europe. More recently, confinement and stability studies on tokamaks worldwide have increased confidence in ITER's performance. Significant progress has been achieved in tokamaks around the world, most notably DOE's DIII-D facility managed by General Atomics in San Diego, CA, on the mitigation of edge-localized modes and other forms of major disruption that cause plasma instabilities. This understanding has increased confidence that ITER can both meet the desired objectives and will further advance knowledge on how to control burning reactor-scale plasma dynamics.

The basic fusion sciences research program sponsored by the DOE and implemented at leading U.S. universities, industry and national laboratories is of such strategic importance since it is key to addressing the scientific challenges that ITER will address. The basic research program is pivotal because it:

(a) advances burning plasma science and technology, contributing to the science and technology basis of ITER and acquiring accessible burning plasma knowledge in advance of ITER to enhance the research effectiveness of ITER, and

(b) positions the U.S. to be a leader in burning plasma research topics, thus enabling the U.S. to exploit its investment in ITER.

The scientific challenges that ITER will resolve include topics in burning plasma dynamics, effects of energetic particles and size-scaling of physical processes. These topics are already key research areas on today's tokamaks. The U.S. is a founding member of the International Tokamak Physics Activity, which enhances the coordination of joint tokamak research on the world's toroidal facilities under the auspices of ITER.

### *Technological Challenges of ITER and beyond ITER*

Technology hurdles have existed throughout the history of fusion research. However, through a combination of innovation and opportunity capture, these hurdles have consistently been vaulted. ITER's technology challenges in magnets, heating and current drive, instrumentation, vacuum, plasma-facing components, etc., have been resolved such that there are no prohibitive technological barriers foreseen.

For an attractive electricity-producing fusion reactor, research beyond ITER will be required. ITER's pulsed operation is sufficient to meet the primary objective to achieve and study burning plasma, but does not represent a complete prototype of a commercial reactor which would operate for longer durations and at a higher duty factor possibly at higher power density. As such, further scientific and technological advances beyond ITER will be necessary to ultimately enable an attractive fusion power system. Promising materials have already been identified[4], but development of these materials and components is not within the mission of ITER and will require other test facilities in the future. Innovations and refinements of the confinement configuration will enhance the attractiveness of fusion reactor concepts and should be an essential element of worldwide fusion research in addition to research on ITER.

Progress in magnetic confined fusion has also relied heavily on theoretical modeling and empirical validation through experimental tests. Because of the complexity of plasma turbulence, magnetohydrodynamics (MHD), and other advanced physics phenomena and systems integration, state-of-the-art computational power and advanced diagnostic instruments will be continue to be keys to understanding. Leadership-class supercomputers and superior diagnostics will enable enhanced understanding of ITER plasma behavior. Existing niobium-titanium (NbTi) and niobium-tin ($Nb_3Sn$) superconductors are sufficient for ITER; more attractive fusion magnet systems may be enabled by development of more advanced superconducting magnets. Such disruptive technologies will continue to contribute to the advancement of fusion systems.

---

[4] For example, the FESAC report on "Opportunities for Fusion Materials Science and Technology Research Now and During the ITER Era" (February 2012), [http://science.energy.gov/~/media/fes/pdf/workshop-reports/20120309/FESAC-Materials-Science-final-report.pdf](http://science.energy.gov/~/media/fes/pdf/workshop-reports/20120309/FESAC-Materials-Science-final-report.pdf)

*Management Challenges*

As the current ITER governance framework was being formulated in 2003-06, three characteristics were determined to be paramount to mission success:

1. engagement of the top fusion physics and engineering talent available worldwide,
2. equitable sharing of the cost and risk such that no single sovereign nation bore the entire cost, or burden of risk, and
3. opportunity for development of industrial capabilities in ITER-related areas.

Achievement of these attributes was considered essential to forge the global team needed to meet the grand challenge of fusion. The equitable sharing was negotiated to be 1/11 (~9%) for the 6 non-host partners, including the U.S., and a 5/11 (~45%) share for the European Union host. For an approximately 9% share of the construction cost, the U.S. receives access to 100% of the project benefits. While the international partnership adds complexity and uncertainty to the project management and planning, the cost sharing affords sufficient national cost savings to overcome the cost increase related to the international aspects.

The ITER Project represents a grand management challenge no less in magnitude than the Manhattan and Apollo Projects, or the more recent International Space Station Program. Meeting grand challenges such as these required the unwavering commitment of highly skilled and dedicated teams. The ITER team is engaged in continuous improvement as a path to mission achievement. In November 2013, an external ITER Management Assessment report identified 11 specific recommendations for improvements. These recommendations have since been adopted by the ITER Council and translated into action plans that were approved by the Council and are now being implemented. The U.S. DOE and the U.S. ITER Project Office are actively engaged in the implementation of the action plans.

## CLOSING REMARKS

The ITER Project is making significant and measurable progress around the world. In the U.S., the ITER project is making good progress, constrained by funding. The U.S. project team has been aggressively proactive in performance of systems engineering with the ITER Organization to define the requirements and interfaces for U.S. systems, sufficiently to enable the U.S. to proceed with acceptable risk to fabrication of the systems needed for the integrated systems test of the core tokamak and First Plasma. The U.S. First Plasma systems constitute about 2/3 of the U.S. hardware contributions, with the remaining 1/3 being that balance of systems needed to produce and handle the large fusion power and enable detailed measurements of plasma behavior. First Plasma subsystem designs are sufficiently mature and the cost basis sufficiently sound to proceed to fabrication, with the greatest uncertainties related to the extended schedule. To address these uncertainties, a 47% contingency is included in the cost basis. According to a recent GAO report, "DOE's current cost estimate for the U.S. ITER Project reflects most of the characteristics of a reliable cost estimate, and its schedule estimates reflect all characteristics of a reliable schedule"; the GAO assessment concluded that the cost estimate developed by the U.S. ITER Project Office for DOE "substantially met best practices for comprehensive, well-documented, and accurate estimates."[5]

---

[5] *Actions Needed to Finalize Cost and Schedule Estimates for U.S. Contributions to an International Experimental Reactor*. GAO-14-499: Jun 5, 2014, pp. 25, 22.

The U.S. ITER schedule is driven by the international schedule for building construction and component assembly and installation. The present realistic U.S. schedule does not meet the currently agreed ITER international schedule (first plasma in 2020, not later than 2021), but could meet a realistic ITER international schedule if the associated U.S. funding profile is appropriated. The development of such a U.S. funding profile should be part of the international project planning effort wherein the Member countries and the ITER Organization refine individual schedules for component fabrication and overall installation and commissioning to achieve an acceptable integrated international master schedule, with supporting Member funding profiles. The U.S. ITER Project looks forward to the completion of that activity in the next year.

ITER will address the challenge of producing and controlling a self-heated burning plasma, the core of a magnetically-confined fusion reactor and an essential achievement for fusion energy development. Next steps beyond ITER will build on ITER science and technology, and address issues of fusion materials and components, power-conversion systems including breeding of the tritium fuel, and concept improvement. We see a realistic schedule for ITER that achieves both First Plasma and demonstration of self-heated, burning plasma within the next 20 years.

Thank you, Madame Chair and Members of the Committee. I will be happy to answer any questions you may have.

**Ned R. Sauthoff, Ph.D.**
Director, U.S. ITER Project Office
Tel: 865-574-5947
sauthoffnr@ornl.gov

Dr. Ned Sauthoff is a plasma physicist and project manager of the U.S. Contributions to ITER Project, the U.S. portion of an international partnership aimed at demonstrating the scientific and technological feasibility of fusion energy using magnetic confinement of plasmas. ITER is a large toroidal magnetic confinement device of the tokamak configuration that is being built by China, the European Union, India, Japan, South Korea, the Russian Federation, and the United States to enable study of a self-heated “burning” plasma, the core of a fusion reactor. It is sited in St. Paul-lez-Durance, France.

Prior to the establishment of the U.S. ITER Project Office, Ned was a physics researcher and head of the Off-Site Research Department at the Princeton Plasma Physics Laboratory (PPPL), where he managed experimental and theoretical work on leading facilities around the United States and the world to address key fusion physics and technology questions.

Early in his PPPL career, Ned developed x-ray instrumentation and performed research on tokamak plasmas. He managed design and operation of the control and data system for the Tokamak Fusion Test Reactor until 1985, and headed the PPPL Computer Division until 1988, the Princeton Beta Experiment until 1990, the Experimental Projects Department until 1992, the Physics Department until 1994, and the Plasma Science and Technology Department until 1997.

He is a fellow of the American Physical Society, the American Association for the Advancement of Science, and the Institute of Electrical and Electronics Engineers. Ned received his Bachelor of Science degree in physics and Master of Science degree in nuclear engineering from MIT and his Ph.D. in astrophysical sciences from Princeton University.