# Department of Energy Office of Science

# Fiscal Year 2008

# Performance Evaluation of UT-Battelle, LLC for the Management and Operations of the Oak Ridge National Laboratory

**February 2009**

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## I. OVERALL SUMMARY RATING/FEE

Performance-Based Score and Adjectival Rating:

The basis for the evaluation of UT-Battelle, LLC's, (the Contractor) management and operation of the Oak Ridge National Laboratory (ORNL) (the Laboratory) during Fiscal Year (FY) 2008 centered on the Objectives found within the following Performance Goals:

**1.0 Provide for Efficient and Effective Mission Accomplishment**

**2.0 Provide for Efficient and Effective Design, Fabrication, Construction and Operations of Research Facilities**

**3.0 Provide Effective and Efficient Science and Technology Program Management**

**4.0 Provide Sound and Competent Leadership and Stewardship of the Laboratory**

**5.0 Sustain Excellence and Enhance Effectiveness of Integrated Safety, Health, and Environmental Protection**

**6.0 Deliver Efficient, Effective, and Responsive Business Systems and Resources that Enable the Successful Achievement of the Laboratory Missions**

**7.0 Sustain Excellence in Operating, Maintaining, and Renewing the Facility and Infrastructure Portfolio to Meet Laboratory Needs**

**8.0 Sustain and Enhance the Effectiveness of Integrated Safeguards and Security Management (ISSM) and Emergency Management Systems**

Each Performance Goal was composed of two or more weighted Objectives and most Objectives had a set of performance measures, which assisted in determining the Contractor's overall performance in meeting that Objective. Each of the performance measures identified significant activities, requirements, and/or milestones important to the success of the corresponding Objective. The following describes the methodology utilized in determining the Contractor performance rating.

Each Objective within a Goal was assigned a numerical score by the evaluating office. Each evaluation measured the degree of effectiveness and performance of the Contractor in meeting the Objective and was based on the Contractor's success in meeting the set of Performance Measures/Targets identified for each Objective as well as other performance information available to the evaluating office from other sources. Other sources included, but were not limited to, the Contractor's self-evaluation report, operational awareness (daily oversight) activities; "For Cause" reviews (if any); other outside agency reviews [Office of Inspector General (OIG), General Accounting Office (GAO), Defense Contract Audit Agency (DCAA), etc.], and the annual two-week review (if needed). If no performance measures/targets were utilized, the description of the general expectations for the success of the objective was utilized

as the baseline of the effectiveness and performance of the Contractor in meeting the corresponding Objective and in determining the score assigned. The Goal score was then computed by multiplying the numerical score by the weight of each Objective within a Goal. These values were then added together to develop an overall score for each Goal. This score was then compared to Table A to determine the overall grade for each Goal. A set of tables is provided at the end of each Performance Goal section of this document to assist in the calculation of objectives scores to the Goal score. The raw score from each calculation was carried through to the next stage of the calculation process. The raw score for Science and Technology (S&T) and Management and Operations (M&O) was rounded to the nearest tenth of a point for utilization in determining fee as discussed below. A standard rounding convention of x.44 and less rounds down to the nearest tenth (here, x.4), while x.45 and greater rounds up to the nearest tenth (here, x.50).

| **Total Score** | **4.3-4.1** | **4.0-3.8** | **3.7-3.5** | **3.4-3.1** | **3.0-2.8** | **2.7-2.5** | **2.4-2.1** | **2.0-1.8** | **1.7-1.1** | **1.0-0.8** | **0.7-0** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Final Grade | A+ | A | A- | B+ | B | B- | C+ | C | C- | D | F |

**Table A. FY 2008 Contractor Letter Grade Scale**

Based on the evaluation of UT-Battelle's performance against the Goals and Objectives contained within the FY 2008 Performance Evaluation Measurement and Plan (PEMP), the scores and corresponding grades awarded for each are provided within Table B below. Goal weighting defined in Attachments 1 and 2 to the PEMP has been factored into the S&T Goal Scores. Specific information regarding the Contractor's performance in meeting each of the Goals and their corresponding Objectives is provided within Section II of this report.

| S&T Performance Goal | Numerical Score | Letter Grade | Weight | Weighted Score | Total Score |
|---|---|---|---|---|---|
| 1.0 Mission Accomplishment | 3.7 | A- | 39% | 1.45 | |
| 2.0 Construction and Operations of User Research Facilities and Equipment | 3.7 | A- | 30% | 1.10 | |
| 3.0 Science and Technology Program Management | 3.7 | A- | 31% | 1.16 | |
| | | | | **Total Score** | **3.7** |
| **M&O Performance Goal** | **Numerical Score** | **Letter Grade** | **Weight** | **Weighted Score** | **Total Score** |
| 4.0 Leadership and Stewardship of the Laboratory | 3.7 | A- | 15% | 0.56 | |
| 5.0 Integrated Safety, Health, and Environmental Protection | 3.7 | A- | 30% | 1.10 | |
| 6.0 Business Systems | 3.4 | B+ | 20% | 0.67 | |
| 7.0 Operating, Maintaining, and Renewing Facility and Infrastructure Portfolio | 3.6 | A- | 20% | 0.72 | |
| 8.0 Integrated Safeguards and Security Management and Emergency Management Systems | 3.5 | A- | 15% | 0.52 | |
| | | | | **Total Score** | **3.6** |

**Table B. FY 2008 Contractor Evaluation Score Calculation**

Performance-Based Fee Earned:

Utilizing Table B, above, the scores for each of the S&T Goals and M&O Goals were multiplied by the weight assigned and these were summed to provide an overall score for each. The percentage of the available performance-based fee that was earned by the Contractor was determined based on the overall weighted score for the S&T Goals (see Table B) and then compared to Table C below. The overall numerical score of the M&O Goals from Table B was then utilized to determine the final fee multiplier (see Table C), which was utilized to determine the overall amount of performance-based fee earned for FY 2008 as calculated within Table D. Based on the overall performance within the S&T and M&O Goals, the Contractor is awarded $10,058,000 in performance-based fee for FY 2008.

| Overall Weighted Score from Table B. | Percent S&T Fee Earned | M&O Fee Multiplier |
|---|---|---|
| 4.3 | 100% | 100% |
| 4.2 | | |
| 4.1 | | |
| 4.0 | 97% | 100% |
| 3.9 | | |
| 3.8 | | |
| 3.7 | 94% | 100% |
| 3.6 | | |
| 3.5 | | |
| 3.4 | 91% | 100% |
| 3.3 | | |
| 3.2 | | |
| 3.1 | | |
| 3.0 | 88% | 95% |
| 2.9 | | |
| 2.8 | | |
| 2.7 | 85% | 90% |
| 2.6 | | |
| 2.5 | | |
| 2.4 | 75% | 85% |
| 2.3 | | |
| 2.2 | | |
| 2.1 | | |
| 2.0 | 50% | 75% |
| 1.9 | | |
| 1.8 | | |
| 1.7 | 0% | 60% |
| 1.6 | | |
| 1.5 | | |
| 1.4 | | |
| 1.3 | | |
| 1.2 | | |
| 1.1 | | |
| 1.0 to 0.8 | 0% | 0% |
| 0.7 to 0.0 | 0% | 0% |

**Table C. - Performance-Based Fee Earned Scale**

| Overall Fee Determination | |
|---|---|
| Percent S&T Fee Earned from Table C. | 94% |
| M&O Fee Multiplier from Table C. | 100% |
| Overall Earned Performance-Based Fee | 94% |

**Table D. Final Percentage of Performance-Based Fee Earned Determination**

Performance Fee and Rating Adjustment Factor:

| Performance Adjustment Determination | |
|---|---|
| Percent Fee Earned from Table D. | 94% |
| Percentage of Performance Adjustment | 0 |
| Final Percentage of Fee Earned | 94% |
| Final Performance Percentage Awarded | 94% |

**Table E. Performance Adjustment Factor Calculation**

Based on the performance adjustment determination the Contractor is awarded $10,058,000 in performance-based fee for FY 2008.

## II. PERFORMANCE GOALS, OBJECTIVES, AND MEASURES/TARGETS

### 1.0 Provide for Efficient and Effective Mission Accomplishment

**The Contractor produces high-quality, original, and creative results that advance science and technology; demonstrates sustained scientific progress and impact; receives appropriate external recognition of accomplishments; and contributes to overall research and development goals of the Department and its customers.**

The weight of this Goal is 39 percent.

Score: 3.7 Grade: A-

ORNL plays a key role in simulation efforts with many significant contributions to computational science, computer science, and high performance computing (HPC). ORNL researchers are invited to give many talks at the SciDAC annual meeting and other significant conferences related to computational science and high performance computing. ORNL researchers have made many important contributions to related publications and are considered leaders in many aspects of HPC and computational science. However, many years of excellent work has raised Office of Advanced Scientific Computing Research (ASCR) expectations for ORNL such that this level of accomplishment meets expectations with a few key exceptions, which exceeded expectation (climate contributions, Adaptable Input Output System [ADIOS], and other breakthroughs).

Materials sciences programs (in x-ray and neutron scattering, z-contrast electron microscopy, materials discovery and growth, interface science, bulk metallic glasses, and materials theory) and chemical sciences programs (in separations and analysis; catalysis and chemical transformations; and atomic, molecular and optical sciences) demonstrated sustained scientific progress, publication, and impact.

ORNL exhibited exceptional scientific leadership and innovation in its start up of the highly productive BioEnergy Science Center in FY 2008. ORNL has a broad-based research program across Office of Biological and Environmental Research (BER) programs that are highly relevant to Department of Energy (DOE) mission needs. ORNL exhibits strong scientific leadership across these programs and produces highly productive, impactful research results. ORNL scientists exhibit broad leadership in many fields of science and are widely recognized for their expertise. ORNL is exceptionally responsive to BER needs and is very effective at meeting diverse program needs and milestones.

ORNL was very effective in providing the fusion and plasma science research community with the atomic data that they needed. ORNL has done an excellent job in conducting their materials science research activities as well as collaborating with the rest of the U.S. fusion materials community. They are recognized both domestically and internationally for their strong scientific capabilities. ORNL is a center of expertise in heating and fueling technology that helps fusion devices reach new regimes of

experimental operations and the domestic and international research community recognizes this with their many requests for assistance. ORNL theory group continues to make significant contributions on a number of technical issues.

The ORNL nuclear physics group performs at a high level in all areas in mission accomplishment as demonstrated by:

- First measurement anywhere of the cross section for proton capture by F-17, a key reaction to understand the explosions of novae.
- Leadership in the U.S. and among leaders in the world for development of Isotope-Separator-on-Line (ISOL) technology and methods for the production of radioactive ion beams.
- A substantial body of research published in peer-reviewed journals and theses from research at the Holifield Radioactive Ion Beam Facility (HRIBF).
- Effective communication of facility and research progress and plans at the HRIBF Science and Technology Review.
- Conducts and leads studies of heavy quark, J/Y suppression, and prompt photon production in the heavy-ion research at the Relativistic Heavy Ion Collider.
- Important contributions by the two local theory groups, in astrophysics and in nuclear structure, to the planning and interpretation of the HRIBF experimental effort.

ORNL exceeded expectations in mission accomplishment for the Energy Efficiency and Renewable Energy (EERE) programs. The program demonstrated sustained scientific progress and leadership, as well as producing high-quality results that advance science and technology. Significant and notable achievements were identified across multiple program areas. The Buildings Technologies Program demonstrated ninety percent peak demand reduction of cooling loads on residential roofing from its prototype system. In depth testing and analysis of ORNL's insulation doped with phase change material has shown that it will have a significant contribution to peak demand cooling loads and will have moderate energy savings in targeted climate areas. The ORNL Federal Energy Management Program's (FEMP) Super Energy Savings Performance Contract (ESPC) project under Secretary Bodman's Transformational Efficiency Action Management (TEAM) Initiative set a new DOE record for reduced cycle time (months elapsed from kickoff to award). ORNL's Weatherization and Intergovernmental Program performed an analysis of the impact of cap-and-trade carbon policy on residential energy and transportation bills, which marked the first systematic effort to anticipate the impact of such policies at the regional level, by fuel type, and by demographic profile.

ORNL has made significant research achievements and program impacts to the Office of Electricity Delivery and Energy Reliability (OE) in the areas of high temperature superconductivity (HTS) wire processing. The development of a visualization tool for

wide-area monitoring of the grid and assessing value added electrical services, such as reactive power compensation and voltage support, from distributed energy resources. ORNL has accomplished all major milestones in the OE program for FY 2008 including the CPS control milestones and contributed toward accomplishment of the HTS joule target. In some cases milestones were met well ahead of schedule.

In support of National Nuclear Security Administration (NNSA), ninety percent of milestones (45 out of 50) were completed on schedule and within budget. ORNL is an Internationally Recognized Leader in Sensitivity and Uncertainty Analysis and Differential Neutron Cross-Section Measurements for Criticality Safety.

The Global Threat Reduction Initiative (GTRI) mission is: Reduce and protect vulnerable nuclear and radiological material located at civilian sites worldwide. ORNL has been *exceptional* in accomplishing its missions for GTRI; ORNL support, with technical expertise and management, to GTRI field teams has been instrumental in GTRI achieving its metrics for FY 2008. Of particular note is *Operation McCall* in which ORNL repatriated from Iraq to Canada four high activity irradiators deemed to pose a threat to U.S. forces. This part of *Operation McCall* was planned and executed with extraordinary efficiency and effectiveness under very trying physical and security circumstances. ORNL has also provided substantial contributions by providing internationally recognized experts to GTRI input to technical standards being developed by the International Atomic Energy Agency. ORNL provided outstanding support that was critical to GTRI's accomplishment of Highly Enriched Uranium (HEU) spent fuel shipment from Latvia to Russia in April 2008.

ORNL supported the Nuclear Noncompliance Verification program by developing tools and methods to implement international safeguards at uranium conversion and enrichment plants. ORNL supported work in the area of nuclear forensic analysis and administers U.S. participation in the International Atomic Energy Agency (IAEA) Network of Analytical Laboratories and supported the Warhead and Fissile Material Transparency Program. Technical support for the HEU Transparency Program activities was recognized including maintaining operation of the Blend Down Monitoring Systems in Russia and provided senior technical support for monitoring visits to Russian facilities.

ORNL provided broad technical support to Global Initiatives for Proliferation Prevention for projects encompassing specialty materials, chemical process technology, and environmental remediation; two of its projects successfully commercialized, creating sustainable jobs in Ukraine and Russia. ORNL provided support to the International Nonproliferation Export Control Program, specifically maintaining our partnership with Russia and supporting joint training with U.S. Customs and Border Protection. ORNL provided technical support to the International Safeguards and Engagement Program (INSEP), and supported the Additional Protocol team for the DOE complex-wide draft data call process, and provided support in the areas of Gas Centrifuge Safeguards and nuclear infrastructure assistance.

ORNL provided enrichment technology and safeguards training to the IAEA and supported the NA-24 safeguards team on uranium enrichment plant safeguards and Next Generation Safeguards Initiative (NGSI) summer internships, including hosting a Gas Centrifuge Enrichment Plant Safeguards workshop in July 2008, and mentoring 15 student interns. ORNL provided technical reviews for 216 Department of Commerce dual-use cases, and supported: (1) development of Version 2 for on-line access of the Proliferation Trade Control Database (PTCD) by finalizing software and cyber security requirements documents and test plan, enhancing the data search engine and technical data content on commodity overviews, and volume of records; (2) creating and developing a compilation of data on DOE funded software into a data base catalogue which will identify DOE proliferation sensitive codes; and (3) creating a software tool by enhancing existing tools to provide support to the review of DOE technical documents for export controlled information (ECI).

ORNL supported the NGSI, including drafting portions of the NGSI Program Plan. ORNL also supported the India-Pakistan-China net assessment study. ORNL subcontractors produced a supremely high level of technical and administrative support to NA-25 work at Elektrostal and Bochvar.

ORNL provided efficient and effective mission support to NA-25's International Cooperative License (ICL), ICL Assurances, travel and financial data. Support is instrumental in helping NA-25 accomplish its program goals. ORNL provided excellent support to the Office of Nonproliferation and International Security (ONIS) Transportation Security Project (TSP) and the radio frequency (RF) Navy Training and Technical Support (NTTS) Project. Support was efficient and effective.

ORNL did a solid job of providing training expertise in Russia for the Office of Second Line of Defense (SLD) Core Program. This ensured effective mission accomplishment by contributing to a sustainable Russian training effort to support portal deployments. As part of this training support, ORNL supported Russian efforts to exercise the portal deployments, an important part of ensuring effective operation. ORNL subject matter expert, working-level management, logistics, and contracting support of Office of Material Consolidation and Civilian Site (MCCS) Atomflot Port and Kurchatov Institute projects has been excellent.

In support of the Nuclear Energy program, ORNL continues to provide excellent technical contributions in the following areas: Isotope Programs, where ORNL exceeded expectations in meeting customer demands; Nuclear Hydrogen Initiative, in which ORNL consistently challenges the hydrogen community to look for improved synergies to expand the role of nuclear hydrogen; Advanced Fuel Cycle Initiative, where ORNL has developed experimental capabilities as part of the on-going Coupled-End-to-End Demonstration to collect and quantify volatile radioactive emissions, particularly tritium emissions, that have the potential to significantly reduce the environmental impact of world-wide commercial-scale reprocessing plants; and Gen IV/NGNP task in which ORNL deliverables and reports on the AGR TRISO fuel program have been on time, or even early.

But ORNL provided less than effective management on the Advanced Fuel Cycle Initiative in the following areas- schedule estimating, planning, and administration, and personnel misinterpreting Program Manager communications.

In support of FE programs, ORNL is performing tests on candidate materials for steam turbines for use in Ultra-Supercritical Steam Cycle (USC) power plants. This testing encompasses a wide range of materials evaluation. This work was restarted in FY 2008 after a year off due to no funding, and is critical to the success of the USC program.

The Contractor has produced high-quality, original, and creative results that advance science and technology; demonstrates sustained scientific progress and impact; receives appropriate external recognition of accomplishments; and contributes to overall research and development goals of the Department and its customers. The following achievements are noted as support. The researchers have continued their outstanding contributions to DOE's Carbon Sequestration Program that supports the Global Climate Change initiative by conducting field and lab studies that focus on the Greenhouse Gas (GHG) mitigation technology of geologic storage of carbon dioxide. This effort is a Presidential Initiative. ORNL researchers are investigating the use of isotopes and tracers to monitor the fate and transport of carbon dioxide injected into subsurface reservoirs. This work is vital to the Program mission because safe, permanent, and accountable storage of carbon dioxide is a requirement for the successful use of technology. The researchers continue to be in the forefront of this research on the use of tracers, isotopes and reservoir geochemistry and are part of international teams conducting field studies of carbon dioxide injection at DOE's Regional Partnership, Southeast Regional Carbon Sequestration Partnership (SECARB), Cranfield, Mississippi site and the now completed Frio Formation, Texas brine pilot site. Both projects are endorsed as Carbon Sequestration Leadership Forum projects, and have international recognition. The ORNL researchers are providing field support and analyses in their specialty area of tracers, isotopes, and reservoir geochemistry. Their collaboration with the Environmental Protection Agency (EPA) on monitoring, verification, and accounting is also noteworthy, and has led to a proposed rule and recommendation by the EPA that tracers and isotopes should be included as a monitoring criteria. ORNL research has high impact on DOE's Carbon Sequestration Program mission, and is resolving critical questions that are allowing the research area to move forward. As part of the Frio pilot team, their research generated huge interest both within the U.S. and internationally, and led to an invitation to participate in the SECARB Cranfield injection demonstration.

The Solid State Energy Conversion Alliance (SECA) Core Technology Program project has been successful in achieving program objectives. The team's work on solid oxide fuel cell (SOFC) cathode side interfaces, the American Society of Mechanical Engineers (ASME) SOFC Design Basis and assistance to various SECA Industry Teams was effective and efficient.

ORNL is evaluating and improving coatings to provide the basis for more robust hot gas path components in gas turbines when fired with coal-derived syngas and H2-enriched fuel gases. This effort is intended to complement the efforts of other programs in the DOE Syngas/Hydrogen Turbine program by addressing the longer range needs for

improved or new materials for the reliable operation of these turbines. ORNL's bond coat materials based on g-g'-based Pt-rich aluminide coatings, Yttria Stabilized Zirconia (YSZ) top coatings will demonstrate its feasibility in a real turbine environment. This new class of g-g'-based Pt-rich aluminide coatings have much higher strength and less Al interdiffusion than other coatings. These coatings offer the possibility of being more durable than current coatings and their performance is being explored. ORNL continues to make significant contributions to the FE Advanced Research Materials Program by providing much needed solutions to the materials challenges associated with development of advanced power generation systems. ORNL demonstrates its world-renowned status in the execution of this work by producing high-quality, original, and creative research. ORNL is known as one the preeminent and world-class organizations when it comes to research and development for advanced alloys, intermetallics, ceramics, coatings, etc.

ORNL is performing tests on candidate materials for USC power plants. This testing encompasses a wide range of materials evaluation some of which include: mechanical properties of advanced alloys, steamside oxidation evaluations, and fireside corrosion evaluations. This work is critical to the success of the USC program. ORNL continues to publish papers and generate interest in the work from an international audience.

ORNL has provided excellent technical support to the NRC. On the majority of NRC projects ORNL has provided excellent services with regards to project deliverables, communication, and responsiveness to Program Manager needs.

| Science Program Office | Letter Grade | Numerical Score | Objective Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| **Office of Advanced Scientific Computing Research** | | | | | |
| 1.1 Impact | A- | 3.5 | 40% | 1.40 | |
| 1.2 Leadership | B+ | 3.4 | 30% | 1.02 | |
| 1.3 Output | B+ | 3.4 | 15% | 0.51 | |
| 1.4 Delivery | B+ | 3.4 | 15% | 0.51 | |
| | | | | **Total** | 3.44 |
| **Office of Basic Energy Sciences** | | | | | |
| 1.1 Impact | B+ | 3.2 | 50% | 1.60 | |
| 1.2 Leadership | B+ | 3.1 | 20% | 0.62 | |
| 1.3 Output | A- | 3.7 | 15% | 0.56 | |
| 1.4 Delivery | A- | 3.7 | 15% | 0.56 | |
| | | | | **Total** | 3.33 |
| **Office of Biological and Environmental Research** | | | | | |
| 1.1 Impact | A | 3.9 | 30% | 1.17 | |
| 1.2 Leadership | A | 3.9 | 20% | 0.78 | |
| 1.3 Output | A | 3.8 | 20% | 0.76 | |
| 1.4 Delivery | A | 4.0 | 30% | 1.20 | |
| | | | | **Total** | 3.91 |

| Science Program Office | Letter Grade | Numerical Score | Objective Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| **Office of Fusion Energy Sciences** | | | | | |
| 1.1 Impact | A+ | 4.1 | 28% | 1.15 | |
| 1.2 Leadership | A | 4.0 | 24% | 0.96 | |
| 1.3 Output | A- | 3.6 | 23% | 0.83 | |
| 1.4 Delivery | A- | 3.6 | 25% | 0.90 | |
| | | | | **Total** | 3.84 |
| **Office of Nuclear Physics** | | | | | |
| 1.1 Impact | A- | 3.6 | 35% | 1.26 | |
| 1.2 Leadership | A- | 3.6 | 25% | 0.90 | |
| 1.3 Output | A- | 3.7 | 25% | 0.93 | |
| 1.4 Delivery | A- | 3.7 | 15% | 0.56 | |
| | | | | **Total** | 3.64 |

**Table 1.1 - 1.0 SC Program Office Performance Goal Score Development**

| Science Program Office | Letter Grade | Numerical Score | Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| **Office of Advanced Scientific Computing Research** | B+ | 3.44 | 15.8% | 0.54 | |
| **Office of Basic Energy Sciences** | B+ | 3.33 | 49.2% | 1.64 | |
| **Office of Biological and Environmental Research** | A | 3.91 | 17.3% | 0.68 | |
| **Office of Fusion Energy Sciences** | A | 3.84 | 12.3% | 0.47 | |
| **Office of Nuclear Physics** | A- | 3.64 | 5.4% | 0.20 | |
| | | | **Performance Goal 1 Total** | | 3.53 |

**Table 1.2 - SC Program Office Overall Performance Goal Score Development**

| HQ Program Office | Letter Grade | Numerical Score | Objective Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| **Energy Efficiency and Renewable Energy** | | | | | |
| 1.1 Impact | A | 4.0 | 25% | 1.00 | |
| 1.2 Leadership | A | 4.0 | 25% | 1.00 | |
| 1.3 Output | A | 4.0 | 25% | 1.00 | |
| 1.4 Delivery | A | 4.0 | 25% | 1.00 | |
| | | | | **Total** | 3.99 |
| **Electricity Delivery and Energy Reliability** | | | | | |
| 1.1 Impact | A | 3.9 | 25% | 0.98 | |
| 1.2 Leadership | A | 3.8 | 25% | 0.95 | |
| 1.3 Output | A | 3.8 | 25% | 0.95 | |
| 1.4 Delivery | A | 3.8 | 25% | 0.95 | |
| | | | | **Total** | 3.83 |
| **Nuclear Energy** | | | | | |
| 1.1 Impact | A | 4.0 | 25% | 1.00 | |
| 1.2 Leadership | A | 3.8 | 25% | 0.95 | |
| 1.3 Output | A- | 3.6 | 25% | 0.90 | |
| 1.4 Delivery | A- | 3.6 | 25% | 0.90 | |
| | | | | **Total** | 3.75 |
| **National Nuclear Security Administration** | | | | | |
| 1.1 Impact | A | 4.0 | 40% | 1.60 | |
| 1.2 Leadership | A | 4.0 | 20% | 0.79 | |
| 1.3 Output | A | 4.0 | 20% | 0.80 | |
| 1.4 Delivery | A | 4.0 | 20% | 0.80 | |
| | | | | **Total** | 3.99 |
| **Fossil Energy** | | | | | |
| 1.1 Impact | A- | 3.7 | 25% | 0.93 | |
| 1.2 Leadership | A- | 3.7 | 25% | 0.93 | |
| 1.3 Output | A- | 3.5 | 25% | 0.88 | |
| 1.4 Delivery | A | 4.0 | 25% | 1.00 | |
| | | | | **Total** | 3.73 |
| **Department of Homeland Security** | | | | | |
| 1.1 Impact | A | 3.8 | 25% | 0.95 | |
| 1.2 Leadership | A | 3.8 | 25% | 0.95 | |
| 1.3 Output | B+ | 3.3 | 25% | 0.83 | |
| 1.4 Delivery | B+ | 3.3 | 25% | 0.83 | |
| | | | | **Total** | 3.55 |
| **Nuclear Regulatory Commission** | | | | | |
| 1.1 Impact | A | 3.8 | 25% | 0.95 | |
| 1.2 Leadership | A | 3.8 | 25% | 0.95 | |

| HQ Program Office | Letter Grade | Numerical Score | Objective Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| 1.3 Output | A- | 3.7 | 25% | 0.93 | |
| 1.4 Delivery | A | 3.8 | 25% | 0.95 | |
| | | | | **Total** | 3.78 |

**Table 1.3 - Other Program Office Performance Goal Score Development**

| HQ Program Office | Letter Grade | Numerical Score | Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| **Office of Science** | A- | 3.53 | 51.6% | 1.82 | |
| **Energy Efficiency and Renewable Energy** | A | 3.99 | 8.5% | 0.34 | |
| **Electricity Delivery and Energy Reliability** | A | 3.83 | 2.6% | 0.10 | |
| **Nuclear Energy** | A | 3.75 | 5.3% | 0.20 | |
| **National Nuclear Security Administration** | A | 3.99 | 24.4% | 0.97 | |
| **Fossil Energy** | A- | 3.73 | 0.7% | 0.03 | |
| **Department of Homeland Security** | A- | 3.55 | 5.1% | 0.18 | |
| **Nuclear Regulatory Commission** | A | 3.78 | 1.8% | 0.07 | |
| | | | | **Performance Goal 1.0 Total** | 3.70 |

**Table 1.4 - Overall Performance Goal Score Development (weighted by BA & goal %)**

| Total Score | 4.3-4.1 | 4.0-3.8 | 3.7-3.5 | 3.4-3.1 | 3.0-2.8 | 2.7-2.5 | 2.4-2.1 | 2.0-1.8 | 1.7-1.1 | 1.0-0.8 | 0.7-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Final Grade | A+ | A | A- | B+ | B | B- | C+ | C | C- | D | F |

**Table 1.5 – Goal Final Letter Grade**

## 2.0 Provide for Efficient and Effective Design, Fabrication, Construction and Operations of Research Facilities.

**The Contractor provides effective and efficient strategic planning; fabrication, construction, and/or operations of Laboratory research facilities; and are responsive to the user community.**

The weight of this Goal is 30 percent

Score: 3.7 Grade: A-

Over the past year, the Oak Ridge Leadership Computing Facility (OLCF) has truly become a user facility rather than a computer center providing cycles. As noted by the Lehman Review Panel convened in February 2008, the staff at Oak Ridge has succeeded in creating a culture that is focused on building a simulation user facility rather than on merely installing the high performance computing platforms. Five of the top ten scientific breakthroughs, as identified by a panel of computational scientists, were enabled by the staff and resources at the OLCF.

The Spallation Neutron Source (SNS) completed its second full year of commissioning and operations, achieving a power level exceeding 620 kilowatts as a world record. The High Flux Isotope Reactor (HFIR) has maintained a perfect record of on-time start-ups with 99 percent reliability. Both the Center for Nanophase Materials Sciences (CNMS) and the Shared Research Equipment (SHaRE) user facilities operated efficiently and effectively with minimal downtime. The performance of ORNL's researchers in the Transmission Electron Aberration-corrected Microscopy (TEAM) project remains a concern.

ORNL has been very effective in developing user programs and attracting interested scientists to use and contribute to the development of biological applications for neutrons. ORNL plays a critical and highly effective role in the Atmospheric Radiation Measurement (ARM) program as curator of the data archive for the ARM program and the ARM Climate Research Facility. ORNL is highly responsive to diverse user communities involved in the use of neutrons for biological applications and for climate scientists interested in ARM facility data. ORNL effectively leverages its user facility capabilities to develop and enhance its own research capabilities and interests. They have been particularly effective at leveraging ORNL's high performance computing capabilities for both bioenergy and climate modeling applications.

Overall, ORNL exceeded expectations in design, fabrication, and construction of research facilities primarily due to their excellent efforts on ITER. However, ORNL partnered with the Princeton Plasma Physics Laboratory (PPPL) on the National Compact Stellarator Experiment (NCSX), which had significant cost overruns and schedule delays that contributed to the termination of the project.

The ORNL nuclear physics group performs at a high level in all areas of design, fabrication, and operation of research facilities:

- A total of 4,430 hours of radioactive ion beams on target via the Isotope Separator On-Line (ISOL) and in-flight methods, as well as stable beams, exceeding plans. Scientific productivity measured by the number of events in PART/Joules was also exceeded. Reliability was 82 percent, exceeding requirements.

- Continued development of the intensity and variety of ISOL beams, including a critical increase of the intensity of the F-17 beam by a factor of ten.

- Completion of the Fundamental Neutron Physics Beamline (FNPB) cold neutron capability at the SNS, to enable a national neutron physics research program.

ORNL continues to maintain and use its heat pump testing facilities, an excellent resource that is also utilized by industry via Cooperative Research and Development Agreements (CRADAs). ORNL has also been very effective in encouraging and gaining the participation of the other Building America teams in the design and implementation of ORNL lab houses.

Nuclear Hydrogen Initiative-Modest level of planned research activity was curtailed due to Nuclear Hydrogen Initiative (NHI) budget reduction. Compromised level of research was well executed.

| Science Program Office | Letter Grade | Numerical Score | Objective Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| **Office of Advanced Scientific Computing Research** | | | | | |
| 2.1 Effective Facility Designs | A | 3.8 | 10% | 0.38 | |
| 2.2 Construction/Fabrication | A- | 3.5 | 10% | 0.35 | |
| 2.3 Operation of Facilities | A | 3.8 | 70% | 2.66 | |
| 2.4 Support Research Base | B+ | 3.4 | 10% | 0.34 | |
| | | | | **Total** | 3.73 |
| **Office of Basic Energy Sciences** | | | | | |
| 2.1 Effective Facility Designs | A- | 3.7 | 10% | 0.37 | |
| 2.2 Construction/Fabrication | B | 3.0 | 20% | 0.60 | |
| 2.3 Operation of Facilities | A- | 3.7 | 50% | 1.85 | |
| 2.4 Support Research Base | A- | 3.7 | 20% | 0.74 | |
| | | | | **Total** | 3.56 |
| **Office of Biological and Environmental Research** | | | | | |
| 2.1 Effective Facility Designs | | | 0% | 0.00 | |
| 2.2 Construction/Fabrication | | | 0% | 0.00 | |

| Science Program Office | Letter Grade | Numerical Score | Objective Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| 2.3 Operation of Facilities | A- | 3.7 | 90% | 3.33 | |
| 2.4 Support Research Base | A | 3.9 | 10% | 0.39 | |
| | | | | **Total** | 3.72 |
| **Office of Fusion Energy Sciences** | | | | | |
| 2.1 Effective Facility Designs | A+ | 4.1 | 65% | 2.67 | |
| 2.2 Construction/Fabrication | B | 3.0 | 35% | 1.05 | |
| 2.3 Operation of Facilities | | | 0% | 0.00 | |
| 2.4 Support Research Base | | | 0% | 0.00 | |
| | | | | **Total** | 3.72 |
| **Office of Nuclear Physics** | | | | | |
| 2.1 Effective Facility Designs | | | 0% | 0.00 | |
| 2.2 Construction/Fabrication | | | 0% | 0.00 | |
| 2.3 Operation of Facilities | A | 3.8 | 85% | 3.23 | |
| 2.4 Support Research Base | A- | 3.7 | 15% | 0.56 | |
| | | | | **Total** | 3.79 |

**Table 2.1 - 2.0 SC Program Office Performance Goal Score Development**

| Science Program Office | Letter Grade | Numerical Score | Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| **Office of Advanced Scientific Computing Research** | A- | 3.73 | 20.3% | 0.76 | |
| **Office of Basic Energy Sciences** | A- | 3.56 | 63.2% | 2.25 | |
| **Office of Biological and Environmental Research** | A- | 3.72 | 6.7% | 0.25 | |
| **Office of Fusion Energy Sciences** | A- | 3.72 | 5.7% | 0.21 | |
| **Office of Nuclear Physics** | A | 3.79 | 4.1% | 0.16 | |
| **Performance Goal 2 Total** | | | | | 3.62 |

**Table 2.2 - SC Program Office Overall Performance Goal Score Development**

| HQ Program Office | Letter Grade | Numerical Score | Objective Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| **Energy Efficiency and Renewable Energy** | | | | | |
| 2.1 Effective Facility Designs | | | | | |
| 2.2 Construction/Fabrication | | | | | |
| 2.3 Operation of Facilities | A | 4.0 | 100% | 3.98 | |

| HQ Program Office | Letter Grade | Numerical Score | Objective Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| 2.4 Support Research Base | | | | | |
| | | | | **Total** | 3.98 |
| **Nuclear Energy** | | | | | |
| 2.1 Effective Facility Designs | | | | | |
| 2.2 Construction/Fabrication | | | | | |
| 2.3 Operation of Facilities | A+ | 4.1 | 50% | 2.05 | |
| 2.4 Support Research Base | A | 3.8 | 50% | 1.90 | |
| | | | | **Total** | 3.95 |

**Table 2.3 – Headquarters (HQ) Program Office Performance Goal Score Development**

| HQ Program Office | Letter Grade | Numerical Score | Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| **Office of Science** | A- | 3.62 | 87.7% | 3.18 | |
| **Energy Efficiency and Renewable Energy** | A | 3.98 | 10.8% | 0.43 | |
| **Nuclear Energy** | A+ | 3.95 | 1.5% | 0.06 | |
| | | | | **Performance Goal 2 Total** | 3.67 |

**Table 2.4 - Overall Program Office Performance Goal Score Development**

| Total Score | 4.3-4.1 | 4.0-3.8 | 3.7-3.5 | 3.4-3.1 | 3.0-2.8 | 2.7-2.5 | 2.4-2.1 | 2.0-1.8 | 1.7-1.1 | 1.0-0.8 | 0.7-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Final Grade | A+ | A | A- | B+ | B | B- | C+ | C | C- | D | F |

**Table 2.5 – Goal Final Letter Grade**

**3.0 Provide Effective and Efficient Science and Technology Program Management.**

**The Contractor provides effective program vision and leadership; strategic planning and development of initiatives; recruits and retains a quality scientific workforce; and provides outstanding research processes, which improve research productivity.**

The weight of this Goal is 31 percent

Score: 3.7 Grade: A-

ORNL has emerged as an international powerhouse in high performance computing over a short period of time due in large part to the leadership, vision, planning and communications of program management. ASCR does not wish to diminish that accomplishment but has concerns with regard to ORNL spreading its talent over too many activities. In addition, there were several significant shortfalls in FY 2008 that were noteworthy, if not impactful on overall scientific and technical accomplishment of ORNL, which remains impressive.

Program management of materials sciences and chemical sciences research programs and of scientific user facilities has been effective. Materials Sciences program did not reach its full potential due in large part to the lack of a permanent program coordinator.

ORNL has provided exceptional vision, leadership, and management in its development of the BioEnergy Science Center by reaching out to research partners at other institutions and through its engagement of the State of Tennessee. ORNL is among the most responsive laboratories in its consistent and effective interactions with BER. ORNL keeps BER staff well informed of its research progress, plans, and issues that arise. ORNL consults effectively with BER in its scientific planning process. ORNL has also done an exceptional job in recruiting widely recognized, leading scientists to lead and develop laboratory research and capabilities.

The ORNL nuclear physics group performs at a high level in all areas of science and technology program management:

- Effective management of the ISOL radioactive beam program for research by an international user community.
- Responsive and proactive planning with the Office of Nuclear Physics for the transfer of the Isotopes Program to NP.
- Responsive actions and communications with NP concerning facility operations.

ORNL's Building Technologies Program (BTP) has excellent vision for the contributions that the next generation of roofs and materials will play in achieving zero energy buildings. This knowledge has been conveyed to a large array of stakeholders

domestically and internationally through white papers, presentations, and other materials. However, ORNL needs to improve its communication to DOE on issues of potential importance to EERE upper management. Monthly reporting is often too late for weekly highlight reports. ORNL FEMP developed a format for a dashboard report on the Super ESPC program and, since the beginning of fiscal year 2008, has been delivering this report monthly to DOE Headquarters. Using information extracted from a number of databases that ORNL maintains, the report provides a concise summary of key ESPC program statistics. ORNL's Weatherization program has provided leadership through its participation in the Weatherization Plus long-range strategic planning initiative.

ORNL provided strong OE S&T program management support in establishing a strategic vision, assisted on the development of Research and Development (R&D) plans, and delivered quality products. ORNL has also expanded its capabilities and core competencies through careful consideration of resource allocation, leveraging institutional knowledge in computing, and by revitalizing equipment.

ORNL isotope efforts in planning, business strategy development, and communication helped increase customer satisfaction as well as sustain a strong fiscal performance. ORNL notably exceeded expectations overall. Program accomplishments include:

- (Space Program) ORNL has staffed their S&T programs with individuals having abilities in advanced scientific material applications. The material staff has communicated with other government agencies and national laboratories.

- (Nuclear Hydrogen Initiative) ORNL complied with all NE Program Management requirements.

- (GEN IV/NGNP) The AGR TRISO fuel team at ORNL has complied with all NE Program Management requirements.

The ORNL Technical Staff were instrumental contributors in the development of the NNSA Nuclear Criticality Safety Program (NCSP) Ten Year Mission-Vision. ORNL continues to provide visionary leadership in the area of Nuclear Methods and Nuclear Data in the specialized field of criticality safety. ORNL has excelled in its provision of project management services for the BN-350 Permanent Disposition Project during FY 2008. ORNL excelled in management of GTRI's complex fuel return project work in FY 2008. ORNL provided first-rate technical support to International Nuclear Safeguards and Engagement Program's (INSEP's) safeguards and nuclear infrastructure development activities, and made key contributions (e.g., conduct of safeguards cooperation with China, Indonesia, Brazil, Argentina, Australia, the Brazilian-Argentine Agency for Nuclear Material Control and Accountancy). ORNL provided excellent support for infrastructure development seminars, working in cooperation with other labs. Of note was the technical assistance provided for INSEP activities with Morocco, Algeria, and Thailand. ORNL remained proactive in development of new ideas for INSEP engagement as well as logistical preparations for many international meetings. ORNL maintained its role as the technical lead for International Nonproliferation and Export Controls Program (INECP) in Russia and South Africa, provided instructors for

many seminars, and played an important role in curriculum development. ORNL representatives provided high quality technical and project management work and the ORNL staff contributions have enabled the completion of work by the 2008 Presidential deadline, as declared at the 2005 Bratislava Summit Meeting. ORNL support staff is entrusted with a wide and deep range of program management-related responsibilities from advising Headquarters (HQ) on cost projections and budget management, as well as technical evaluation of contract deliverables, and providing site-specific, expert advice to HQ. In all of these capacities, subcontractor employees have demonstrated the highest level of effectiveness and efficiency. ORNL has done a good job of managing its program in data analysis and radiation expertise in support of NNSA's Office of Second Line of Defense.

ORNL provides FE strong leadership in the USC steam turbine program demonstrating their materials knowledge and expertise. The Contractor has provided effective program vision and leadership; strategic planning and development of initiatives; recruiting and retaining a quality scientific workforce; and providing outstanding research processes, which improve research productivity. Key competencies to support research initiatives, quality research plans, and effective communications have been exhibited. The researchers provide a high degree of effective and efficient science and technology research project/program management. This is demonstrated by achievements in the following:

- Extensive joint planning with the outside scientific community is exemplified by their participation in the research team for the Frio pilot project and now the SECARB Cranfield, Mississippi carbon dioxide injection demonstration. Both projects are endorsed as a Carbon Sequestration Leadership Forum (CSLF) projects and have international participation and recognition; results are being provided to the U.S. and international community. Their collaboration with the EPA on monitoring, verification, and accounting is also noteworthy, and has led to a proposed rule and recommendation by the EPA that tracers and isotopes should be included as a monitoring criteria.

- The researchers have articulated scientific vision well with respect to their specialty of use of isotopes, tracers, and reservoir chemistry as a monitoring tool for geologic storage of carbon dioxide. They are world leaders in this area as supported by their unique participation in the CSLF Frio pilot and SECARB Cranfield, Mississippi demonstration site, as well as the invitations to participate in similar geologic storage projects.

- Highly effective and efficient science and technology project/program planning and management have been provided by the researchers. This is supported by the high quality Field Work Proposals submitted, the annual reporting of project status, and the leveraging/synergy with other areas of research such as the Frio injection pilot study and EPA coordination.

In addition, the researchers have been able to meet milestones under FY budget constraints and the contactor has a good management plan with an excellent research team. During this time of reduced funding, ORNL continues to provide quality work and

looks for ways to continue the much needed work in the development of materials for advanced power generation systems. ORNL works with National Energy Technology Laboratory (NETL) to prioritize the work and help identify the most effective and efficient ways to perform the research. ORNL attempts to leverage the FE funding by utilizing data and information gathered from other projects whenever possible.

ORNL has successfully provided scientific expertise to the DHS program office and maintained the programs vision through contact with stakeholders.

ORNL demonstrated outstanding quality and excellence in supporting SCALE for NRC.

| Science Program Office | Letter Grade | Numerical Score | Objective Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| **Office of Advanced Scientific Computing Research** | | | | | |
| 3.1 Effective/Efficient Stewardship | B+ | 3.3 | 30% | 0.99 | |
| 3.2 Project/Program Planning & Management | B | 2.8 | 40% | 1.12 | |
| 3.3 Communications and Responsiveness | B | 3.0 | 30% | 0.90 | |
| | | | | **Total** | 3.01 |
| **Office of Basic Energy Sciences** | | | | | |
| 3.1 Effective/Efficient Stewardship | B+ | 3.4 | 40% | 1.36 | |
| 3.2 Project/Program Planning & Management | B+ | 3.4 | 30% | 1.02 | |
| 3.3 Communications and Responsiveness | A- | 3.7 | 30% | 1.11 | |
| | | | | **Total** | 3.49 |
| **Office of Biological and Environmental Research** | | | | | |
| 3.1 Effective/Efficient Stewardship | A+ | 4.1 | 20% | 0.82 | |
| 3.2 Project/Program Planning & Management | A | 3.8 | 30% | 1.14 | |
| 3.3 Communications and Responsiveness | A | 3.8 | 50% | 1.90 | |
| | | | | **Total** | 3.86 |
| **Office of Fusion Energy Sciences** | | | | | |
| 3.1 Effective/Efficient Stewardship | A | 4.0 | 33% | 1.32 | |
| 3.2 Project/Program Planning & Management | A | 3.8 | 43% | 1.63 | |
| 3.3 Communications and Responsiveness | A | 3.8 | 24% | 0.91 | |
| | | | | **Total** | 3.87 |
| **Office of Nuclear Physics** | | | | | |
| 3.1 Effective/Efficient Stewardship | A- | 3.7 | 40% | 1.48 | |

| Science Program Office | Letter Grade | Numerical Score | Objective Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| 3.2 Project/Program Planning & Management | A | 3.8 | 40% | 1.52 | |
| 3.3 Communications and Responsiveness | A- | 3.7 | 20% | 0.74 | |
| | | | | **Total** | 3.74 |

**Table 3.1 - 3.0 SC Program Office Performance Goal Score Development**

| Science Program Office | Letter Grade | Numerical Score | Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| **Office of Advanced Scientific Computing Research** | B | 3.01 | 17.7% | 0.53 | |
| **Office of Basic Energy Sciences** | A- | 3.49 | 55.1% | 1.92 | |
| **Office of Biological and Environmental Research** | A | 3.86 | 14.5% | 0.56 | |
| **Office of Fusion Energy Sciences** | A | 3.87 | 8.2% | 0.32 | |
| **Office of Nuclear Physics** | A- | 3.74 | 4.5% | 0.17 | |
| **Performance Goal 3 Total** | | | | | 3.50 |

**Table 3.2 – SC Program Office Overall Performance Goal Score Development**

| HQ Program Office | Letter Grade | Numerical Score | Objective Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| **Energy Efficiency and Renewable Energy** | | | | | |
| 3.1 Effective/Efficient Stewardship | A | 4.0 | 34% | 1.35 | |
| 3.2 Project/Program Planning & Management | A | 4.0 | 33% | 1.31 | |
| 3.3 Communications and Responsiveness | A | 4.0 | 33% | 1.31 | |
| | | | | **Total** | 3.96 |
| **Electricity Delivery and Energy Reliability** | | | | | |
| 3.1 Effective/Efficient Stewardship | A- | 3.5 | 34% | 1.19 | |
| 3.2 Project/Program Planning & Management | A- | 3.6 | 33% | 1.19 | |
| 3.3 Communications and Responsiveness | A- | 3.7 | 33% | 1.22 | |
| | | | | **Total** | 3.60 |
| **Nuclear Energy** | | | | | |

| HQ Program Office | Letter Grade | Numerical Score | Objective Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| 3.1 Effective/Efficient Stewardship | A+ | 4.1 | 34% | 1.39 | |
| 3.2 Project/Program Planning & Management | A- | 3.6 | 33% | 1.19 | |
| 3.3 Communications and Responsiveness | A | 3.8 | 33% | 1.25 | |
| | | | | **Total** | 3.84 |
| **National Nuclear Security Administration** | | | | | |
| 3.1 Effective/Efficient Stewardship | A | 3.9 | 34% | 1.33 | |
| 3.2 Project/Program Planning & Management | A+ | 4.1 | 33% | 1.36 | |
| 3.3 Communications and Responsiveness | A | 4.0 | 33% | 1.32 | |
| | | | | **Total** | 4.01 |
| **Fossil Energy** | | | | | |
| 3.1 Effective/Efficient Stewardship | A | 3.8 | 34% | 1.29 | |
| 3.2 Project/Program Planning & Management | A | 3.9 | 33% | 1.29 | |
| 3.3 Communications and Responsiveness | A- | 3.7 | 33% | 1.22 | |
| | | | | **Total** | 3.80 |
| **Department of Homeland Security** | | | | | |
| 3.1 Effective/Efficient Stewardship | A | 3.8 | 34% | 1.29 | |
| 3.2 Project/Program Planning & Management | A- | 3.5 | 33% | 1.16 | |
| 3.3 Communications and Responsiveness | B+ | 3.3 | 33% | 1.09 | |
| | | | | **Total** | 3.54 |
| **Nuclear Regulatory Commission** | | | | | |
| 3.1 Effective/Efficient Stewardship | A | 3.8 | 34% | 1.29 | |
| 3.2 Project/Program Planning & Management | A | 3.8 | 33% | 1.25 | |
| 3.3 Communications and Responsiveness | A | 3.8 | 33% | 1.25 | |
| | | | | **Total** | 3.80 |

**Table 3.3 - HQ Program Office Performance Goal Score Development**

| HQ Program Office | Letter Grade | Numerical Score | Weight | Weighted Score | Overall Score |
|---|---|---|---|---|---|
| **Office of Science** | A- | 3.50 | 39.1% | 1.37 | |
| **Energy Efficiency and Renewable Energy** | A | 3.96 | 10.5% | 0.41 | |
| **Electricity Delivery and Energy Reliability** | A- | 3.60 | 3.2% | 0.12 | |
| **Nuclear Energy** | A | 3.84 | 6.7% | 0.26 | |
| **National Nuclear Security Administration** | A | 4.01 | 30.9% | 1.24 | |
| **Fossil Energy** | A | 3.80 | 0.9% | 0.03 | |
| **Department of Homeland Security** | A- | 3.54 | 6.5% | 0.23 | |
| **Nuclear Regulatory Commission** | A | 3.80 | 2.3% | 0.09 | |
| | | | **Performance Goal 3.0 Total** | | 3.74 |

**Table 3.4 - Overall Performance Goal Score Development**

| Total Score | 4.3-4.1 | 4.0-3.8 | 3.7-3.5 | 3.4-3.1 | 3.0-2.8 | 2.7-2.5 | 2.4-2.1 | 2.0-1.8 | 1.7-1.1 | 1.0-0.8 | 0.7-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Final Grade | A+ | A | A- | B+ | B | B- | C+ | C | C- | D | F |

**Table 3.5 – Goal Final Letter Grade**

## 4.0 Provide Sound and Competent Leadership and Stewardship of the Laboratory.

**The Contractor's Leadership provides effective and efficient direction in strategic planning to meet the mission and vision of the overall Laboratory; is accountable and responsive to specific issues and needs when required; and corporate office leadership provides appropriate levels of resources and support for the over all success of the Laboratory.**

The weight of this Goal is 15 percent

**Provide Sound and Competent Leadership and Stewardship of the Laboratory Goal measured the Contractor's Leadership capabilities in leading the direction of the overall Laboratory. It also measured the responsiveness of the Contractor to issues and opportunities for continuous improvement and corporate office involvement/commitment to the overall success of the Laboratory.**

Score: 3.7 Grade: A-

### 4.1 Provide a Distinctive Vision for the Laboratory and an Effective Plan for Accomplishment of the Vision to Include Strong Partnerships Required to Carry Out those Plans.

Score: 3.9 Grade: A

ORNL has demonstrated a vision for the laboratory that aligns with the DOE and Science mission. The laboratory planning is outcome based as evidenced by continued successful operation of user facilities like HFIR, HPC, SNS and CNMS, etc. Sustained partnerships have established initiatives like the bio-energy center, and Tennessee bio-fuels initiative, and the National Science Foundation (NSF) tera-grid award. ORNL has in place partnerships with over 200 universities including established mentor protégé relationships with Morehouse College and Jackson State. ORNL signed seven Memorandums of Understanding (MOUs) to expand international collaborations, provided significant contributions to the community through United Way records, and organized 34 volunteer activities in the community. ORNL continued to support education initiatives that provided equipment to 5 science labs, and provided student scholarships and teacher grants and made a significant contribution to the governor's academy for math and science. ORNL also provided a baseline for understanding and trending the cost of doing business to provide ORNL and DOE a baseline on funds distribution and cost drivers sensitive to laboratory costs.

4.1.1 Assessment of the adequacy of the Laboratory's vision as represented by the Laboratory Agenda.

Score: 3.9 Grade: A

ORNL is performing well regarding the Vision based on the FY 2008 Laboratory Agenda. ORNL's vision and focus centers around six core competencies: neutron sciences, computing and computational sciences, advanced materials and interfacial chemical processes, biological and environmental sciences, energy and engineering sciences, and counterterrorism and nonproliferation. The vision involves delivering and sustaining its mission via providing leadership in the six core competencies. UT-Battelle, LLC has successfully articulated its vision to its leadership team who in turn has established initiatives and objectives that drive the various scientific and technological organizations at the Laboratory toward high levels of achievement in science and technology. ORNL is exceeding the overall objectives for this metric.

4.1.2 Assessment of the scope and effectiveness of partnerships.

Score: 3.9 Grade: A

ORNL is performing well for effectiveness of Partnership activities. ORNL's partnership activities are extremely important to its mission and to achieving and sustaining its success as a World Class Research and Development Laboratory in its six core competencies. Collaborations with the core universities, other universities, foreign research institutions, and other laboratories have been instrumental in ORNL's success regarding S&T initiatives such as: CNMS, Leadership Class Computing, NSF Teragrid award, NSF Cyber infrastructure for Frontier Research, DOE Bioenergy Science Center, Tennessee Biofuels Initiative, National Institute for Mathematical and Biological Synthesis, I-81 Corridor Biofuels, Climate Modeling Leadership, Energy Frontier Research Centers, etc. ORNL participation in multiple Joint Institutes, collaborative proposals, Joint Faculty, joint workshops, and Historically Black Colleges and Universities (HBCU)/Minority Education Institution partnerships all enhance the Laboratory's capabilities and diversity in accomplishing its missions. ORNL has in place partnerships with over 200 universities including establishing mentor protégé relationships with Morehouse College and Jackson State. ORNL signed seven MOUs to expand international collaborations.

4.1.3 Assessment of ORNL's standing in the community.

Score: 4.0 Grade: A

UT-Battelle provided significant contributions to the community through United Way records and organized 34 volunteer activities in the community. ORNL continued to support education initiatives that provided equipment to 5 science labs, and provided student scholarships and teacher grants and made a significant contribution to the governor's academy for

math and science. The renovation of Oak Ridge High School, largely funded by the $55 million raised by UT-Battelle, was completed this year.

4.1.4 Development a baseline for understanding and trending the cost of doing business.

Score: 3.6 Grade: A-

ORNL also provided a baseline for understanding and trending the cost of doing business to provide the laboratory and DOE a baseline on funds distribution and cost drivers sensitive to laboratory costs.

**4.2 Provide for Responsive and Accountable Leadership throughout the Organization.**

Score: 3.6 Grade: A-

The laboratory leadership was successful during the period in initiating improvements in SBMS. ORNL worked on eleven workflow processes to improve its and other Battelle laboratories' performance. Overall these work process/flow improvements will increase the performance and reduce cost. Corrective actions plans were adequate, usage of Assessment and Commitment Tracking System (ACTS) was effective, and effectiveness reviews generally indicated corrective actions were closed appropriately and the improvements were observable. During the period, leadership was very successful in keeping management focused on the priorities and also managing the U.S. ITER Project Office (USIPO) and retaining its staff. The laboratory also supported the Office of Science and Technology Policy by hosting a science and technology workshop, which was attended by approximately 200 representatives from universities, private industry, DOE Laboratories, and government officials. Issues identified by external reviews indicated improvements could be made in both conference management and cyber security. Preparation for the conference management review was not thorough; after the review, implementation plans and execution of work needed additional work. UT-Battelle demonstrated pro-active operational management as demonstrated by development and execution of plans for transfer of newly generated waste, support for the Integrated Facilities Disposition Project program and overall management of infrastructure projects. Lab management has been very involved in working the issues. Cyber security issues were identified during the year through a red team effort. Numerous enhancements are being implemented with strong lab leadership and support.

4.2.1 Organizational leadership in Integrated Performance Management.

Score: 3.7 Grade: A-

UT-Battelle successfully worked with other Battelle laboratories to evaluate eleven workflow processes during FY 2008. Outcomes from three of these

are in the implementation phase at ORNL. Overall these work process/flow improvements will increase the performance and reduce cost.

4.2.2 Progress against commitments and effectiveness of actions taken as a result of audits and assessments.

Score: 3.4 Grade: B+

UT-Battelle progress in meeting commitments and expectations in response to audits and assessments from DOE has been mostly acceptable with a few exceptions. Corrective action plans for FY 2008 DOE Assistant Manager for Science (AMS) assessments met expectations and any content issues were readily corrected. Status of UT-Battelle in meeting corrective actions is tracked in ORION (the DOE tracking system for issues). Closure timeliness of corrective action was adequate and few extensions were required. Also, UT-Battelle made effective use of ACTS for providing closure evidence. A DOE AMS corrective action effectiveness review for the FY 2006 DOE HQ Office of Independent Oversight Inspection of emergency management indicated acceptable results with all findings being closed in a fully effective manner. Corrective actions plans were adequate, usage of ACTS was effective, and many of the effectiveness reviews indicated corrective actions were closed appropriately and the improvements were observable. During the period, leadership was very successful in keeping management focused on the priorities and also keeping the USIPO and its staff. A couple of issues identified by external reviews indicated improvements could be made in both conference management and cyber security. In the conference management area, aggressive action was taken by lab leadership to address the deficiencies. The implementation plans and execution of work had room for improvement. The cyber security issue was identified during the year and significant efforts are ongoing to enact lasting improvements.

**4.3 Provide Efficient and Effective Corporate Office Support as Appropriate.**

Score: 3.6 Grade: A-

Corporate involvement in laboratory operations and finance and audit areas was very visible. Corporate entities took very seriously any concerns or issues raised by DOE during the period. The Battelle community of practice has been very involved in nano-safety, 10 CFR 851 rule implementation, and safety leadership. Support for the Modernization of Laboratory Facility (MLF) facility was visible, and the corporate committee's efforts to ensure focus on contractor assurance were notable. The contractor assurance program continued to perform well and reviews found no issues and some notable practices. Overall support to ITER and fusion has been strong. The Board of Governors provides effective oversight to the laboratory through these committees and other corporate initiatives.

4.3.1 Corporate leadership in safety and infrastructure management.

Score: 3.7 Grade: A-

Corporate involvement in laboratory operations and finance and audit areas was very visible. Corporate entities took very seriously concerns or issues raised by DOE during the period. The Battelle community of practice has been very involved in nanosafety, 10 CFR 851 rule implementation, and safety leadership. Support for the MLF facility was visible, and the corporate committee's efforts to ensure focus on contractor assurance were notable. The Board of Governors provides oversight to the laboratory through these committees and other corporate initiatives.

4.3.2 Successful implementation of Contractor Assurance System (CAS).

Score: 3.4 Grade: B+

UT-Battelle continues to effectively maintain and implement a CAS. Evidence of effective implementation includes: (1) The UT-Battelle response for the FY 2007 AMS assessment of CAS was received on April 24, 2008. Given that there were no findings and only observations in the assessment report, a formal Corrective Action Plan (CAP) was not required. However, UT-Battelle was requested to provide a response to the observations, which they did in an acceptable manner. During September 2008, an assessment of CAS and Integrated Safety Management (ISM) was performed by DOE AMS as part of the Contractor Formal Assessment Program. This assessment indicated that the commitments made in the April response were implemented. (2) The FY 2008 Health, Safety, and Security (HSS) assessment of Radiochemical Engineering Development Center (REDC) noted a strength in the implementation of CAS elements for self-assessment, issues management, feedback and improvement, and performance evaluation/trending. The assessment team provided positive comments about the use of ACTS, the involvement of supervisors and workers in assessment processes, recording and tracking low-level precursor issues, and periodic analysis of trends. (3) The FY 2008 DOE AMS assessment of the UT-Battelle ISM and CAS indicated that UT-Battelle continues to implement an effective CAS program and that forward progress has been and is continuing to be made. The assessment indicated no findings or observations specific to CAS. One notable practice was reported related to effective evaluation of Lessons Learned by some UT-Battelle organizations.

| ELEMENT | Letter Grade | Numerical Score | Objective Weight | Total Points | Total Points |
|---|---|---|---|---|---|
| **4.0 Effectiveness and Efficiency of Contractor Leadership and Stewardship** | | | | | |
| 4.1 Provide a Distinctive Vision for the Laboratory and an Effective Plan for Accomplishment of the Vision to Include Strong Partnerships Required to Carry Out those Plans | A | 3.9 | 40% | 1.56 | |
| 4.2 Provide for Responsive and Accountable Leadership throughout the Organization | A- | 3.6 | 30% | 1.08 | |
| 4.3 Provide Efficient and Effective Corporate Office Support as Appropriate | A- | 3.6 | 30% | 1.08 | |
| | | | **Performance Goal 4.0 Total** | | 3.7 |

**Table 4.1 – Goal Performance Rating Development**

| Total Score | 4.3-4.1 | 4.0-3.8 | 3.7-3.5 | 3.4-3.1 | 3.0-2.8 | 2.7-2.5 | 2.4-2.1 | 2.0-1.8 | 1.7-1.1 | 1.0-0.8 | 0.7-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Final Grade | A+ | A | A- | B+ | B | B- | C+ | C | C- | D | F |

**Table 4.2 – 4.0 Goal Final Letter Grade**

## 5.0 Sustain Excellence and Enhance Effectiveness of Integrated Safety, Health, and Environmental Protection.

**The Contractor sustains and enhances the effectiveness of integrated safety, health, and environmental protection through a strong and well-deployed system.**

The weight of this Goal is 30 percent

**The Sustain Excellence and Enhance Effectiveness of Integrated Safety, Health, and Environmental Protection Goal measured the Contractor's overall success in preventing worker injury and illness; implementation of ISM down through and across the organization; and providing effective and efficient waste management, minimization and pollution prevention.**

Score: 3.7 Grade: A-

A very strong management commitment to sustaining excellence and enhancing integrated Environment, Safety and Health (ES&H) was demonstrated during FY 2008. This was evidenced by (1) the continued reduction in Days Away, Restricted, or Transferred (DART) and Total Recordable Cases (TRC) rates and the notable DART rate achieved, (2) the aggressive safety leadership program, and (3) the planning for the transition of waste management operations to UT-Battelle. The effectiveness of the UT-Battelle ES&H programs was validated by both external assessments and UT-Battelle self-assessments. Continued attention is needed in improvement of the quality of safety basis documentation submittals.

### 5.1 Provide a Work Environment that Protects Workers and the Environment.

Score: 3.6 Grade: A-

5.1.1 Achieve DOE-SC goal for reduction of DART rate (0.25).

Score: 4.0 Grade: A

The FY 2008 DART rate of 0.17 was over 30 percent lower that the SC goal of 0.25 and 30 percent lower than the rate for FY 2008. This represents outstanding progress in the reduction of serious injuries.

5.1.2 Achieve DOE-SC goal for reduction of TRC rate (0.65).

Score: 2.7 Grade: B-

The TRC rate for FY 2008 was 1.05, which is 61percent above the SC goal of 0.65. Although significantly above the SC goal, the rate represents a decrease of 25 percent from FY 2007 and sustained improvement since FY 2002. Focused evaluation on the most prevalent types of injuries and

targeted feedback resulted in a reduction in the number of strains and sprains by 50 percent during FY 2008. Although the goal was not reached, there was sustained improvement and strong management commitment to recordable case reduction this area.

5.1.3 Execute Effective Safety Leadership Program.

Score: 4.0 Grade: A

UT-Battelle executed a comprehensive safety leadership program during FY 2008 that continued to expand on program activities and initiatives from previous years. Of particular note during FY 2008 was the establishment of a Human Performance Initiative (HPI) Steering Committee that provides HPI strategic direction, monitors and evaluates HPI effectiveness, and provides a forum for HPI discussions of process improvements. This coupled with enhanced communication of HPI information to the workforce and the revised Safety Leadership Workshop constitutes a notable enhancement of the HPI program. Through the Management Observation and the STOP observation processes, over 12,000 workplace observations, and notably 12,000 interactions with employees associated therewith, were conducted during FY 2008. The I Care/We Care program continued to be a key element of safety improvement efforts. Also significant were the aggressive efforts to provide employees with real-time communications of safety information. Taken together, the above reflects an outstanding commitment to safety leadership.

5.1.4 Demonstrate effective implementation of the 10 CFR 851 Program.

Score: 4.1 Grade: A+

The annual update of the ORNL Worker Safety and Health Program description was submitted as required. The corrective actions relative to the fire barrier and pressure vessel variance requests were completed as scheduled. Items of note included (1) UT-Battelle taking the leadership role in establishing an Energy Facility Contractors Group Pressure Safety Task Team and (2) receiving a recommendation from an outside registrar that the ORNL safety and health program be registered as conforming to Occupational Health and Safety Advisory Services (OHSAS) 18002:2007.

5.1.5 Maintain doses as low as reasonable achievable (ALARA) through effective radiological control of work activities.

Score: 3.7 Grade: A-

The estimated average dose to individuals with a measurable dose for CY 2008 was 86 mrem, which is 14.3 percent of the ALARA control limit and 57 percent of the B+ Target level. No individual has received a dose that

triggered occurrence reporting. This, in part, is attributable to the rigorous implementation of the ALARA program.

5.1.6 Achieve and maintain a high level of compliance with environmental requirements. This measure does not include releases, inspection findings, or permit nonconformances, outside UT-Battelle's influence or control, as a result of activities conducted by other DOE prime contractors or tenants of the Science and Technology Park.

Score: 3.4 Grade: B+

ORNL's performance for FY 2008 was acceptable given the complexities and magnitude of the environmental programs. ORNL maintained ISO 14001 certification, EPA's Performance Track status and Tennessee's TP3 program status. However, for FY 2008 ORNL has had five incidences of permit noncompliances in the Clean Water Act NPDES area. The Air, Radioactive National Emission Standards for Hazardous Air Pollutants, Resource Conservation and Recovery Act (RCRA), Toxic Substance Control Act and Potable Water programs were in full compliance with environmental regulatory requirements. No significant issues were identified during any regulatory audits or inspections or external reviews of the ORNL Environmental Management System during the ISO14001 recertification external audit.

5.1.7 Timely completion of natural phenomena actions identified in DOE approved implementation plan for DOE O 420.1B.

Score: 3.0 Grade: B

Overall performance for this metric was acceptable. Non-reactor Nuclear Facilities Division (NNFD) completed their items on time. However, for Building 7920 there were numerous errors and omissions identified by both DOE and ORNL that had to be corrected. The Research Reactors Division (RRD) completed their items on time. However, the schedule that was submitted to DOE for needed modifications to the facility was not in accordance with DOE O 420.1B and required additional work/details/clarifications.

5.1.8 Demonstrate effective management of the Price Anderson Amendments Acts (PAAA) Program for both nuclear safety and worker safety and health.

Score: 3.3 Grade: B+

Effective management of the PAAA program was maintained during the period. ORNL continues to aggressively screen appropriate events for enforcement applicability, and self-identifies and reports non-compliances. ORNL had no enforcement actions during this evaluation period.

5.1.9 Occurrence reporting processes effectively address events/incidents promoting continuous improvement and lessons learned. This includes timely and accurate reporting determinations, well developed reports, appropriately developed, implemented and closed corrective actions, and analysis and utilization of occurrence reporting data to initiate process/program improvements.

Score: 3.0 Grade: B

Reporting has been timely and corrective actions have been effective for the occurrences reported this year. There is opportunity for improvement in the development of and the information provided in the reports submitted.

**5.2 Provide Efficient and Effective Implementation of Integrated Safety, Health, and Environment Management.**

Score: 3.6 Grade: A-

Oversight activities by external parties including DOE, state regulators, and third-party accreditors as well as self-assessments by UT-Battelle validated that UT-Battelle is effectively and efficiently implementing integrated environment, safety, and health programs for the full range of mission activities at ORNL. While several areas for improvement were identified, there were no notable areas of diminished performance. Numerous positive performance attributes were identified.

5.2.1 Validation of Environment, Safety, and Health (ES&H) programs through external assessments.

Score: 3.8 Grade: A

During FY 2008, there were numerous external assessments by DOE AMS and others that provided information on the viability of the UT-Battelle implementation of ES&H programs. Key assessments include: Eight DOE-AMS formal assessments of ES&H related activities (hoisting and rigging, software QA, unneeded material and chemicals management, facility categorization of Building 5505, electrical AHJ corrective action, Safety Basis implementation at NNFD, effectiveness review for OA-30 FY 2005 assessment, and implementation of CAS and ISM); routine walkthroughs by DOE Facility Representatives, AMS Program Managers, and Oak Ridge Office (ORO) Subject Matter Experts (SMEs). A third party registrar performed a surveillance audit of the ORNL Environmental Management System (EMS); and DOE HQ Office of Independent Oversight assessments of nuclear safety and emergency management. Based on the results of these assessments, it was concluded that UT-Battelle is adequately implementing

their ES&H programs with no notable areas of diminished performance identified. Several findings and observations were noted in program implementation; however, none were represented a systematic breakdown in performance and numerous positive performance attributes were noted that provide offsetting impacts.

5.2.2 Validation of Environment Safety and Health programs through internal assessments.

Score: 3.4 Grade: B+

UT-Battelle continues to maintain an effective program of internal assessments including both self-assessments by line programs and management system owners as well as independent assessment conducted by the I/O organization and by Environment, Safety, Health, and Quality. No major issues were noted by DOE with implementation of these internal assessment programs. Key indicators of acceptable performance include Line and Program Manager Self-Assessments and Independent Assessments.

Line and Program Manager Self-Assessments: (1) The Facility and Operations Directorate Fabrication Division continues to maintain a notable program of routine SME assessments for UT-Battelle hoisting and rigging operations. The FY 2008 HSS assessment of REDC noted a strength in the implementation of the NNFD assessment program. Assessments were noted to be effective and to include input from supervisors and workers. (2) DOE ORNL Site Office staff participated with four UT-Battelle Divisions in their quarterly ES&H walkthroughs (Material Sciences and Technology; Chemical Sciences; Nonreactor Nuclear Facilities; and Physics Divisions. No issues were noted with the quality and conduct of these self-assessments. (3) The FY 2008 AMS assessment of the ORNL ISM/CAS included review of implementation of Performance Assessment Plans (PAPs) for four ORNL organizations (Physics Division, Engineering Science and Technology Division, Environmental Protection and Waste Services Division, and Biological and Environmental Science Directorate). This review noted that organizations are maintaining frequent self-surveillance of safety in their facilities and are self-assessing selected ES&H management system implementation.

Independent assessments: (1) The UT-Battelle Operational Awareness Program (OAP), which includes DOE participation, continues to function smoothly and meet the expectations of both DOE and UT-Battelle management. (2) The Oversight and Assessment Services organization continues to implement an effective independent internal assessment program that covers ES&H programs and line self-assessment programs. DOE participation in some of these assessments and review of the reports for all others indicates that the program meets DOE expectations.

**5.3 Provide Efficient and Effective Waste Management, Minimization, and Pollution Prevention.**

Score: 4.0 Grade: A

Laboratory Waste Services (LWS) managed their program such that there were no issues or violations. The waste quantity in storage at the end of the FY (which will become the responsibility of the Office of Science) was minimal, with significant effort applied to ship all waste in the queue to Bechtel Jacobs Corporation. Pollution Prevention Efforts led to 2 HQ awards one of which also received a White House "Closing the Circle" award. The Transition of Newly Generated Waste was completed with no issues or major problems, which considering the number of organizations involved, was a notable achievement. There was a topic of concern regarding the handling of certain waste generated and stored at the Spallation Neutron Source that was not totally resolved during FY 2008. Accordingly, this item will be carried over as unresolved into FY 2009 and any impacts addressed in the FY 2009 PEMP.

5.3.1 Effective and efficient management of waste accumulation and disposition activities as measured by:

a) Notifications of non-compliance with Waste Acceptance Criteria requirements from waste treatment, storage, and disposal operators.

b) Number of Department of Transportation (DOT) or State/Federal environmental regulatory agency Notice of Violations due to improper waste shipments.

Score: 4.0 Grade: A

All LWS activities were accomplished without any issues of notices of violation. Shipments were made in a timely manner resulting in a relatively small backlog of waste to become the responsibility of SC. No time extension requests were in place for any waste except the 3019 filters being disposed of for EM. An impromptu surveillance of the Waste Certification program by National Nuclear Security Administration resulted in no findings or observations and positive comments on the program by the surveillance team. LWS initiated an innovative trade with Bechtel Jacobs Corporation (BJC) eliminating the need and cost of repackaging two sea land containers, instead sending them directly to disposal. This program also effectively managed the transfer/processing of liquid waste and disposal of the tank from an inactive site at Y-12. Waste Operations also hosted the Summer Low-Level Waste Corporate Board meeting receiving recognition for the quality of the meeting and arranging last minute tours of SNS.

5.3.2 Effectively manage pollution prevention program activities, including identification and implementation of actions to reduce significant environmental impacts within divisions under research and facilities directorates.

Score: 4.0 Grade: A

Eight acceptable P2 division initiatives were identified and completed that meet the criteria for acceptable efforts versus the 7 required. In addition, UT-Battelle won two DOE Star awards for their P2 programs, one of which also won a White House "Closing the Circle" award (Green Transportation Initiative), indicating positive evidence of continuing high levels of performance.

5.3.3 Prepare for an efficient transfer of newly generated waste responsibilities in FY 2009 (from DOE-EM to DOE-SC) through effective implementation of the ORNL newly generated waste transition (NGW) plan.

Score: 4.0 Grade: A

UT-Battelle took the lead in developing a transition plan for NGW that addressed both EM and SC issues. Preparation of the plan actually started in advance of a request by DOE. All activities identified in the transition plan were completed early or on time with the exception of those involved with facility transfers, which were delayed due to timing of a revised permit, which was out of UT-Battelle's control. Steps have been put in place to eliminate any impact from this delay. No major issues were encountered and all areas smoothly handled resulting in a cooperative and successful transfer, despite the fact that four different entities were involved (each with their own set of priorities), the effects of the Continuing Resolution and the ongoing workload.

| ELEMENT | Letter Grade | Numerical Score | Objective Weight | Total Points | Total Points |
|---|---|---|---|---|---|
| **5.0 Sustain Excellence and Enhance Effectiveness of Integrated Safety, Health, and Environmental Protection** | | | | | |
| 5.1 Provide a Work Environment that Protects Workers and the Environment | A- | 3.6 | 45% | 1.62 | |
| 5.2 Provide Efficient and Effective Implementation | A- | 3.6 | 40% | 1.44 | |

| ELEMENT | Letter Grade | Numerical Score | Objective Weight | Total Points | Total Points |
|---|---|---|---|---|---|
| of Integrated Safety, Health and Environment Management | | | | | |
| 5.3 Provide Efficient and Effective Waste Management, Minimization, and Pollution Prevention | A | 4.0 | 15% | 0.60 | |
| | | | | **Performance Goal 5.0 Total** | 3.7 |

**Table 5.1 – Goal Performance Rating Development**

| Total Score | 4.3-4.1 | 4.0-3.8 | 3.7-3.5 | 3.4-3.1 | 3.0-2.8 | 2.7-2.5 | 2.4-2.1 | 2.0-1.8 | 1.7-1.1 | 1.0-0.8 | 0.7-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Final Grade | A+ | A | A- | B+ | B | B- | C+ | C | C- | D | F |

**Table 5.2 – Goal Final Letter Grade**

**6.0 Deliver Efficient, Effective, and Responsive Business Systems and Resources that Enable the Successful Achievement of the Laboratory Missions.**

**The Contractor sustains and enhances core business systems that provide efficient and effective support to Laboratory program and it's mission(s).**

The weight of this Goal is 20 percent

**Provide Business Systems that Efficiently and Effectively Support the Overall Mission of the Laboratory. Goal measures the Contractor's overall success in deploying, implementing, and improving integrated business systems that efficiently and effectively support the mission(s) of the Laboratory.**

Score: 3.4 Grade: B+

**6.1 Provide an Efficient, Effective, and Responsive Financial Management System**

Score: 2.5 Grade: B-

The appraisal of the UT-Battelle, LLC financial management system considers the quality, timeliness, and accuracy of data provided by UT-Battelle. In addition, results of reviews conducted and the responsiveness to financial issues and concerns as they arise during the year are also considered as part of the overall evaluation of the financial management system.

UT-Battelle's Internal Audit Services were among the best in completing all scheduled audits and in providing quality and timely reports. In addition, the UT-Battelle budget staff was very responsive regarding budget formulation activities, action items, and support for the Integrated Project Team assigned to the Integrated Facility Disposition Project.

Even though there were several areas that made significant progress during FY 2008, there are areas in the UT-Battelle Chief Financial Officer (CFO) organization's operations that require improvement. External reviews and UT-Battelle Internal Audit reviews identified deficiencies in the areas of accounts payable, accounts receivable, capital accounting, and accounting related to the Isotopes Program. However, corrective actions have been initiated that should adequately address the deficiencies noted.

6.1.1 Systems and processes exist that ensures the financial staff is knowledgeable, process necessary skills, and maintain adequate level of training to perform the assigned financial management functions.

Score: 3.2 Grade: B+

UT-Battelle staff was requested to support HQ CFO in reviewing the Integrated Contractor travel policies. The purpose was to identify which best practices might be adopted for Federal employee travel in an effort to reduce travel costs. The UT-Battelle staff was very knowledgeable about the policies, processes, and metrics and this was clearly demonstrated during the briefing provided to the HQ staff.

6.1.2 Accurate, timely, and complete financial reports are provided to DOE in accordance with Departmental requirements for key activities/deliverables including accelerated financial statement reporting, Standard Accounting and Reporting System (STARS submissions, annual budget submissions, and other financial data calls.

Score: 2.6 Grade: B-

UT-Battelle was very responsive regarding budget formulation. For example, UT-Battelle submitted the FY 2010 budget before the due dates required by the FY 2010 Budget Call. In addition, the UT-Battelle financial staff prepared an excellent package of budget review documents in support of the FY 2010 Safeguards and Security budget.

UT-Battelle worked closely with ORO CFO staff to ensure that funding was properly aligned so no significant programmatic impacts resulted from the Continuing Resolution during FY 2008. Also, during FY 2008, UT-Battelle provided same day responses regarding numerous requests to certify funds availability for the withdrawal of allotment from HQ.

UT-Battelle provided effective support to a HQ CFO team, which requested meetings to review local ORO Integrated Contractor's accounts receivable. UT-Battelle demonstrated good preparation for the meeting by being able to discuss the detailed status of each bill.

UT-Battelle volunteered to support the Phase I pilot for processing inter-entity transactions between Integrated Contractor's and DOE by using the Department of Energy Payment and Collection (DOE-PAC) system. This system eliminates Treasury-based payments between DOE and its Integrated Contractors. UT-Battelle has been involved in the pilot from the beginning (March 2008) and has submitted DOE-PACs before the due date with no problems.

UT-Battelle submissions for the monthly STARS were timely. In addition, UT-Battelle resolved all of the Integrated Contractor Trial Balance Reconciliations and associated STARS differences in a timely manner.

After issues occurred during November, December, and January, the timeliness and accuracy of the monthly Statement of Cash Activity report appeared to be improving; however, during August, significant problems

recurred. The problems required ORO CFO and HQ staff to work after hours to reconcile. There were no problems identified in September.

Even though the third quarter financial statement analysis and footnote disclosures were provided by the due date, the Oak Ridge Financial Service Center had to request more detail on capital leases and significant changes in financial statement balances. These problems were raised to UT-Battelle's financial management staff and, as a result, there were no issues with the year-end submission.

UT-Battelle's third quarter Environmental, Safety, and Health liability submission did not accurately reflect the liability associated with compliance issues. The submission included a line item to replace laboratory space. Inclusion of the entire line item was not in agreement with the accounting standard; thus, requiring last minute adjustments to the June STARS report. After the third quarter submission, increased involvement by UT-Battelle's financial management staff resulted in the year-end submission requiring no adjustments and included the necessary certification.

6.1.3 Prompt efficiency in the financial operational processes to ensure accuracy of information necessary so financial operations facilitates R&D activities.

Score: 1.8 Grade: C

UT-Battelle provided excellent support to the Integrated Project Team assigned to the Integrated Facility Disposition Project as ORO prepared to obtain approval for Critical Decision-1.

UT-Battelle monitored the status of FY 2008 funding allocations to the HFIR operating account. Reallocations to the fuel inventory account were processed to ensure sufficient funds were available for the procurement of fuel required to operate the HFIR.

UT-Battelle failed to advise the ORO CFO of severe funding shortfalls for the operation of the Mammalian Genetics Research Facility (MGRF) so that appropriate action could be taken. Rather, a portion of the MGRF operating costs was transferred to the legacy cost pool and treated as excess capacity. Since MGRF has an identified funding program, excess capacity was not appropriate. UT-Battelle was directed to report the costs against the correct program, which resulted in incurred costs that exceeded the funds provided at the cost level for FY 2008.

Several issues were identified during the year involving the prices charged or costs recovered. UT-Battelle failed to fully implement the requirements of DOE Order 522.1 *"Pricing of Departmental Materials and Services"* that were included in the Contract in 2005. Even after elimination from the

DOE Order, Federal Administrative Charge waivers continued on consultant services. Also, while UT-Battelle required user facility customers to provide an appropriate advance, Internal Audit questioned whether the method of developing rates was equitable. This was exacerbated by the fact that rates charged to users were not being updated timely (one facility's rates were last approved in 2003) and one facility was relying on waivers of full cost that had no basis in existing DOE financial policy. UT-Battelle responded by establishing a task team to evaluate the equity of user facility charging practices.

6.1.4 A-123 Compliance: FY 2008 directed scope of work is completed on schedule and in compliance with applicable guidance.

Score: 3.2 Grade: B+

UT-Battelle met expectations from the implementation of the FY 2008 Office of Management and Budget Circular A-123, Appendix A requirements and submitted all deliverables on time. FY 2008 was the first year contractors were required to implement a risk-based cyclical testing approach. Internal Audit fully incorporated ORO CFO guidance on the Annual Risk-Based Controls Assessment tool and utilized it in conducting tests during the A-123 reviews.

6.1.5 Adequacy of financial management system and processes as determined by internal audits, self-assessments, and external audits.

Score: 1.8 Grade: C

UT-Battelle responded and cooperated with the ORO CFO Audit Liaison regarding the OIG/Government Accountability Office reviews. During FY 2008, UT-Battelle responded to requests and met all deadlines regarding these reviews.

After an audit at another Department of Energy (DOE) facility regarding questioned timekeeping practices, the ORO CFO requested a study to evaluate whether uncompensated overtime materially impacted cost allocations. UT-Battelle Internal Audit (IA) accommodated the request by modifying the audit schedules and contacting other Battelle units to develop a consistent approach. Results indicated that no material change would result if all time had been recorded.

KPMG identified two issues in the annual audit of the Isotopes financial statements –revenue recognition in the correct period and proper statement of customer advances. While in aggregate these items are not material to ORO CFO, they are material to the Isotopes program and the corrective actions were initiated and have been completed by UT-Battelle.

As a part of the FY 2007 Financial Statement Audit, KPMG noted

UT-Battelle failed to transfer constructed assets to completed plant assets in a timely manner. As a result, depreciation was understated in one period and "catch-up" depreciation was required in a later period. The auditors noted that transfers should have occurred between six months and seven years sooner.

While conducting a review of Joint Appointees at DOE laboratories, OIG determined that several laboratories, including ORNL, were not achieving full cost recovery. UT-Battelle was instrumental in providing documentation on the current program and in reviewing the ORO CFO "white paper" supporting continuation of the joint faculty program. UT-Battelle has taken action to correct the problem.

During the OIG audit of the FY 2006 Statement of Costs Incurred and Claimed, it was determined that UT-Battelle failed to provide sufficient reimbursement for organization burden (i.e., indirect cost) associated with unallowable costs for corporate home office support. After making the initial calculation of the adjustment, UT-Battelle worked closely with Oak Ridge Financial Service Center to ensure full cost was recovered.

During the OIG review of conferences, several issues were noted that needed to be addressed with certain unallowable costs recovered and better controls needed to ensure effective implementation of the order.

On September 25, 2008, UT-Battelle Internal Audit staff issued a report on Accounts Payable processes. The report identified several issues with payment timeliness.

**6.2 Deliver Efficient, Effective, and Responsive Acquisition and Property Management Systems.**

Score: 3.9 Grade: A

6.2.1 Effective acquisition and contract management systems as determined by DOE balanced scorecard goals and DOE stakeholder's evaluations results.

Score: 3.8 Grade: A

The award of the CM/GC (construction manager/general contractor) for the MLF Project missed the initial schedule and was delayed by two months, moving project activity into the next FY. Communications between Acquisition Management personnel and DOE continue to be effective during FY 2008; cooperation/communication with Division Director has been outstanding. The contractor continues to operate efficient and effective Acquisitions Management and Contracts Management systems. Responses to DOE inquiries were extremely prompt with all recorded requests being responded to by the due date. With the exception of the

Veteran-Owned Small Business subcontracting goals, ORNL met both the HQ Benchmarks and DOE-ORO goals in all other subcontracting areas for FY 2008. The Small Business Program Manager received the DOE Small Business Management and Operations Program Manager of the Year Award.

6.2.2 Effective property management systems (property, materials, and fleet) as determined by DOE balanced scorecard goals and DOE stakeholder's evaluations results.

Score: 3.9 Grade: A

The contractor continues to operate an efficient and effective personal property management system. Two UT-Battelle employees have obtained the designation as Certified Machinery and Equipment Appraisers, which will be utilized to facilitate maximum returns on property sales and trade-ins. As a leader in DOE's High Risk property management program, UT-Battelle's control and disposition process is used by other sites as an example supporting training. Two UT-Battelle property personnel are National Officers for the National Property Management Association (NPMA), and another two are serving as local NPMA chapter officers. UT-Battelle's property management staff is currently working to transfer property to the Government involving NNSA. Another major effort that is currently being worked is the transfer of personal property for the ITER Project. ORNL is the leader in the Computers for Learning Program in Oak Ridge and is the top performing laboratory in the Department. ORNL conducted two High Risk Property courses at Oak Ridge and Oakland that is an Acquisition Career Development Program certification requirement. Materials Management has a very good receiving and control system and continues to look for improvements. Materials Management staff manages precious metals to the highest standards and continues to look for ways to improve the efficiency of inventories by reviewing regulations and recommending changes to improve their system and assist other sites. The Fleet Manager report/transactions submitted to DOE are very detailed and are of the highest quality. Communication by the ORNL Fleet Manager is outstanding with the ORO Fleet Manager. ORNL received the White House Closing the Circle Award for ORNL's Green Transportation Initiative, which was presented to the ORNL Fleet Manager and Materials Management staff at the White House. ORNL received the Office of Science's Best in Class and DOE P2 Award for the green transportation initiative. These accomplishments are a direct reflection of ORNL's Fleet Manager's dedication to turning the fleet green and promoting the use of alternative fuels (Ethanol and Bio-diesel). ORNL's Motor Vehicle Utilization rate exceeded the National Standard of 94 percent.

**6.3 Provide an Efficient, Effective, and Responsive Human Resources Management System and Diversity Program.**

Score: 3.4 Grade: B+

6.3.1 Maintain Competitive Total Compensation.

Score: 3.3 Grade: B+

Compa-ratio targets for the year were met. The ratio for all job families combined was 0.98 and for Scientists and Engineers the ratio was 0.99. UT-Battelle compensation program redesign proposal, to more closely align the UT-Battelle salary structures with market practices, was approved as submitted.

6.3.2 Conduct a Benefits Valuation Comparative Analysis to compare the value of our benefits programs to benefits programs in like organizations.

Score: 3.4 Grade: B+

UT-Battelle's Ben Value study resulted in a rating of 101.5, which is within the 100 - 105 range. This score indicates that the benefits provided by UT-Battelle are 1.5 percent above the 15 comparators that were benchmarked. In addition, UT-Battelle submitted their 2007 cost study this year, which compares their benefits cost to U.S. Chamber of Commerce (COC) Employee Benefit Study. This study further supports that UT-Battelle's benefits are competitive to the market.

6.3.3 Strengthen Management Performance.

Score: 3.3 Grade: B+

UT-Battelle conducted two Boot Camps and they were viewed positively in an independent oversight evaluation. The completion rate was 100 percent and the participant evaluations were 4.2 on a scale of 5.0. The target was met.

6.3.4 Maintain healthy labor relations and facilitate improved communications between union and management.

Score: 3.5 Grade: A-

The grievance process and labor relations are being effectively managed. The target was exceeded by significantly reducing the number of grievances and resolving all grievances before proceeding to arbitration.

6.3.5 Ensure sound HR practices, processes, policies, and systems are compliant with internal and external laws, regulations, and policies.

Score: 3.3 Grade: B+

UT-Battelle Human Resources performed 19 internal self-assessments and participated in four external assessments, which revealed compliance to internal policies, external laws, and regulations.

**6.4 Provide Efficient, Effective, and Responsive Management Systems for Internal Audit and Oversight; Quality; Information Management; and Other Administrative Support Services as Appropriate.**

Score: 3.6 Grade: A-

6.4.1 Adequacy of planning and execution of internal audits and timeliness of audit follow-up and resolution.

Score: 4.0 Grade: A

UT-Battelle's performance continued to be among the best in audit services. The IA performed audit responsibilities in accordance with the FY 2008 approved audit plan. Audit topics were selected utilizing a risk-based assessment. IA completed 12 of the 15 required audits and currently has three in process. The IA reports have excelled in quality and timeliness. In addition, IA responded to outside audit areas and has been proactive in providing additional support at the request of the ORO CFO.

The IA initiated 18 investigations for resolving various complaints relating to potential waste, fraud, and abuse. Seven management requests for advisory services in various operational areas were also performed. In support of the Contracts Division, IA requested and analyzed Defense Contract Audit Agency pre- and post-award audits. This effort provided audit advice to the Contracts Division regarding the award of proposed subcontracts and the allowability and reasonableness of costs claimed under cost type subcontracts.

6.4.2 Results of independent assessment of management systems.

Score: 3.3 Grade: B+

UT-Battelle completed three management system effectiveness evaluations in FY 2008 as agreed upon between DOE and UT-Battelle with DOE participation. The score reflects the completion of these and the results obtained on the three assessments when considered together.

6.4.3 Demonstrate a successful self-assessment program through review of line management feedback and improvement programs.

Score: 3.6 Grade: A-

UT-Battelle completed four assessments of line organizations in FY 2008, as agreed upon between DOE and UT-Battelle, with DOE participation. The score reflects the completion of these and the results obtained on the four assessments when averaged together.

A Performance Assessment Program-Spot Check of UT-Battelle's Logistical Services Division (LSD) was held on August 5-8, 2008. The purpose of the assessment was to evaluate the effectiveness of the LSD Performance Assessment Program in three different areas using nine different criteria. Final Report, UT-Battelle Report Number IO-2008-17, was issued September 2008. Two opportunities for improvements were noted that included 1) usage of the ACTS for documenting self-assessments and 2) documenting the corrective actions that are fixed on the spot or soon after an assessment is completed.

## 6.5 Demonstrate Effective Transfer of Technology and Commercialization of Intellectual Assets.

Indicators of Technology Transfer and Economic Development performance are in four broad areas: Intellectual Property (IP), Legal, Commercialization, Industrial Partnerships, and Regional Partnerships. Those areas include: Patent Management, IP Management System, Invention Disclosures, Transaction Support, Privately funded Technology Transfer, Licensing, Inventorship Support, Technology Maturation, Research Contracts, Research Partnerships, Science and Technology Park, Business Systems, Lab of the South Initiatives, Innovation Valley Initiatives, Economic Development Linkages, and Entrepreneurial Support.

Score: 3.9 Grade: A

UT-Battelle received 167 new invention disclosures with 65 inventions elected. Twenty-five fee-bearing licenses, 203 non-fee-bearing (LandScan) licenses, 23 material transfer agreements, and 220 non-disclosure agreements were executed. Filed 66 U.S. patent applications and had 24 U.S. patents issue. Executed 115 new non-federal, Work for Others (WFO) agreements, 14 new CRADAs, 111 new User Agreements and 267 new Appendix As to User Agreements. Licensing revenue in FY 2008 was $ 2.546 million. UT-Battelle was very successful in competing with the other Battelle-managed laboratories for the $1.5 million that Battelle makes available for maturation annually. UT-Battelle has so far secured funding for nine projects, for a total of $885,000 in maturation funding, from UT and Battelle. These projects will advance the state of the technologies in order to better position them for licensing opportunities. One of the Battelle Memorial Institute/University of Tennessee-funded maturation projects also received maturation funding of $60K

from the FY 2007 EERE maturation funds. ORNL received approximately $2.5 million in maturation funding from EERE in FY 2007 dollars, which were allocated to eight maturation funding projects in FY 2008, each requiring a dollar-for-dollar match (either funds in or in-kind) from an industrial partner. Those projects are ongoing and have resulted in approximately seven CRADAs, two WFO Agreements, and two patent license option agreements thus far. ORNL competed in DOE/EERE's Technology Commercialization Fund proposal competition for FY 2008 maturation funds during FY 2008. ORNL's proposal was selected for funding at the level of $1.5 million, one of only three laboratories to receive the maximum amount awarded of $1.5 million.

| ELEMENT | Letter Grade | Numerical Score | Objective Weight | Total Points | Total Points |
|---|---|---|---|---|---|
| **6.0 Deliver Efficient, Effective, and Responsive Business Systems and Resources that Enable the Successful Achievement of the Laboratory Missions** | | | | | |
| 6.1 Provide an Efficient, Effective, and Responsive Financial Management Systems | B- | 2.5 | 25% | 0.63 | |
| 6.2 Provide an Efficient, Effective, and Responsive Acquisition and Property Management Systems | A | 3.9 | 10% | 0.39 | |
| 6.3 Provide an Efficient, Effective, and Responsive Human Resources Management System and Diversity Program | B+ | 3.4 | 20% | 0.68 | |
| 6.4 Provide Efficient, Effective, and Responsive Management Systems for Internal Audit and Oversight; Quality; Information Management; and Other Administrative Support Services as Appropriate | A- | 3.6 | 30% | 1.08 | |
| 6.5 Demonstrate Effective Transfer of Technology and Commercialization of Intellectual Assets | A | 3.9 | 15% | 0.59 | |
| | | | **Performance Goal 6.0 Total** | | 3.4 |

**Table 6.1 – Goal Performance Rating Development**

| Total Score | 4.3-4.1 | 4.0-3.8 | 3.7-3.5 | 3.4-3.1 | 3.0-2.8 | 2.7-2.5 | 2.4-2.1 | 2.0-1.8 | 1.7-1.1 | 1.0-0.8 | 0.7-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Final Grade | A+ | A | A- | B+ | B | B- | C+ | C | C- | D | F |

**Table 6.2 – Goal Final Letter Grade**

## 7.0 Sustain Excellence in Operating, Maintaining, and Renewing the Facility and Infrastructure Portfolio to Meet Laboratory Needs

**The Contractor provides appropriate planning for, construction and management of Laboratory facilities and infrastructures required to efficiently and effectively carry our current and future S&T programs.**

The weight of this Goal is 20 percent

**The Sustain Excellence in Operating, Maintaining, and Renewing the Facility and Infrastructure Portfolio to Meet Laboratory Needs Goal measured the overall effectiveness and performance of the Contractor in planning for, delivering, and operations of Laboratory facilities and equipment needed to ensure required capabilities are present to meet today's and tomorrow's complex challenges.**

Score: 3.6 Grade: A-

### 7.1 Manage Facilities and Infrastructure in an Efficient and Effective Manner that Optimizes Usage and Minimizes Life Cycle Costs.

Score: 3.8 Grade: A

7.1.1 The Nuclear Operations Directorate consolidation program will reduce the nuclear facilities footprint with emphasis on relocation of strategic capabilities to Melton Valley.

Score: 3.4 Grade: B+

ORNL NNFD continued to make progress in reducing the nuclear footprint in Bethel Valley with the downgrading of Building 5505 to a Category 3 nuclear facility. They also made significant progress in relocating the Manipulator Shop from Bethel Valley to Melton Valley with the transfer of Building 7935 from EM to SC control. Finally a number of offices and user support areas in Melton Valley were upgraded. The NNFD met their assessment goals for FY 2008 by down grading Building 5505, negotiating the transfer of Building 7935, and consolidating personnel in Melton Valley.

7.1.2 Timely completion of System Design Descriptions (SDD) as identified in DOE approved implementation plan for DOE O 420.1B.

Score: 3.5 Grade: A-

UT-Battelle issued all the SDD's scheduled for FY 2008 on time. However, RRD issued one SSD, Primary Coolant High Pressure System

SDD, which had three punch-list items. It does not appear that the SDD was complete when issued.

7.1.3 Effective utilization of funds for maintenance and deferred maintenance programs.

Score: 4.0 Grade: A

The Maintenance Investment Index for the agreed upon infrastructure was 3.39 percent which exceeded the 3.0 percent target. Expenditures on deferred maintenance during FY 2008 exceeded $8M, well surpassing the $6.0M target established in the Ten-Year Site Plan, which is a notable achievement (Actual deferred maintenance removed by these actions was over $6M). In addition, all data was submitted early or on time for all maintenance reports and the support to the Facility Information Management System was excellent, resulting in a shortened evaluation and a result of "Green."

7.1.4 Provide efficient and effective maintenance program tools to evaluate maintenance needs and minimize impacts of aging infrastructure.

Score: 4.0 Grade: A

UT-Battelle has taken the initiative for the SC complex in developing a Mission Readiness program. UT-Battelle has hosted/lead several meetings on this subject as well as provided input and presentations for SC. SC considers ORNL to be the lead in this effort and has accepted their concepts. In a more specific step, UT-Battelle has also institutionalized steps to ensure change in mission was factored into reviews of facilities/areas as necessary to help ensure their reliability for the new/modified program.

7.1.5 In support of the goals of the DOE's Transformational Energy Action Management (TEAM) initiative, and the goals and objectives contained in Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management, the Contractor shall cooperate with federal Site Office personnel to provide full and open access to the maximum extent practicable to NNSA/DOE-contracted Energy Service Companies (ESCOs) under Energy Savings Performance Contracts (ESPC), to facilitate on-site assessments of opportunities to improve the Site's energy efficiency, water reduction and renewable energy improvements, and shall provide advisory assistance in reviewing ESCO recommendations as directed by the Contracting Officer. The Contractor shall ensure ESCO personnel are granted access pursuant to contractual requirements; monitor ESCO activities to ensure that site safety and security requirements are adhered to; promptly provide information requested by ESCO personnel to assist them in development viable recommendations; and, when directed by the

Contracting Officer, assist the Site Office in the Monitoring and execution of ESPC projects.

Score: 4.0 Grade: A

ORNL performed in an outstanding manner in assisting DOE and working with the ESCO (JCI) to help DOE prepare for and monitor and execute the ESPC. This is the most aggressive TEAM initiative work in the DOE complex. ORNL has exceeded expectations in this successful endeavor.

7.1.6 Assessment of the actions completed by ORNL, which indicated a current and/or future improvement in energy efficiency.

Score: 4.0 Grade: A

Based on the ESPC work and other Laboratory and community energy efficiency projects (renewables, executable plans), the lab has exceeded expectations in this area.

7.1.7 Effective utilization of appropriate funds for the management of unneeded material and chemicals (UMC).

Score: 3.8 Grade: A

The UMCs Report was delivered on time and in a condition ready for submittal to HQ. All work was completed safety and without incident. Total funding provided by overhead (OH) exceeded $2.2M, which was a 10 percent increase over the baseline target.

7.1.8 Effective utilization of appropriate funds for excess facility disposition.

Score: 4.0 Grade: A

Planned OH funded work consisted of nine facilities representing approximately 5,800 square feet. Actual OH funded work dispositioned 25 facilities representing over 10,000 square feet. Planned work funded through the Office of Science consisted of completion of demolition of 2010 (12,946 sf), which was completed within the budget. There were no work stoppages, injuries, or violations during this effort. The actual square footage removed (approximately 23,400) exceeded planned (approximately 18,700) by 25 percent with no issues, concerns, or incidents, which should be considered a notable achievement. In addition to the demolition, several reviews and on site visits by outside organizations in support of the IFDP were accomplished by the same staff. This was a significant unexpected increase to the workload of this group.

7.2 **Provide Planning for and Acquire the Facilities and Infrastructure required to support Future Laboratory Programs.**

Score: 3.5 Grade: A-

7.2.1 Evidence that the laboratory has a clear vision for future infrastructure needs and has used innovative planning to accomplish that vision.

Score: 3.7 Grade: A-

UT-Battelle provided input for infrastructure into a section for the first Annual Business Plan. The plan was well received at DOE HQ when present during this FY.

7.2.2 Improve process by which capital-planning base is approved.

Score: 3.3 Grade: B+

UT-Battelle developed a process for improving the efficiency of approval for General Plant Project/Institutional General Plant Project/Institutional General Plant Equipment projects as promised before the end of the FY. DOE has approved this process.

7.2.3 Aggressively prepare and implement a tailoring plan that is based on a commercial approach for designing and constructing the MLF lie item project that will provide critical contemporary labs for materials and chemistry research laboratories.

Score: 3.3 Grade: B+

UT-Battelle successfully attained CD-1 for this project during FY 2008 and awarded the contract for the Architect Engineer for project design. The award of the CM/GC missed the initial schedule and was delayed by two months, which moved this project activity into the next FY.

7.2.4 Develop ORNL West Campus to support Life Science and Bioenergy capabilities.

Score: 3.4 Grade: B+

Since targets were met to renovate buildings 1504 and 1505, and the target was met for the West Campus Improvements project, UT-Battelle is ensuring development of the West Campus to support Life Sciences and Bioenergy capabilities.

7.2.5 Develop ORNL utility systems to support ongoing and future mission initiatives such as supercomputing.

Score: 3.6 Grade: A-

The ORNL Facilities Development Division met their goals for FY 2008 by completing the reconfiguration of the 4000 Substation under budget and completing the 5000 Area upgrade ahead of schedule. The Facilities Development Division demonstrated excellent project execution in FY 2008, by completing projects ahead of schedule and under budget.

7.2.6 Demonstrate effective project management execution and leadership in all projects on the approved planning base.

Score: 3.4 Grade: B+

UT-Battelle successfully demonstrated effective project management by using leading project indicators for project performance as promised and delivering projects on the planning base on schedule and in some cases ahead of schedule. Although the Facilities Development Division had some excellent project performances (i.e., 4000 Substation Reconfiguration and 5000 Area Upgrade) in FY 2008 in completing projects ahead of schedule and under budget. Some projects (i.e., Melton Valley Trailer Projects) that were under estimated and completed behind schedule. Areas of decreased execution did not diminish overall project performance.

| ELEMENT | Letter Grade | Numerical Score | Objective Weight | Total Points | Total Points |
|---|---|---|---|---|---|
| **7.0 Sustain Excellence in Operating, Maintaining, and Renewing the Facility and Infrastructure Portfolio to Meet Laboratory Needs** | | | | | |
| 7.1 Manage Facilities and Infrastructure in an Efficient and Effective Manner that Optimizes Usage and Minimizes Life Cycle Costs | A | 3.8 | 35% | 1.33 | |
| 7.2 Provide Planning for and Acquire the Facilities and Infrastructure Required to support Future Laboratory Programs | A- | 3.5 | 65% | 2.28 | |
| | | | | **Performance Goal 7.0 Total** | 3.6 |

**Table 7.1 - Goal Performance Rating Development**

| Total Score | 4.3-4.1 | 4.0-3.8 | 3.7-3.5 | 3.4-3.1 | 3.0-2.8 | 2.7-2.5 | 2.4-2.1 | 2.0-1.8 | 1.7-1.1 | 1.0-0.8 | 0.7-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Final Grade | A+ | A | A- | B+ | B | B- | C+ | C | C- | D | F |

**Table 7.2 – Goal Final Letter Grade**

## 8.0 Sustain and Enhance the Effectiveness of Integrated Safeguards and Security Management (ISSM) and Emergency Management Systems.

**The contractor sustains and enhances the effectiveness of integrated safeguards and security and emergency management through a strong and well-deployed system.**

The weight of this Goal is 15 percent.

**The Sustain and Enhance the Effectiveness of ISSM and Emergency Management Systems Goal measured the Contractor's overall success in safeguarding and securing Laboratory assets that supports the mission(s) of the laboratory in an efficient and effective manner and provides an effective emergency management program.**

Score: 3.5 Grade: A-

UT-Battelle continued to enhance ISSM programs with some weaknesses observed in cybersecurity and in protection of classified information. UT-Battelle demonstrated strong leadership and performance in the planning, conduct, and evaluation of the 2008 full participation exercise and conducted an aggressive drill and exercise program.

### 8.1 Provide an Efficient and Effective Emergency Management System.

Score: 3.7 Grade: A-

Significant progress was made toward achieving full maturity of the emergency management program.

8.1.1 Conduct a successful Full Participation Exercise in FY 2008.

Score: 3.7 Grade: A-

The full participation exercise Comprehensive Emergency Management Exercise 2008 (CEME08) was developed and executed using an effective, structured approach for planning, conducting, and evaluating the exercise. Notable areas included (1) the use of a project scheduling approach to support the management of the process and (2) expansion of exercise play to include the transition to recovery. Overall, the exercise was conducted, controlled, and evaluated effectively and reliably. CEME08 activities were significant in that (1) weaknesses in dispersion modeling were identified and corrected during the planning process and (2) significant weaknesses in incident command and control were identified during the exercise as a result of the multi-casualty nature of the scenario.

8.1.2 Conduct FY 2008 Emergency Management drills and exercises.

Score: 3.7 Grade: A-

UT-Battelle executed the FY 2008 drill and exercise program in accordance with the established exercise plan. The program was rated "Effective Performance" by a Headquarters inspection team in September 2008. One finding resulted from the inspection regarding the need to expand the facility-level annual drill and exercise activities, and one opportunity for improvement was identified regarding enhancement of the five-year exercise planning process.

**8.2 Provide an Efficient and Effective System for Cyber-Security.**

Score: 2.8 Grade: B

UT-Battelle continued the third year of a defense in depth implementation. Measured improvements were made. An intrusion during November and a red team intrusion later in the year identified a number of additional opportunities for improvement. This is an area that requires continuous management attention and support.

8.2.1 Review and update the ORNL Classified Cyber Security Program and implement appropriate controls for classified information and provide a rigorous defense-in-depth for classified information and information systems.

Score: 2.7 Grade: B-

The Defense in Depth (DID) effort continued during the year and efforts to maintain an effective program were recognized. Issues with awareness by employees precipitated an opportunity for intrusion and internal weaknesses allowed the red team opportunities to gather information and data. Significant responsive efforts are noted among lab leadership and all cyber staff as the issues were identified.

8.2.2 Complete a DOE-SC Site Assist Visit (SAV) regarding implementation of DOE M 205.4-1.

Score: 2.8 Grade: B

The DOE SAV was conducted early in the fiscal year and corrective actions were identified which have been ongoing. Some issues identified were consistent with issues identified by external groups.

**8.3 Provide an Efficient and Effective System for the Protection of Special Nuclear Materials, Classified Matter, and Property.**

Score: 3.7 Grade: A-

8.3.1 Maintain adequate security posture to Design Basis Threat (DBT) requirements.

Score: 3.9 Grade: A

UT-Battelle prepared for and supported a very successful force on force and continued to update documentation and implement the program consistent with applicable DBT requirements.

8.3.2 Timely completion of corrective actions in response to DOE-approved corrective action plans in response to SP-41 and DOE-ORO security surveys.

Score: 3.4 Grade: B+

UT-Battelle continued to implement and complete corrective actions as planned and or approved by DOE.

8.3.3 As funding permits, continue to implement view technology that improves security at ORNL.

Score: 3.7 Grade: A-

ORNL continues to implement technology improvements, which enhances its posture and exceeded plans in the FY 2008 Memorandum of Agreement.

**8.4 Provide an Efficient and Effective System for the Protection of Classified and Sensitive Information.**

Score: 3.7 Grade: A-

In CMPC, Technical Surveillance Countermeasure, and IOSC, UT-Battelle has mature security programs with seasoned security professionals. They are responsive and primarily timely with a few opportunities for improvement.

8.4.1 Continue Informational Security Programs that educate the ORNL community on the importance of protecting security information, and the negative impacts that security violations can cause on scientific programs.

Score: 3.6 Grade: A-

Information security training is conducted routinely during the year. The laboratory director led a review and discussion on protection of classified material and expectations.

8.4.2 Conduct random Operations Security (OPSEC) reviews throughout the laboratory.

Score: 3.4 Grade: B+

UT-Battelle continues to operate OPSEC reviews throughout the laboratory and the operational and research staff has been responsive in addressing issues.

8.4.3 Assist the ORNL community in the prevention of security violations by ensuring that ORNL maintains a strong Authorized Derivative Classification Program.

Score: 3.3 Grade: B+

UT-Battelle maintains a strong Authorized Derivative Classifier program. Some issues were identified during the year, particularly in the training, reinforcement of expectations, and practices of employees performing a specific project. Efforts need to remain vigilant to ensure high integrity of program.

8.4.4 Implement an effective Counter Intelligence (CI) program, which provides DOE and contractor personnel information and activities with the necessary CI services.

Score: 4.0 Grade: A

UT-Battelle has been very effective in working with DOE related to CI issues.

| ELEMENT | Letter Grade | Numerical Score | Objective Weight | Total Points | Total Points |
|---|---|---|---|---|---|
| **8.0 Sustain and Enhance the Effectiveness of Integrated Safeguards and Security Management (ISSM)** | | | | | |
| 8.1 Provide an Efficient and Effective Emergency Management System | A- | 3.7 | 20% | 0.74 | |
| 8.2 Provide an Efficient and Effective System for Cyber-Security | B | 2.8 | 25% | 0.70 | |
| 8.3 Provide an Efficient and Effective System for the Protection of Special Nuclear Materials, Classified Matter, and Property | A- | 3.7 | 25% | 0.93 | |
| 8.4 Provide an Efficient and Effective System for the Protection of Classified and Sensitive Information | A- | 3.7 | 30% | 1.11 | |
| | | | | **Performance Goal 8.0 Total** | 3.5 |

**Table 8.1 – Goal Performance Rating Development**

| Total Score | 4.3-4.1 | 4.0-3.8 | 3.7-3.5 | 3.4-3.1 | 3.0-2.8 | 2.7-2.5 | 2.4-2.1 | 2.0-1.8 | 1.7-1.1 | 1.0-0.8 | 0.7-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Final Grade | A+ | A | A- | B+ | B | B- | C+ | C | C- | D | F |

**Table 8.2 – Goal Final Letter Grade**

# APPENDIX 1

# PROGRAM SPONSOR EVALUATION

## Program Sponsor Evaluation

To evaluate UT-Battelle's Science and Technology performance, surveys were sent to major HQ Program Offices, the U.S. DHS, and U.S. NRC Offices that sponsor work at the Laboratory. The chosen offices were those whose FY 2008 Budget Authority (BA) was equal to or greater than the higher of either 1 percent of the Laboratory's operating budget or $5M.

The survey objectives were developed from performance Goals 1 through 3 described in the Plan. Sponsors were asked to score the objectives following the criteria defined in the Plan. The final rating for each goal was determined by calculating a weighted average of the program offices that responded, using the program offices' pre-determination of the goal/objective importance and their current year BA as weighting factors.

The performance evaluation survey data for program sponsors Appendices 2 through 9. The tables in Sections 1 through 3 of this report summarize the survey scoring. The Performance Summary Statements (PSSs) for goals 1 through 3 (from the survey shown on pages A1-2, A1-3, A1-4) are shown in the body of this report. The PSS for Objections on that survey are shown in the following Appendices. The comments provided by the NRC survey are also shown in Appendix 9.

# APPENDIX 2

# OFFICE OF SCIENCE

# PERFORMANCE EVALUATION SURVEY DATA

## SC 21 Office of Advanced Scientific Computing Research (ASCR)

### 1.1 Science and Technology Results Provide Meaningful Impact on the Field

In FY 2008 ORNL continues to have a broad and significant impact in both Computer Science and Computational Science.

Computer Science

ORNL developed and released a new input/output (I/O) componentization library dubbed the Adapatable I/O System (ADIOS) or, more popularly, ADIOS to make the process of getting information in and out of a supercomputer easier and more effective.

ORNL research shows that certain benchmarks do not accurately represent Translation Lookaside Buffer (TLB) behaviors of real applications. The analysis shows that two benchmark suites that are understood to represent scientific application behavior (Standard Performance Evaluation Corporation Central Processing Unit and High Performance Computing Challenge) are not representative of the TLB behavior of important full-scale applications. Furthermore, the paper demonstrates that false conclusions drawn from benchmark TLB performance can have significant ramifications for application performance.

The I/O working group at ORNL posted an updated version (v03) of its MPI-I/O driver for Lustre. This version is made compliant with the latest ANL MPICH2-1.0.6p1 release, along with other feature enhancements.

Computational Science (SciDAC)

ORNL made several significant contributions in support of the efforts of the Intergovernmental Panel on Climate Change (IPCC), which was named a co-recipient of the 2007 Nobel Peace Prize for its work in "disseminating greater knowledge about man-made climate change." The OLCF and NERSC provided more than half of the simulation data for the joint DOE/NSF data contribution to the United Nations IPCC Fourth Assessment Report. In addition, the Earth System Grid, a coalition of research centers (ANL, LANL, LBNL, LLNL, ORNL, NCAR, NOAA/PMEL, and USC) maximize accessibility of climate simulation data by the international research community.

Four of the "Top Ten Recent Breakthroughs in Computational Science and Enabling Technologies" supported by ASCR, as determined by an external panel of experts in FY 2008, were the work of ORNL researchers in partnership with other institutions. These included:

Astrophysicists Discover Supernova Shock-wave Instability and a Better Way to Spin up Pulsars

First Principles Flame Simulation Provides Crucial Information to guide Design of Fuel Efficient Clean Engines

Breakthrough Fusion Simulation Sheds Light on Plasma Confinement

Closing In on an Explanation for High-Temperature Superconductivity

A large multi-institutional team, co-led by ORNL, used its all-orders spectral algorithm (AORSA) code to demonstrate that radio waves will be effective in heating the multinational ITER fusion reactor. This work, via an image created by OLCF visualization specialist, was featured in the cover article of July's edition of the journal Physics of Plasmas.

An ORNL team used the OLCF to improve the understanding of the processes governing the anomalous increase of normalized capacitance in nanometer-size nanoporous carbon. The findings indicate that the experimentally observed exponential increase in capacitance for pores smaller than a nanometer is related to the adsorption of desolvated ions (as opposed to ions dressed with a solvant shell) inside pores that are too small to accommodate the dressed ions.

A team with ORNL researchers completed the largest run in fusion simulation history, which used 93 percent of the OLCF Cray XT4. The GTC (Gyrokinetic Toroidal Code) run also revealed, among other things, that for a device the size of ITER, the containment vessel will demonstrate GyroBohm scaling, meaning that the heat transport level is inversely proportional to the device size. In other words, the simulation supports the ITER design: a larger device will lead to more efficient confinement.

A team of materials scientists co-led by ORNL used the OLCF to successfully simulate the behavior of water in the presence of the common catalyst titanium dioxide. The computational scientists were able to compare their results with results from a team of ORNL experimentalists, who evaluated the same system of water and titanium dioxide molecules using neutron-scattering techniques. The work not only improves our understanding of a process that is already important in areas such as fuel cell design and geosciences, it also prepares the way for simulations of ever more complex systems.

"Modeling the Earth System" team members at Sandia, ORNL, and NCAR have been focusing on the integration and evaluation of new, more scalable, dynamical cores (based on cubed-sphere grids) into the atmospheric component of the Community Climate System Model (CCSM). The first model successfully integrated in FY 2008 uses a new formulation of the spectral element method that locally conserves both mass and energy and has positive preserving advection. This dynamical core allows the CCSM

atmospheric component to use true two-dimensional domain decomposition for the first time, leading to unprecedented scalability demonstrated on Lawrence Livermore National Laboratory's BG/L system. As part of the project's model verification work, a record-setting one-year simulation was completed in FY 2008.

ORNL led team used OLCF to probe the nature of fleeting, unstable nuclei in an effort to better understand all nuclei, stable and unstable alike and described their work in the November 2007 issue of *Physics Today*. The team's work has potential ranging from making nuclear power generation more stable and reliable to ensuring the effectiveness of America's nuclear stockpile.

### 1.2 Provide Quality Leadership in Science and Technology

ORNL are leaders in critical and highly competitive areas of Computer Science as evidence by publications, invited talks, and committees. Standouts include Geist and Bernholdt.

ORNL staff play leadership roles throughout SciDAC and ORNL SciDAC projects have been extremely successful in INCITE competitions. The MADNESS code has delivered a breakthrough code for chemistry and is already being adapted for fusion and nuclear physics, and ORNL staff leadership in the fusion community was noted in especially strong reviews in FY 2008.

ORNL also organized many notable workshops and other outreach activities for young investigators and students - including disadvantaged students. ORNL should be commended for the continued success of the RAMS program and the impact in encouraging disadvantaged students toward careers in computer science, mathematics, and computational science.

Junqing Sun, in collaboration with staff from ORNL and UT, presented his Ph.D. thesis at Supercomputing 2007 and won first place in the ACM Student Research Poster Competition. His work showed that obtaining double-precision accuracy via iterative refinement of single precision, significantly reduced computation time on FPGAs while still preserving double-precision accuracy.

An ORNL student intern was awarded the ACM/IEEE-CS HPC Ph.D. Fellowship. The fellowship was awarded for work on HPC center storage and distributed storage research and work dealing with fault tolerance that he conducted with his advisor at NC State. This is the first year of this extremely competitive program, honoring exceptional Ph.D. students throughout the world with the focus areas of High Performance Computing, Networking, Storage, and Analysis.

### 1.3 Provide and Sustain Science and Technology Outputs that Advance Program Objectives and Goals

ORNL did critical software work for leadership systems that are utilized across the Department and worldwide (i.e., Luster Operating System). ORNL efforts in Fast Operating Systems and Harness are developing the next generation approach to big distributed tightly coupled computing systems that are fault tolerant - a critical obstacle to further progress in these systems with high long-term payoff and international impact. In Computational Science, ORNL has a broad impact both through the facility staff and the other research staff. Publications are strong across the ASCR projects. However, this is in accordance with our high expectations for lab with the resources and talent of ORNL.

### 1.4 Provide for Effective Delivery of Science and Technology

The quantity and quality of the ORNL program in ASCR core research is especially strong in key areas both in terms of publications and continued progress as meets ASCR's high expectations for ORNL research.

ORNL researcher peer reviews are generally strong and participation in ASCR projects is high, as would be expected of such an excellent program. ORNL performed particularly well, but as expected of such a strong group, in a highly competitive FY 2008 solicitation in Fast Operating Systems.

ORNL Software is made available via open source in a timely manner with documentation and support.

### 2.1 Provide Effective Facility Design(s) as Required to Support Laboratory Programs

Throughout the project, ORNL has identified the delivery of the Gemini interconnect on time and availability of AMD quadcore chips as high-level risks. Actively monitoring these risks is one example that ORNL has been proactive in adopting recommendations from previous DOE Lehman and Operational Assessment reviews. As a result, the 2008 Lehman Review panel of the OLCF found that "in part because of the habits and processes developed, the LCF detected early problems with the development of the AMD processor and Gemini interconnect, socialized these issues with all stakeholders including all levels of DOE and then undertook intense partnership discussions with technology suppliers to develop an alternate solution to maintain schedule and cost with only a limited perturbation in scope from the original baseline definition of the resource." Equally important, the LCF developed a test suite of representative applications to demonstrate that the alternative solution would meet the needs of the

scientific community. The Lehman Review panel recommended the installation of the alternative proposed for the 1 petaflop system.

While upgrading the Cray XT4 this year, staff at the OLCF project was also engaged in site preparation for the installation of the Cray XT5. Because of their close working relationship with Cray, ORNL convinced Cray to design the XT5 cabinets to run on 480 volts instead of the typical 208 volts. This change saved over $1M in site preparation costs because the smaller power cords needed less copper and additional transformers to drop voltage to 208 volts were required.

### 2.2 Provide for the Effective and Efficient Construction of Facilities and/or Fabrication of Components

During FY 2008, staff at the Oak Ridge Leadership Computing Facility has successfully completed a level 2 milestone with upgrade of their Cray XT4 from 119 Teraflops (TF) to 263 Teraflops within scope, cost, and schedule. With the successful completed of the hardware acceptance of the 1 Petaflop (PF) Cray XT5, the OLCF is currently on track to complete their level 1 milestone ahead of schedule, within cost and increased scope. Examples of the OLCF's effectiveness in the execution phase of their current project include:

- **Commitment to environment, safety, and health**: The Cray XT5 cabinets are liquid cooled and all of the refrigerant for the cabinets was delivered as gas cylinders. The OLCF director stood down the installation of the liquid coolant until he received assurance from the ORNL ES&H subject matter experts that the proposed installation and storage procedures were safe.

- **Initiative to communicate emerging problems or issues**: There were several hardware and software issues that delayed the acceptance of the 263 TF upgrade. On weekly integrated project team calls, OLCF staff detailed stability problems that ranged for the lack of boot software for the AMD quadcore chip to bugs in chip logic that implements hypertransport protocols.

An integral part of a leadership computing facility project is identifying scientific applications that will be used during the transitions to operations to thoroughly test the machines. Because of the delay in the acceptance of the 263 TF machine, ORNL had to revise its plan and run the early science runs during the operations. More attention needs to be paid to this area.

### 2.3 Provide Efficient and Effective Operation of Facilities

At the FY 2008 Lehman Review, the panelists found that the "management of the LCF was a key factor in the facility's ability to deliver leading-class

computing and that they focused their attention on building a simulation user facility as opposed to merely installing large platforms."

In FY 2008, ORNL provided approximately 143M hours for 30 INCITE projects. The Scientific Support staff is recognized as world leaders in providing support for its users. The Operational Assessment panel found the "group focus on ensuring application readiness and projecting application performance had proved highly valuable to its user community as demonstrated by its scientific achievements."

Five of the "Top Ten Recent Breakthroughs in Computational Science and Enabling Technologies" supported by ASCR, as determined by an external panel of experts in FY 2008, were the result of simulations run on the OLCF.

OLCF staff also developed the ADIOS for high performance I/O, which enabled the GTC Fusion simulation code to write over 60 TB of data in 20GB/second on 29k core and the Chimera Astrophysics code's I/O to go from 20 minutes to 1.4 seconds.

**2.4 Utilization of Facility to Grow and Support Lab's Research Base and External User Community**

The OLCF continues to provide outreach and training and uses the OLCF director's reserve to attract new users to the facility. They have established several user groups and subcommittees to actively engage the scientific community in identifying their future needs.

Because of the LCF resources at ORNL, the lab has attracted the interest of other Federal agencies such as DOD, National Oceanic and Atmospheric Administration and NSF. While there are certain synergistic benefits to broadening the scientific community at ORNL, we are concerned that the OLCF staff is focused on too many non-DOE projects. For example the head of the scientific support group is also the Acting head of a similar group for the newly installed NSF facility.

**3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision**

Efficiency and Effectiveness of joint planning (e.g., workshops) with outside community

- ORNL has done an outstanding job in FY 2008 with regard to outreach for INCITE, SciDAC, Computer Science and HPC development. If anything ORNL may be too successful at outreaching to other funding agencies.

Articulation of scientific vision

- ORNL has developed a well-articulated and very ambitious science and facilities vision and is executing it proficiently through both research and facility planning and operations.

Development of core competencies, ideas for new facilities and research programs, and ability to attract and retain highly qualified staff.

- ORNL continues to attract some of the best researchers from around the world to implement its vision including Hack in FY 2008.

### 3.2 Provide Effective and Efficient Science and Technology Project/Program Planning and Management

Quality of R&D and/or user facility strategic plans

- ORNL continue to excel in this area. Not only does ORNL deliver high quality plans for each facility they leverage the other resources at ORNL within plans and make good use of the full portfolio. If anything, ASCR is concerned that ORNL may be too successful at facility planning and overstretch its talent.

Adequacy in considering technical risks; success in identifying/avoiding technical problems; and effectiveness in leveraging (synergy with) other areas of research;

- ORNL had a significant cyber security event, which falls under this area because ORNL failed to leverage the significant, successful, and directly relevant WFO activities to strengthen its internal protections.

Demonstration of willingness to make tough decisions (i.e., cut programs with sub-critical mass of expertise, divert resources to more promising areas, etc.).

- ORNL is adept at optimizing its facility and research portfolio through tough decisions.

However, this is not true of ORNL management of other activities especially conferences and publications. The FY 2008 IG investigation of ORNL conference management resulted in significant embarrassment to the Department and ASCR and could have been avoided had ORNL management exercised the discipline it demonstrates in managing its science portfolio.

### 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs

The quality, accuracy, and timeliness of response to customer requests for information

- ASCR is disappointed with ORNL insistence on NCCS branding rather than OLCF branding in reporting outreach and accomplishments. However, reporting of such has been of an extremely high quality and

frequency. ASCR would like to see more from the base research programs to match facility reporting. Responsiveness with regard to one communications effort was disappointing but not enough to tarnish the overall rating.

The extent to which the Contractor keeps the customer informed of both positive and negative events at the Laboratory so that the customer can deal effectively with both internal and external constituencies.

- This was not a high point in FY 2008. Although the facility generally met expectations (many ORNL managers are exceptional in this area while others have proven less so), ORNL should have been more forthcoming with regard to potential problems regarding the new building.

The ease of determining the appropriate contact (who is on-point for what)

- In general, ORNL is among the best at providing clear roles and responsibilities. However, the ORNL Applied Math program needs to improve communications with ASCR program managers.

## SC 22 Office of Basic Energy Sciences (BES)

### 1.1 Science and Technology Results Provide Meaningful Impact on the Field

The BES Materials Sciences and Engineering (MSE) Division-supported programs of Scattering Sciences and Condensed Matter Physics were not reviewed in FY 2008. These programs continued to be productive and demonstrated sustained scientific progress. The FY 2007 review pointed out potential programmatic overlap between projects supported by the Condensed Matter Physics program and the CNMS and the opportunity for dedicated leadership in the Condensed Matter Physics projects. Based on reviewer comments, BES requested ORNL management to clearly define the scope for each of the projects so as to eliminate potential redundancies and to develop a comprehensive staffing and management plan for each individual project to fully capitalize on the unique scientific opportunities and research talents at the laboratory. ORNL management took steps to respond to the BES guidance; their monitoring of the delineation of program support and resultant research accomplishments is strongly encouraged.

The MSE Division-supported Materials Chemistry programs were reviewed in late FY 2007. BES communicated the reviewer guidance to the laboratory in early FY 2008. Overall, the reviewers felt that the program at ORNL encompassed scientific areas with a good mix of research topics. However, both the reviewers and BES staff found that all three field work proposals (FWPs) did not fully realize the synergies expected of DOE laboratory programs. BES recognized that in many cases the synergies were still developing, since the staffing plans and scientific leadership of some FWPs were still in transition. Ultimately, for a world-class DOE laboratory

program, synergy among the principal investigators, a coherent programmatic focus of a multi-principal investigator effort, and use of unique laboratory facilities at ORNL are critical program attributes for justifying continued BES funding in these program areas. The program will undergo an interim on-site peer review in FY 2009 to assess progress towards accomplishing these attributes. The BES programs in Physical and Mechanical Behavior, Electron and Scanning Probe Microscopy, and Synthesis and Processing will be reviewed in FY 2009. These programs continued to be productive and to demonstrate sustained scientific progress.

Two projects supported by the BES Chemical Sciences, Geosciences, and Biosciences (CSGB) Division in Catalysis Science were reviewed on site in April 2008. The first, on heterogeneous systems, was very strongly praised, especially the synthetic elements where atomic layer deposition and surface sol-gel deposition techniques were used to create novel oxides for characterization and study. The work was synergistic with other BES funded programs and made excellent use of the CNMS at ORNL and the National Synchrotron Light Source at Brookhaven National Laboratory. The second project, concerning organic chemical transformations at surfaces (especially those mediated by free radical intermediates) also reviewed well. Of particular note was the recent acquisition of a 700MHz solid state NMR with impressive capabilities to characterize novel surfaces and interfaces.

The laboratory's Geosciences Program completed a reorganization of its FWP structure into three tasks. All encompassed excellent science, particularly in the applications of neutron scattering to geosciences. One project was renewed for FY 2009-2011 based on excellent reviews.

A Hydrogen Fuel Initiative project in nanoscale catalysis, supported through the CSGB Division and initiated in FY 2005, was peer reviewed by panel in FY 2008; the project was terminated due to insufficient progress toward its performance goals.

Ongoing CSGB Division supported programs in Separations and Analysis and Atomic, Molecular, and Optical Science were not reviewed in FY 2008, but continued to be very productive and to demonstrate sustained scientific progress.

### 1.2 Provide Quality Leadership in Science and Technology

The majority of programs supported at ORNL by the BES MSE Division were deemed of excellent quality in recent reviews. These include projects in the areas of x-ray, neutron, and electron scattering and instrumentation; theory and computation in condensed matter and materials physics; and correlated electron materials research, including novel cooperative phenomena and new forms of order, nanoscale electronic phase separation, low-dimensional magnetism, and quantum criticality in transition-metal

oxides. However, programs in Materials Chemistry required significant improvement in terms of strategic hires and planned research directions.

The Catalysis Science review confirmed that the many of the capabilities and accomplishments of the ORNL program were world class, especially with the addition of the state-of-the-art NMR. The approach to all of the research problems was seen as leading-edge (especially in synthesis) and in some cases unique. Several of the investigators have international reputations as leaders in the field.

**1.3 Provide and Sustain Science and Technology Outputs that Advance Program Objectives and Goals**

The activities supported by the MSE Division continued to produce a large number of excellent quality, peer reviewed journal articles. The program frequently reported research accomplishments.

The quantity and quality of CSGB Division supported project research outputs in peer-reviewed journals were deemed exceptional by peer review. In particular, the review of the ORNL catalysis programs in FY 2008 revealed 63 publications in peer-reviewed journals during the previous three-year funding cycle.

**1.4 Provide for Effective Delivery of Science and Technology**

The activities supported by the MSE Division were effective in transmitting the results to the community. ORNL management for the materials research program was very responsive to BES requests for the delivery of scientific results.

CSGB Division research programs were effective and efficient in meeting scientific objectives and milestones, as measured by peer review; the programs were responsive to requests from BES for information and research highlights.

**2.1 Provide Effective Facility Design(s) as Required to Support Laboratory Programs**

ORNL made suitable progress with the SNS Instruments-Next Generation-II (SING-II) Major Item of Equipment (MIE) project. This project underwent an Independent Project Review by an Office of Project Assessment committee in December 2007. This review confirmed the readiness of the project to baseline its first instrument, which was accomplished via a CD-2a milestone attained in February 2008.

ORNL aggressively pursued attainment of CD-0 for the SNS Second Target Station. The project produced a comprehensive report, which has been

reviewed by a panel of external reviewers that recommended that the project go forward. The project assisted BES in the production (and final approval) of the Mission Needs Statement, which is the only project related document required for CD-0. CD-0 is scheduled for early in FY 2009.

ORNL made suitable progress with SNS Power Upgrade Project, another MIE project. This project underwent several reviews and is ready for CD-1 early in FY 2009. The project was configured to remove as many risks as possible and should make great progress in FY 2009.

**2.2 Provide for the Effective and Efficient Construction of Facilities and/or Fabrication of Components**

ORNL progressed adequately with its SNS Instruments-Next Generation (SING) MIE project. This project underwent a status review by an Office of Project Assessment committee in December 2007. No major findings of a pejorative nature arose from this review. Meanwhile, this project successfully completed its first two instruments, via the achievement of CD-4a and CD-4b milestones in February and September, respectively. The project's controls group was key to supporting an Office of Engineering and Construction Management surveillance visit in May 2008 and follow-on activities pertaining to the Earned Value Management System. The only significant criticism was that this follow-on responsiveness could have been improved, leading to a more timely resolution of the outstanding issues.

ORNL is a partner in the DOE Transmission Electron Aberration-corrected Microscopy (TEAM) project. The ORNL role in TEAM involved development, evaluation, and alignment procedures of the pre-specimen electron probe corrector via a leased prototype column that was delivered to ORNL. However, in consultation with TEAM project principals, this ORNL work scope was revised in FY 2008, in part because testing this probe corrector was not as critical to the project due to the development of a high-brightness gun and in part because some of the ORNL principal investigators who were originally planning to contribute their expertise to the TEAM effort were not involved by FY 2008. TEAM project monthly reports from the beginning of FY 2008 up to and including May 2008 showed that ORNL performance "remains a concern." The revised ORNL work scope emphasizes technique development, particularly in depth sectioning using STEM narrow focal depths, as a procedure ultimately useful in single-atom tomography.

**1.3 Provide Efficient and Effective Operation of Facilities**

The SNS completed its second full year of commissioning and operations. Beam power steadily increased during FY 2008 to a power level exceeding 620 kilowatts, a world record. More than 2800 hours of neutron beam were delivered to six instruments, which were used by 165 unique users. By the

end of FY 2009, there will be 10 instruments in the user program. SNS co-managed and hosted a summer school on neutron and x-ray scattering.

Since the HFIR restarted operation in May 2007 with a functioning Cold Source it has maintained a perfect record of on-time start-ups with 99 percent reliability. There were seven instruments in operation, with plans to operate two additional instruments in FY 2009. The number of unique users was 265. Staff morale improved markedly with the successful Cold Source Project completion and the HFIR restart.

Both the CNMS and the SHaRE user facilities operated efficiently and effectively with minimal downtime. Operating time and capabilities were constrained, primarily by budget limitations and by equipment maintenance and repair needs. Changes in the suite of equipment supported and offered by SHaRE were responsive to user needs, and partnering with other units was effective, although the diffusion of ownership and responsibility of many instruments across several units and facilities may lead to future issues.

**2.4 Utilization of Facility to Grow and Support Lab's Research Base and External User Community**

The user programs at SNS and HFIR support the ORNL research program and the external user community. The CNMS continued to support both internal (ORNL) and external science strongly in FY 2008, with an increase in the number of users in FY 2008 over the already substantial levels reported in FY 2007. The CNMS continued to implement responses to reviewer and BES recommendations from their initial operations review in FY 2007. The SHaRE facility added access to new instrumentation that expanded capabilities, broadened its support of the lab's research base, and attracted users at levels comparable to those of the prior three years. Performance was good, but the facility was slow to respond to some of the recommendations from its last review in FY 2006 and should be taking more aggressive steps to improve its visibility, stature, and output in the research community.

**3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision**

The programs supported at ORNL by the MSE Division addressed several key areas of import to BES and the Department including the programs in scattering science and instrumentation, correlated electron systems, structural materials, and theory and computation.

The Director of the ORNL Chemical Sciences Division was an effective leader of the CSGB Division projects at ORNL and was especially active in fostering collaborations with the CNMS and the SNS.

### 3.2 Provide Effective and Efficient Science and Technology Project/Program Planning and Management

Management of the programs supported by the MSE Division was in transition with an acting coordinator. Management was instrumental in responding to on-site peer review guidance; however, the program did not reach its full potential due to the lack of a permanent program coordinator. ORNL management should continue to be vigilant in maintaining delineation between programs funded by the MSE Division and those supported by the BES Scientific User Facilities Division.

The Director of the ORNL Chemical Sciences Division was an effective and active spokesperson for the programs in the Division, as evidenced in the CSGB Division FY 2008 laboratory management review.

### 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs

Management of the programs supported by the MSE Division generally was effective with frequent communications with BES program staff.

Communications between CSGB Division and the ORNL management in the Chemistry Division program were thorough and timely.

## SC 23 Office of Biological and Environmental Research (BER)

### 1.1 Science and Technology Results Provide Meaningful Impact on the Field

The Laboratory manages one of three DOE BioEnergy Research Centers (BRCs), the BioEnergy Science Center (BESC). Fiscal Year 2008 was the first full year of the center and the year for bringing the research team and supporting staff together and establishing ties to the collaborating institutions, such as the National Renewable Energy Research Laboratory (NREL). Despite the 'start-up' nature of BESC during FY 2008, the center was highly productive and is already having an impact and generating considerable enthusiasm for the bioenergy field. BESC scientists published 17 journal articles during this year, including several that have been cited by the journals for high visibility.

The Laboratory makes important contributions to Genomics: GTL foundational science. It is a leader in research into the biological applications of mass spectrometry, particularly those relevant to DOE missions in energy and environment. Its efforts are critically important to the computational analysis and GenBank deposition of microbial sequences from the Joint Genome Institute (JGI) sequencing pipeline. In addition, its computational support and analyses are critical to the progress and continued

productivity of the Shewanella Federation, an excellent example of interlaboratory collaboration. Similarly, the Laboratory-led effort to sequence the Poplar genome as well as other plants in the JGI pipeline is transforming the field of plant genomics.

ORNL is using its mouse resources to study the health effects of low-dose radiation exposure, enabling integration of low-dose response data across levels of biological scale. ORNL has also made a number of contributions to microarray development that have had an impact of the biomicroelectronic field.

A peer review of the Environmental Remediation Sciences Program's (ERSP) Integrated Field Research Center (IFRC) project during FY 2008 showed the project to be on track and quite productive, with 25 new publications in FY 2008 in high quality peer-reviewed journals. Two of these publications are highly cited.

ORNL's climate research program is very productive and is moving the field forward. Progress on the development of the Integrated Terrestrial Carbon Model is very good. A new Carbon Dioxide Information Analysis Center report that shows that a regional shift in fossil fuel carbon emissions was the focus of interest by scientists, the public, and decision makers.

### 1.2 Provide Quality Leadership in Science and Technology

The Laboratory has outstanding scientific leadership, and is making use of their vision to develop novel, yet well-organized approaches to addressing major national problems. All four Directorates with significant involvement in BER biological research have attracted prominent scientists with international reputations to lead projects for BER. These scientists have been instrumental in making the Laboratory a world leader in developing new scientific approaches that are visionary, high-payoff, well-organized efforts to meet DOE's long-term goals in its energy missions.

The quality of the scientists hired by the Laboratory for the BESC leadership and research staff is outstanding. BESC scientists have recently received several awards for excellence, including election as a Fellow of the American Academy of Microbiology, a Fellow of the Electrochemical Society, and the Chairman of the executive committee of the Board of Scientific Counselors of the U.S. Environmental Protection Agency.

The ORNL ERSP project plans to undertake high-risk/high payoff/long-term research efforts in the area of mercury contamination, a major shift in focus for this program. ORNL management has sought out and attracted external/collaborative efforts with widely recognized scientists to bolster internal scientific expertise in mercury. The ORNL IFRC project continues to be very productive with 25 new publications in FY 2008, and one

publication was the most highly cited article in *Environmental Science & Technology* for the period ending December 2007. While ORNL staff participated in several national/international meetings and co-led one workshop on modeling subsurface biogeochemical processes, more efforts to lead workshops and breakout sessions are needed.

Scientists in ORNL's climate change research programs have led four workshops. Progress in ORNL's activities in mitigation is very good. An ORNL scientist is the co-chair of the Science Steering Group for the Climate Change Science Program's (CCSP) North American Carbon Project, the focus of the CCSP carbon cycle program. ORNL led the development of the CCSP's "Unified Synthesis Product." These products were a major deliverable for CCSP.

### 1.3 Provide and Sustain Science and Technology Outputs that Advance Program Objectives and Goals

BESC has already produced significant Intellectual Property (eight inventions, including two in preparation) and is facilitating its eventual commercialization. BESC has developed in a remarkably short period of time a high throughput characterization pipeline for the analysis of feedstock samples using pyrolysis and other tools. The on-site, one-year review of the BESC science and operations cited strong progress during the first year and optimism for future success. The researchers in GTL Foundational Science publish important proteomic research and science application papers in leading journals.

GenBank submissions of microbial sequences are a major and sustained output of ORNL. These microbial (and now plant) genomes provide the fundamental "parts list" for biological investigations into BER-mission relevant processes of bioenergy, waste cleanup, and carbon sequestration.

During FY 2008, the ORNL IFRC project received positive review comments and has been responsive to suggestions for improving output. The ORNL IFRC project has produced a number of important publications and the multiple Principle Investigators (PIs) have made presentations at a number of national and international meetings. While ORNL spent much of FY 2008 reorienting their research activities, there were some noteworthy publications from previously funded research during FY 2008.

ORNL's climate change research activities have been very productive and scientists published 76 journal articles.

### 1.4 Provide for Effective Delivery of Science and Technology

Biological research programs at the Laboratory are highly effective in meeting milestones established by the Laboratory and by DOE. BESC was

established from the ground up during FY 2008, with only organizational planning carried out prior to the start of the fiscal year. The center became fully operational in all of its major aspects before the end of the year, which is an extraordinary accomplishment. External reviews of management processes (carried out during the year) and scientific programs (at the end of the year) determined that BESC was meeting or exceeding all goals and milestones for the initial year and exceeding expectations of Program Office management in making the center fully functional and productive. BESC met a major milestone in implementing a Laboratory Information Management System that not only addresses the need to capture all experimental data throughout the Center (including the partner institutions), but also provides a framework for future Intellectual Property agreements. BESC was the only one of the three BRCs to reach this milestone ahead of schedule. This will have a significant impact on the productivity of this center and influence informatics at existing and future BRCs. BESC scientists actively described their work to the greater biofuels community of scientists and in addition initiated collaboration with scientists at other BRCs. Also noteworthy is that BESC has created outreach opportunities to describe to the public BESC capabilities and background information to explain the biofuels field. The venues include K-12 curricula, workshops, television specials (Discovery Channel), and numerous interviews and articles in the popular press.

ORNL has met all milestones for the artificial retina project.

During FY 2008, ORNL met all scheduled dates for the submission of program documentation, completed all activities within budget, and has been fully responsive to BER guidance, both for the ORNL IFRC project and for the SFA program. The ORNL IFRC project delivered high quality quarterly reports for FY 2008 on time.

The ORNL climate change research projects met all their milestones. The project objectives fully met DOE goals.

**2.1 Provide Effective Facility Design(s) as Required to Support Laboratory Programs**

N/A

**2.2 Provide for the Effective and Efficient Construction of Facilities and/or Fabrication of Components**

N/A

**2.3 Provide Efficient and Effective Operation of Facilities**

The Laboratory is developing an expanded community of neutron technology users at both the SNS and HFIR and is providing a vigorous support environment and innovative outreach to stimulate interest in new applications. The number of users of the BER funded Small-Angle Neutron Scattering station at HFIR in FY 2008 was large, well beyond the available experimental time despite the station only completing commissioning shortly before the start of the year.

The ARM Climate Research Facility (ACRF) exceeded its operating metrics for each quarter for FY 2008. The ACRF met with several user groups, including international workshops, and has begun developing a system for user-defined conditional sampling of archived ACRF data for climate model applications. ORNL manages the ACRF Archive, which is a primary user entry point. ORNL successfully recruited personnel to cover key facility activities.

### 2.4 Utilization of Facility to Grow and Support Lab's Research Base and External User Community

Innovative use of the SNS and HFIR by the Laboratory extends the application of neutrons both for completely new kinds of research studies and to complement x-ray structural biology applications. The Laboratory has created a powerful program in this area that is attracting a substantial external user community and enabling progress on critical aspects of its own programs in bioenergy research.

A GTL/SciDAC effort was started in FY 2008 at the Laboratory, in collaboration with the National Renewable Energy Laboratory, and made significant progress towards applying the Laboratory's Leadership Computing system for benchmarking bioenergy computations. An INCITE project is making highly visible progress and publications in developing new methods and force fields for complex lignocellulose calculations. Both efforts represent leadership in bioenergy computing.

In FY 2008, ACRF users produced significant science and have made improvements to several climate models. The CCSM is one of these impacted models, and the new representation of aerosols will improve the simulations for the next IPCC assessment. Users have also improved the accuracy of weather forecast models. The ACRF has been active with outreach; thus, the number of users significantly exceeded DOE expectations for FY 2008. ORNL enhanced ACRF web-based interfaces to determine user satisfaction and to solicit other user comments. Future analyses of this input will be critical for modifications to the system.

### 3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision

The Laboratory is outstanding in its vision for the biological sciences. It has anticipated developing opportunities for addressing DOE missions requiring biological research. It has made effective use of major user facilities and existing research organizations to make this possible.

BESC has done a remarkable job integrating a common scientific program across multiple partners. Their management design includes several means for coordination, including science retreats, Wiki sites, meetings and conference calls, and a strict management process, including formal, periodic documentation. BESC has partnered with high quality scientists who are recognized by their community for excellence, such as Fulbright Scholars.

In FY 2008, ORNL successfully developed a research plan that significantly shifted the direction of their subsurface science research efforts towards mercury contamination. In this effort, ORNL sought out external mercury expertise/collaborations and empanelled an external scientific advisory committee. The ORNL program is now positioned to deliver fundamental understanding of mercury biogeochemistry in the environment. ORNL has leveraged their efforts in mercury research with more applied research on mercury that is funded by DOE's Office of Environmental Management (EM-22). The ORNL ERSP program includes use of world-class user facilities (SNS, computing facilities) as well as collaboration from local and external leaders in the scientific community. The planned vision for the ORNL science plan appears quite promising, but management will need to continue to ensure the environmental relevance of the effort. The IFRC project has a strong vision and multiple external participants who have been quite productive in conducting both mission-critical as well as high-risk research.

ORNL's climate change research program has been very productive and is developing plans that should enhance their research capabilities. ORNL has approved a Laboratory Directed Research and Development (LDRD) project that focuses on the next generation Free Air Carbon Enhancement (FACE) experiments.

### 3.2 Provide Effective and Efficient Science and Technology Project/Program Planning and Management

The Laboratory provides highly proactive and effective program planning to integrate capital and human resource capabilities relevant to the biological sciences across the laboratory, including essential expertise and instrumentation in several directorates. BESC is a successful example of such multidisciplinary laboratory integration, with scientific strengths in environmental and biological

sciences partnering with world-class facilities in neutron scattering and leadership class computing. The Laboratory demonstrates a strong commitment to developing the synergies among individual research elements to create added scientific value. At the same time, Laboratory management maintains a clear distinction between BER-funded fundamental research and applied technology programs, while promoting handoff of new scientific accomplishments to the latter organizations.

The Laboratory does a very good job of interacting with and ensuring the Oak Ridge Site-wide Institutional Review Board (which is run by ORISE and is responsible for review of Human Subjects projects from all Oak Ridge sites) has the materials it needs to conduct thorough reviews.

Both the IFRC project and the ORNL ERSP project have proactive and robust plans that have required management at ORNL to make hard decisions during 2008. The new ORNL mercury project has reached out for external expertise/ collaboration to bolster program expertise. Several former ERSP projects have been re-tasked to conform to the new focus on mercury contamination requiring the laboratory to make difficult management decisions. Both the on-going IFRC project and the new ORNL SFA project plans were reviewed during 2008. The IFRC project appears well on track, and the ORNL mercury project, after some additional revision, now appears to also be well on track.

ORNL has selected a portfolio of LDRD projects that focus on developing key capabilities in climate change research. These efforts cross SC program office lines and include both BER and the Office of Advanced Scientific Computing Research funded scientists.

### 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs

The Laboratory provides highly effective communication with the BER management and program staff for their biological research programs. There are clear channels of communication from each Directorate involved in BER-funded research to headquarters. BER requested many reports during FY 2008 not only for BESC's start-up phase, but also for the other biological research programs. Reports were complete, timely, and informative. As a strong driver in BESC's efficient program planning processes, the BESC team invested significant resources into management reporting and milestone evaluation. They showed flexibility during this first year of the Center in altering their reporting and project management systems to 'right size' their reporting requirements.

ORNL has been quite proactive in keeping BER informed on activities for both the climate and environmental remediation research projects, including advance notification of exciting research results and team member

participation in important local, national and international meetings with scientists and others. These projects provide quarterly updates on progress in a timely manner.

## SC 24 Office of Fusion Energy Sciences (FES)

### 1.1 Science and Technology Results Provide Meaningful Impact on the Field

The Virtual Laboratory for Technology (VLT), which is operated by ORNL for the fusion program, continues to function very well in bringing together a diverse set of fusion technologies in a cohesive way to support both current and future fusion experiments.

ORNL continues to perform well in the Ion Cyclotron Heating (ICH) and Pellet Fueling programs. They are the lead laboratory for these areas in the U.S. Fusion Energy Sciences program. They participate in a number of national and international collaborations that are mutually beneficial. They develop new ICH and fueling components for experimentation in a number of national research laboratories and participate in conducting experiments when such components are used. In the fueling area, they lead the world and are responsible to provide the pellet injectors for ITER. They are responsible for providing the ICH transmission line components as well as the Electron Cyclotron Heating waveguide components for ITER because of their expertise.

ORNL provided design, fabrication and maintenance activities on a number of ICH and pellet fueling components and systems both for domestic and foreign experimental programs. ORNL developed high frequency (50 Hz) pellet dropper that has been deployed on DIII-D. The device is being used to trigger high frequency edge localized modes (ELMs) with the goal of reducing ELM energy deposition in the divertor for an ITER-scalable test of pellet pacing. In addition, ORNL supported General Atomics in upgrading a number of auxiliary systems on DIII-D. The upgrades resulted in a significant improvement in heating the plasma.

The quality of ORNL work on fusion materials research continues to be outstanding. ORNL has made important contributions to the domestic and international efforts on modeling of irradiation damage and helium effects, on issues of ceramic composites (focusing on silicon carbide fibers in a silicon carbide matrix) and on body-centered cubic metals (focusing on vanadium alloys and ferritic steels). The ORNL Fusion Materials Research program has done an outstanding job of redirecting its efforts in response to the Office of Fusion Energy Sciences (OFES) requests to provide more support for the burning plasma program, which is our highest priority.

The Controlled Fusion Atomic Data Center (CFADC) has been effectively run to provide data to the fusion and plasma science community. The ORNL atomic data center is internationally recognized. Atomic program participants have

effectively worked with the IAEA atomic data unit to improve their atomic physics data system. The research performed is outstanding as demonstrated by the publications and invited talks that the group presents.

The ORNL theory program continued to concentrate on five major areas: 1) turbulence and transport in plasmas; 2) innovative confinement configurations (stellarators); 3) use of RF waves to heat and control advanced confinement regimes; 4) advanced tokamak modeling, and 5) computational plasma physics on massively parallel computer platforms.

The ORNL theory group has continued to make considerable progress in all of the areas they focused on. For example, theory group members have made progress in understanding self-organization in plasmas and have shown that their research has applications in other areas. The fractional derivative approach was applied to transport problems with good success. Other members of the team have extended the AORSA code to three dimensions to study RF heating in stellarators and used it to calculate non-Maxwellian effects from fast ion tails. The results from the effort are being used successfully to understand the fundamental RF properties of plasmas.

The ORNL theory group continues to be involved in all phases of stellarator theory including having major collaborations with other labs and universities and providing support to operating stellarator experiments around the world. In addition, the group has been contributing successfully to the National Spherical Torus Experiment national effort.

### 1.2 Provide Quality Leadership in Science and Technology

ORNL leads the fusion materials research activities under two major joint programs with Japan, the DOE-Japan Atomic Energy Authority (JAEA) and DOE-Ministry of Education, Culture, Sports, Science and Technology (MEXT) collaborations. Under the DOE-JAEA collaboration, ORNL continues to lead planning of the test matrix for irradiation studies of ferritic steels in ORNL's HFIR, resulting in a matrix that will make optimal use of this testing opportunity. Under the DOE-MEXT collaboration, which ended recently, ORNL led the effort to complete an irradiation campaign in HFIR on vanadium alloys and SiC/SiC composites, and made outstanding contributions in addressing the feasibility of insulator coatings for vanadium alloys. A new DOE-MEXT collaboration named TITAN has been initiated which has a focus on the issues in developing plasma facing materials. ORNL staff, because of their scientific expertise in materials, played a substantial role in two workshops devoted to developing the research agenda in this new collaborative program. The Director of the VLT did an outstanding job of representing the technology community within the broader fusion community and in other national forums. He provided excellent direction to the VLT performers, particular in redirecting their efforts to support the burning plasma program, which is our highest priority.

ORNL led an international collaboration with the European Union Joint European Torus (JET) in fueling and heating. ORNL has provided key components to JET for the new high frequency, fueling, and ELM Mitigation pellet injector. ORNL provided critical support in the commissioning and operation of the JET "ITER-like" antenna. In collaboration with JET staff, ORNL has developed and tested tuning/matching algorithms that can accommodate the dynamic load changes associated with ELMs.

The theory group members are all highly qualified and experienced plasma scientists with expertise in a diverse range of areas. A number of them are internationally recognized and respected. They have published numerous papers in refereed journals during the past few years and given several invited talks at national and international meetings. The theory group has had and continues to have considerable impact on both the U.S. and world fusion programs in the five areas mentioned above through their extensive collaborations. The ORNL theory group successfully interacts with many other laboratories and institutions. They play an important role in the Office of Science Scientific Discovery through Advanced Computing (SciDAC) effort. Communications with DOE have improved this year.

### 1.3 Provide and Sustain Science and Technology Outputs that Advance Program Objectives and Goals

ORNL is also taking a lead role in expanding fusion materials modeling at the atomic level, bringing to bear the latest nanoscience tools to improve the understanding of micro-structural evolution and damage accumulation of materials in fusion environments. The ORNL program and staff are well regarded by the international materials science community, with a high profile in meetings such as the International Conference of Fusion Reactor Materials, which is the premier fusion materials conference held every two years.

ORNL provided significant advancement in various fields, including the development and fabrication of RF diagnostics, antenna, gyrotrons, and transmission lines. They have also been instrumental in furthering the development of pellet injection technology and diagnostics. The VLT functioned in a highly effective manner throughout the year. Preparations for the annual Field Work Proposal Meeting were of high quality, including the coordination of the many technology task areas.

The ORNL theory group maintained a high level of output that included: advancing the physics understanding of present experiments; preparing the knowledge base required for realistic extrapolation to burning plasma experiments such as ITER; suggesting new ideas and approaches to stimulate experimental campaigns leading to improved performance; and improving our computational tools that use state-of-the-art leadership class computers.

### 1.4 Provide for Effective Delivery of Science and Technology

ORNL staff has consistently delivered on their milestones to DOE and provided their input for international collaborative programs on a timely basis. In 2008 this included initiating a new U.S.-Japan collaboration on plasma facing materials and completing a major HFIR irradiation experiment. Operational difficulties have occasionally delayed completion of specific experiments, but the fusion materials staff has been very effective in working around any difficulties that this has caused.

The upgrade of the Multi-charged Ion Research Facility was completed satisfactorily. This upgrade will enhance the ability of ORNL to provide data to the fusion and plasma science research community.

The ORNL theory team continues to effectively deliver the theory and computation science needed for the fusion program.

### 2.1 Provide Effective Facility Design(s) as Required to Support Laboratory Programs

In FY 2008, the third year of funding for the U.S. Contributions to ITER MIE Project, the USIPO has continued to do an exemplary job in managing the U.S. commitments to the ITER Project, which is being built in Cadarache, France, in spite of a serious budget reduction that occurred in December 2007. The budget was reduced from $160M to $10.6M. Near the end of the fiscal year, $15.4M was added in a supplemental allocation providing a fiscal year total of $26M plus some carryover from previous years allocations. This budget reduction has seriously impacted the ability of the U.S. to meet its planned commitments in the forms of hardware, personnel, and cash. Nonetheless, the USIPO management exerted tremendous efforts to scale the project back while maintaining a core team that focused on progress on the high-risk items of the U.S. hardware allocation.

The FY 2008 scaled-back domestic activities included a limited amount of credited and voluntary work on the part of the USIPO staff in the areas of project management, project control, work breakdown structure design and preparation for the U.S. hardware manufacturing and fabrication, procurement, human resources, financial planning, and scheduling.

Internationally, the USIPO staff provided a limited amount support to and coordination of the U.S. voluntary efforts of the U.S. Burning Plasma Organization (USBPO) and the fusion community involvement in the high priority items identified by the ITER Science and Technology Advisory Committee. The USIPO also provided voluntary efforts to support the ITER Organization in the areas of project management, scheduling, procurements, and human resources. The USIPO has worked hard to identify and take part in a limited number of high-priority areas that impact U.S. scope areas.

The USIPO leadership sought and found equilibrium survival-mode conditions that enabled the delivery of high-value, though limited results to the U.S. ITER Project in support of the project.

**2.2 Provide for the Effective and Efficient Construction of Facilities and/or Fabrication of Components**

The performance of the NCSX project team at ORNL has been good from a technical and delivery standpoint. In response to concerns raised by the Lehman review committee ORNL began an accelerated program of design tasks required for the assembly of the completed field period modules into the full NCSX torus, the coil services and coil protection systems, the liquid nitrogen cool-down system, and techniques and procedures for measurement of magnetic flux surfaces in the completed device. Between February and May 2008, ORNL nearly doubled its engineering support of NCSX construction to ~12 FTEs and worked to improve project communication and coordination.

Despite intense work by both PPPL and ORNL staff, DOE was forced to terminate NCSX in late May 2008. Over the remaining months of the fiscal year, the design work was fully documented for possible future use, and closeout reports were prepared.

**2.3 Provide Efficient and Effective Operation of Facilities**

**NA**

**2.4 Utilization of Facility to Grow and Support Lab's Research Base and External User Community**

**NA**

**3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision**

ORNL has a critical role in the materials, fueling, and ICH areas. They have been very effective in conducting their own research activities as well as interacting with the rest of the organizations that are conducting similar research. They have been very effective in the utilization of their limited resources and in adjusting their program as the need arises. The management of the VLT has gone very well. The VLT Director has done an excellent job of representing the technology part of the fusion community.

ORNL continues to focus its efforts on the most important tasks of the materials program: material issues with the ITER device, the ITER test blanket program, and U.S. participation in international collaborations of a bilateral nature (mainly Japan) and of a multi-national nature (mainly, with Europe, Japan, and the

Russian Federation under the International Energy Agency (IEA) Implementing Agreement on Fusion Materials). ORNL has provided excellent vision to the rest of the fusion materials community in planning their activities to minimize overlap and maximize output with limited resources.

In the atomic data area, ORNL has performed in outstanding manner as demonstrated by the publications and invited talks that the group presents. Atomic program participants have effectively worked with the IAEA atomic data unit to improve their atomic physics data system. The CFADC has been effectively run to provide data to the fusion and plasma science community.

USIPO has continued to do an exemplary job in providing effective and efficient management and direction, in spite of a devastating reduction in funds three months into the fiscal year. Because of the budget shortfall, the USIPO was unable to meet most of the commitments of the ITER Project in FY 2008; however, through effective management activities, the USIPO was able to downsize the effort to be consistent with the available funds, and at the same time, to prioritize the use of its limited resources on those hardware items with the largest cost and schedule risk. In particular, it is the vision of the USIPO that the completion of the ITER design as soon as possible is paramount to manage cost and schedule. To this end, the USIPO has effectively managed the call for help from the ITER Organization by the careful insertion of U.S. personnel resources to expedite completion of the design, particularly in those areas that are critical to the U.S. hardware allocation commitments. Through the USIPO chief science and technology officers, the call was issued to the U.S. community for assistance. As the U.S. fusion community responded, USIPO effectively created the infrastructure to enable participation of the appropriate subject matter experts. Effective management of the resource needs enabled the placement of the appropriate skills where needed. Of particular note is that the U.S. holds the leadership position in the civil infrastructure area of the design effort.

### 3.2 Provide Effective and Efficient Science and Technology Project/Program Planning and Management

ORNL's performance in fusion materials research and materials support for ITER continues to be excellent. Substantial progress was made in carrying out the HFIR irradiation experiments and post-irradiation examination of specimens that are part of the two US-Japan collaborations with JAEA and MEXT. Mechanical property data was obtained from two JAEA-DOE irradiation vehicles, and irradiation of a MEXT-DOE capsule was completed. Significant new experimental results include contributions to ITER materials needs for fracture toughness data on CuCrZr alloys and development and testing of a new cast austenitic stainless steel for blanket module fabrication. Post-irradiation data on a new, ORNL-developed oxide-dispersion-strengthened steel indicated it has a unique combination of high strength and good toughness, which was maintained after irradiation.

ORNL has done an excellent job of leading the VLT. A major challenge that was overcome during the period was determining and putting in place an efficient mechanism to proceed with the US/Japan collaboration on the TITAN project. ORNL also worked well with the community to provide input to the budget planning meeting and the National Research Council panel evaluating the U.S. research program plan for ITER. The VLT director also represented U.S. interests on the ITER Science and Technology Advisory Committee

### 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs

ORNL communicated on a regular, frequent basis concerning the performance of the NCSX project. Appropriate personnel were readily available to present pertinent information and respond to inquiries in a timely manner. The ORNL Deputy Project Leader committed additional staff to support NCSX construction and worked to improve project communication and coordination in order to recover schedule and reduce cost uncertainties.

ORNL is highly responsive to DOE and to fusion community input in setting the direction of their work, as well as providing both written and oral communication on the progress and issues. They have also helped the other contractors involved in fusion materials research in guiding their activities to be consistent with the overall needs of the program. ORNL has done an excellent job of working with OFES and the community in providing input for the U.S. members of the ITER Science and Technology Advisory Committee.

Management of the ORNL atomic physics program is very effective in communicating with Headquarters.

The USIPO staff serves on numerous working groups, advisory committees, and ad hoc groups. In addition, the management staff and Work Breakdown Structure managers are frequently meeting and working with ITER Organization personnel to advance the activities of the ITER Project. The USIPO staff routinely communicate the activities, findings, actions, concerns, etc. to the Office of Science and Office of Fusion Energy Sciences staff on a weekly or more frequent basis. The USIPO conducts quarterly Integrated Project Team meetings consisting of project and program staff, and they provide Monthly Reports, which provide assessments on the technical, cost and schedule aspects of the U.S. ITER effort.

## SC 26 Office of Nuclear Physics (NP)

### 1.1 Science and Technology Results Provide Meaningful Impact on the Field

**Objective 1.1 Performance Summary Statement:**

The ORNL Physics Department low energy subprogram scientists conduct high priority research at the HRIBF in nuclear structure and nuclear astrophysics with radioactive ion beams and stable beams, addressing goals of the national program. The experiments in nuclear structure emphasize studies of properties, delayed proton emission and alpha decay of nuclear near the proton drip line, discovery and initial measurement of properties of nuclei near the doubly closed shell nucleus Ni-78, and reaction studies and coulomb excitation studies of nuclei near Sn-132. Reaction studies seek to understand if reactions using neutron rich rare beams have advantages for producing super-heavy nuclei.

The ORNL scientists have accomplished the first direct proton capture measurement of F-17, a reaction, which is key to understanding novae explosions. The (d,p) reaction has been measured on Sn-130, a nucleus believed to play an important role in the production of elements heavier than tin.

The target/ion source group has continued to develop the laser ion source for future experiments with a new radioactive ion beam production platform, and continues the development of aluminum beams at the High Power Target Laboratory (HPTL).

The ORNL neutron physics group are preparing for installation of the npdgamma experiment at the FNPB at the SNS, the first experiment that will be conducted at the facility.

The 2008 DOE S&T panel review evaluated the PHENIX STAR experiment as being high quality as demonstrated by many scientific measurements and numerous publications that have appeared in refereed journals. The ORNL Relativistic Heavy Ion group continues to conduct/lead studies of heavy quark, and J/Ψ suppression, and prompt photon production. First publications have been reported which could have an impact on the field.

The nuclear data effort compiles and evaluates data for heavy nuclei, as well as data relevant to nuclear astrophysics, contributing to the national nuclear data program.

### 1.2 Provide Quality Leadership in Science and Technology

**Objective 1.2 Performance Summary Statement:**

The ORNL staff provides the only competency in radioactive ion beams with the ISOL in the United States. Researchers provide leadership in nuclear structure

and nuclear astrophysics with ISOL techniques and reaccelerated radioactive ion beams, and conduct research and development in the techniques and methods required for those studies.

The ORNL staff are leaders in the development of a cold and ultracold beam line at the Spallation Neutron Source, and the experimental program that will utilize the facility.

The research staff utilizes the High Power Target Laboratory to develop new target/ion source combinations. Researchers from international laboratories seek collaboration with the ORNL group to develop new beam production capabilities.

The ORNL group is highly regarded in tackling difficult physics analyses tasks and assuming leadership roles in the readout electronics for the PHENIX silicon Vertex Tracker (VTX) project and the CERN ALICE Electromagnetic Calorimeter project.

The two local theory groups interact with HRIBF experimentalists. The astrophysics theory group is active in the areas of core-collapse supernovae, neutrino transport, and the nucleosynthesis in explosive astrophysical environments. The nuclear structure theory group, which demonstrates strong leadership on an international scale, is active in ab initio reaction calculations, coupled cluster theory, shell model, and energy density functional calculations. The theory groups spend a reasonable fraction of their effort directly on HRIBF related activities.

The nuclear data program's evaluation of data for nuclear astrophysics coordinates well with the experimental and theory programs in nuclear astrophysics at HRIBF.

### 1.3 Provide and Sustain Science and Technology Outputs that Advance Program Objectives and Goals

The ORNL low energy nuclear physics group has authored or co-authored a substantial body of work (23 papers) published in peer-reviewed journals. Six theses result from research in at HRIBF.

The ORNL nuclear theory group has published 31 papers in peer-reviewed journals.

Publications and citations meet the amount and/or quality typically expected for an excellent body of work. The ORNL heavy ion group has authored or co-authored 21 papers that were published in peer-reviewed journals.

Overall, 70 invited talks were presented by ORNL nuclear physics personnel.

### 1.4 Provide for Effective Delivery of Science and Technology

The ORNL Physics Division's FWP is comprehensive, with a reasonable financial and workforce plan. At the HRIBF Science and Technology Review, the personnel effectively presented the accomplishments of the facility, and presented their proposed research and plans for equipment development clearly.

ORNL scientists have developed a new beam line (LeRIBSS) and experimental capabilities to study stopped radioactive nuclear beams and are implementing new measurement capabilities for neutron decay of these nuclei. This capability enables access to more neutron-rich nuclei than previous methods at HRIBF.

The ORNL FNPB project has received the CD-4a decision for the cold neutron beam line, bringing that part of the project to a completion successfully.

The scientists at HRIBF have continued to serve as mentors for outside users and operated experimental equipment in order to help accomplish the user program, and have perfected the ranging-out method to tag very short-lived radioactive nuclei for decay studies.

Program/project goals and/or milestones are largely met. ORNL group has effectively responded to all DOE technical review recommendations. Response to a DOE recommendation made in the ALICE USA Science Review has been delayed by six-months.

The nuclear data researchers have a comprehensive plan to incorporate evaluated data into the nuclear astrophysics program and developed and maintain on-line tools available to the community.

### 2.1 Provide Effective Facility Design(s) as Required to Support Laboratory Programs

NA

### 2.2 Provide for the Effective and Efficient Construction of Facilities and/or Fabrication of Components

NA

### 2.3 Provide Efficient and Effective Operation of Facilities

The HRIBF had a highly successful campaign during the year between Science and Technology Reviews providing radioactive ion beams (RIBs) via the ISOL and in-flight methods (~2350 hours). During FY 2008, over 1500 hours of RIBs on target were provided. The total number of beam hours, including research hours, beam studies, and setup time reached 4430 hours, exceeding

plans. The overall reliability of the facility is very good (~82 percent), exceeding the requirement in PART/Joules of 80 percent.

The intensity and variety of radioactive ion beams continues to grow. Particularly important during the last year was the factor of 10 increase in the intensity of the F-17 beam that enabled the key proton capture experiment on the nuclide for the first time.

The HRIBF facility had a radioactivity spill that resulted in no radioactive ion beam running during the last quarter of FY 2008. The incident has been systematically and responsibly dealt with in preparation for resumption of radioactive ion beam operations. Stable beam operation was resumed to continue a productive physics program.

**2.4 Utilization of Facility to Grow and Support Lab's Research Base and External User Community**

The HRIBF users program is effective with continued updates and improvements in the users website. The HPTL is utilized to develop new beams and ion source capabilities for the radioactive ion beam program including Al beams. Construction of IRIS2, a second source of radioactive ion beams, will provide new capabilities and increase RIB availability. This accelerator improvement project is making good progress and maintaining cost and schedule baselines.

The laser ionization capabilities are being developed and applied to the production of radioactive ion beams to address issues that are unique to HRIBF.

With completion of the cold beam line of the FNPB at the SNS, the Laboratory is poised to be a world-leading center for fundamental research with neutrons. This facility will accommodate a variety of experiments to be executed by the U.S. community of neutron physicists, and has initiated a Program Advisory Committee to vet user proposals.

The LeRIBSS beam line enables an enhanced program for users with stopped radioactive ion beams by taking advantage of production at the HPTL.

**3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision**

The Physics Division has developed a strategic plan for the facility that related the HRIBF research to the national physics program, identifies nuclear beam developments that are needed and other resources necessary to carry out the program.

The HRIBF staff effectively carries out the stewardship of nuclear physics research with both reaccelerated and stopped radioactive ion beams produced

via the ISOL method. This effort includes the research and development necessary to extend the technologies and methodologies necessary for a vital program. The facility serves an international user community.

The HRIBF staff has a vision for upgrades of the facility, including options for a new driver capability, which would significantly extend the capabilities of the facility for higher intensity radioactive beams. These options include an electron accelerator, a rototron, to be a driver for electo-fission, and a new proton accelerator as the driver for a fission source and production of proton rich nuclei.

The Physics Division is effective in planning for a leading in-house and user research program utilizing the neutron capabilities at the FNBP.

### 3.2 Provide Effective and Efficient Science and Technology Project/Program Planning and Management

The Physics Division has developed upgrade options for the HRIBF including the fabrication of the second production platform IRIS2, options such as the electron or cyclotron driver to enhance the facility, and a pathway to improve the performance of the present ORIC driver accelerator.

The Physics Division has effectively planned and managed the construction of the FNPB, with the successful approval of CD-4a for the cold beam line portion of the project. Within the resources available, the Division is establishing a research and operations group for the neutron physics program.

The Physics Division and Physical Sciences Directorate have been responsive and proactive in working with the Office of Nuclear Physics in preparation for transfer of the Isotopes Program to the Office in FY 2009. A bottom-up exercise of Cf-252 production at the HFIR enabled the identification of a more cost effective and efficient path forward for Cf production.

### 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs

The Physics Division responds to requests for information in a timely manner, with information that is reliable. Biweekly teleconferences between the Office of Nuclear Physics and the Physics Division provide a mechanism to communicate issues and concerns routinely.

Information concerning a recent radioactivity spill at HRIBF, including an understanding of the radiological issues, cleanup process and analysis of the causes and preventive measures, was effectively communicated by the Physics Division and Physical Science Directorate.

The Physical Science Directorate and personnel involved in the Isotopes Program were very responsive to the requirements of the Office of Nuclear Physics in preparation for the transfer of the Isotopes Program to NP.

# APPENDIX 3

# ASSISTANT SECRETARY FOR ENERGY EFFICIENCY AND RENEWABLE ENERGY

# PERFORMANCE EVALUATION SURVEY DATA

U.S. Department of Energy

Office of Energy Efficiency and Renewable Energy

Performance Evaluation Report of the

UT-Battelle, LLC for

Management and Operations of Science and Technology at the

**Oak Ridge National Laboratory**

For the period October 1, 2007, to September 30, 2008

## 1. Executive Summary

The Office of EERE participates in the award-fee evaluation process to assess the performance of National Laboratories in the area of science and technology. This requirement originates from the annual "Standards of Performance-Based Fee" clauses negotiated between the U. S. DOE and a contractor M&O a National Laboratory. Existing contracts call for annual evaluations. The result of the evaluation - the overall weighted score for the science and technology goals awarded by all DOE programs - determines the percentage of the available performance-based fee that the M&O contractor earns. EERE prepared this evaluation as its input to DOE's award-fee evaluation of UT-Battelle, LLC's operation of the ORNL. It assesses ORNL's performance of work for programs in EERE from October 1, 2007, to September 30, 2008.

Each reporting EERE program that obligated $1.0 million or more to ORNL during the performance period evaluated the Laboratory's performance using the Performance Goals and Objectives specified by DOE. The overall rating for each Performance Goal represents a weighted average grade of ratings received from EERE program offices. The computation uses each program's year-to-date obligations at ORNL as of August 31, 2008, as the weighting factor.

The following EERE programs submitted evaluations: BP; BTP; FEMP; Hydrogen, Fuel Cells and Infrastructure Technologies Program (HFCIT); Industrial Technologies Program (ITP); Vehicle Technologies Program (VTP); and Weatherization and Intergovernmental Activities (WIP).

EERE rated ORNL's performance for fiscal year 2008 with a score of 4.00 for Goal 1: Accomplish Mission; 3.98 for Goal 2: Effective and Efficient Operation of Facilities; and 3.96 for Goal 3: Effective Science and Technology Research Project and Program Management. ORNL's total score for fiscal year 2008 is 3.99.

| NUMERICAL GRADES BY PERFORMANCE GOAL | GOAL 1: ACCOMPLISH MISSION | GOAL 2: EFFECTIVE AND EFFICIENT OPERATION OF FACILITIES | GOAL 3: EFFECTIVE SCIENCE AND TECHNOLOGY RESEARCH PROJECT AND PROGRAM MANAGEMENT |
|---|---|---|---|
| 2. BIOMASS | 3. 3.77 | 4. 3.60 | 5. 3.70 |
| 6. BUILDING TECHNOLOGIES PROGRAM | 7. 3.63 | 8. 3.90 | 9. 3.00 |
| 10. FEDERAL ENERGY MANAGEMENT PROGRAM | 11. 3.40 | 12. 3.50 | 13. 3.67 |
| 14. HYDROGEN, FUEL CELLS AND INFRASTRUCTURE TECHNOLOGIES PROGRAM | 15. 3.85 | 16. 3.90 | 17. 3.80 |
| 18. INDUSTRIAL TECHNOLOGIES PROGRAM | 19. 4.08 | 20. 4.07 | 21. 4.07 |
| 22. VEHICLE TECHNOLOGIES PROGRAM | 23. 4.15 | 24. 4.10 | 25. 4.20 |
| 26. WEATHERIZATION & INTERGOVERNMENTAL ACTIVITIES | 27. 3.95 | 28. 3.90 | 29. 3.93 |
| **30. WEIGHTED AVERAGE GRADE** | **31. 4.00** | **32. 3.98** | **33. 3.96** |
| **34. FINAL NUMERICAL RESULT** | **35. 3.99** | | |

Grades of 3.3 or higher signify that ORNL's work toward a goal translates to substantive performance and results for the program. The following chart illustrates how numerical scores translate into letter grades.

| Total Score | 4.3-4.1 | 4.0-3.8 | 3.7-3.5 | 3.4-3.1 | 3.0-2.8 | 2.7-2.5 | 2.4-2.1 | 2.0-1.8 | 1.7-1.1 | 1.0-0.8 | 0.7-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Final Grade | A+ | A | A- | B+ | B | B- | C+ | C | C- | D | F |

## 36. Introduction

This evaluation has been prepared as part of DOE's contractual obligation to assess UT-Battelle, LLC's performance for M&O of science and technology at ORNL. Specifically, it assesses ORNL's support of EERE program offices in science and technology and its ability to assist these program offices in maintaining the overall EERE mission: to strengthen America's energy security, environmental quality and economic vitality through public-private partnerships.

This evaluation report, covering the period from October 1, 2007, through September 30, 2008, comprises five sections. The first section highlights the given performance goals, objectives and measures provided to each DOE EERE technical program office. The second section addresses the process followed to grade the laboratory's performance. The third section presents the overall grades resulting from the evaluation. The fourth section lists key achievements and areas of concern. The fifth and final section provides guidance for the next performance period.

## 37. Performance Goals, Objectives, and Measures

This evaluation focuses on grading the contractor's performance against Performance Goals as described below. Each evaluator measures progress against these Performance Goals using a set of Performance Objectives and Performance Measures, defined as follows:

- Performance Goal: This is a general overarching statement of the desired outcome for each major performance area.
- Performance Objective: An objective is a statement of desired results for an organization or activity within a major performance area.
- Performance Measure: A performance measure provides a reviewer a quantitative or qualitative method for characterizing performance to assist in assessing achievement of the corresponding Performance Objective.

The Performance Goals and Performance Objectives used by EERE, for the most part, adopt the standardized versions of goals and objectives defined by the Office of Science, as stated in the following:

- Goal 1: Accomplish Mission
  - Objective 1.1: Accomplish Mission
  - Objective 1.2: Leadership
  - Objective 1.3: Produce high quality, original, and creative results that advance science and technology (recognition of science and technology breakthroughs).
  - Objective 1.4: Delivery
- Goal 2: Effective and Efficient Operation of Facilities
  - Objective 2.1: Provide effective and efficient operation of facilities supporting EERE program.
- Goal 3: Effective Science and Technology Research Project and Program Management

- Objective 3.1: Effective program vision and leadership.
- Objective 3.2: Effective and efficient science and technology project and program planning and management.
- Objective 3.3: Effective and efficient communications and responsiveness to EERE and Project Management Center (PMC) needs.

EERE also adjusted the Performance Measures under Goal 1 to include success in meeting program milestones and other criteria appropriate to applied research. EERE uses only one Performance Objective under Goal 2, namely the effective and efficient operation of facilities to support EERE programs. EERE only constructs facilities at the NREL.

## 38. Evaluation Processes: Numerical Scores and Averaging

After collecting the scores, EERE weighted them against specific program obligations for fiscal year 2008 at ORNL, as reported in DOE's Standard Accounting and Reporting System as of August 31, 2008. The following table lists the total funding obligated by each program.

| Program Office | Year-To-Date Obligations at ORNL as of August 31, 2008 ($ Thousands) |
|---|---|
| Biomass | $11,198,076 |
| Building Technologies Program | $7,538,617 |
| Federal Energy Management Program | $2,038,500 |
| Hydrogen, Fuel Cells and Infrastructure Technologies Program | $9,932,328 |
| Industrial Technologies Program | $13,840,808 |
| Vehicle Technology Program | $46,009,712 |
| Weatherization & Intergovernmental Program | $1,870,000 |
| **Total** | **$92,428,041** |

EERE then computed a weighted average score for each Performance Goal.
The following example illustrates the algorithm used to compute a weighted average.

| Program | Numerical Score | Fiscal Year 2008 Obligations | Weighted Score |
|---|---|---|---|
| One | 4.3 | $2,000,000 | 8,600,000 |
| Two | 3.9 | $20,000,000 | 78,000,000 |
| Three | 3.3 | $6,000,000 | 19,800,000 |
| **SUM** | | **$28,000,000** | **106,400,000** |
| **Weighted Average (Sum of Weighted Score/Sum of FY 2008 Obs)** | | | **3.80** |

## 39. Outcome by Performance Goal

EERE rated ORNL's performance for fiscal year 2008 with a score of 4.00 for Goal 1: Accomplish Mission; 3.98 for Goal 2: Effective and Efficient Operation of Facilities; and 3.96 for Goal 3: Effective Science and Technology Research Project and Program Management.

The following table highlights the numerical grade issued by each of the program offices by Performance Goal and the overall grade for EERE:

| 40. NUMERICAL GRADES BY PERFORMANCE GOAL | Goal 1: Accomplish Mission | Goal 2: Effective and Efficient Operation of Facilities | Goal 3: Effective Science and Technology Research Project and Program Management |
|---|---|---|---|
| Biomass | 3.77 | 3.60 | 3.70 |
| Building Technologies Program | 3.63 | 3.90 | 3.00 |
| Federal Energy Management Program | 3.40 | 3.50 | 3.67 |
| Hydrogen, Fuel Cells and Infrastructure Technologies Program | 3.85 | 3.90 | 3.80 |
| Industrial Technologies Program | 4.08 | 4.07 | 4.07 |
| Vehicle Technologies Program | 4.15 | 4.10 | 4.20 |
| Weatherization & Intergovernmental Activities | 3.95 | 3.90 | 3.93 |
| **Weighted Average Grade** | **4.00** | **3.98** | **3.96** |

Based upon the scores assigned by each program office for each Performance Goal and Objective,

ORNL's overall final numeric score is 3.99, as calculated in the table below:

| Goal | EERE Weight | Weighted Numerical Score (All Programs) | Portion of Final Score |
|---|---|---|---|
| Goal 1: Accomplish Mission | 60% | 4.00 | 2.40 |
| Goal 2: Effective and Efficient Operation of Facilities | 10% | 3.98 | 0.40 |
| Goal 3: Effective Science and Technology Research Project and Program Management | 30% | 3.96 | 1.19 |
| **Final Numerical Score** | **3.99** | | |

The following chart illustrates how numerical scores translate into letter grades.

| Total Score | 4.3-4.1 | 4.0-3.8 | 3.7-3.5 | 3.4-3.1 | 3.0-2.8 | 2.7-2.5 | 2.4-2.1 | 2.0-1.8 | 1.7-1.1 | 1.0-0.8 | 0.7-0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Final Grade | A+ | A | A- | B+ | B | B- | C+ | C | C- | D | F |

## 41. Selected Examples of Achievements and Deficiencies

EERE, in the order of each Performance Goal, has highlighted selected major achievements recognized throughout fiscal year 2008. It also addresses certain areas within ORNL's R&D environment needing management attention.

**GOAL 1: ACCOMPLISH MISSION** with the following objectives:

- Accomplish Mission;
- Leadership;
- Produce high-quality, original and creative results that advance science and technology (recognition of science and technology breakthroughs); and
- Delivery.

**SIGNIFICANT ACHIEVEMENTS**

- Biomass

  Objective 1.1

  Intermediate blend testing conducted by ORNL is highly important because it provides objective, credible testing of fuel blends in a number of engine configurations. This data is critical to the mission of the program. International Analytical Data for feedstock production and land cover in Brazil and other parts of the world provided by ORNL contributed greatly to the Global Trade and Agriculture Production Model. This information is also very important in addressing the indirect land use issue. ORNL has stepped up its effort to meet the BP mission by addressing sustainability efforts by creating a virtual sustainability center and assigning key staff to it. ORNL's recognized technical leadership is important to the BP.

  Objective 1.2

  ORNL is a recognized leader in DOE's National Laboratory network for feedstock analysis, vehicle testing, and the new area of sustainability. ORNL-led Billion Ton study is still recognized as the major feedstock supply report. The Intermediate blend testing work for ethanol blends is well recognized for its contribution. Sustainability support at the Ecological Society of America (ESA) Conference helped keep the sustainability issue in the proper context. Without ORNL's heavy involvement, the outcome of the ESA Conference would have had a different outcome, perhaps setting back the BP.

  Objective 1.3

  The facilities, scientists, and engineers conducting the intermediate blends testing at ORNL are considered advanced and unique. Their research product developed during this performance period was outstanding. The Integrated Biomass Supply and Logistics Model was developed by ORNL and is a unique tool to simulate the collection, harvesting, and transport operations needed to supply agricultural biomass to a biorefinery. ORNL capabilities for feedstock supply analysis are viewed as unique by BP and the output is highly regarded.

  Objective 1.4

None

- Building Technologies Program

  Objective 1.1

  ORNL continued its significant impact on the envelope industry in fiscal year 2008. Leading companies routinely seek ORNL advice on the development of new product designs, analysis, testing, and partner collaboration. ORNL demonstrated ninety percent peak demand reduction of cooling loads on residential roofing from its prototype system. Optimization work was significant, however only preliminary results were expected in fiscal year 2008. Stage gate analysis shows the most cost effective markets. ORNL also completed a major update to the insulation guidelines for the U.S. in collaboration with industry and received significant cost share. Daily web traffic is around fifteen hundred (1500) visits per day. ORNL continued to provide outstanding whole-house research that contributes toward achieving the Building America (BA) net zero homes goal for the mixed/humid climate and to communicate the results of BA research to builders and consumers.

  Objective 1.2

  ORNL continues to exhibit strong industry leadership. For example, ORNL plays key roles within the American Society of Testing and Materials arena and within the American Society of Heating, Refrigerating, and Air-Conditioning Engineers Technical Committee 4.4 as its lead. ORNL also has contributed significantly to our international leadership on the IEA Buildings Agreement, Annex 41. We have a long-term collaboration with the Fraunhoffer Institute in Germany, which has shown the world how to manage moisture in buildings that is a major contributor to energy efficiency and building durability. ORNL contributed significantly towards coordinating the integration of individual components into cost-effective lab house designs for the mixed/humid climate.

  Objective 1.3

  ORNL has been working on insulation that has been doped with phase change material. In fiscal year 2008, ORNL was able to pass all of the fire rating tests that have been a major obstacle for commercialization. In depth testing and analysis has shown that it will have a significant contribution to peak demand cooling loads and will have moderate energy savings in targeted climate areas.

  Objective 1.4

  ORNL has been very effective in recruiting builder and other partners for their research as well as reaching out to the other BA teams. They have also provided outstanding support in coordinating the implementation and outreach activities with other government agencies and nongovernment organizations. ORNL has been able to support BTP, despite tight deadlines, with a high quality product without any impacts to any milestones.

- Federal Energy Management Program

  Objective 1.1

  ORNL completed industrial assessments at two Air Force facilities and provided key technical support to allow DOE's Forrestal Building to obtain the Energy Star

label. ORNL's support to DOE FEMP's Industrial Facilities Initiative was featured in the winter issue of Energized, a Naval Facilities Engineering Service Center publication. ORNL supported the Green Energy Parks meeting hosted by the Department of Interior, National Parks Service in Golden, Colorado from January 16 to 17, 2008, to facilitate EERE partnerships between national parks service sites and utility partners. Technical Experts from ORNL provided four presentations and organized two sessions at the Federal Government's annual conference, GovEnergy, held in Phoenix, Arizona in August 2008. The sessions were targeted to lawyers and procurement officials. The presentations included metering, energy modeling, partnering with utility companies on energy security issues, and hybrid solar lighting. ORNL completed a report evaluating the cost savings from the Super ESPC program. ORNL's analysis indicates that Super ESPC projects are delivering greater cost savings than were guaranteed by the ESCOs, partly because utility rates have risen faster than agreed to stipulations in the contracts.

Objective 1.2

ORNL is the lead lab for FEMP's successful Industrial Facilities Initiative. The initiative uses tools developed by DOE's ITP and the services of university-based Industrial Assessment Centers (IAC) to provide high quality assistance to federal facilities with industrial processes. Services have been provided to Navy shipyards, Army ammunition depots, U.S. mint, and the postal service processing facilities. As part of FEMP's Industrial Facilities Initiative, led by ORNL, an IAC team conducted industrial energy assessments of compressed air systems at Arnold Air Force Base in Tennessee and Columbus Air Force Base in Mississippi. The assessments identified energy conservation measures that would annually save 155,860 million British Thermal Units when implemented.

ORNL teamed with DOE's ITP to develop a presentation for GovEnergy2008 that highlighted the successful Industrial Technologies Initiative. The presentation was titled "Working Together to Help Federal Complex Save Energy and Money."

ORNL's Super ESPC project under Secretary Bodman's Transformational Efficiency Action Management (TEAM) Initiative set a new DOE record for reduced cycle time (months elapsed from kickoff to award). The $89 million project was completed within nine months and the lessons learned from the project can be applied to other ESPCs. The project features a partial de-centralization of ORNL's central steam plant including the installation of a DOE-ITP developed Cleaver Brooks "Super Boiler" and an innovative wood-chip fired biomass plant.

ORNL leads Subtask C of IEA Annex 46. Operating under IEA's Energy Conservation in Buildings and Community Systems Program, the objective of the Annex is to provide tools and guidelines for decision makers, energy managers, performance contractors, and designers to improve the working environment of government buildings through energy-efficient retrofitting projects. The Annex includes four subtasks, and the objective of Subtask C is to develop best practices for the use of energy savings performance contracts as a method of reducing energy use in government building. During FY 2008, a country report was completed on U.S. best practices in government ESPC.

Objective 1.3

None

Objective 1.4

None

- Hydrogen, Fuel Cells and Infrastructure Technologies Program

  Objective 1.1

  ORNL produced one patent, one patent application, three invention disclosures, seventeen peer reviewed publications and sixteen significant or invited presentations, as discussed further in the Supporting Comments section below. Progress was made toward Hydrogen Program metrics in the areas of fuel cell, storage and delivery (which is noted in a later objective under this goal). Examples include a key 2004 paper on the nitrided Ni-50Cr alloy and fuel cell performance, which is currently the most cited paper in Scripta Materialia from the year 2004 (out of 480+ papers) and a first key Membrane Electrode Assemblies (MEA) characterization paper, which is currently the fourth most cited paper in the Journal of the Electrochemical Society in 2005 (out of 900+ papers).

  ORNL has made unique and notable contributions to the field of hydrogen science in its characterization of Polymer Electrolyte Membrane Fuel Cells (PEMFCs) such as Transmission Electron Microscope (TEM) characterization to assist developers in understanding their fuel cell performance and degradation issues. The tool, when used by developers, has led to significant improvements in membrane chemistry, performance, and catalyst deposition.

  Another contribution is in three-dimensional (3-D) depth-profiling and image reconstruction methodologies, which were used to evaluate the through-thickness structure of individual catalyst particles and to probe the structure of powder agglomerates and electrodes. This technique provides information regarding micrometer to nanometer-scale microstructure and constituent placement/connectivity within the different MEA layers.

  ORNL has demonstrated that binding ammonia to aluminum borohydride produces a solid that desorbs hydrogen beginning at ninety degrees Celsius. This material contains theoretically twelve percent hydrogen by weight, and the presence of ammonia causes a fundamental change in the desorption reaction pathway compared to aluminum borohydride alone.

  Objective 1.2

  ORNL has structured its work to exploit the natural synergies between work sponsored by VTP and HFCIT. Both programs support Materials Programs that have projects that focus on sensor development, advanced diagnostics, and measurements of chemical markers in fuel cell and emissions control devices. In addition, capabilities and equipment are shared effectively between the offices maximizing the research conducted by minimizing and sharing equipment costs.

  ORNL has developed the HyTrans model, which played a major integrating role in DOE's analysis of hydrogen and fuel cell market transformation scenarios.

  In fiscal year 2008, ORNL conducted scenario analyses and served as a lead author of the major multi-author report entitled "Analysis of the Transition to Hydrogen

Fuel Cell Vehicles and the Potential Hydrogen Energy Infrastructure Requirements." This highly visible report provides the first formal U.S. government study on integrated hydrogen transition scenarios.

Initial studies on friction stir welding (FSW) of pipeline steels funded by DOE's ITP have shown considerable weld property and quality improvement over conventional arc welds. FSW also greatly reduces the construction cost. The work led to a partnership between ORNL, ExxonMobil, and several other industrial partners to further develop and commercialize FSW technology for construction of natural gas pipelines. This new project, effectively leverages DOE ITP's effort, and will provide considerable momentum toward the application of FSW for more cost-effective construction of hydrogen steel pipelines.

Objective 1.3

First-principles computational calculations were used to identify Calcium as a possible metal coating for carbon nanostructures capable of storing hydrogen with promising binding energy. ORNL has made great progress toward demonstrating that composite (non-metallic) pipeline technology can provide a reliable, high-performance hydrogen delivery pathway and can achieve the hydrogen program cost targets.

Objective 1.4

Within the agreement milestone timeline, ORNL demonstrated proof-of-principle on two methods: fiber-optic based luminescence in nanocrystalline phosphors and optical detection of physisorbed hydrogen on microcantilever arrays. The advantage of these methods is that the underlying optronics technology is widely employed in consumer electronics and telecommunications, which indicates that the sensors should be inexpensive to manufacture in large quantities.

- Industrial Technologies Program

Objective 1.1

ORNL maintained an outstanding research and development program in the materials sciences. ORNL developed advanced materials that enable more efficient industrial manufacturing, many times in hostile environments.

Objective 1.2

ORNL provided exceptional leadership for the Industrial Technologies materials program. ORNL staff stepped in during a time when the Industrial Technologies Program staff had been depleted of personnel with material expertise, enabling the ITP materials program to continue to contribute effectively to the overall program goals.

Objective 1.3

ORNL developed significant advancements in the understanding of materials used in demanding industrial environments. Advancements included contributions to the understanding of the lifetime and wear resistance of advanced nano-composites, development of super-hard nano-coatings suitable for dynamic industrial applications, and the performance of novel materials for use in membrane separation technologies.

Objective 1.4

ORNL provided exceptional response to the needs of the ITP. ORNL staff stepped in during a time when the ITP staff had been depleted of personnel with material expertise, enabling the ITP materials program to perform in a timely and effective manner.

- Vehicle Technologies Program

  Objective 1.1

  Advanced Combustion Engines: A brake thermal efficiency (BTE) of forty-three percent was demonstrated on a light-duty diesel engine, meeting a fiscal year 2008 Joule milestone. Advanced engine technologies investigated in fiscal year 2008 include thermal energy recovery, electrification of auxiliary components, lubricants, and fuel properties. Thermal energy recovery (TER) was not used to meet forty three percent BTE but several TER approaches were explored and analyzed, and a Rankine bottoming cycle system was constructed for on-engine experiments. ORNL continues to lead engine efficiency activities for DOE and has been successful in the integration of several on-going activities focused on advanced engine technologies on the path to demonstrating the 2010 DOE FreedomCAR objectives of forty-five percent BTE. The path to forty-five percent BTE makes use of key discoveries in advanced combustion, emission controls, and fundamental thermodynamics at ORNL as well as from other DOE laboratories, universities, and industry. ORNL's accomplishments were documented in approximately sixty manuscripts and presentations for technical conferences and working group meetings, as well as archival journals. Many of the presentations were invited by industry, academia, and other technical institutions.

  Automotive Lightweighting Materials: Under the FreedomCAR Initiative, low-cost carbon fibers are being produced at ORNL from chemically modified textile polyacrylonitrite (PAN) fibers in collaboration with Fibras Sinteticas de Portugal, S.A., a textile fiber producer located in Lisbon, Portugal. Fibers are produced and chemically pretreated in Portugal and then sent to ORNL for evaluation, oxidative stabilization, and carbonization. Carbonized fibers of diameter exceeding program goals were obtained. Additionally, tow property measurements of twenty-six thousand filament tows were made with tow properties of two hundred to two hundred twenty-eight tensile tangent modulus (GPa) and 2.14 to 2.69 GPa strength have been obtained. Lignin has a significant potential cost advantage over even textile grade PAN as a precursor material for lower cost carbon fiber production. Extensive work at ORNL has identified means by which such intractable lignins can be rendered melt-spinnable through the addition of appropriate plasticizing agents, including certain hardwood lignins. The lignin blend was readily melted and spun on the multifilament spinning equipment shown in the Figure. Fibers were continuously spun over a period of several hours, with progressive adjustment in winding speed until the target filament diameter of ten micrometers was achieved.

  Energy Storage: After developments in the lithium ion battery materials and processing assessment, ORNL has been recognized as a leading thought organization, which can significantly enhance the field of materials and processing for lithium ion batteries combined with highly advanced in-situ characterization of materials and their failure mechanisms. Therefore, ORNL was invited to provide

an overview article on materials and processing to the *JOM* Special Issue on Materials and Coatings for Energetics entitled, "Materials and Processing for Lithium-ion Batteries," (JOM, 60 (2008) 9, 43-48). Graphite fiber and foam structures have been shown to perform well as cathode current collectors for rechargeable batteries. Results have been presented at meetings of the Electrochemical Society and a short publication is in press. Power Electronics and Electric Machines Monthly progress reports were submitted to DOE. An annual review was conducted mid-year as part of DOE's mega review and a program kickoff meeting was held with auto partners, suppliers, and other Federal agencies to gain feedback on the project portfolio at the beginning of the fiscal year. Detailed reviews of each project were conducted at tech team meetings. Publications for the year included sixteen in Institute of Electrical and Electronics Engineers (IEEE) venues (two at the Advanced Power Electronics Conference; three at the Power Electronics Specialist Conference; and eleven in IEEE Transactions publication), four in non-IEEE conferences and one IEEE journal article. All projects in the portfolio achieved their technical objectives for fiscal year 2009.

Fuels: ORNL has played a leadership role in resolving issues with the release of the FACE fuels for purchase by interested researchers. All nine of the FACE diesel fuels have been formulated and are available for purchase. ORNL has worked to provide samples of the fuels for experimentation and analyses to other interested labs, including Pacific Northwest National Laboratory (PNNL), NREL, Sandia National Laboratory, and Canadian National Centre for Upgrading Technology (NCUT). ORNL has worked with PNNL and NCUT to provide an exceptionally thorough characterization of the chemical makeup and physical properties of the fuels that will be critical in establishing the impact of fuel properties on advanced combustion processes. ORNL investigated fundamental performance relationships among market fuels through the application of advanced statistical methods to the analysis of fuel data. A study was completed examining the impacts of biodiesel formulation on efficiency and emissions when used in a high efficiency clean combustion (HECC) mode. An investigation comparing biodiesel homogeneous charge compression ignition (HCCI) data to kinetic model results showed that methyl butanoate has limited applicability as a kinetic surrogate for biodiesel. ORNL, in collaboration with NREL, DOE VTP, and DOE BP, has been instrumental in assessing the impact of intermediate ethanol blends on the U.S. legacy fleet of vehicles and small, non-road engines (SNRE). Substantial new information has been collected, analyzed, and reported to DOE on the impact of these new fuels. A literature review has been published, the first of several detailed reports highlighting the results of the program has been written and fully reviewed by DOE, outside experts, and the EPA and is soon to be published. Two coordinated SNRE efforts have been completed at ORNL and NREL, and a third subcontracted effort (placed via competitive request for proposal) is also complete. A report detailing the results of these studies was prepared and publication is imminent. A contract was placed with Battelle to assist with data analysis and experimental design of the intermediate blends programs. A detailed vehicle test program plan was completed with industry and EPA input. A report detailing the results of these studies has been prepared and publication is imminent. Three

vehicle testing contracts were placed; two at Transportation Research Center to augment vehicle tests at ORNL and to test cars originally assigned to Argonne National Laboratory, and one at the Colorado Department of Public Health, Aurora Emissions Technical Center for testing of NREL vehicles. Contracts for purchase of thousands of gallons of fuel were placed and the fuel delivered. ORNL has data on dozens of cars that have undergone over three hundred test operations. Another twenty-two cars have been acquired and are starting emissions tests in cooperation with EPA, and an additional twenty-five vehicles have been recruited for first phase of catalyst durability studies; screening of half of these vehicles is complete. ORNL and NREL staffs are working closely with the Coordinating Research Council (CRC) to review data from this project, which will assist in vehicle selection for a $9 million ORNL/CRC project on catalyst durability. Contracts and teams with CRC were placed to quickly obtain data on driveability and materials compatibility (NREL). A competitive solicitation for catalyst durability was issued and an award was made (ORNL). Multiple presentations, summaries, status reports, and interactions with headquarters, industry, and EPA have been prepared and conducted.

ORNL's Fuels Engines and Emissions Research Center (FEERC) had forty-two fuels-related papers and presentations in fiscal year 2008. When papers associated with other activities are included, the number of papers and presentation is considerably higher and includes a broad range of topics related to VTP goals. Some examples representative of the fuels-related papers include the following:

- ORNL presented seven papers at the 2007 Society of Automotive Engineers (SAE) Powertrain and Fluid Systems Meeting, more than any other national laboratory.
- At the 2008 SAE Small Engine Technology Conference, ORNL presented an invited plenary presentation on DOE's intermediate ethanol blends program.
- At the 2008 Diesel Engine Efficiency and Emissions Research (DEER) Conference, ORNL contributed five session presentations and five poster presentations.
- At the 2008 SAE Government/Industry Meeting, ORNL contributed two presentations on DOE programs.
- At the 2007 SAE HCCI International Symposium, ORNL had two invited presentations on recent HCCI research activities at ORNL.
- At the 2008 SAE Powertrain, Fuels, and Lubricants Meeting, ORNL submitted eleven papers for presentation, more than any other national laboratory.

High Temperature Materials Laboratory: Members of the High Temperature Materials Laboratory (HTML) User Programs authored or co-authored forty-two journal articles published during FY 2008. The covers of the February 2008 Materials Research Society (MRS) Bulletin and March 2008 Journal of Materials Chemistry include images obtained with HTML's aberration-corrected electron microscope as part of HTML user projects with the University of Texas. The cover of the July 2008 Journal of the American Ceramic Society includes an image

obtained in a user project with researchers from Rice University.

Objective 1.2

Advanced Combustion Engines: ORNL co-directs the Cross-cut Lean Exhaust Emissions Reduction Simulation (CLEERS) activity with General Motors. CLEERS was initiated in 2001 and became a dynamic forum for information exchange and cooperation related to emission control phenomena in support of building robust computer simulations. This activity helps focus key efforts of VTP to ensure that advanced engines are able to meet emissions standards. The eleventh CLEERS workshop was held in 2008 with at-capacity attendance of over 100 participants. FACE was initiated in fiscal year 2006 to provide a scientifically designed set of research fuels to better elucidate the effects of fuel properties on advanced combustion. ORNL and NREL work as a team with CRC and several industry representatives to ensure the success of FACE. ORNL continues to serve as the Emissions Strategic Advisor to the Powertrain, Fuels, and Lubricant (PF&L) Activity. Additionally, ORNL staff has been selected to serve a two-year term as a Member-at-Large of the Land and Sea Group, the parent organization of PF&L and other technical activity structures of SAE. ORNL staff serve as Chairman of SAE Combustion and Fuels Committee that oversees all manuscripts related to combustion and fuels. Numerous ORNL staff members serve as session organizers and reviewers. Advanced Combustion Engines research at ORNL won an R&D 100 award in 2008. Three patent applications were filed and one patent was awarded from a prior-year application. Staff won the SAE Withrow Award for Outstanding Oral Presentations, the SAE Forest R. McFarland Award for outstanding leadership, and the ORNL Distinguished Engineer Award.

Automotive Lightweighting Materials: ORNL staff received numerous recognitions including the 2008 Outstanding Leadership Team Award for the advancement of plastics in the automotive field given by the Society of Plastics Engineers Automotive Division to be received on November 20, 2008. Selected to be general chairman of the international 2008 Carbon Fibre conference in October in Hamburg, Germany, ORNL staff was formally inducted as a Fellow of the American Carbon Society and was selected as the American Carbon Society's "Graffin Lecturer" for the 2008/2009 period.

Energy Storage: ORNL worked closely with the United States Advanced Battery Consortium Tech Team and General Motors to receive guidance on its concepts and ideas, and ORNL established successful collaborative efforts with the University of Michigan and A123 Systems Inc, resulting in two joint projects (one funded through VTP and one through the ITP) after only one year. ORNL has initiated discussions with Research Center Juelich Projekttraeger Juelich, the German Research Foundation, and the German Ministry of Education and Research to establish a long-term partnership on lithium ion battery research and to help foster the technology.

Fuels: ORNL and NREL have shown substantial leadership with DOE in planning and coordinating the politically sensitive intermediate blends program. This effort has required both substantial independence and interaction with industry. This has been achieved through leadership in CRC and with individual firms and trade organizations. A new CRADA was initiated in fiscal year 2008 with Reaction

Design in support of the Model Fuels Consortium. This effort supports development of surrogate fuel data for determination of kinetic reaction mechanisms associated with advanced combustion modes. A new CRADA with General Motors (GM) is being initiated to investigate the potential benefits of ionic liquid lubricants. These lubricants do not contain sulfur and may represent a pathway toward improved efficiency and emissions control performance. FEERC partnered with HTML and the University of Tennessee to establish a new research platform at FEERC for investigating energy efficiency and ionic liquid lubricating oils. ORNL responded rapidly to a need for data in support of Underwriters' Laboratory (UL) recertification of E85 fuel dispensers. (UL briefly withdrew their certification in 2007.) An experimental apparatus was developed and operated extensively to complete the E85 and E25 long-term exposure studies, meeting the aggressive UL timetable for data availability. ORNL staff prepared a draft Report To Congress on Flex Fuel Vehicle optimization, helping DOE comply with an Energy Independence and Security Act of 2007 requirement. ORNL staff is the Treasurer of the Central States Section of the Combustion Institute. ORNL staff is a member of the Transportation Research Board's Transportation and Air Quality Committee. Other ORNL staff members are frequent session organizers for ASME, SAE, DEER, and the Combustion Institute. Organizations that have directly sponsored work at ORNL fuels-engines lab this fiscal year have included an auto manufacturer, the University of Kentucky, two heavy-duty diesel engine manufacturers, the National Center for Manufacturing Sciences, EPA, and an energy company.

High Temperature Materials Laboratory: Members of HTML staff were recognized for their contributions to various professional societies and programs. ORNL staff was elected Fellow of the American Ceramic Society in April 2008; elected Fellow of the Society of Tribologists and Lubrication Engineers; received the Outstanding Young Manufacturing Engineer Award by the Society of Manufacturing Engineers; the International Conference on Wear of Materials organizing group has named the top award in its Poster Session after an ORNL staff member to honor his contributions to the field of wear of materials; and staff members served as session or conference chairs, co-chairs, or organizers for nine national meetings. In addition, ORNL staff was appointed counselor of the Engineering Ceramics Division of the American Ceramic Society from October 2007 to October 2008; served as a member of the Advisory Committee for the Materials Innovations in an Emerging Hydrogen Economy conference in Cocoa Beach, Florida from February 24 to 27, 2008; served as a member of the Industrial Advisory Council for the Department of Materials Science and Engineering at the University of Alabama-Birmingham; and is the Associate Editor of the Journal of the American Ceramic Society.

Objective 1.3

Advanced Combustion Engines: The research team led by ORNL personnel received an R&D 100 award for the development of a Spatially Resolved Capillary Inlet Mass Spectrometer. This technology is capable of obtaining gas samples inside the confined spaces of reactors like automotive catalysts, fuel reformers or fuel cells, measuring changes in chemical composition in both space and time within

the reactors. This technology was used in the optimization of the groundbreaking 2007 Dodge Ram heavy-duty pickup truck, which met 2010 emissions control standards three years ahead of schedule. More recently, the technique has been modified to make intracatalyst ammonia measurements. In a CRADA with Cummins, ORNL has developed and validated a diagnostic method for measuring the fuel into the oil in near real time. The method is based on laser-induced fluorescence and uses a minimally invasive optical fiber probe. Intended primarily for R&D use, this instrument will enable engine developers to calibrate the timing and amount of fuel injection to minimize the oil dilution. The method was evaluated at Cummins. Patents and licensing are in progress. Other firms have expressed interest in the method.

An X-ray device was successfully applied to image the internal structure of a diesel particle filter to reveal locations of soot or degradation. Also, technology stemming from a successfully demonstrated neutron imaging of diesel particulate filters using a neutron source in Germany is being shared with ORNL Spallation Neutron Source staff to develop this capability as well as spray imaging capabilities at ORNL. The thermodynamic availability of thermal energy discarded to the environment on a light-duty diesel engine has been mapped both experimentally and with detailed simulations (SAE 2008-01-0293). An improved understanding of this energy from a thermodynamic Second Law perspective has provided new insight into the potential of thermal energy recovery for conditions consistent with light-duty vehicle drive cycles. These studies have led to a new WFO agreement between ORNL and major engine manufacturer.

Automotive Lightweighting Materials: Six patents and invention disclosures were filed. The use of friction stir spot welding (FSSW) for spot welding of automotive sheet steels is a relatively new idea with no history of technical development. The process is being evaluated on two uncoated high-strength steels. Strength testing is successfully establishing that FSSW can produce spot welds that exceed industry standard minimum strength values. Studies are further establishing the importance of stir tool materials and geometry on weld strength and minimized processing times. Successful development of this technology will allow greater use of advanced high-strength steel (AHSS) as a lightweighting material in the manufacturing environment. ORNL has successfully developed the initial version of a new, robust computer aided engineering (CAE) simulation procedure and the companion test database to predict the behavior of resistance spot weld in crash analysis of auto body structural components. The new spot weld element formulation takes into account the complex microstructure and property gradients, and changes in fracture mode of resistance spot welds of advanced high-strength steels under high-deformation rates. It offers an effective CAE design and engineering tool for further light weighting opportunities from optimized use of AHSS and ultra high-strength steels. Several auto and steel companies have begun or plan to implement the newly developed CAE simulation tool in their applications.

Fuels: ORNL researchers completed and published results from an initial study of the effects of biodiesel use on diesel exhaust gas recirculation (EGR) cooler fouling processes. This study produced direct, in-situ measurements of the thermal

conductivity and other fouling layer properties that are critical to successfully modeling the fouling process. These measurements are believed to be unique, first-of-their kind results. Studies of particulate oxidation kinetics conducted by ORNL have shown that particulate produced when using some biodiesel blends exhibits a lower ignition temperature and faster oxidation rates than particulate produced when using ultra low-sulfur diesel. This phenomenon is a potential benefit to the performance of diesel particle filters. Ongoing studies are under way to fully describe the characteristics of the particulate that result in this behavior. This project also produced first-of-their kind neutron tomographic images of full-size particle filters loaded with particulate. This technique produces detailed cross-sectional images and opens a new pathway to studies of fuel and after treatment system compatibility.

Researchers at ORNL developed and deployed two coupon exposure vessels for dynamic materials compatibility experiments targeted towards improved ethanol utilization. These devices are unique in that they provide the ability to investigate materials compatibility with ethanol at elevated temperatures and pressures. A means to operate a Saab Biopower in closed-loop lean mode was developed so that the potential for silver-alumina lean-nitrogen oxide catalysts could be investigated. The vehicle was successfully operated at lean air to fuel equivalence ratios (as much as forty percent lean). The silver-alumina catalyst technology was shown to provide over ninety percent nitrogen oxide reduction. As a team member to Cummins HECC research contract, ORNL conducted an experimental and data analysis project to define the effects of fuel properties on HECC. Under direct industry funding, ORNL generated new data on soot filters, EGR coolers, and other proprietary components. ORNL was selected by a major oil company to perform proprietary WFO fuel experiments. Four patent applications were filed in FY 2008.

High Temperature Materials Laboratory: Members of HTML were involved in several projects with industrial users that have advanced the state of the art of energy-related technologies. Capstone Turbines Engineering and Chief Technology Officer, Mark Gilbreth, wrote "I am writing this letter to make you aware that Capstone's success in developing its leading edge technology is largely due to work we have been doing at ORNL through the HTML User Program. The HTML User Program provides a unique opportunity to researchers such as an ORNL Senior Engineer to work side-by-side with leading experts on world-class instruments to analyze our materials and to understand the mechanisms responsible for their degradation." Sean Fleming of Metalsa wrote: "We decided to pursue a user project at ORNL HTML because of the high level of expertise and equipment HTML had available for conducting research in the area of residual stresses. From the analysis of the results obtained in our user project at HTML it is expected that the weight of several of our current frame rails can be reduced by ten to twenty percent, which translate to as much as one hundred to two hundred pounds per truck for the frame rails alone. If we extrapolate to an annualized basis, this could represent as much as thirty million pounds of steel savings for Metalsa clients." Tim Gordon of GEO2 provided the following testimonial of his user experience at HTML: "GEO2 is a startup company based in Boston and funded exclusively by angel investors and venture capitalists. We believe that

using ceramic fibers instead of powders that are typical with our competitors will enable GEO2 diesel particulate filters to break the strength-porosity compromise that our competitors all struggle with. My user visit in April 2008 could not have been more productive and helpful in promoting the successful commercialization of GEO2 technology. The resources at Oak Ridge including both the scientific instruments as well as the deeply knowledgeable and experienced staff are unparalleled. Working with them we were able to improve, as we will describe in a forthcoming presentation, the value of GEO2's fibrous microstructure."

Objective 1.4

Advanced Combustion Engines: Approximately ninety percent or more of the fiscal year 2008 milestones in Fuels and Engines are complete or on track for the end of fiscal year 2008.

Automotive Lightweighting Materials: Property targets for developing textile-based precursors were met nine months ahead of schedule. The initial study of the new Wolfangel chopping gun design was completed three months ahead of time with both standard and alternative blade coatings. The down select of advanced stabilization technologies for conversion of carbon fiber precursors was accomplished two months ahead of schedule. The resulting technology yields a stabilization and oxidation route that can be accomplished in one-third to one-fourth the time required by conventional technologies.

Energy Storage: ORNL provided many more white paper efforts and concept studies for materials and processing than was expected in the short time frame of the assessment.

Fuels: Approximately ninety percent or more of the fiscal year 2008 milestones in Fuels and Engines are complete or on track for the end of fiscal year 2008.

High Temperature Materials Laboratory: The HTML User Program met the milestones associated with its operating plan for fiscal year 2008, including the installation of a Hitachi HF-3300 microscope by March 2008. This microscope, the first one of its kind in the U.S., was installed in November 2007 and was fully operational in January 2008. The microscope has several unique features that make it an invaluable tool for the evaluation of materials. This microscope was acquired by combining contributions from EERE's VTP and HFCIT programs; the Office of Basic Energy Sciences (BES); and from the Office of Electricity Delivery and Energy Reliability.

- Weatherization & Intergovernmental Activities

  Objective 1.1

  ORNL provides mission critical support to the WIP in the areas of program evaluation, building audit research, energy market analysis, and rapid-response analytical capability. ORNL fiscal year 2008 significant sustained technical achievements include the:

  Publication of the field validation studies on the Manufactured Home Energy Audit (MHEA) tool.

  Revision of the MHEA for field release as part of the Weatherization Assistant.

  Publication of updated projections of the 2007-2008 low-income energy

expenditure forecasts.

Publication of the forecasted impact on low-income energy and transportation bills of potential carbon control policies.

Initiation of state-level performance evaluations in North Carolina and New York.

Leadership in the design of DOE HQs policy initiative for lead-safe weatherization. See, Eisenberg, J., "The Impact of Carbon Control on Electricity and Gasoline Expenditures of Low-Income Households," ORNL, Oak Ridge, Tennessee, April 2008; McCold, L., Goeltz, R., Ternes, M., and Berry, L., "Texas Field Experiment: Performance of the Weatherization Assistance Program in Hot-Climate, Low-Income Homes," ORNL, Oak Ridge, Tennessee, April 2008; Eisenberg, J., "Short and Long-Term Perspectives: The Impact on Low-Income Consumers of Forecasted Energy Price Increases in 2008 and a Cap-and-Trade Carbon Policy in 2030," ORNL, Oak Ridge, Tennessee, December 2007; and Ternes, M., "Validation of the Manufactured Home Energy Audit (MHEA)," ORNL, Oak Ridge, Tennessee, November 2007.

Objective 1.2

ORNL is a leader in the field of computerized residential audit instruments for field professionals. States are free to choose any audit instrument for use in the Weatherization Assistance Program. More than forty have selected and use ORNL developed Weatherization Assistant as their primary computerized audit tool. ORNL recently field tested the MHEA tool and further upgraded the software. A downloadable version will be released through the Weatherization Assistance Program Technical Assistance Center website in November 2008. MHEA is now the audit standard for use by state and local agencies for this housing type. This was the culmination of a ten-year development process.

Objective 1.3

ORNL's analysis of the impact of cap-and-trade carbon policy on residential energy and transportation bills marks the first systematic effort to anticipate the impact of such policies at the regional level, by fuel type, and by demographic profile.

Objective 1.4

ORNL provided both technical analytical assistance and program support to WIP leadership in a timely and effective manner. ORNL met or exceeded all Corporate Management and Planning System (CPS) milestones. ORNL facilitated the implementation of EERE initiatives through expeditiously funding non-profit associations and energy advocacy groups such as the National Governors Association and the Alliance to Save Energy.

**NOTABLE ACHIEVEMENTS**

- Biomass

  Objective 1.4

  The analytical effort supporting the Federal Biomass R&D Board's Feedstock Economics Interagency Working Group was accomplished in a tight timeframe

and required ORNL economists to work with multiple models and their counterparts at U.S. Department of Agriculture (USDA). The testing for intermediate ethanol blends was an extraordinary effort performed under tight deadlines, which the lab did not always meet. For example, the report completed in August 2008 was initially scheduled for April 2008. Furthermore, schedule changes were not appropriately communicated to Program Management in a timely manner.

- Building Technologies Program

  Objective 1.1

  ORNL is a leader in heat pump technology and is facilitating the development and market introduction of heat pump water heater (HPWH) technology as a replacement for conventional electric storage water heaters. There are strong indications that ORNL will complete all of its technical objectives in the agreement milestones found in CPS.

  Objective 1.2

  ORNL is a leader in heat pump technology and is facilitating development of several surrogate technologies including the integrated heat pump (IHP), HPWH, air source heat pump and ground source heat pump technologies. Their laboratory work is not opening new opportunities or changing the direction of research. Their scope is very much limited to heat pump technology and basic incremental increases in efficiency. For ORNL to be a world-class leader not just in heat pump technology (that has been around for some time), ORNL must work on the development of advanced cooling and heating technologies and propose new ideas. Conventional combined heating and cooling systems for buildings are mature technologies approaching their peak efficiency. Advanced technologies are needed to leapfrog beyond incremental improvements in conventional vapor compression including humidity control technologies.

  Objective 1.3

  ORNL has contributed significant research towards meeting the net zero goal for the mixed/humid climate. ORNL is a leader in heat pump technology and is facilitating development and market introduction of HPWH technology as replacement for conventional electric storage water heaters. More needs to be done than just recycle old ideas again to DOE. They are advancing science and technology by developing design tools for heat pumps and air conditioners including IHP that simulate the steady-state performance and allow users to specify key performance parameters for modeling and optimization. Their laboratory work is not producing original and creative results.

  Objective 1.4

  ORNL has completed all major deliverables with the exception of the cool roof integrated calculator. Due to a variety of priority issues including demands from industry, ORNL has been able to juggle the impacts to deliverable schedule and seeks agreement to any changes by the technology development manager.

- Federal Energy Management Program

  ORNL exercised initiative and provided technical support which significantly enhanced DOE's efforts to help agencies save energy and money in operating their

facilities as evidenced by the following examples:

In support of the Green Energy Parks Initiative, ORNL conducted a webinar for representatives from the southeast region of the National Parks Service on how to use Utility Energy Service Contracts to get EERE technologies into park buildings. The webinar led to a meeting with the Deputy Superintendent, Chief of Facilities, and Chief of Resource Education of Great Smoky Mountains National Park and as a follow-on activity participated in a value analysis workshop to review three conceptual designs for a new visitor center for the North Carolina entrance to the park. The workshop provided ORNL with the opportunity to introduce technologies to the park planners such as ground source heat pumps, tubular skylights (Solar Tube), radiant floor heating, water heating using geothermal or passive solar, and infrared heating.

ORNL provided introductory and advanced Super ESPC training for numerous Federal agency personnel. The training is designed to help address the concerns and reduce the risks perceived by federal site personnel unfamiliar with ESPC before they commit to multi-million dollar long term contracts. ORNL continued demonstrating hybrid solar lighting at a Navy Installation in Hawaii and provided an overview of the technology at GovEnergy. The technology was developed at ORNL and licensed to Sunlight Direct, Inc.

Objective 1.4

ORNL was prompt in meeting its obligations to FEMP throughout the performance period by meeting agreement milestones. Quality training classes, workshops, and web-based training were delivered according to the schedule.

- Hydrogen, Fuel Cells and Infrastructure Technologies Program

  Objective 1.1

  A preliminary cost assessment indicates that nitrided Fe-20Cr-4V can potentially meet DOE bipolar plate cost targets.

  Objective 1.3

  Karren More's work on Advanced Transmission Electron Microscopy is being used by GM, Arkema, Plug Power, Honda, and Gore to characterize their fuel cell membranes and MEAs. ORNL produced the first set of hydrogen diffusion and permeation data for pipeline steels and their welds in a high-pressure hydrogen environment, using a unique high-pressure hydrogen permeation measurement system.

  Objective 1.4

  Four commercially available pipeline steels commonly used for construction of pipelines but with different microstructures have been tested in high-pressure hydrogen atmospheres. It was observed that certain steels exhibit reduced levels of embrittlement and thus may be more suitable for high-pressure transmission of hydrogen. Use of such steels may ensure optimum reliability while maintaining costs at levels comparable to that of other pipeline steels.

- Industrial Technologies Program

Objective 1.1

There is a strong integration of industry into all the materials work at ORNL. This provides a strong deployment possibility as the research is proven.

- Vehicle Technologies Program

Objective 1.1

Automotive Lightweighting Materials: ORNL completed the design and manufacturing of a set of resistance spot welds for weld quality studies. A well-prepared sample set is very important for the follow-on infrared (IR) inspection and other weld quality analysis and simulations. Completed initial IR imaging of samples using four different heating and cooling methods on the sample set. Very distinct thermal signatures were observed. It was a crucial step to ensure the non-contact IR technique can be developed into a practical on-line quality control system. Finite element analysis was conducted using the actual weld geometry and various heating or cooling conditions. The ability to simulate IR inspection and predict weld response will allow this technique to adapt to different manufacturing environments. Analyses have indicated that performing of comingled reinforcing fibers with thermoplastic fibers and compression molding of this blend to make the thermoplastic fibers become the composite matrix can be an economically attractive route to producing relatively high production rate parts. However, the chopper gun on standard P4 machines is currently the rate-limiting factor for achieving economic targets. A prototype higher speed chopper was obtained to explore routes to higher output processing. Extensive trials were conducted by ORNL staff, assisted by the Automotive Composites Consortium (ACC) Processing Group. The chopper performed at ultimate design speed, but the total number of tows was limited by motor torque. ORNL worked with ACC to select and design capability to replace the existing Wolfangel chopper motor with a somewhat faster and significantly higher power motor and drive electronics. Shafting and other components required upgrades, which have been completed. With these improvements, reliable chopper output approaching 20 kg/min for the upgraded Wolfangel system have been demonstrated versus approximately 2.3 kg/min limitations of the existing P4 chopper when chopping our baseline TwinTex product. Targets to meet process economic goals were approximately 12-15 kg/min. The fundamental metallurgical factors causing the observed property changes have been identified, and an integrated thermal-mechanical-metallurgical welding process and performance model has been developed to correlate and predict the weld property changes from the steel chemistry and welding process conditions. The unique stress partitioning phenomenon among different phases critical to the deformation and crash resistance of transformation-induced plasticity steels has been revealed via an in-situ neutron scattering experiment. We also demonstrated the feasibility for considerable fatigue life improvement (over an order of magnitude) for AHSS arc welds through welding process refinements. The weld joint efficiency has been developed as a practical engineering index to quantify the effects of welding on the microstructure and property (static, fatigue, impact) of a wide range of advanced high-strength steels, and it has been employed by the industry for various welding processes. The integrated welding simulation model has been applied by the auto and steel

industry. ORNL completed an assessment on the cost-effectiveness of twenty-five percent weight reduction in body and chassis components of light-duty vehicles. ORNL is developing high strain rate tests that are used to determine performance of new high strength steels in automotive impact. This information is necessary for better use of high strength steels in automobile structural components and vehicle weight reduction. Impact performance is the most critical criterion that limits the use of new materials in vehicle design. The tests are conducted in the strain range for which standardized test equipment and testing standards are not available. ORNL is developing equipment, instrumentation, data processing, and testing procedures that can determine material properties in this loading range. The test data is communicated to the automotive companies and industry consortia via regular monthly review meetings and the project web site. ORNL is developing and conducting high strain rate tests that are used to determine performance of magnesium (Mg) alloys in automotive impact. This information is necessary for wider use of Mg alloys in automotive applications, including structural components. The new tests will be capable of characterizing evolving material properties during the deformation by interruption of high-speed tests at prescribed deformation levels. The deformation is followed up by microstructural analysis and material modeling that will result in new constitutive models for computational simulation.

Energy Storage: Four white papers are being developed, and are scheduled to be finalized by October 2008.

High Temperature Materials Laboratory: HTML staff members made twenty presentations at national and international conferences.

Objective 1.2

Automotive Lightweighting Materials: Staff members were asked to give the following plenary lectures:

ORNL staff was selected as one of six plenary and special lecturers at the "Carbon 2008" conference in Nagano, Japan (one of the others of whom was the Nobel Prize winner for the discovery of fullerenes, so-called "Buckyballs").

ORNL staff was selected to provide a lecture on "FreedomCAR and Low Cost Carbon Fiber for Automotive Applications" at the United Kingdom's Foresight Vehicle Annual Conference, "Future Lower Cost Carbon Fiber for Autos: International Scale-up and What is Needed," at the Society of Plastics Engineers Annual Automotive conference, "Investment in the Carbon Fibre Business for Commercial Grade Low Cost Composites" at the 2008 Carbon Fibre Conference in Hamburg, Germany, and "Development of Lower Cost Carbon Fiber for High Volume Applications" at the Composites and Polycon Conference in Tampa, Florida.

Norris was selected to provide a lecture on "Affordable Composites-Low Cost Carbon Fiber, Performing, and Related Activities at ORNL, National Shipbuilding Research Program" at the ShipTech 2008 conference in February 2008.

Energy Storage: ORNL set long-term goals and program plans for ORNL's energy storage R&D through the formation of an Electrical Energy Storage Programmatic Steering Group including program managers for all major sponsors (DOE VTP, DOE ITP, DOE Office of Electricity Delivery and Energy Reliability, and Defense Advanced Research Projects Agency) and important technical contacts in several divisions and the Electrical Energy Storage Scientific Advisory Group leading scientific discussions and development. This work led to internal investments of $1.3 million in the area of in-situ characterization, battery materials testing and processing, and external programs worth more than $6 million.

Objective 1.3

Advanced Combustion Engines: In studies of biodiesel effects on EGR cooler fouling, the team was able not only to determine the mass and chemistry of the deposits, but also their thermal conductivity. Deposit thermal conductivity is a key parameter in modeling the relation of the deposit formation process to the performance of the EGR cooler. These data are characteristically absent from the literature because of the difficulty in accomplishing the conductivity measurement. ORNL used a flash diffusivity method at HTML.

Automotive Lightweighting Materials: Forty-three significant research papers were published. ORNL developed the X-Ray Micro-Topography unit to evaluate in-situ properties of materials during stressing in support of ORNL/PNNL/ACC/National Science Foundation modeling efforts, which was the first unit of this type anywhere.

Energy Storage: The first experimental efforts on new and advanced materials processing for batteries based on our initial assessment have begun and first results have been presented to the VTP program manager. Equipment for battery materials testing and in-situ characterization is arriving and concepts for first experiments are laid out and will start within calendar year 2008. The challenge of interface instability prohibiting the use of metallic lithium anodes has been addressed with the special physical vapor deposition capability available at ORNL. This provides for smooth and well-controlled surface of the lithium, which is not feasible at other laboratories. In addition, we are exploring vacuum-deposited barrier layers that may inhibit dendrite initiation.

Objective 1.4

Automotive Lightweighting Materials: The establishment of spinning conditions for spinning and winding of softwood lignin fiber tows was completed on schedule. A method of using hardwood lignin as the plasticizer for softwood lignin was developed yielding a 100 percent natural product precursor independent of oil based additives.

Energy Storage: All milestones and deliverables have been in a timely manner and have fulfilled or succeeded the statement of work in either timeliness or target goal.

- Weatherization and Intergovernmental Activities

  Objective 1.1

  None

Objective 1.2

ORNL continues to be a leader in the field of energy market analysis and bill estimation. Its projections have been used by the Weatherization network of state and local agencies as well as by the state managers of the Low-Income Home Energy Assistance Program. The laboratory's analytical methodology for energy price and bill projections for low-income consumers has now been adopted by the National Consumer Law Center. ORNL program staff share information, tools, and techniques with numerous other organizations in the weatherization field, such as, the National Association for State Community Services Programs, the National Community Action Foundation, and the National Low Income Energy Consortium.

Objective 1.3

ORNL exhibited leadership in DOE Headquarters' lead-safe weatherization policy group and state-level weatherization evaluations with North Carolina, New York, and Rhode Island.

**1. Supporting Comments**

- Biomass

  Objective 1.2

  In addition to what is provided above as a significant accomplishment, although it is not supported directly by EERE/BP, it is worth noting that the stature of ORNL within the biomass research community increased significantly because ORNL won one of three prestigious Biomass Centers supported by DOE Office of Science and ORNL's role in the Tennessee Biomass Initiative.

- Weatherization and Intergovernmental Activities

  Objective 1.1

  Since fiscal year 1990, ORNL has been key to the evaluation of the economic impacts and improvements to the technical performance of the Weatherization Assistance Program. The primary activities are:

  Performing extensive engineering, analysis, and computer modeling in support of Weatherization technologies, particularly the National Energy Audit Tool.

  Conducting extensive methodology development, field management, and implementation of various evaluation efforts that have assessed the performance of the Weatherization Program.

  Providing economic analysis, impact assessment, and policy evaluation of leveraging opportunities for the program, particularly in the context of energy industry restructuring and other regulatory proceedings.

  Conducting energy market assessment, management information analysis, and policy evaluation for EERE Headquarters and multi-state management operations.

**GOAL 2: EFFECTIVE AND EFFICIENT OPERATION OF FACILITIES** with the following objective:

- Provide effective and efficient operation of facilities supporting EERE program.

**2. Significant Achievements**

- Biomass

  Objective 2.1

  The testing facility for the intermediate blend testing at ORNL is only one of a very small number of places where this work could be performed. Research conducted at this facility has a reputation for the highest quality with results accepted as unbiased, with processes considered to be of the highest caliber.

- Building Technologies Program

  Objective 2.1

  ORNL continues to maintain the state of the art thermal performance chambers and field test facility in Charleston. In fiscal year 2008, ORNL developed a new air permeation test apparatus that is being used to support our joint project with the air barrier industry to evaluate, characterize, and demonstrate a large array of air barrier solutions. ORNL continues to maintain and use its heat pump testing facilities wisely, an excellent resource that is also utilized by industry via CRADAs. A lot of time and effort has been spent on this facility at ORNL, but just because one has this excellent resource, it should not place any blinders into the development of advanced cooling and heating technologies. Advanced technologies are needed to leapfrog beyond incremental improvements in conventional vapor compression including humidity control technologies.

- Federal Energy Management Program

  Objective 2.1

  ORNL continues to be very responsive to FEMP. Communications with FEMP are frequent. This includes providing timely input to the quarterly Joule report, quarterly project and costing information, participating in FEMP Headquarters conferences, and routine face-to-face meetings with FEMP staff.

- Hydrogen, Fuel Cells and Infrastructure Technologies Program

  Objective 2.1

  ORNL completed design, construction, and demonstration of a novel testing system: the self-loaded miniature multiple-notch tensile test. A state-of-the-art TEM was purchased in FY 2008 for PEM fuel cell MEA, catalyst, and membrane structural and compositional characterization.

- Industrial Technologies Program

  Objective 2.1

  This Objective is not relevant. ORNL did not maintain a user facility for ITP.

- Vehicle Technologies Program

  Objective 2.1

  Advanced Combustion Engines: The additional engine cell construction is near completion. This engine cell has 600 horsepower direct current and 230

horsepower alternating current double-ended motoring dynamometers (industry-donated or purchased with non-VTP funds), and is able to accommodate up to three engine setups simultaneously. The engine cell is also approved for and equipped to handle a variety of fuels including diesel, ethanol/gasoline, and natural gas. Three industry partners are supplying engines and/or controls to accommodate multiple work-for-others and CRADA projects in this engine cell. ORNL has provided approximately $1.1 million of internal funding to support the development of this capability. Engines to be installed in the near future include a Caterpillar C-15 ACERT™ engine to support a potential CRADA with Caterpillar, an advanced ethanol fueled engine developed by GM Delphi for thermal efficiency work, and a large single cylinder Waukesha natural gas engine to study the effects of siloxane contamination on engine combustion efficiency and durability. ORNL developed a bench-scale/micro-scale flow reactor for catalyst research. This new combination bench is capable of the characterization of catalytic materials ranging in size from powders to monolith core samples. The reactor incorporates automated controls and safety interlocks that enable unattended 24 hour per day operation.

Automotive Lightweighting Materials: ORNL designed, developed, and procured the precursor evaluation line, which is a one-of-a-kind operational unit for developing and evaluating future and alternative precursor materials. This highly flexible line is being used to develop textile, lignin and polyolefin-based precursor materials. The unit can handle single filaments and multi-filament tow of precursors in batch or semi-continuous modes of operations.

The proof-of-concepts for developing lignin, modified PAN, and textile PAN-based carbon fibers have been demonstrated using this facility this year. An important requirement of our project is to have the ability to measure isotope ratio depth profiles using the Secondary Ion Mass Spectrometry (SIMS) facility at ORNL. The SIMS instrument (Cameca ims4f ion microscope) is being upgraded for the high sample load of this project initially with hardware improvements, to be followed by method and automated software developments. Completed upgrades include improved pumping of the secondary ion source, permitting a vacuum of ten to eleven torr. This level of vacuum virtually eliminates interferences caused by formation of secondary ion hydrides, which in fact are the principle impediments in isotope ratio measurements. Pending upgrades include integration of optical and electronics microscopic systems with the secondary ion microscope systems of the Cameca. These upgrades will permit automated determination of exactly where on a sample measurements are being made at any given time.

Fuels: FEERC research facilities and staff of approximately forty researchers operated without recordable injuries or incidents of environmental contamination this year. The engine control system on one of the two GM 1.9-liter engines has been upgraded to a flexible microprocessor based system and is now fully operational. Several new analytical techniques/methods were developed to address project measurement needs using existing or modified equipment this year.

High Temperature Materials Laboratory: In FY 2008, the HTML User Program received (as of September 2008) a total of fifty-seven proposals: thirty-eight from universities, seventeen from industry, and two from national laboratories. During

fiscal year 2008, members of the HTML User Program actively participated in an ORNL User Facility Program Process Improvement Team that performed a comprehensive review of user programs at ORNL to ensure ORNL is properly positioned to effectively serve the user community. In fiscal year 2008, the HTML User Program upgraded several instruments that were obsolete or had become non-operational. The Anter Laser Thermal Diffusivity System was upgraded; a Hitachi HF-3300 microscope was acquired to replace an HF-2000 field emission TEM that supported the HTML User Program and other research programs for more than 15 years; Data Transfer System Electronics were acquired for ORNL's high-speed Phoenix infrared camera; a Modulated Differential Scanning Calorimeter (TA Instruments DSC Q2000) was acquired for improved measurements of specific heat capacity at low temperatures; a ThermoFisher Scientific K-Alpha X-ray Photoelectron Spectrometer was acquired by combining funds from EERE's VTP and HFCIT and BES; a compact, portable surface roughness measuring instrument was acquired to enable accurate measurements of wear on engineering components as well as test specimens; a new, digital hardness testing system offering thirty standardized hardness scales was acquired; and a unique new capability was added to enable testing the elevated-temperature oxidative wear resistance of high-performance materials under repetitive impact situations, like those experienced in diesel engine exhaust valves.

- Weatherization & Intergovernmental Activities

  Objective 2.1

  WIP activities require limited use of ORNL's laboratory facilities.

**NOTABLE ACHIEVEMENTS**

- Building Technologies Program

  Objective 2.1

  ORNL has been very effective in encouraging and gaining the participation of the other BA teams in the design and implementation of ORNL lab houses.

- Hydrogen, Fuel Cells and Infrastructure Technologies Program

  Objective 2.1

  Two fully automated test stands (one new, one existing) and associated hardware were brought online in fiscal year 2008 to evaluate fuel cells that utilize thin (0.1 millimeter thick) stamped metallic bipolar plates.

- Vehicle Technologies Program

  Objective 2.1

  Advanced Combustion Engines: During the intense campaign of vehicle studies with ethanol blends, the much-used and aging dynamometer absorber unit sustained a coupling/bearing failure. Spare parts were located and the lab was returned to operation with only three days of downtime. To generate large volumes of data in a wide range of projects, ORNL's engine and vehicle laboratory uses many drums of fuel of many different compositions. To provide safe storage, a prefabricated conditioned fuel storage container has been acquired.

  Automotive Lightweighting Materials: ORNL established multiple partnerships for

the User Center piece of equipment evaluating the crashworthiness of multiple materials and crash structure designs. ORNL tested magnesium, aluminum, high strength steels, carbon fiber composites, and glass fiber composites. Information was used in structural designs and in development of crash models. During the last year, ORNL has extensively used a pilot line to produce carbon fiber from textile PAN-based large tow precursor. In spite of the fact that the unit operates at low production line speed (eight to ten inches per minute), it has proven to be a very dependent unit to reproduce the batches of fibers. A minor peripheral modification of unit (to continuously monitor temperature) has been accomplished.

Energy Storage: VTP was able to utilize the available ORNL User Centers and equipment (e.g., HTML and the Material Processing Laboratory) in its efforts on characterization, testing, and processing.

**GOAL 3: EFFECTIVE SCIENCE AND TECHNOLOGY RESEARCH PROJECT AND PROGRAM MANAGEMENT** with the following objectives:

- Effective program vision and leadership;
- Effective and efficient science and technology project and program planning and management; and
- Effective and efficient communications and responsiveness to EERE and PMC needs.

**3. Significant Achievements**

- Biomass

Objective 3.1

Although still in the developmental phase, the Knowledge Development Framework (KDF), as envisioned by the Computational Sciences Division at ORNL is a creative vision of how datasets may be molded together as a tool to help provide insight and answer numerous questions of national and regional significance related to bioenergy development. The formation of the Sustainability Center at ORNL and the providing of laboratory directed research and development projects to build capability are a step toward the future. Although it is too early to envision exactly how sustainability will play out in the future, the vision and leadership displayed by ORNL in this regards is a positive step in that direction.

Objective 3.2

Due to the nature of ORNL feedstock program management and interactions with other areas of research including feedstock interface with conversion technologies, USDA's feedstock efforts, Sun Grant Initiative with universities, sustainability efforts, feedstock support for the integrated biorefinery projects, and growing feedstock interest at the national and international levels, ORNL is making an effort to bring coherency to program planning and management. The latest delivered Project Management Plans (aka statements of work) represent a significant improvement in this management process.

Objective 3.3

ORNL responded to headquarters challenges about managing biomass related efforts among the different ORNL Divisions related to Geographic Information System

(GIS) related work. Interacting with the Sun Grant Universities for GIS-related data collection and incorporation into the future KDF at ORNL was also a challenge. While further work remains, headquarters is confident that the management structure has been put in place to manage this complex area.

- Building Technologies Program

  Objective 3.1

  ORNL has excellent vision for the contributions that the next generation of roofs and materials will play in achieving zero energy buildings. This has been conveyed to a large array of stakeholders domestically and internationally through white papers, presentations, and other materials. ORNL has also assisted the technology development manager in arranging an executive envelope industry forum to help improve our communication with leading proactive industry partners.

  Objective 3.2

  ORNL does a very good job in executing its project management, especially considering the reality of continuing resolutions, industry desires, changing priorities, etc. Overall, ORNL is able to meet all of its key requirements while seeking agreement with the technology development manager.

- Federal Energy Management Program

  Objective 3.1

  ORNL's technical leadership in support of key aspects FEMP's Super ESPC program is very important to the program's success by helping the FEMP management team make informed decisions for continued improvement of the program. For instance, ORNL developed a format for a dashboard report on the Super ESPC program and, since the beginning of fiscal year 2008, has been delivering this report monthly to DOE Headquarters. Using information extracted from a number of databases that ORNL maintains, the report provides a concise summary of key ESPC program statistics such as the value of new projects in the pipeline, cumulative awards by agency and ESCO, average project interest rates, average cycle times, and average delivery time for annual measurement and verification reports. In addition, ORNL continues to chair the permanent subcommittee on ESPC quality assurance, and also chairs a working group whose objective is to develop policies on management and administration of agency-wide ESPC project portfolios in their performance period. As part of the quality assurance program, ORNL reviewed over 25 Annual Super ESPC measurement and verification reports for projects across the country. This represents 20 percent of active Super ESPC projects. This fiscal year, ORNL completed its pay-from-savings evaluation of FEMP's Super ESPC program. ORNL evaluated the energy savings based upon actual utility rates compared to the value of the rates found in the contracts. In aggregate, the results indicate that Super ESPC projects are delivering greater cost savings than were guaranteed by ESCOs, partly because utility rates have risen faster than the agreed to stipulations in the contracts. ORNL brokered a meeting between FEMP and Tennessee Valley Authority (TVA) strengthening collaboration on Utility Energy Services Contract (UESC) services to major federal customers. The collaboration will allow TVA to be fully aware of FEMP services and for TVA to send information on these completed projects to FEMP.

Objective 3.2

ORNL has shown great flexibility in re-focusing technical support for FEMP as office priorities have changed, most notably by providing strong support to the Secretary of Energy's TEAM initiative and a re-invigorated ESPC program, where quality issues remain a concern. For example, ORNL reviewed nineteen Super ESPC project initial proposals and nineteen final proposals primarily for projects in the Southeastern U.S. ORNL is the recognized leader in ground source heat pump technology and routinely reviews projects that included ground source heat pumps as an energy conservation measure. These projects total $450 million in project investment for approximately $1.6 billion in savings. ORNL provided expert technical services for critical revisions to guidance documents that are crucial to the success of the Super ESPC program. These documents included Delivery Order Guidelines, Practical Guide for Savings and Payments in Super ESPC Delivery Order, and the Super ESPC Agency Project Binder. ORNL also took the initiative to spearhead a closer collaboration between FEMP and ITP's efforts to deploy new technologies by including ITP's Superboiler and wireless sensors in their on-site ESPC. ORNL conducted sessions on "breaking down the barriers" to development and implementation of projects at the Federal Utility Partnership Working Group meetings in San Diego, California and in Destin, Florida. The Federal Utility Partnership Working Group is comprised of utility companies and Federal agencies with the purpose of establishing utility energy services contracts to deploy EERE technologies. The sessions are a key component of FEMP's strategic action plan for increasing the use of UESC.

Objective 3.3

ORNL continues to be very responsive to FEMP. Communications with FEMP are frequent. This includes providing timely input to the quarterly Joule report, quarterly project and costing information, participating in FEMP Headquarters conferences, and routine face-to-face meetings with FEMP staff.

- Hydrogen, Fuel Cells and Infrastructure Technologies Program

Objective 3.1

ORNL co-organized a fuel cell symposium on "Materials in Clean Power Systems III: Fuel Cells, Hydrogen-, and Clean Coal-Based Technologies" symposium at the TMS 2008 Annual Meeting and Exhibition. ORNL provided leadership to the Hydrogen Delivery Tech Team, which establishes the program roadmap and reviews and directs R&D portfolio activities. Working directly with DOE HFCIT, ORNL has provided significant technical input to the Hydrogen Storage Subprogram.

Objective 3.2

ORNL achieved project objectives and key milestones within budgeted costs and established schedules. To maintain low or target uncosted balances, ORNL worked diligently with staff and subcontractors.

Objective 3.3

ORNL responds rapidly to address questions, comments, and needs from headquarters. Tim Armstrong identified strengths and weaknesses of current delivery liquefaction technology projects following a short-notice request to tour current

liquefaction facilities on the Gulf Coast. The information from these site visits was incorporated into the program guidance for the hydrogen liquefaction projects. ORNL staff identified contacts from composite pipeline companies who spoke at a Delivery Tech Team meeting to show that this technology (which had the potential to meet DOE short and long term targets) is being tested in the field and is closer to commercialization than most industry representatives had believed.

- Industrial Technologies Program

  Objective 3.1

  ORNL has provided ITP with an effective platform for advancing the state-of-the-art characterization of industrial materials.

  Objective 3.2

  ORNL has provided effective plans in a broad range of R&D and demonstration areas, including industrial materials, fuel and feedstock flexibility, and energy intensive processes.

  Objective 3.3

  ORNL has proven to be exceptionally responsive to the requirements of ITP Headquarters staff. ORNL staff stepped in and provided timely support during a time when ITP staff had been depleted of personnel with materials expertise, enabling ITP materials program to continue to contribute effectively to the overall program goals.

- Vehicle Technologies Program

  Objective 3.1

  Advanced Combustion Engines: ORNL is at the leading edge of development of a new research project area in lean-burn direct injection (DI) gasoline based engines. ORNL had begun lean-burn advanced ethanol work and started CRADA with Delphi for advanced DI ethanol engines in prior years. ORNL visited two auto manufacturers to discuss CRADA options in early fiscal year 2008 and drafted a CRADA plan with Chrysler in FY 2008.

  Automotive Lightweighting Materials: ORNL developed and coordinated a five-year research plan with the Automotive Composites Consortium, American Chemistry Council, and other industry stakeholders. The plan allows for purposeful directing of the research efforts to achieve overall EERE and VTP goals. ORNL developed an agreement for coordination of research efforts in composites with the UK's Foresight Vehicle Program. The first effort is a joint collaboration on the UK team's ECO3 vehicle design project. ORNL also began a project to jointly develop textile-based precursors with a Portuguese company.

  Energy Storage: ORNL's efforts are in close collaboration and discussion with major participants in DOE and EERE. ORNL works with GM, Ford, Toyota, A123 Systems, Johnson Controls, Honeywell, U.S. Advanced Battery Consortium, U.S. Council for Automotive Research, Lux Research, and many other organizations to effectively create and share its vision and leadership. ORNL had many briefings to demonstrate and share its vision and provided invited lectures and an invited review paper on those efforts.

  Fuels: Researchers at ORNL, PNNL, and NCUT have established a synergistic team

approach to the understanding and development of future fuels from oil sands. This cooperation has extended to the FACE program to facilitate better analyses of fuels with the expectation that this will lead to better understanding of fuel effects on combustion processes. FEERC staff members have formed leveraged projects with the BP at the encouragement of VTP fuels leaders. ORNL, in collaboration with NREL, VTP, and BP, has been instrumental in assessing the impacts of these fuels on the legacy fleet of small non-road engines and vehicles. The team is able to jointly plan specific activities and evaluate intermediate blends in vehicles both in-house and through subcontracted research to generate maximum amount and quality of data rapidly. A detailed vehicle test program plan to assess the impact of intermediate ethanol blends on the U.S. legacy vehicle fleet was completed with industry and EPA input. A report detailing the results of these studies has been prepared and publication is imminent.

High Temperature Materials Laboratory: HTML has established collaborations with other DOE programs including EERE's HFCIT program; BES's Shared Research Equipment and CNMS programs; and the Office of Electricity Delivery and Energy Reliability, to acquire and maintain its unique capabilities for materials characterization.

Objective 3.2

Advanced Combustion Engines: ORNL provides well-thought-out AOPs, which make use of the multi-disciplinary expertise of ORNL personnel. This approach has been very effective in providing new insight into issues and benefits associated with the integration of advanced engine, emissions, and fuels technologies. ORNL has recently restructured and established the Energy and Transportation Sciences Division to better focus on these topics as well as to improve internal collaboration between the transportation and materials related sciences. A recent example of improved internal collaboration is a new CRADA and WFO agreement with a major engine manufacturer. This new working relationship is serving to improve collaboration between the engine/combustion and materials teams at ORNL as well as at the industry partner.

New collaborations between the engine/combustion and power electronics teams at ORNL are also becoming more frequent and important as hybrid and related vehicle technologies continue to be demonstrated as paths to improved overall vehicle system efficiency.

Automotive Lightweighting Materials: ORNL evaluated a proposed plan to jointly develop textile based carbon fiber precursors with a textile mill located in Grimsby, UK. After a buyout of the plant from the Chinese company, Bluestar, and visits by ORNL staff members it was determined that the Chinese only wanted to develop the precursor to compete against American companies. ORNL avoided possible embarrassment to DOE and the government by terminating any development activities. We were able to use contacts with the Department of Defense to greatly slow down the Chinese development of this export controlled, critical technology. During this year, one of our key partners faced criminal indictments and went bankrupt due to issues with technologies that were not related to any of the automotive lightweighting materials or ORNL projects. The result was that we suddenly were left without a viable partner and without access

to equipment to conduct research for the Advanced Oxidation and Advanced Stabilization projects. We responded quickly by securing the rights to ORNL generated data and program paid-for equipment. ORNL developed alternative plans and coordinated options with Sentech, who bought out the facilities and interests that were critical to the project and hired the key non-ORNL staff members. Less than nine months after the crisis happened, the project is now back on track and proceeding at full pace.

Energy Storage: ORNL's efforts are multidisciplinary to build the best available team and provide excellent proposals for DOE. ORNL has been successful with two major proposals providing about $4.2 million alone. In addition, ORNL has developed three white papers with different organizations to address major technical barriers for technology development under full consideration of technical risks to ensure success in identifying and resolving those problems.

Fuels: FEERC is located offsite at the National Transportation Research Center facility and therefore has lower overhead charges. This results in approximately a ten percent savings as compared to the main campus, and most likely provides a cost advantage over other National Laboratories.

Objective 3.3

Advanced Combustion Engines: ORNL readily requests information and is proactive regarding sending technical highlights and important news about upcoming meetings and visits of interest. ORNL contributes to program updates requested by headquarters, including materials used in presentations to FreedomCAR directors and at events like the National Academy Reviews and SAE meetings. ORNL program managers visit headquarters roughly once per month to discuss all issues and conduct teleconferences in between visits. ORNL provides technical highlight input to the DOE weekly reader on a frequency of about once per month.

ORNL has provided support for proposal reviews for headquarters and the National Energy Technology Laboratory when asked and is responsible for VTP annual reports in fuels and engines areas.

Automotive Lightweighting Materials: This program is in constant communication with the program managers. Milestones are met and program reports are sent as requested. ORNL program management regularly attends many of the same coordination meetings as DOE program staff. Concerns regarding the partner for the development of oxidation and stabilization technologies were quickly communicated to DOE program management and they have been kept informed as developments have occurred. As a result, alternative partners have been found and the projects are back on track. The development of five-year research plans has aided in the development of future budget requests and conducting multi-project program reviews serves as a forum to keep program management informed.

Energy Storage: All headquarters requests have been handled in a timely manner. Over the project period ORNL briefed headquarters staff three times with the team of principal investigators and many more times during programmatic visits, phone conferences and e-mail conversations. ORNL kept the headquarters staff informed about its activities, successes, and problems at any time. ORNL received excellent suggestions for teaming up with other organizations and advice on technical areas

from major industrial partners.

High Temperature Materials Laboratory: The HTML User Program submits four quarterly reports and one annual report to VTP.

- Weatherization and Intergovernmental Activities

  Objective 3.1

  ORNL has consistently provided vision and leadership to WIP through:

  Extensive participation in the Weatherization Plus long-range strategic planning initiative.

  Cutting edge performance in residential audit design (see MHEA discussion in Objective 1.2 above).

  Recognized expertise in market assessment and energy expenditure analysis for low-income households.

  Facilitated outreach to national stakeholder organizations.

  Coordination with state and local stakeholders to enhance their implementation of the Weatherization Assistance Program.

  Objective 3.2

  ORNL project planning is both efficient and effective. The ORNL Research Manager is the single point of contact with WIP. He assigns tasks and allocates responsibilities to the Audit, Evaluation, and Administrative Team leads. This has enabled ORNL to produce timely results on requests for information and analysis with administrative efficiency and a minimum of confusion. ORNL responded quickly and flexibly to urgent EERE requests to expand relationships with the National Governors Association, the Alliance to Save Energy, and the American Council for an Energy-Efficient Economy.

  ORNL also continued to provide accurate and timely analysis on a wide variety of program issues and management challenges.

  Objective 3.3

  ORNL provided:

  Rapid and effective response to headquarters and PMC requests for information and assistance.

  Presented key policy and strategic management options to WIP on a variety of issues.

  Expeditiously processed subcontract awards to the Alliance to Save Energy and other groups implementing urgent EERE corporate priorities.

**NOTABLE ACHIEVEMENTS**

- Building Technologies Program

  Objective 3.1

  ORNL management seems to want to focus integration research activities on those technologies being developed at ORNL. ORNL staff should be encouraged to consider all available technologies in developing designs for the lab houses that have the potential to lead to cost effective net zero designs. ORNL needs to work

on developing advanced technologies that are going to play an important part in achieving zero energy buildings. These technical pathways may include some non-heat pump technologies and ORNL needs to be prepared for a future heating, ventilation, air conditioning (HVAC) portfolio that may include a wide range of advanced HVAC technologies. Just because ORNL is a world-class heat pump technology researcher, does not mean they cannot be a world-class leader in other HVAC technologies too. ORNL needs to look into other advanced HVAC technologies that have the potential to leapfrog beyond incremental improvements in conventional vapor compression including humidity control technologies.

Objective 3.2

The lab house research for the mix/humid climate has produced outstanding results. ORNL needs to develop strategies for assisting other BA researchers to replicate this success in other climate zones. ORNL did a good job in executing its project management, but ORNL needs to do a better job in leveraging and interacting with other areas of research, development, and demonstration. There is room for improvement in how the lab research homes program interacts with HVAC R&D, Building America, and other parts of BTP. ORNL should create a master plan that discusses this interaction and synergy.

Objective 3.3

During this past year, it appears that ORNL management has attempted to change the direction of BA research before revising the scope of work and obtaining DOE approval. ORNL did an excellent job with monthly reports and with providing feedback on financial information, such as spend rates and uncosteds. The technology development manager appreciated the financial information provided on a monthly basis on the status of the work at ORNL at the agreement level (task basis). Excellent work.

- Hydrogen, Fuel Cells and Infrastructure Technologies Program

  Objective 3.2

  ORNL provided timely feedback in order to modify plans, reviewed projects and proposals, contributed to the Annual Peer Review and progress reports, provided feedback participation in the Centers of Excellence, and represented DOE at national and international conferences

- Vehicle Technologies Program

  Objective 3.1

  Advanced Combustion Engines: ORNL co-directs CLEERS activity with Dick Blint of GM. ORNL assisted in coordination of technical agendas for the FreedomCAR Advanced Combustion and Emission Control and Diesel Crosscut Team meetings and contributes regularly with data and information. ORNL and NREL work as a team with CRC and several industry representatives to ensure the success of FACE. ORNL is coordinating with Sandia National Laboratory, the University of Wisconsin, and industry on a common engine geometry for combustion and emission controls research. FEERC personnel are leveraging activities with BP at the encouragement of VTP fuel leaders. In general, ORNL provides a significant level of technical planning and analysis for the 21st Century Truck Partnership and holds specific responsibility for the strategic areas of advanced engines and safety.

Objective 3.2

Automotive Lightweighting Materials: Carbon fiber development efforts were successfully coordinated not only with the automotive companies but also with carbon fiber companies, potential new suppliers, and with other industries with the same needs. Those industries include bio-fuels, infrastructure, wind energy, oil and gas, hydrogen storage, and defense. The result is a critical mass of interests from differing industries to conduct the research and to provide a sufficient base of potential users that will encourage new material producers to enter the market.

- Weatherization & Intergovernmental Activities

ORNL staff provided numerous high quality trainings to state, regional, and national conferences on the:

Use of the Weatherization Assistant audit tool.

National Evaluation of the Weatherization Assistance Program.

Impact of changing energy prices on low-income consumers.

Use of evaluation methods and results at the state level.

The implementation of new lead-safe weatherization policy and practice in the Weatherization network.

**4. Notable Deficiencies**

- Building Technologies Program

Objective 3.3

ORNL needs to improve its communication to DOE on issues of potential importance to EERE upper management. Monthly reporting is often too late for weekly highlight reports. While ORNL is very responsive to the technology development manager, macro communications to higher-level audiences needs to be improved.

Objective 3.3

The replacement of the Manager was not communicated well and the opportunity for a better transition was missed by not announcing the Acting Manager sooner.

## 42. Guidance for the Next Performance Period

**PERFORMANCE EXPECTATIONS FOR OAK RIDGE NATIONAL LABORATORY FOR THE NEXT PERFORMANCE PERIOD** (for example, anticipated accomplishments and level of work, areas of concentration and remedial actions).

- Biomass

DOE BP's expectations for sponsored activities at ORNL remain high. The BP recognizes ORNL's senior management support and involvement in delivering high quality research as well as management, and the desire to exceed the expectations of the BP. The BP supports the decision by ORNL senior management to bring more feedstock expertise to the Lab Relationship Manager position. The Biomass Feedstock Team appreciates the difficulty of supporting the management of projects with universities under the Sun Grant Initiative, as well as bringing better coherence to allied new KDF efforts being supported in the Computational Science Division, the Environmental Science Division, and

GIS/Field trials R&D under the Sun Grant Initiative. Ongoing efforts to bring in additional personnel to support the management of ORNL activities related to the DOE Regional Biomass Energy Feedstock Partnership Program and a resource economist to support analytical feedstock efforts should enhance product delivery during the next performance period. Continued high level performance for feedstock resource assessment is also expected.

- Building Technologies Program

  ORNL needs to continue its excellent work on developing, evaluating, and analyzing the next generation of building envelope technologies. However, as many people in the country seek ways to save energy in the short term, ORNL will have to focus more attention on providing the additional enabling research materials such as fact sheets, web pages, etc. that can highlight our past research to result in greater sales of energy efficient products globally. Work should also assist industry in highlighting the macro potential savings from greater investment in the envelope technology area. BTP expects ORNL staff to continue the outstanding research and deployment support they have provided to the BA program.

  BTP would like to see more involvement in the planning and implementation of the lab house research by the other teams in the other climate zones so as to achieve an integrated national lab house research program.

- Federal Energy Management Program

  FEMP anticipates increase emphasis being given to tracking a wide range of ESPC related performance metrics in the coming year in support of the new Super Indefinite Delivery/Indefinite Quantity (IDIQ) contract. The aim of this work will be to measure all aspects of ESPC cycle time in order to identify and correct process constraints on the part of Federal agencies as well as ESCOs.

- Hydrogen, Fuel Cells and Infrastructure Technologies Program

  HFCIT expects ORNL to bring the Hydrogen Production/Proton Transport Membrane project to a logical conclusion in fiscal year 2009 by identifying a successful metric(s) for the technology (e.g., minimum required hydrogen flux to meet DOE membrane targets) and by documenting progress-to-date towards the metric(s). For hydrogen storage efforts for both the Metal Hydride and Sorption Center of Excellence efforts, collaborations should be increased both within and across DOE's portfolio. For materials, the dynamic performance of the materials should be emphasized with estimates of net available gravimetric and volumetric capacities given, taking into account the conditions needed to release and store the hydrogen. For modeling work, theorists should also stress validation of theoretical predictions with experimental results. ORNL should continue the manufacturing work in high-strength carbon fiber that would enable the manufacture of durable, lightweight, compressed hydrogen storage vessels. (Unfortunately, the current cost of the fibers is much too high for automotive use) Melt spun PAN is considered an attractive way to reduce the cost of PAN precursor fibers, but there are currently no melt-spun PAN fibers on the market and we know of no current industrial work on melt spinning PAN. An approach to melt spinning with novel co-monomers has been conceived that should produce

high molecular weight "fibrous" materials. Acrylonitrile and methyl acrylate were co-polymerized successfully into several compositions, successfully completing the first key step in developing melt spinnable PAN fibers.

- Industrial Technologies Program

  The Industrial Technologies Program expects ORNL to continue to provide outstanding support. ITP anticipates that the laboratory will continue to excel in the area of industrial materials development. In addition, ITP expects that the laboratory will exhibit comparable performance in three new areas of research, development, and deployment: nano-manufacturing, energy intensive processing, and fuel flexibility.

- Vehicle Technologies Program

  Keep up the great work!

- Weatherization & Intergovernmental Activities

  Performance expectations and targets will be identified as part of WIP's review of ORNL's FY 2009 AOP. The primary areas of concentration will continue to be weatherization research, evaluation, and outreach. No remedial actions are anticipated.

**INPUT ON CONCERNS FOR LABORATORY MANAGEMENT** (discussion of potential problem areas):

- Biomass

  The BP expects substantial improvement in the timeliness and delivery of the Intermediate Blends program, reflecting the importance of this program to the Nation's Energy security and Climate Change efforts. In terms of suggestion, we would like ORNL to anchor this program with more senior leadership, so it results in:

  Proactive work with BP and VTP programs to identify the bottlenecks and accelerate the timeline.

  Transparent and real-time communication between ORNL and senior DOE program leadership.

  A strong understanding of the schedule.

  The ability to meet the demand for high-level communications to very senior stakeholders in government and industry.

  A total commitment to identify a plan to complete all testing for tier-two vehicles by Spring 2010.

- Building Technologies Program

  ORNL should improve its communications with DOE and responsiveness for issues that are of concern for the Buildings Program and EERE upper management. Once the statements of work are approved, it is expected that ORNL management will facilitate implementation of these activities as approved.

- Federal Energy Management Program

  FEMP technical assistance funds to ORNL for FY 2008 were provided late in the

year and ORNL management will need to maintain vigilance on improving uncosted balances during fiscal year 2009.

- Hydrogen, Fuel Cells and Infrastructure Technologies Program

  ORNL must communicate more effectively on personnel transitions, identify impacts on the program and projects due to the transitions, and announce new personnel broadly to the Program

- Industrial Technologies Program

  No potential problems are foreseen.

- Vehicle Technologies Program

  None.

- Weatherization & Intergovernmental Activities

  None.

**Peer-Reviewed Publications:**

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Dai, S. Invention disclosure submitted that is related to synthesis of mesoporous carbon.

Yoon, M., S. Yang, Zhenyu Zhang, and David Geohegan. Invention disclosure "Hydrogen Storage on Ca Doped Nanostructures." submitted.

Wang, J.-Y. Three invention disclosures were submitted for materials testing in hydrogen environments – associated with steel pipelines for hydrogen delivery.

Co-Organizers, HyWays IPHE Workshop, Aug 5, 2008, Changsha, China. "Hydrogen Roadmapping Activities in Europe, the U.S., and Other IPHE Countries,"(embedded in HyForum 2008 Conference). (Part of HyWays-IPHE Team developing presentation materials and leading the workshop.)

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Brady, M. P., et al., "Stamped and Nitrided Stainless Steels for PEM Fuel Cell Bipolar Plates," 2007 Fuel Cell Seminar & Exposition, San Antonio, TX, Oct. 15-19, 2007.

Dai, S., "Surface Functionalization of Porous Carbon: A Rational Approach," invited lecture, Nanoporous Materials V, Vancouver, B.C., Canada, May 25-28, 2008.

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Greene, D. L., Z. Lin, P. N. Leiby, D. Bowman, "Integrated Market Analysis of the Impacts of Hydrogen Storage Costs on the Transition to Fuel Cell Vehicles," presented at the Hydrogen Storage Tech Team Meeting, Detroit, Michigan, July 17, 2008.

Greene, D. L., "Analysis of the Transition to Hydrogen Fuel Cell Vehicles and the Potential Hydrogen Infrastructure Requirements," plenary presentation at DOE Hydrogen Program Merit Review and Peer Evaluation Meeting, June 9, 2008.

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# APPENDIX 4

# ASSISTANT SECRETARY FOR ELECTRICITY DELIVERY AND ENERGY RELIABILITY

# PERFORMANCE EVALUATION SURVEY DATA

## Condensed Summary

### Objective 1.1 Science and Technology Results Provide Meaningful Impact on the Field

ORNL has initiated and developed many pioneering works in the fundamental understanding of applied research of HTS that are being used as reference data and standard investigative tools by researchers worldwide in the areas of cryogenic dielectric properties and research on nano-dot columns self-assembly by pulsed laser deposition (PLD).

Key ORNL awards include: 2008 National FLC (Federal Laboratory Consortium for Technology Transfer) Excellence in Technology Transfer Award, 2008 Nano50 Innovator Award, and 2007 Energy Solutions Center (ESC) Partnership Award For Innovative Energy Solutions

### Objective 1.2 Provide Quality Leadership in Science and Technology

The results of ORNL research in the areas of HTS wire continues to be a trend setter and guide the focus of Industry efforts in areas such as flexible single crystal templates, nanodot pinning centers, cryogenic dielectrics, filamentization of wires and buffer technologies.

ORNL staff members are visible in leadership positions in HTS and electricity communities as evidenced by the number of external stakeholders, international institution collaborations, meetings/symposiums organized, and service on journal editorial boards, professional/trade/industry organizations boards and technical society fellows.

### Objective 1.3 Provide and Sustain Outputs that Advance Program Objectives and Goals

DOE-OE peer reviews indicate that ORNL performs at world class levels in the HTS program and consistently rank among the highest scores. ORNL has over 50 peer reviewed articles that were published or submitted in the HTS program and over 20 in the Visualization and Controls and Distributed Systems Integration areas in addition to 3 intellectual property-related documents have been filed.

### Objective 1.4 Provide for Effective Delivery of Products

ORNL has accomplished all major milestones in the ORNL Electric Delivery Technologies Program for FY 2008 including the CPS control milestones and contributed toward accomplishment of the HTS Joule target. In some cases, the milestones were met well ahead of schedule.

### Objective 3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision

ORNL led the Laboratory Working Group's Electricity Delivery Focus Group and has been a contributor to planning efforts related to Smart Grid vision and metrics. Over the past year, ORNL has added a key program manager with a rich history in the utility industry whose cited reasoning for the move was the quality of research, facilities, and expertise at ORNL.

**Objective 3.2 Provide Effective and Efficient Science and Technology Project/Program Planning and Management**

ORNL Electric Delivery program managers are constantly seeking leveraging opportunities across OE areas, such as dielectric materials, and Energy Efficiency and Renewable Energy areas, such as renewable systems integration, vehicle technologies (Plug-in Hybrid Electric Vehicle), power electronics, energy storage). ORNL is also leveraging opportunities with the DHS on HTS applications, visualization and controls, and risk assessment tools for cyber security operations.

**Objective 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs**

In FY 2008, ORNL has continued to provide high quality, accurate, impartial and timely responses to request for information and technical assistance and delivered Quarterly Reports on schedule. When appropriate, ORNL has coordinated with experts both internal and external to ORNL, and acted as an information center to compile the necessary information in a clear and organized manner.

**FY 2008 Summary**

In FY 2008, ORNL continued its significant contribution towards the DOE Office of Electricity Delivery and Energy Reliability program mission. Through each of the technical areas within ORNL's Electric Delivery program, ORNL staff has demonstrated science and technology leadership, the ability to meet critical milestones and provide effective science and technology program management.

In the High Temperature Superconducting (HTS) program, ORNL's efforts in developing second generation (2G) HTS wire continue to lead in technical breakthroughs and achieving record-breaking performance in wire development. ORNL is successfully transferring innovative designs from laboratory settings to real-world device demonstrations evident in the continued success at Ape's Bixby sub-station.

In the Visualization and Controls (V&C) area, the development of the Visualizing Energy Resources Dynamically on Earth (VERDE) tool provides DOE with a unique ability for wide-area monitoring of the electric grid, which will assist the federal government in responding to major impacts on the electric and energy infrastructures. This tool has supported the recovery efforts during Hurricanes Gustov, Hannah and Ike this year.

In the Distributed Systems Integration area, ORNL is utilizing its Distributed Energy Communication and Controls (DECC) Laboratory to assess value added electrical services, such as reactive power compensation and voltage support, from distributed systems. Through the accomplishments within the DECC facility, the functionality of distributed energy systems and integration with the electric grid will be improved. This year continued testing of multiple devices on the ORNL distribution system was achieved and the results are providing valuable information on the dynamic response of the devices using ORNL's innovative control schemes. A project has been established with Southern California Edison that will take these concepts and methodologies from the laboratory to the field. The location will be Southern on California Edison (SCE's) service

territory, Catalina Island. This effort will help operators better understand response to power system events and help utility engineers implement innovative control methodologies. These accomplishments are a sample of ORNL's science and technology leadership and achievements towards major impacts in the electric delivery community.

In order to achieve these goals, ORNL has displayed effective science and technology program management. A key element of research and development activities is systems integration. ORNL is a unique laboratory that is bringing renewables integration and analysis and interactions with the grid along with end use applications, such as smart grid and zero-energy buildings technologies. Through effective program management, ORNL has been able to leverage program to establish state-of-the-art demonstrations with TVA that include integration of zero-energy technologies and smart grid concepts. Additionally, ORNL has been active in articulating a vision for power electronics research and development. ORNL has been very successful in defining critical milestones and meeting all of the goals established for FY 2008. This report highlights all of the major accomplishments in the Electric Delivery Technologies program at ORNL.

**Goal 1.0 Provide for Efficient and Effective Mission Accomplishment**

**Objective 1.1 S&T Results Provide Meaningful Impact on the Field**

In FY 2008, ORNL HTS Program researchers produced and assisted in the achievement of original and innovative results that significantly advanced the DOE program mission to develop High Temperature Superconducting (HTS) wires (second generation 2G wires and advanced coated conductors for low ac losses), and to demonstrate prototype HTS power applications. These pioneering achievements include novel buffer architectures that may enable low-cost practical 2G wires, novel nano-heterostructures that advanced the understanding of pinning and resulted in record-breaking wire performance, discovery of a new crossover phenomenon that points the way to an isotropic performance, and successful transfer of innovative designs from laboratory setting to real-world device demonstration. In the V&C area, the Visualization tool (VERDE) tool went operational in the OE Energy Restoration Center and now provides DOE with a unique ability to have wide-area monitoring of the electric grid. During the 2008 hurricane season, the tool assisted the federal government response to major impacts on the electric and energy infrastructures. Additionally, the tool has been adopted by utilities, such as Entergy, and being used in their control operations centers. In the Distributed Systems Integration area, ORNL is utilizing its Distributed Energy Communication and Controls (DECC) Laboratory to assess value added electrical services, such as reactive power compensation and voltage support, from distributed systems. Through the accomplishments within the DECC facility, the functionality of distributed systems and integration with the electric grid will be improved resulting in reliability benefits to the grid. These accomplishments are a small sample of ORNL's science and technology leadership and achievements towards major impacts in the electric delivery community.

Key ORNL awards include: ***2008 National FLC Excellence in Technology Transfer Award*** -" High-Performance LMO-Enabled, High Temperature Superconducting Wires;" ***2008 Nano50 Innovator Award*** - "Sustained contributions to self-assembly of nanomaterials to form novel nanocomposites;" ***2007 Energy Solutions Center (ESC) Partnership Award For Innovative Energy Solutions*** for the GEDAC (gas-engine driven heat pump rooftop unit) working with our industry partners Southwest gas, Team Consulting, and Blue Mountain Energy.

**Objective 1.2 Provide Quality Leadership in Science and Technology**

ORNL has consistently been willing to pursue novel approaches that can provide innovative solutions to immediate or future issues. High risk high pay-off solutions are balanced by core competency-based R&D to ensure steady progress in the program mission. In this regard, the ORNL HTS Program has consistently dedicated a portion of its effort in strategic areas of research that are potentially disruptive or are of high risk with high potential returns. One such example in FY 2008 is a novel flexible ceramic single-crystal faceted fiber template that the Peer Reviewers commented as "This could have a profound effect on the next generation of coated conductors... The PI should be commended for taking this radical step..." and "I consider in any case this development as a very significant one in the international scene." In V&C, ORNL researchers have proposed an innovative concept to use industrial loads for regulation in the power system. Alcoa has agreed to move forward on providing regulation from their aluminum smelting loads. If this concept works it will benefit both power system reliability and the aluminum industry. In Distributed Systems Integration, ORNL has developed a unique laboratory for controlling distributed systems that companies such as Southern California Edison are working on incorporating into their operations. The California Energy Commission is now interested in collaborating in this area. The sustained leadership and excellence in S&T output of the ORNL Electric Delivery Program is outstanding and its researchers have received many recognitions and accolades in the form of awards, fellowships, directorships on technical boards, positions on journal editorial boards, conference/ meeting/ workshop organizing and chairing roles, as well as book (chapter) editing and authoring tasks.

**Objective 1.3 Provide and Sustain Science and Technology Outputs that Advance Program Objectives and Goals**

DOE-OE peer reviews indicate that ORNL performs at world class levels in the HTS program and consistently rank among the highest scores. ORNL has over 50 peer-reviewed articles that were published or submitted in the HTS program and over 20 in the V&C and DSI areas.

**Objective 1.4 Provide for Effective Delivery of Science and Technology**

ORNL has accomplished all major milestones in the ORNL Electric Delivery Technologies Program for FY 2008 including the following control milestones: Demonstrate slot-die coated micron metal organic deposition (MOD) YBCO and MOD LZO with an average performance of over 80 A per tape for a 344 wire; Demonstrate an $I_c$ of 1000 A/cm at 77 K and self-field; Produce world's first kilometer-class 2G wire; Establish thermal properties as a function of filler content in one nanocomposite system; Complete database on literature data for LN2 breakdown; Expand real-time visualization & monitoring capability of transmission lines for key regions; Evaluate analytical techniques for using independently controlled DE sources in parallel to supply dynamic reactive power.

**Goal 3.0 Provide Effective and Efficient Science and Technology Program Management**

**Objective 3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision**

In FY 2008, ORNL provided strong S&T program management support in establishing a strategic vision, assisting on R&D plans and ensuring delivery of quality R&D products. ORNL led the Laboratory Working Group's Electricity Delivery Focus Group to support DOE and linking the DOE office of science with the applied energy programs. Input from industry was also incorporated into the final product. The group assessed the state of the electric grid, identified emerging trends, and determined science and technology opportunities that could address the challenges of modernizing the grid. The final report was presented to the three Under Secretaries. The final report was used by the Office of Electricity in the budget planning process and has been used to articulate a need for R&D in the electric grid area. ORNL HTS Program Office has demonstrated exceptional vision and leadership in assisting the DOE sponsor in developing Quarterly Joule Targets, future research directions, HTS technology alignment with the Smart Grid, as well as continuing development of Initiatives for 2G wire for Commercial Readiness and other enabling technologies. By aligning the ORNL activities with immediate and emerging needs as well as maintaining cutting edge research capabilities, ORNL has established itself as "The Place" to perform HTS research, evident in the support that the Department of Homeland Security is seeking from the Lab to provide subject matter expertise and independent testing service and advice for their Resilient Electric Grid project. ORNL has also expanded its capabilities and core competencies through careful consideration of resource allocation. By revitalizing equipment, ORNL has been able to upgrade its ac loss facility as well as creating a wire test system that combines low temperature, high current and high field capabilities. In addition, other new capabilities have been established with minimum investment. By providing world class and up-to-date facilities as well as a setting that encourages pioneering and novel research initiatives, ORNL has been able to retain its world-class researchers, and continued its reputation as a world leader in HTS research.

**Objective 3.2 Provide Effective and Efficient S&T Project/Program Planning and Management**

ORNL maintains its high quality of R&D through regular strategic planning and evaluation of its R&D projects and research capabilities. Technical risks are evaluated against potential return through careful identification and consideration of technical issues. To mitigate financial risks, ORNL leverages research activities with other offices, such as EERE (vehicle technologies, Commercial Technology Development Funds), through discretionary activities (LDRD activities), and through other agencies and funding sources (DHS, ONR, Venture Capital). All these considerations and analyses are used to regularly update our strategic as well as operation plans to reflect changing conditions and needs, and to ensure program leadership and relevance. ORNL HTS strategic projects include crosscutting technologies that leverage resources for maximum return. One example is our highly innovative dielectric nano-composite work that is leveraged with OE, SBIR and ORNL LDRD funds. Another example is the upgrade of ORNL's fault current testing capability that is leveraged by substantial funding from DHS. Development of this improved capability will greatly assist DOE in its power transmission and delivery missions.

ORNL demonstrated a willingness to make tough decisions. To maximize productivity and ensure relevancy, the program does not shy away from redirection of effort that eliminates projects of low-return in favor of high-risk high-return emerging needs. For the HTS program, one example is the termination of long-length single crystal alloy metal work in favor of high-strength textured template via warm rolling. Another example is the deferment of extra-functional buffer work in favor of flexible ceramic single-crystal faceted fiber template initiative. Highly exciting return has already

been achieved in both of these new areas. One FY 2008 HTS Peer Reviewer commented on the fiber template work that "I'm giving ORNL a 10...for having the imagination to conceive adapting/adopting optical fiber technology as a perhaps revolutionary new substrate...(ORNL's strengths are) Boldness and creativity." Also, ORNL has been focused on effectively completing research in reciprocating engines, thermally activated technologies, combined heat and power and materials areas that were of interest to the DE Program but no longer relevant to the mission of DOE-OE. The projects were either completed, brought to a logical conclusion, or funding from other sources outside OE was secured to continue the work.

**Objective 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs**

In FY 2008, ORNL has continued to provide high quality, accurate, impartial and timely response to sponsor requests for information. Issues, whether positive or negative, are communicated to the sponsor so that plans and actions can be formulated collectively. Emerging issues are communicated immediately to avoid any surprise. Well-established points of contact are known to sponsors, collaborators and stakeholders. For others, the program office is constantly manned during office hours to direct any request to appropriate personnel. To assist the programmatic tasks of our DOE sponsor, ORNL prides itself in providing rapid, impartial and accurate information and inputs on request, usually in the same day. These requests range from simple status update to more involved inputs such as those for the Joule target. When appropriate, ORNL has coordinated with experts both internal and external to ORNL, and acted as information center to compile the necessary information for our sponsor in a clear and organized manner. The DOE sponsor is kept informed through real-time e-mail updates, regular telephone calls and scheduled reports. In addition, the office maintains frequent contact with our sponsor via telephone calls to ensure that requests and sponsor programmatic needs are met. ORNL program managers make regular trips to meet the DOE Program Manager in person to discuss programmatic issues in detail. Moreover, detailed Quarterly Reports and an Annual Report are provided to our sponsor on schedule.

**ORNL High Temperature Superconductivity (HTS) Program**

**Goal 1.0 Provide for Efficient and Effective Mission Accomplishment**

**Objective 1.1 S&T Results Provide Meaningful Impact on the Field**

***Summary*** - In FY 2008, ORNL HTS Program researchers produced and assisted in the achievement of original and innovative results that significantly advanced the DOE program mission to develop HTS wires (second generation 2G wires and advanced coated conductors for low ac losses), and to demonstrate prototype HTS power applications. These pioneering achievements include novel buffer architectures that may enable low-cost practical 2G wires, novel nano-heterostructures that advanced the understanding of pinning and resulted in record-breaking wire performance, critical evaluation of wire response depending on conductor design, and successful transfer of innovative designs from laboratory setting to real-world device demonstration. In the process, ORNL HTS program has contributed substantially to the stewardship of the DOE program mission.

These results have been published in HTS and non-HTS peer reviewed journals (26 papers published, 28 pending, see Appendix for all publications in FY 2008). The significant number of

publications in scientific journals outside of the field of superconductivity demonstrates the crosscutting nature of some of the program research focuses. All these published works proved to have significant impact in the field of superconductivity, and have influenced the research community thoughts on what wire architectures are feasible and what is the limit of wire performance. These results also resolved many critical questions and have collectively moved the HTS field forward in a significant way.

ORNL has initiated and developed many pioneering works in the fundamental understanding and applied research of HTS that are being used as reference data and standard investigative tools by researchers worldwide. For example, cryogenic dielectric properties of conventional materials have been obtained and organized by ORNL, and are posted on a public database website for the use by worldwide scientific community. Also, the innovative ORNL work of nano-dot columns self-assembly by PLD is now being used as a standard method to investigate the effects of engineered defects in HTS. A new non-contact Jc angular measurement method can provide data on previously inaccessible regimes, and promises to become a standard measurement tool.

As a result of the sustained leadership and excellence in S&T output of the ORNL HTS Program, its researchers have received many recognitions and accolades in the form of awards, fellowships and invited presentations. These include a 2008 National FLC Excellence in Technology Transfer Award and a 2008 Nano50 Innovator Award. An ORNL HTS scientist has also been elected as a Corporate Fellow of UT-Battelle (ORNL).

**Feasibility of high performance 2G wires with simplified substrate architectures demonstrated. Approach can potentially reduce wire cost significantly.**
2G wires have complicated buffer architectures. For example, RABiTS contains 3 buffer layers that are deposited by physical vapor deposition (PVD). To achieve cost reduction and increase reliability, it is desirable to reduce the number of buffers and employ cheaper solution techniques. In FY 2008, ORNL researchers have fabricated a two-layer structure with solution LZO and PVD $CeO_2$ layers and demonstrated a high $I_c$ of *242 A/cm* in a 0.8 MOD YBCO deposited by AMSC. The same two-layer buffer architecture has been deposited on surface modified metal templates leading to a high $I_c$ of *266 A/cm*. These results show that simplified substrates are feasible.

**Pioneering work by ORNL in the incorporation of self-assembled nanodots extended to non-BZO dopants.**
The pioneering work of nano-scale columnar defects comprised of self-assembled BZO nanodot columns developed by ORNL has been successfully demonstrated for non-BZO dopants. Since the ability to self-assemble is greatly influenced by the strain in nanodot/HTS, it is important to examine other dopants structures to provide manufacturers with alternatives. In FY 2008, ORNL researchers have determined that non-Ba oxides including MgO, $BaSnO_3$, and $SrZrO_3$ can self assemble. This result is highly significant since breakdown in self-assembly due to insufficient strain - deposition rate combination can limit the options of wire manufacturers.

**ORNL HTS researchers <u>discovered Never-Before-Seen</u> critical current crossovers in 2G wires. Developed initial model to describe these behaviors. Discovery may point toward ways to obtain isotropic performance in these anisotropic superconductors.**

Critical current density Jc dependence on material orientation in a magnetic field is an important quantity for practical devices; typically Jc varies with field orientation. ORNL researchers have discovered *new single- and double-crossover behaviors* in high performance 2G wires with artificial columnar defects. *Jc at these crossover points are isotropic*, rather than highly anisotropic. They have also developed a description of this phenomenon that is based on a mathematical model. These newly discovered behaviors point toward pinning strategies that can potentially result in isotropic performance in these superconducting wires. The discovery is highly significant in the fundamental understanding of these materials and can greatly simplify the application design process. This discovery and understanding led a Peer Reviewer to comment: "It is so good, I wish I could be a participant."

**ORNL develops World's First non-contact critical current angular measurement capability. Method will greatly facilitate characterization of state-of-the-art wires.**
HTS are intrinsically anisotropic, and Jc varies greatly with direction of applied magnetic field. To date, all such measurements have been performed using electrical transport through small samples. As state-of-the art wires carry more and more currents, the transport approach presents many practically insurmountable limitations. To solve these problems, ORNL researchers have developed world's first non-contact magnetic angular Jc measurement method. Jc for extended angles can be obtained under a *wide range of temperatures and field strengths*. Initial measurements showed that *non-contact results agree with transport results*. Peer Reviewers were quite excited because "The (ORNL) program devises and implements novel experimental methods to establish previously inaccessible properties for understanding the materials in regimes of technological relevance." It is expected that this innovative measurement method will be adopted by institutions around the world.

**ORNL created online database on literature data for LN2 breakdown.**
During FY 2008, ORNL researchers have been working on creating a liquid nitrogen (LN2) cryogenic dielectric properties database. The database is now *available online* and access is initially limited to HTS program stakeholders. Creation of this database involved extensive efforts in the collection of relevant publications, sorting and classification, and sorting strategy. This unique database, which is more comprehensive than commercially available versions, presently contains 257 citations. The database offers enhanced searching flexibility, and the resulting citation information list is given, along with all search terms each paper satisfies, and occasional additional comments. http://www.ornl.gov/sci/fed/cryogenic/SP_Regis.shtml

**ORNL research article amongst the 10 most cited papers published in last 10 years in *Superconductor Science & Technology (SUST)*. This and two other articles amongst the top 10 most cited superconductivity papers since 2003 in a number of journals.**
The paper titled "Irradiation-free, columnar defects comprised of self-assembled nanodots and nanorods resulting in strongly enhanced flux-pinning in $YBa_2Cu_3O_{7-x}$ films" by Goyal et al., Supercond. Sci. Technol. 18, 1533 (2005), is in the top 10 most cited paper published in SUST during the last ten years. Most importantly, ALL other nine papers in the list relate to the superconductor $MgB_2$ as it was discovered during this time span, and hence many $MgB_2$ papers were highly referenced. In addition, this and two other ORNL articles are amongst the ten most cited superconductivity papers in the past five years in *Physics Review Letters, Physical Review B, Journal of Applied Physics, Applied Physics Letters* and *Superconductor Science & Technology* group of journals.

**ORNL HTS research article featured in the 2007 *Superconductor Science and Technology Journal* special highlights collection.**
An ORNL research article entitled "Strong enhancement of flux pinning in $YBa_2Cu_3O_{7-x}$ multilayers with columnar defects comprised of self-assembled $BaZrO_3$ nanodots" by Kang et al. is featured in the 2007 Highlights Collection by the international journal *Superconductor Science and Technology* (SUST). Comprising 27 papers, articles in the Collection were selected from hundreds of SUST papers by its International Editorial Board for their *presentation of outstanding research.* This is the second consecutive year that one or more ORNL HTS articles have received this recognition. Achievement of this distinction signifies that OE-sponsored HTS research activities at ORNL are of the highest caliber and are at the cutting-edge of HTS science and technology.

**Significant number of ORNL HTS research published in wide variety of journals.**
In FY 2008, ORNL HTS researchers have authored or co-authored a large number of peer reviewed articles in a variety of journals (see Appendix). Due to the crosscutting nature of the research projects, these papers are not restricted to journals that are dedicated to superconductivity. Some of these journals include:

*Journals specific to superconductivity:*

| | | |
|---|---|---|
| Supercond. Sci. Tech. | IEEE Trans on Applied Superconductivity | |
| Physica C | Virtual J. of Applications of Supercond. | |

*General multi-disciplinary journals:*

| | | |
|---|---|---|
| Nature | Physical Review B | Applied Physics Letters |
| J. of Applied Physics | Applied Physics A | Applied Physic Express |
| J. of Materials Research | J. of Materials Science | J. American Ceramic Society |
| J. Minerals, Met. & Mater. | Nanotechnology | Virtual J. Nanoscale Sci & Tech |

*Non-superconductivity specialty journals:*

| | | |
|---|---|---|
| J. Phys: Conden. Matter | Adv. Cryo. Engr. | Cold Facts: Mag. CSA |
| J. Electronic Mater. | IEEE Trans Dielectrics and Electrical Insulation | |
| Optics Communications | | |

**ORNL researchers invited to present research results in major scientific meetings.**
These include: International Symposium on Superconductivity, Materials Research Soc Spring Management, Applied Superconductivity Conference, International Workshop on Coated Conductors for Applications, Conference on Electrical Insulation and Dielectric Phenomena, Materials Science and Technology Conference and Exhibition, International Cryogenic Materials Conference, International Conference on Textures of Materials, Workshop on Advanced Materials for Energy Applications, Global Climate and Energy Project workshop, National Nano Engineering Conference, Gordon Research Conference on Solid State Chemistry, Conference on Magnet Technology, and Annual Electric Power Research Institute (EPRI) Superconductivity Conf.

**ORNL HTS Program and researchers received major International/ National/ Regional awards for sustained excellence and innovation.**

- ***2008 National FLC Excellence in Technology Transfer Award.*** A technology entitled "High-Performance LMO-Enabled, High Temperature Superconducting Wires" by SuperPower Inc., and ORNL is named a winner of the 2008 National FLC Excellence in Technology Transfer Award. Based on an ORNL patented LMO buffer technology that was wholly funded by OE, this work transitioned the technology from laboratory discovery to commercial manufacturing.

- ***2008 Nano50 Innovator Award.*** ORNL HTS researcher was named the winner of a 2008 Nano50 Innovator Award by Nanotech Briefs magazine. This international award recognizes individuals as a leader or pioneer in a specific area of nanotechnology having a significant background of accomplishments in advancing the state of the art. The individual was selected for the award based on his contributions to self-assembly of nanomaterials to form novel nanocomposites.
- ***2008 Tennessee Governor's Awards for Excellence***. ORNL HTS researchers were presented with Tennessee Governor's Awards for Excellence in FY2008. These awards are given to Tennessee residents who, by demonstrating excellence in their work and community activities, improves the economic and quality of life of the State. These researchers received the awards based on their ingenuity and continuing effort in moving the LMO buffer technology into the market place.

**In addition, ORNL HTS researchers have received other awards.**

- ***2008 ORNL Key Contributor Award & Significant Event Award***. A team of ORNL researchers won a Key Contributor Award and a Significant Event Award for their work on the development of IBAD-based second-generation superconducting wires. These researchers are part of the multi-division ORNL-SuperPower CRADA team that developed an award winning LMO buffer technology, participated in the integration of this technology into SuperPower's HTS wire manufacturing process, and enabled the licensing of this technology.
- ***2008 ORNL Outstanding Mentor Award.*** ORNL HTS researcher received an Outstanding Mentor Award for his service to the next generation of scientists and engineers. Director of the Office of Science's Office of Workforce Development for Teachers and Scientists gave the keynote speech, where he stressed the importance of the commitment ORNL makes to students and teachers participating in the Lab's education programs.

**Objective 1.2 Provide Quality Leadership in Science and Technology**

***Summary*** – ORNL has consistently been willing to pursue novel approaches that can provide innovative solutions to immediate or future issues. High risk high pay-off solutions are balanced by core competency-based R&D to ensure steady progress in the program mission. In this regard, the ORNL HTS Program has consistently dedicated a portion of its effort in strategic areas of research that are potentially disruptive or are of high risk with high potential returns. In FY 2008, these include a novel flexible ceramic single-crystal faceted fiber template that the Peer Reviewers commented as "This could have a profound effect on the next generation of coated conductors… The PIs should be commended for taking this radical step…" and "I consider in any case this development as a very significant one in the international scene." In addition, ORNL researchers also developed an innovative "virtual filamentization" approach to ac loss reduction, as well as improving on trend-setting initiatives such as solution buffer technology and the novel cryogenic dielectric nanocomposite effort.

The sustained leadership and excellence in S&T output of the ORNL HTS Program is regarded as one of the best in the world. The pioneering and trend-setting R&D works advocated by the ORNL HTS program served to attract and retain World Leaders in the field of HTS. The World-Class caliber of the program staff is evident by the leadership roles they hold; there are 8 Fellow positions in 7 professional societies and corporate structures, 10 Directorships on 7 professional, trade and

industry boards, and 17 editorial positions in 12 professional publications. In addition, ORNL researchers have organized and chaired many scientific meetings and workshops. Because these scientists are regarded as international leaders who are doing the best works in the field, they are also eagerly sought after for collaborations by researcher worldwide.

**ORNL develops New advanced flexible single crystal fiber template for low AC loss HTS and other applications.**

It has long been recognized that present coated conductor templates are not ideal for low AC loss and other functional applications. If one is to design an advanced conductor, it should posses the following characteristics:

- HTS should be in the form of filaments;
- Template should be single crystalline and flexible;
- Template should be non-magnetic and non-conducting;
- Conductor should have a simple architecture;
- Conductor throughput should be at reasonable volumes;
- Conductor/Wire should be amendable to bundling, twisting and transposition;
- Processing should take advantage of wire technologies that have been developed;

ORNL has developed an advanced *flexible ceramic Structural Single-crystal Faceted Fibers template* that can satisfy all these demanding requirements. Up to 10 meters-long flexible faceted fibers have been fabricated at reasonable rates. Capped by a single $CeO_2$ buffer, initial Jc of 0.4 $MA/cm^2$ at 77K self-field has been obtained on thin HTS grown on these templates by PLD. This work has attracted worldwide attention, with inquires on potential collaboration from domestic and international companies.

**World's First demonstration of BZO columns using "commercial" HTS deposition technique. Massive in-field performance enhancement seen in MOCVD 2G wire.**

ORNL HTS researchers have been pioneering the incorporation of BZO nanodots into HTS films by pulsed laser deposition. This resulted in massive pinning enhancement, and the technique is being duplicated by researchers worldwide. ORNL researchers have been working closely with SuperPower to incorporate BZO nano-columns into MOCVD HTS. In FY 2008, the team has discovered that through appropriate manipulations, self-assembled BZO nanodots can be incorporated into MOCVD HTS layers. The team has been successful in significantly increasing the in-field performance of MOCVD HTS produced by SuperPower. $J_c$ at H//c, 77K, 1T was substantially *increased by nearly 170 percent* and the minimum $J_c$ was *increased by 100 percent.* SuperPower has started to incorporate these self-assembled nanodots into its *production wires.*

**ORNL is pioneering the developing of an innovative "virtually filamentized" 2G wire. Initial experiments showed that approach is effective in reducing ac losses.**

Tape-like 2G wires should be filamentized to reduce ac losses. ORNL scientists are developing a novel approach by selectively damaging narrow stripes of buffer layer on which the HTS coating is deposited (virtual filamentization). This approach is simpler and will avoid mechanical integrity issues. Transport measurements along and across these virtual filaments showed highly anisotropic Ic's, which is a positive indicator of the effectiveness of the approach. Also, magnetic hysteresis measurements confirmed that adjacent filaments are effectively decoupled. Work to fabricate longer samples and perform definitive ac loss tests is underway. This innovative approach has generated interests from potential collaborators, with ASG at FSU already onboard for MOI testing.

**ORNL's pioneering work resulted in cryogenic nano-dielectric composites with enhanced thermal property without electrical degradation.**
Solid dielectric materials are needed for low temperature high voltage HTS applications. Unfortunately, off-the-shelf materials are not designed to possess desired physical properties for cryogenic environment. ORNL researchers are pioneering the development of cryogenic dielectric nano-composites. In FY 2008, they developed a method to form *uniformly dispersed nano-particles with narrow size distribution* in a dielectric matrix in-situ. These materials do not degrade the dielectric strength. More importantly, tests indicated that the nano-composites have better thermal conductivity. This is a highly desirable characteristic where heat dissipation is important. These successes have attracted collaborations from NIST, Composite Technology Development and CAPS at FSU. By taking the initiative, ORNL has affected the direction of R&D in this vital area.

**ORNL shatters own high in-field critical current record of thick HTS film on technical substrate.**
A significant number of practical HTS applications require wires that retain high critical currents Ic in the presence of sizable magnetic fields. Effective flux pinning centers must therefore be incorporated into the HTS matrix. ORNL researchers have been pioneering the work of self-assembled BZO nanodot columns in HTS. They have previously established a world record of a minimum Ic of 353 A/cm under all field angle conditions at 65K and 3T in a 4-micron thick HTS film deposited on IBAD-MgO technical substrate. Recently, these researchers have optimized the process, and have succeeded in shattering their own record; minimum Ic under all field angles at 65K and 3T was determined to be *435 A/cm*. In addition, the 77K self-field Ic has increased from a strong value of 670 A/cm to a very high value of *~1,000 A/cm*. Furthermore, 65 K self-field Ic was estimated to be an unprecedented value of *~3,000 A/cm*. Work with wire manufacturing partner to integrate these special pinning centers into commercial 2G HTS wire *has also been successful*.

**ORNL HTS buffer technology licensed by SuperPower. Effort resulted in <u>World Records and major Awards</u>.**
An ORNL patented LMO buffer technology has been licensed by SuperPower Inc. This buffer technology was fully integrated into SuperPower's HTS wire manufacturing process, and has enabled SuperPower to accomplish the following achievements:

- Substrates up to 1.5 km length and broke the 1 km threshold (World Record).
- A 1.3 km 2G wire with 153 A/cm Ic, which broke the 1 km wire threshold and the 200,000 A-m performance barrier (World Records).
- ORNL and SuperPower are winning partners of a 2007 R&D100 Award and a 2008 National FLC Excellence in Technology Transfer Award.
- SuperPower has supplied 33,000 meters of 2G wire to customers in FY 2008.

A signing ceremony to execute the licensing agreement was held at ORNL on January 9, 2008. Officials who participated in the ceremony include Patricia A. Hoffman DOE-OE Principal Deputy Assistance Secretary, as well as ORNL Laboratory Director, VP & CTO of SuperPower, and Director of ORNL Partnership Directorate.

**Albany HTS cable successfully re-energized. New <u>world's first</u> cable section comprised of SuperPower's 2G wire that incorporates licensed ORNL buffer technology.**
On February 21, 2008, officials from DOE-OE, New York State Energy Research and Development Authority, County and City government gathered with representatives from the Albany HTS cable team in Schenectady, New York, to commemorate the successful re-energization of the power cable.

This cable contains a new section that is fabricated using SuperPower's 2G wire that incorporates licensed ORNL buffer technology, making it the first on-the-grid 2G wire-based HTS device in the world. Nearly 10,000 meters of SuperPower's commercial 2G wires that incorporated licensed ORNL buffer technology were used in the fabrication of the 2G cable section.

**ORNL continues to assist industry in R&D of HTS power applications.**
ORNL continues its leadership position in applied superconductivity and applications. Consequently, ORNL is the go-to laboratory to resolve HTS application R&D issues. During FY 2008, ORNL HTS researchers have collaborated with Southwire/nkt cables, Praxair, Waukesha Electric Systems and SuperPower on the development of HTS cable, HTS transformer and HTS fault current limiter. More importantly, urgent help was sought from ORNL experts by Department of Homeland Security, AMSC and SuperPower in the testing of inherent fault current limiting cables as well as model 2G wire cables.

**ORNL has collaborated with many external U.S. stakeholders in FY 2008.**
ORNL HTS researchers have collaborated with many U.S. stakeholders in order to maintain leadership positions in various areas of HTS R&D, provide assistance as well as disseminate information and technical know-how. These included:
*Industry:* AMSC, SuperPower, MetOx, Ametek, Southwire, Praxair, AEP, Entergy, ConEd, Waukesha Electric Systems, Direct Vapor Technologies, Composite Technology Development, Aspen Aerogels, Crystal Materials, FUJIFILM Dimatix, Hexion.
*Research institutions:* LANL, ANL, BNL, NIST-Boulder, NIST-Gaithersburg, AFSOR.
*Academia:* U. of Tennessee, U. of Houston, U. of Wisconsin-Madison, U. of Kansas, Florida State U.-ASG, Florida State U.-CAPS, U. Dayton Research Institute, Utah State U., North Carolina A&T U.
Additionally, ORNL HTS Program is partner in 3 DOE 2008 SBIR/STTR awards Aspen Aerogels Inc, Composite Technology Development, and MetOx.

**ORNL scientists highly sought after as collaborators by international institutions.**
With reputations as World Leaders who are doing the best works in fundamental science and applied technology of HTS and related areas, ORNL researchers are highly sought after as collaborators by their international colleagues. Collaborations include:

- Cambridge Univ.(UK) – Superconductor on ordered nano-pore templates.
- Augsburg University (Germany) – Grain boundary supercurrent flow.
- Ataturk University (Turkey) – HTS studies and equipment development.
- Yokohama National University (Japan) – AC losses.
- Uppsala University (Sweden) – Dielectrics, relaxation and optical properties.
- Chalmers U. of Technol (Sweden) – Insulation materials and diagnostics in HV.
- University of Potsdam (Germany) – Dielectric relaxation and polymer physics.
- Technical University of Denmark – AC loss measurement of wires and cables.
- Danish university (Denmark) – HTS Cable performance.
- nkt cable (Germany, Denmark) – HTS cable development, analysis and testing.
- Sumitomo Electric Industries (Japan) – HTS Fault Current Limiter development.
- Nissan Electric (Japan) – HTS Fault Current Limiter development.

**ORNL worked with industry to defend RABiTS portfolio in European court.**

***A European patent, which infringes on ORNL's RABiTS technology, was issued to a Dresden, Germany institution. ORNL worked with its industry partner, and the patent in dispute was revoked in entirety. The German institution has appealed in FY 2008, and ORNL has prepared and submitted response to this appeal. This was the first time in the history of ORNL and UT-Battelle that a patent was defended in any court.***

**ORNL HTS Program researchers have organized national/International meetings and chaired in numerous sessions.**

ORNL researchers have assumed leadership roles and were responsible for the organizing or programming of the following meetings:

- 2007 Conference on Electrical Insulation and Dielectric Phenomena;
- 2007 Int'l Workshops on Coated Conductors for Application;
- 2008 Materials Research Society Annual Spring Meeting: HTS Symposium;
- 2008 Applied Superconductivity Conference;
- 2008 15th International Conference on Textures of Materials;

**ORNL HTS researcher is only one of two people outside of Spain invited to attend the Workshop on "Material Challenges for future applications in energy and environment." Also gave an invited Plenary Talk.**

ORNL staff attended and gave an invited Plenary Talk at the Workshop on "Material Challenges for future applications in energy and environment" in Barcelona, Spain from December 17-18, 2007. Title of his talk is "Self-assembly in complex oxides." He was one of only two people invited from outside Spain for this Workshop.

**ORNL researchers serve on journal editorial boards, professional/trade/ industry organization boards, and as technical society fellows.**

By serving these functions, ORNL researchers provide a visible leadership role in the broad scientific community and affect the emphasis and directions of research:

- *Principal Editor*, Journal of Materials Research;
- *Associate Editors*, J of the American Ceramic Soc;
- *Associate Editor*, Advanced Science Letters;
- *Guest Editor*, Advances in Cryogenic Engineering, Vol. 53, 2008;
- *Guest Editor*, Special Issue on "Superconducting Wires and Tapes," Journal of Electronic Materials, Oct. 2007;
- *Technical Editors*, IEEE Trans. on Applied Superconductivity, ASC Aug. 2008;
- *Members*, Board of Editors, Superconductor Science & Technology;
- *Member*, Board of Editors, The Open Applied Physics Journal;
- *Member*, Board of Editors, The Open Electrical & Electronics Engineering Journal;
- *Member*, International Advisory Board, Journal of the Korean Institute of Applied Superconductivity and Cryogenics;
- *Member,* Advisory Board, NanoTech Briefs Magazine;
- *Member,* Advisory Board, Recent Patents in Materials Science;
- *Fellow*, American Physical Society;
- *Fellow,* American Ceramic Society;
- *Fellow,* American Association for the Advancement of Science;
- *Fellows,* Institute of Physics;
- *Fellow*, American Society for Metals;

- *Consulting Fellow*, World Innovation Foundation;
- *Corporate Fellow,* UT-Battelle/ORNL;
- *Vice President*, Commission on Cryophysics Cryoengineering, International Institute of Refrigeration;
- *Historian*, Dielectrics and Electrical Insulation Society;
- *Chair*, Nominating Committee, Conference on Electrical Insulation and Dielectric Phenomena;
- *Board members,* Cryogenic Society of America;
- *Board member,* IEEE Applied Superconductivity Conference;
- *Board members,* IEEE Conference on Electrical Insulation and Dielectric Phenomena;
- *International Advisory Board member,* International Superconductivity Symposium;
- *International Advisory Board member,* International Workshop on Coated Conductor for Applications;
- *International Organizing Board member,* International Workshop on Coated Conductor for Applications;
- *Board member,* Coalition for the Commercial Application of Superconductivity;
- *Advisory Board member,* Metal Oxide Technologies Inc.

**Objective 1.3 Provide and Sustain Science and Technology Outputs that Advance Program Objectives and Goals**

***Summary*** – In FY 2008, ORNL HTS program has produced high quality output from experimental and theoretical research. These results have been reported in 26 published peer reviewed articles and 28 submitted/to be published articles. Also, 3 Intellectual Property-related documents have been filed (see Appendix). In addition, Peer Reviewers were very satisfied with the progress of the ORNL HTS projects; ORNL projects swept the top rankings in two of the three Peer Review technical sessions.

**ORNL HTS projects swept the top rankings in two of the three Annual Peer Review technical sessions. Project scored #3 in the third session.**

At the FY 2008 HTS Annual Peer Review, twelve ORNL HTS talks were presented in three sessions: Strategic Research, 2G Wire Development, and Applications. The three panels of international experts were highly complimentary on the projects, with ORNL sweeping the top rankings in two sessions (Strategic and 2G wire), and a #3 in the third:

- ORNL's Strategic Substrate, Conductor Characterization and Analysis, and Engineered Columnar Defects projects were *ranked number ONE, TWO and THREE* in the Strategic Research session, respectively. Awarding of ALL top spots to a single institution has never occurred before in the history of the Peer Review. ALL three projects received World Class rankings, with the Strategic Substrate project receiving an ultra-high score of 96.3 out of a perfect 100 points.
- The ORNL-SuperPower CRADA and the ORNL-AMSC CRADA projects were *ranked number ONE and TWO* in the 2G wire session, respectively. This is the second consecutive year that ORNL-SuperPower CRADA has been ranked #1, with yet another unprecedented high score of 98.5 points. Both CRADA projects received World Class rankings.
- The ORNL-led SPI/SPE Readiness Review project was *ranked number THREE* in the HTS Applications session.

- Out of 38 projects presented at the FY2008 Peer Review, ORNL led or co-presented 12 project presentations Of these 12, *FIVE received World Class ratings, and FOUR received Excellent ratings.*

**Objective 1.4 Provide for Effective Delivery of Science and Technology**

***Summary*** – In FY 2008, ORNL HTS Program office assisted in the coordination and monitoring of the OE-HTS program Joule Target to ensure that it is successfully met. In addition, all ten of the ORNL HTS Program CPS control milestones have been met. Furthermore, all major Program AOP milestones and targets have been met or exceeded. Results were communicated to stakeholders via regular reports as well as presentations in meeting and publications. Results were also communicated to our DOE sponsor via regular e-mail, phone calls as well as OE highlight contributions.

Various program targets were planned based on peer reviewers' comments and available funding so as to utilize the limited resources efficiently and effectively to produce results that will help to achieve the DOE mission. Equipment associated with discontinued projects was retrofitted for other areas of research that are of higher impact to DOE's goal. Regular meetings with DOE sponsors and partners were held in order to assess changing needs and issues so that research plans can be adjusted accordingly.

**DOE OE-HTS FY2008 Joule Target met through ORNL's 2G Wire Development subcontracts to industry.**

In FY 2008, ORNL participated in the coordination, monitoring and reporting of HTS Quarterly Joule Milestones. Successful achievement of these targets was accomplished through ORNL's 2G Wire Development subcontracts to industry. Quarterly progress was tracked, and quarterly status reports were compiled with documentation and provided to DOE sponsor. The Joule Milestone that was met in FY 2008 is:

- Demonstrate prototype 50,000 A-m critical current-length for second-generation wire.

**All ten FY 2008 ORNL HTS Program CPS Control milestones have been met on or ahead of schedule.**

Following is the listing of CPS control milestones, due dates and accomplished dates:

1. Demonstrate slot-die coated MOD YBCO and MOD LZO with an average performance of over 80 A per tape for a 344 wire. (Due July 31, 2008) Met on July 22, 2008.
2. In joint development with SuperPower, demonstrate an $I_c$ of 1000 A/cm at 77 K and self-field. (Due July 31, 2008) Met on July 14, 2008.
3. Develop MOD based seed layer to sustain an $I_c$ of 250 A/cm. (Due July 31, 2008) Met on July 18, 2008.
4. Establish the feasibility of using contactless magnetic techniques to conduct angular dependent $I_c$ measurements over a wide temperature and field range. (Due April 30, 2008) Met on March 7, 2008.
5. Completion of critical current uniformity stability study of 2-m long YBCO coated conductors. (Due May 31, 2008) Met on May 22, 2008.
6. Establish thermal properties as a function of filler content in one nanocomposite system. (Due July 31, 2008) Met on June 20, 2008.

7. Provide preliminary results on partial discharge in G10 in liquid nitrogen. (Due Sept. 30, 2008) Met on Sept. 26, 2008.
8. Complete database on literature data for LN2 breakdown. (Due June 30, 2008) Met on June 27, 2008.
9. Produce world's first kilometer-class 2G wire. (Due July 31, 2008) Met on July 1, 2008.
10. Complete electromechanical testing of coated-conductor joints at 76 K on a total of 10 samples (fabricated by ORNL, NIST, AMSC and SuperPower) with various solders, using different soldering procedures. (Due July 31, 2008) Met on June 30, 2008.

**All major FY 2008 ORNL HTS Program AOP milestones have been met or exceeded:**
As in past years, ORNL HTS Program has met or exceeded its annual performance goals and milestones. In the planning and execution of these milestones, adjustments were made based on critical needs, latest scientific information and insights, reviewers' suggestions as well as available budget. Appropriateness of these adjustments was affirmed by acceptance and endorsement of DOE sponsor as well as positive reviewer feedbacks in subsequent peer review.

**Goal 2.0: Design, Fabrication, Construction, and Operations of Facilities: Provide for Efficient and Effective Design, Fabrication, Construction, and Operations of Facilities**
43.
Not Applicable

**Goal 3.0 Provide Effective and Efficient Science and Technology Program Management**

**Objective 3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision**

***Summary*** – In FY 2008, the ORNL HTS Program Office has demonstrated exceptional vision and leadership in assisting the DOE sponsor in developing Quarterly Joule Targets, future research directions, HTS technology alignment with the Smart Grid, as well as continuing development of Initiatives for 2G wire for Commercial Readiness and other enabling technologies. By aligning the ORNL activities with immediate and emerging needs as well as maintaining cutting edge research capabilities, ORNL has established itself as "The Place" to perform HTS research. *Trend-setting scientific vision* for the HTS technology was articulated in the form of innovative initiatives and research emphasis. Initiatives such as novel tailor-made cryogenic dielectric nano-composites and conductor engineering of spices have already gained acceptance by the HTS community, and ORNL has established new partnerships with industry and government laboratories. New innovations such as flexible ceramic single-crystal faceted fiber template and non-contact Jc angular measurement technique have generated much interest.

ORNL has also expanded its capabilities and core competencies through careful consideration of resource allocation. By revitalizing equipment, ORNL has been able to upgrade its ac loss facility as well as creating a World's First non-contact critical current angular measurement capability. In addition, other new capabilities have been established with minimum investment. By providing world class and up-to-date facilities as well as a setting that encourages pioneering and novel research initiatives, ORNL has been able to retain its world-class researchers, and continued its reputation as a world leader in HTS research. ORNL HTS program counts amongst its staff scientists who sit on editorial board of scientific journals, researchers who are Fellows of

international professional societies and researchers who are Directors of various professional, trade and industry boards. These scientists have imitated many pioneering research topics and techniques that are being duplicated by leading researchers worldwide.

**ORNL continues to maintain and develop *pioneering research approaches and capabilities* to retain in-house scientific expertise.**
Retention and attraction of highly skilled and creative staff is a vital component of the ORNL HTS Program. By pioneering in trend-setting cutting edge research topics such as Jc crossover analyses for isotropic performance, non-contact Jc angular measurement technique development, flexible ceramic single-crystal faceted fiber template innovation, self-assembled nanodots, and novel dielectric nano-composites, the program has been able to retain and attract world leaders in HTS technology even in this time of budget constrain.

**ORNL HTS researcher selected as UT-Battelle Corporate Fellow.**
ORNL researcher has been selected as an UT-Battelle Corporate Fellow. Goyal was recognized for sustained outstanding achievements in the fundamental materials science and in the transition of scientific discoveries from the laboratory to the marketplace in the field of HTS. Designation as a Corporate Fellow is made on a limited basis to recognize exceptionally gifted individuals throughout the ORNL organization for their technical achievement. There are currently 31 active Corporate Fellows.

**ORNL established new core capabilities to maintain its *world leadership position* in *trend-setting* HTS and related research.**
*ORNL contactless superconducting wire characterization equipment*

Superconducting wires are highly anisotropic (that is, wire performance changes with the direction of magnetic field). Consequently, the wire performance must be thoroughly characterized under all applicable temperature and magnetic field conditions. However, as the wire performance is improved, it becomes difficult or impossible to pass progressively large test electric currents through the wire. ORNL has developed a novel experimental contactless wire characterization equipment that will allow wire performance testing at all applicable temperature and magnetic field conditions. *This is the only such equipment in the world*, and is available to the DOE program and its stakeholders.

*Fault current testing upgrade to ORNL Cable Test Development Laboratory*

Fault current limiter is a highly sought after technology that can prevent equipment damage, promote grid reliability and resiliency, and defer expensive equipment upgrade. After ongoing upgrade that is slated for completion at the end of 2008, the ORNL fault current testing capability will uniquely combine high voltage, high fault current, high pressure and cryogenic environment under a well integrated setting. Upgrade of this *one-of-a-kind facility* is leveraged with DOE and DHS funds, and is intended to operate as a national resource for power equipment testing. The facility is already scheduled for usage in collaboration with U.S. superconducting power equipment manufacturers, and will be available to the DOE program and its stakeholders. (Specifications: Sub-cooled down to 67K; High pressures up to 20 bar; High fault currents up to 60,000 $A_{rms}$ AC at high test voltages up to 600 V AC).

**ORNL HTS Program ensures effective and efficient use of resources in establishing new and upgrading existing capabilities.**

Capabilities in ac loss testing and HTS splice fabrication have been established or upgraded by revitalizing equipment and in-house fabrication of parts. No new capital equipment was purchased for these capabilities:

*ORNL completed upgrade of ac loss test facility to greatly increase the efficiency and turn-around time of measurements:*

To expand ORNL capabilities in ac loss characterization, an upgrade involving the implementation of electrical ac loss measurement has been successfully completed. Previously, ac losses in long length tapes (10-15 cm) have been measured thermally. While this method is reliable, the existing configuration would only allow for 1-2 samples measured *per week* due to the amount of liquid nitrogen needed to cool the magnet. ORNL researchers have now implemented an electrical-based ac loss measurement system, which resulted in the number of samples that can be measured in perpendicular field to increase to one-to-two samples *per day*. Benchmark characterizations have been performed on commercial wires, and the system was validated. This improvement will allow efficient and rapid characterization of samples from CRADA partners as well as prototype 2G wires developed at ORNL.

*New test assembly improves characterization and quality control of YBCO coated conductor splices.*

In the majority of superconducting power applications using HTS wires, splices are a necessary part of device fabrication. In order to minimize the impact of splices on a given device, the splices need to have a low resistance while maintaining strength to withstand the stresses and strains that the wire experiences. ORNL has *improved its spice characterization capability* by developing a test capability where both the current leads and voltage taps are compression fitted to the splice. This preserves the quality of the splice, and also allows for the tested splice to be immediately shipped to NIST for further follow-up testing.

**Objective 3.2 Provide Effective and Efficient S&T Project/Program Planning and Management**

***Summary*** – In FY 2008, ORNL continues to maintain its high quality of R&D through regular strategic planning and evaluation of its R&D projects and research capabilities. Technical risks are evaluated against potential return through careful identification and consideration of technical issues. All these considerations and analyses are used to regularly update its strategic as well as Annual Operation plans to reflect changing conditions and needs, and to ensure program leadership and relevance.

ORNL HTS strategic projects include crosscutting technologies that leverage resources for maximum return. One example is ORNL's pioneering dielectric nano-composite work that is leveraged with *DOE-OE (V&C), DOE-SBIR and ORNL LDRD funds*. Another example is the development of its core RABiTS template for photovoltaic applications, which is leveraged with *DOE-EERE and venture capital funds*. Most importantly, an upgrade of ORNL's fault current testing capability is leveraged by substantial funding from the *DHS*. Development of this improved capability will greatly assist DOE in its power transmission and delivery missions.

To maximize productivity and ensure relevancy, the program does not shy away from redirection of effort on projects of lower-return in favor of *high-risk high-return emerging needs*. One example is the termination of inkjet filament work in favor of a virtual filamentization approach. Another example is the deferment of extra-functional buffer work in favor of flexible ceramic single-crystal faceted fiber template initiative. Highly exciting return has already been

achieved in both of these new areas. One FY 2008 Peer Reviewer commented on the fiber template work that "I'm giving ORNL a 10...for having the imagination to conceive adapting/adopting optical fiber technology as a perhaps revolutionary new substrate... (ORNL's strengths are) boldness and creativity."

**Objective 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs**

***Summary*** – In FY 2008, ORNL HTS Program has continued to provide high quality, accurate, impartial and timely response to sponsor requests for information. Issues, whether positive or negative, are communicated to the sponsor so that plans and actions can be formulated collectively. When appropriate, ORNL HTS Program Office has coordinated with experts, and acted as information center to compile the necessary information for the sponsor in a clear and organized manner. ORNL HTS Program Office has kept its DOE sponsor informed by providing real-time e-mail updates on breaking news as well as contributions to OE Weekly Highlights on an as-warranted basis. In addition, the office maintains frequent contact with its sponsor via telephone calls to ensure that requests and sponsor programmatic needs are met. Emerging challenges are communicated immediately to avoid any surprise. Well established points of contact are known to sponsors, partners and stakeholders. Moreover, CPS Control Milestones Reports, Joule Target Quarterly Reports, detailed Quarterly Reports and an Annual Report are provided to the sponsor on schedule. For others, the program office is constantly manned during office hours to direct any request to appropriate personnel.

**ORNL Efforts for HTS outreach, display and websites.**
ORNL assisted in the dissemination of program information by engaging in the Grid Application Collaborative as well as manning HTS display at venues such as Grid Week and APPA Expo. In addition, a public accessible ORNL HTS Program website is maintained and updated regularly. The web address is included in all the ORNL HTS information sheets, mentioned whenever possible, and is found in many major HTS sites. Information contained in the ORNL HTS website include contact information, annual reports, quarterly reports, Peer Review presentations, program highlights, press releases, available facilities, other reports as well as links to major HTS websites. Moreover, a database website on dielectric properties of selected conventional materials and one on liquid nitrogen are available to interested device manufacturers and stakeholders.

**ORNL Visualization & Control Program**

**Goal 1.0: Provide for Efficient and Effective Mission Accomplishment**

**Objective 1.1 S&T Results Provide Meaningful Impact on the Field**

***Summary*** - In FY 2008, ORNL Visualization and Control Program researchers have produced and assisted in the achievement of original and innovative results that have significantly advanced the DOE program mission to develop real-time, wide area situational awareness in order to improve the response time to major disturbances. The VERDE system went operational in the DOE-OE Energy Restoration Center on June 1st – the first day of the 2008 hurricane season. The tool was successfully used to assist DOE-OE staff in the field respond to Hurricanes Dolly, Gustav and Ike and is also being implemented by the industry. ORNL has also been a leader, providing innovate

concepts to improve transmission reliability, such as load as a resource and large industrial loads providing regulation. The concept of regulation from large industrial loads has been adopted by Alcoa. This past year, ORNL continues to work with the aluminum company to demonstrate the concept of using the aluminum smelters for regulation on the electric systems at their Warrick plant. ORNL has also established a project with Digital Solutions Inc and TVA on controlling air conditioning systems for spinning reserves to improve system reliability.

**ORNL Developed VERDE tool - Visualizing Energy Resources Dynamically on Earth - for Energy Asset Visualization**

In partnership with the TVA, ORNL has developed a capability that helps visualize the status of the electric transmission system infrastructure. The capability toolkit, called VERDE – Visualizing Energy Resources Dynamically on Earth, takes advantage of the Google Earth® platform to display spatio-temporally tagged data. Custom libraries describe the electrical transmission network in the Eastern United States and the status of each transmission line. The line status layer updates every minute and shows the lines that are in an "abnormal" condition. VERDE displays transmission lines with a voltage rating of 230-kV and above. In FY 2008, ORNL developed another methodology to pull in data from market regions that allows access to voltage levels of 138kV. In this past year, expansion of the tool has focused on the area of coverage in the Eastern Interconnection and Texas as the number of transmission lines being monitored has increased from 916 to 5621 during the FY. VERDE also provides geospatial information such as population counts of regions of interest, analysis and prediction results, and weather impacts and overlays. Other energy infrastructure is also being integrated into the system to assess the interdependencies with the energy and electric systems. ORNL presented the tool capabilities to industry organizations, utilities and reliability transmission organizations. As a result of this work, the tool is being used in the DOE OE Energy Restoration Center to assist in federal response from major disruptions to the energy infrastructure. Entergy has installed the system in their control room, PJM has access to the tool and the Florida Reliability Coordinating Council is planning to use this system, as well.

**ORNL applying Supercomputer capabilities to Grid Modeling and Analysis**

ORNL is working with TVA system planning engineers on improving contingency analysis by using supercomputing capabilities to improve grid analysis and significantly reduce computing time This project, called Xtreme Power Systems Analysis uses test case data for basic contingency analysis of the TVA electric grid; a typical TVA solution time runs between 5 to 10 hours. By using power industry standard analysis code (PSS/E), specially converted use on the ORNL Institutional Cluster (OIC), ORNL's analysis indicated the same calculations could be performed in 2 hours with a single OIC processor or 10 seconds by judiciously parsing the analysis to 128 OIC processors. The goal is to consider calculation time reduction for a full-system dynamics double-contingency (N-2) screening study. The TVA estimates the same study would take two years with existing serial processing capability, putting that type of analysis out-of-reach of any large electric utility. With appropriate task prioritization for multiple processors, it is anticipated that the same calculation can be performed in less than 168 hours. The project is demonstrating capability of using high performance computing with industry standard software and non-reduced models to perform full-systems analysis for standard utility planning studies, with implications for near-real time analysis in operations on a scale previously not accessible to the utility industry. Because of the large number of variables and equations associated with static and dynamic electric grid calculations, the electric utilities have historically used approximations and specialized code for planning or operations analysis.

**ORNL Demonstrating Value of Spinning Reserve from Hotel Air Conditioning Loads**
ORNL has developed a project with Digital Solutions, Inc. and TVA to install demand response technology in the Music Road Hotel in Pigeon Forge, Tennessee. DSI has installed advanced PTAC controllers in all 162 rooms of the Music Road hotel in Pigeon Forge, Tennessee and thermostat controls in the common areas. These controllers provide energy efficiency benefits to the hotel operator. The controllers also provide spinning reserve capability by allowing the utility to remotely immediately curtail the entire air conditioning load at the hotel. Further, the controllers themselves monitor power system frequency and curtail the air conditioning load instantaneously if frequency dips indicating a serious power system reliability problem. The utility specifies what frequency the controllers respond to. Different controllers can be set to respond at different frequencies, creating a droop curve response identical to generator governor response. TVA and Sevier County Electric have installed high speed metering at the hotel to enable monitoring of spinning reserve testing. ORNL and TVA are in the process of designing the testing program. Testing is expected this summer. The hotel can now respond to power system contingencies by rapidly reducing up to 37 percent of its load. Periodic testing is scheduled through the fall and winter and a report is in preparation. The success of this demonstration can show how load can improve system reliability while reducing the need to spin turbines thereby saving fuel and reducing emissions.

**ORNL Advancing Design of Secure, Modular High Power Density Transformer**
ORNL continues to work with industry on novel approaches to improve power density of transformers and also looking at innovative designs in which the magnetic components are placed around a "core" consisting of the electrical components. ORNL is using thermo-mechanical models to consider materials and processing conditions that will improve the material properties of the transformer core steel. The modeling work has been submitted for publication.

**Objective 1.2 Provide Quality Leadership in S&T**

ORNL has consistently been willing to pursue novel approaches that can provide innovative solutions to immediate or future issues. ORNL has dedicated a portion of its effort in strategic areas of research that are potentially disruptive or are of high risk with high potential returns. An example of this is the development of high saturation flux core steels through thermo-mechanical processing techniques. Additionally, ORNL researchers have proposed an innovative concept to use industrial loads for regulation in the power system. Alcoa has agreed to move forward on providing regulation from their aluminum smelting loads. If this concept works it will benefit both power system reliability and the aluminum industry.

**VERDE Tool Assists in Hurricane Infrastructure Security and Energy Restoration Operations**
The ORNL developed VERDE tool provided real-time status of the bulk electric transmission systems before, during and after landfall for Hurricane Dolly, Tropical Storm Edouard, Tropical Storm Fay, Hurricane Gustav, Hurricane Hannah, and Hurricane Ike. The tool displayed abnormal line status with good and increasing reliability through the hurricane season. Using hurricane prediction data for the projected path and landfall of Hurricanes Gustav and Ike along with population distribution data and substation service areas, the VERDE program was able to estimate the number of electrical customers that would be without power several days before landfall. These estimates correlated well with results after landfall from the utilities. As recovery activities proceeded after Hurricanes Gustav and Ike, reachback from ESF-12 deployed personnel was

provided to reconcile utility provided outage and restoration estimates with status displays within VERDE as well as resolving data stream issues during the damage assessment phases of the hurricane strike.

**ORNL Developing Tool to Predict Remaining Life Analysis on Conductors**: ORNL is working with EPRI to develop tools to predict the service life of high temperature low sage (HTLS) conductor systems for any arbitrary loading history that includes geographic location, tensioning load during erection and number of thermal cycles associated with operation during peak periods. This ground breaking work could result in major improvements in the transmission capacity of the electric grid and in its reliability, without significant modifications to its infrastructure. The work to performed as part of the proposed research included the 1) thermo-mechanical evaluation of aluminum alloys used for the fabrication of HTLS conductor system, including the splice connector; 2) development of time-dependent failure criteria and experimentally-based inelastic constitutive models; 3) incorporation of models into computational tools for parametric studies, predictions of remaining life and analyses of structural tests and 4) confirmatory structural evaluations. Initially, Aluminum Conductor Steel Reinforced (ACSR) conductors will be evaluated and the ***work has already highlighted major design flaws in certain splice connections*** which require attention. Representatives from the high temperature conductor industry, such as CTC and 3M, have shown great interest in the results of this work. A report has been written and accepted by IEEE, "The Integrity of ACSR Full Tension Splice Connector at Higher Operation Temperature," John Jy-An Wang et al.

**ORNL Assisting in Validation of Load Regulation from Industrial Systems**
Based on innovative concepts being developed at ORNL, discussions have been on-going with Alcoa over the past two years to utilize their smelters for regulation into the electric grid market. If this demonstration is successful, it will be excellent for both power system reliability and the aluminum industry. MISO has agreed to allow Alcoa's Warrick plant to supply regulation when the MISO regulation market opens – currently in the fall of 2008. ORNL is working with Alcoa to analyze the data from the test. Alcoa is currently testing communications and controls with MISO's automatic generation control system and to control the aluminum plant. ORNL is playing a key role as the facilitator between Alcoa and the NYISO for obtaining regulation from the Alcoa Massena plants, located in New York. The project is leveraging DOE efforts through a NYSERDA funded project with Alcoa and ORNL. Additionally, ORNL has facilitated interactions between Alcoa and the Bonneville Power Administration system operators to discussion applicability to the Pacific Northwest.

**ORNL Re-establishes Electric Grid Consortium in FY08**
ORNL, in partnership with DOE-OE has re-established an Electric Grid Consortium to provide a process for engineering development, demonstration, and validation of selected technologies and practices for transition into broad use by electric utilities. The technologies and practices selected for transition fall into two categories of support: one category referred to as "Core Projects" with cost-share support from the DOE, and a second referred to as "Sponsor Projects" with sole support by membership fees. These projects are highly leveraged with industry on near term technologies that can be deployed into the field within two to three years.

**ORNL Leadership in Wireless Control Security.**

ORNL, utilizing its expertise in wireless communications, led the development of a white paper that analyzes the management of wireless devices introduced to, or in proximity of facilities under requirements imposed by the North American Electric Reliability Corporation (NERC) critical infrastructure protection standards. An anticipated paper is being developed: Considerations Associated with Wireless Systems When Implementing NERC Critical Infrastructure Protection Standards; Teja Kuruganti, Walter Dykas, Wayne Manges, Tom Flowers, Mark Hadley, Paul Ewing, Thomas King, and Hank Kenchington. Additionally, ORNL presented a related paper: Process Control Security Forum (PCSF); August 24-28, 2008 in La Jolla, CA

**Objective 1.3 Provide and Sustain S&T Outputs that Advance Program Objectives and Goals**

DOE-OE peer reviews indicate that ORNL performs at exceptional levels in the V&C area. For example, the powerline conductor accelerated test facility recorded the highest score in the V&C area at the last peer review meeting in 2006. ORNL has over 20 peer reviewed publications in the V&C and DSI areas.

**Objective 1.4 Provide for Effective Delivery of S&T**

ORNL has accomplished all major milestones in the ORNL Electric Delivery Technologies Program for FY 2008 including a key milestone of expanding real-time visualization & monitoring capability of transmission lines for key regions.

**Goal 2.0: Design, Fabrication, Construction, and Operations of Facilities**

**44.**

Not Applicable

**45. Goal 3.0 Provide Effective and Efficient Science and Technology Research Program Management**

**Objective 3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision**

***Summary*** – In FY 2008, ORNL demonstrated exceptional vision and leadership in assisting the DOE in continuing development of initiatives for enabling technologies. ORNL has aligned its activities with immediate and emerging needs as well as maintaining cutting edge research capabilities while establishing partnerships with industry and government laboratories. ORNL has also expanded its capabilities and core competencies. By incorporating the computational leadership with power systems research it has created a unique expertise in visualization and analysis of the electric and energy infrastructure. In addition, other new capabilities have been established with minimum investment. By providing world class and up-to-date facilities, ORNL has been able to retain our world-class researchers and bring in experts from other technical fields and organizations. Over the past year, ORNL has added a key program manager with a rich history of the utility industry. Reasoning for the move is the quality of research, facilities and expertise at ORNL.

**Ideas for New Facilities and Capabilities to Support OE Mission**: ORNL has been working with industry and the DOE to develop power delivery test facilities to test advanced technologies and ensure reliable operations in the field. Part of the new concepts is to consider a power electronics test facility which would complement the existing facilities at ORNL such as PCAT, HTS Cable Test Lab and the DECC facility.

**Objective 3.2 Provide Effective and Efficient Science and Technology Project/Program Planning and Management**

**All major ORNL FY 2008 ORNL OE Program milestones have been met or exceeded:** As in past years, ORNL has met or exceeded its annual performance goals and milestones. In the planning and execution of these milestones, adjustments were made based on critical needs, latest scientific information and insights, reviewers' suggestions as well as available budget. These milestones have been reported to DOE program managers. The quality of research that is produced from ORNL is excellent as evident in the VERDE tool, load as a resource concepts being demonstrated in the market and advanced conductor work in identifying failure modes and recommending new designs to the industry.

**ORNL Implemented new CPS financial Tracking System**: ORNL worked with DOE-OE program management to pilot ORNL implementation of a new financial tracking system. DOE-HQ staff interfaced with ORNL business and financial officers to determine specification for the tracking tool. This project has worked very well and will now be implemented by other national laboratories.

**ORNL Synergy with other programs**: ORNL Electric Delivery program managers are constantly seeking leveraging opportunities across OE areas, such as dielectric materials, and EERE areas, such as renewable systems integration, vehicle technologies (plug-in hybrid electric vehicles [PHEV], power electronics, energy storage). ORNL is also leveraging opportunities with DSH on HTS applications, visualization and controls and risk assessment tools for cyber security operations.

**Objective 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs**

***Summary*** – In FY 2008, ORNL has continued to provide high quality, accurate, impartial and timely response to sponsor requests for information. ORNL has kept our DOE sponsor informed by providing real-time e-mail updates on breaking news as well as contributions to OE Weekly Highlights on an as-warranted basis. In addition, the office maintains frequent contact with our sponsor via telephone calls to ensure that requests and sponsor programmatic needs are met. Issues, whether positive or negative, are communicated to the sponsor so that plans and actions can be formulated collectively. Emerging issues are communicated immediately to avoid any surprise. When appropriate, ORNL has coordinated with experts both internal and external to ORNL, and acted as information center to compile the necessary information for our sponsor in a clear and organized manner. ORNL was a member of the Smart Grid Organizing Committee for the Smart Grid Implementation Workshop held in June 2008. ORNL staff participated in developing the technical scope and agenda of the meeting and served as a technical advisor for one of the break out groups.

**Communications Outreach Materials Development**
ORNL pro-actively worked with DOE on a display of OE funded-technology research and development. This display was established for the IEEE T&D Expo in Chicago in April 2008 and drew a lot of interest from industry attendees.

**Renewable & Distributed Systems Integration and**
**Energy Storage & Power Electronics Programs**

**Goal 1.0: Provide for Efficient and Effective Mission Accomplishment**

**Objective 1.1 S&T Results Provide Meaningful Impact on the Field**

**Development of Adaptive Control Method for Local Voltage Regulation**
ORNL has developed an adaptive control method for Distributed Energy Resources that will work in harmony with conventional utility control to rapidly regulate local voltage. The method is adaptable to a range of distribution system designs. The algorithms have been used in simulations using system models and in actual tests using the synchronous condenser and inverters at ORNL's Distributed Energy Communication and Controls (DECC) facility. ORNL is now working to initiate changes to IEEE Standards to permit local voltage regulation. ORNL staff has had technical discussions with the IEEE 1547.6 working group urging that the standard be changed to permit local voltage regulation when the utility permits it and is drafting a formal letter to the working group outlining the technical justifications.

**Development of a Tariff for Reactive Power**
ORNL has partnered with the California Independent System Operator and the Pacific Gas and Electric Company to prepare a study of the value of local reactive power supply from four sample PG&E customers. The study proposed a sample tariff that will help to amortize the cost of new inverter installations, and the local reactive supply will reduce distribution system losses, increase transmission capacity, and increase the margin to voltage collapse. Both a full report and brief version have been prepared. The brief report has been submitted to an IEEE conference for publication.

**Development, Documentation and Use of Oak Ridge Competitive Electricity Dispatch (ORCED) Model for Studies on PHEV and the Grid**
The ORCED model has been expanded and used for a variety of OE projects over the past ten years. In FY 2008, ORNL applied the model to two studies of interest to OE, updated the documentation from 1997, and placed the latest model on the ORNL website for interested researchers in industry, government, and academe. In January 2008, ORNL released a report on the potential impacts of PHEVs on each region's grid in the U.S. that employed the ORCED model.
<http://www.ornl.gov/info/ornlreview/v41_1_08/regional_phev_analysis.pdf>

The report results were published in the November 2008 issue of the *ORNL Review* magazine and ORNL issued an accompanying press release. Numerous trade publications, general press, and websites referenced the paper and several industry and government organizations contacted ORNL for additional information. Documentation of the ORCED model and a copy of the model were released on the web in June 2008.

<http://apps.ornl.gov/~pts/prod/pubs/ldoc9472_orced_modelfinal.pdf<http://www.ornl.gov/sci/engineering_science_technology/cooling_heating_power/orced/orcedexe.htm>

**ORNL Leading Value Proposition Study of PHEVs**
A project co-funded by OE and the EERE Office of Vehicle Technologies was established by ORNL, with the support of SENTECH, EPRI, and General Electric, to conduct a study of the benefits, barriers, technical and infrastructure requirements, opportunities and challenges of grid-connected, plug-in hybrid electric vehicles in order to establish potential value propositions that will lead to commercially viable PHEVs. The first phase, conducted in FY 2008, consisted of: identification of potential propositions through a workshop with an guidance committee and other stakeholders; down-selection of business cases for further study; development of the analytical toolset using current technical research and industry-recognized models of vehicle design, battery controls, and electric utility grid operation; and evaluation of the first down-selected value proposition using the toolset to identify the conditions under which the value to the owner will justify the cost or investment. The reports from the first three tasks can be found at http://www.sentech.org/phev/.

**Key ORNL Award**
***2007 ESC Partnership Award For Innovative Energy Solutions*** for the GEDAC (gas-engine driven heat pump rooftop unit) working with our industry partners Southwest gas, Team Consulting, and Blue Mountain Energy.

**Objective 1.2 Provide Quality Leadership in Science and Technology**

**DECC Laboratory Capabilities for Industry**: ORNL has developed the DECC laboratory for studying dynamic voltage and power factor control supplied from distributed energy (DE) resources. This unique laboratory currently has installed both inverter and rotating based technologies. Plans for expanding DECC to include multiple inverter-based DE systems were developed and include: 1) a research inverter for a 50kW PV system, 2) remote inverter site to be placed at building 3129 to give us multiple inverter locations, 3) air conditioner stall testing system and 4) a bidirectional PHEV station. The 50kW of PV arrays have been installed on the north end of the ORNL campus, which will enable the DC power from the array to both provide the storage of solar energy to battery and use it to provide reactive power for voltage regulation. The importance of this is that two inverters will be installed – a conventional system and a separate research inverter with voltage regulation which will be used as a comparison to conventional technology. Additionally, a remote location has been identified for a 300A converter to expand the capability of DECC from one inverter to multiple inverter systems for testing. Several high-efficiency air conditioners will be connected to the inverter panel through a variable transformer so that we can stall the unit when we block its air flow and start the induction motor. The test setup will be used to evaluate the ability of the inverter controls to prevent air conditioner stall, which is a serious and growing issue for many utilities like SCE, which has a service area of high density air conditioner loads. ORNL is installing at the DECC a 100kW Elliott microturbine, to be completed by the end of FY 2008. The project will use the microturbine to provide power to buildings 3114 and 3147 while providing a new microturbine testing capability for DECC.

**Objective 1.3 Provide and Sustain S&T Outputs that Advance Program Objectives and Goals**

**Evaluate Adaptive Methods for Local Voltage Regulation**
ORNL has developed an adaptive control method for Distributed Energy Resources (DER) that will work in harmony with conventional utility control to rapidly regulate local voltage. The method is adaptable to a range of distribution system designs. The algorithms have been used in simulations using system models and in actual tests using the synchronous condenser and inverters at ORNL's DECC facility. Simulations of faults in the sub-transmission system with and without DER support have been conducted to evaluate the performance and response of various penetrations of DER. A technical paper was completed and presented in July for the IEEE PES Meeting in Pittsburgh. A report summarizing the results will be completed by September 30th.

**Buildings, Renewables Systems Integration with the Grid**
ORNL operates an energy research park comprised of five low-energy homes in a Habitat for Humanity subdivision in Lenoir City, Tennessee. Four homes are now occupied but continue to provide home performance data. The fifth home (2,600 square feet) is being used as a Habitat for Humanity office and meeting space and incorporates a solar water heater, a zero-energy (zehcore) utility wall, a geothermal heat pump, efficient building materials and appliances, and a GridPoint energy management system. A GridPoint system was installed in June 2007 and was successfully used to deploy GridPoint's 6 kWh of battery storage for home energy use during times of peak demand. The batteries were recharged in the evenings during off peak times. The web enabled GridPoint system allows a user to monitor their energy usage and deploy the batteries via the web. This functionality allows a user to deploy based on feedback from TVA on times of distribution stress (such as during the drought of August 2007). This effort integrates the GridPoint system with 12 solar panels to be installed on the roof the fifth home. A fully integrated system will enable the home to produce more power than the home needs during critical Utility System Peaks (due to the efficiency of the home, and smart operation) and enable ORNL to deploy batteries charged with solar power to measure and study the solar power integration with the energy management system. The energy storage units inside GridPoint or additional external batteries could be charged and discharged to simulate a PHEV used five days a week to commute to work or school. The system can be used to simulate the charging of the PHEV battery as well as its support of the grid while charging by developing an overnight charging profile. The optimization of the charge and discharge will be employed with a likely time of day rate structure for this geographical region. This would be a look at a future car linked to renewable energy resources and a near zero energy house with a daily cost to operate just the house of less than $1.00 day.

**Objective 1.4 Provide for Effective Delivery of Science and Technology**

**Successful Testing of multiple DE devices with balanced control and unbalanced control in series** ORNL successfully tested both its new unbalance inverter voltage regulation control with both the inverter and synchronous condenser in series on April 21, 2008. On May 1, 2008, ORNL tested its inverter with a new current control added to our balance voltage control to limit the inverter's current during transient events to prevent the inverter from tripping out and to continue supporting system voltage.

**Reactive Reserves Using Dynamic Reactive Sources for Correcting Distribution System Voltage Problems** The simulations included the development of new load composition model that

includes small air conditioning (A/C) and ZIP (constant impedance, constant current and constant power) loads to evaluate the ability of voltage regulation DE to mitigate A/C stall and support voltage for nonlinear loads, such as compact fluorescent lighting. A report on the simulation work will be completed by September 30th.

**Thermo-Mechanical Modeling of Power Electronic Integrated Gate Bipolar Transducer (IGBT):** Analyses of the thermo-mechanical stress state of the subcomponents of an IGBT was enabled using u-FEA software. The u-FEA software was developed from co-sponsorship of EERE. These analyses allowed the examination of local stress concentrations caused by the complex and non-idealized architecture of the subcomponents, and subsequent recommendations of geometrical redesign. The analysis showed that the large thermal expansion mismatch between the thick copper base plate and the adjoining ceramic substrate produced large stresses that would result in cracking and/or delamination and electrical failure.

**Goal 2.0: Design, Fabrication, Construction, and Operations of Facilities: Provide for Efficient and Effective Design, Fabrication, Construction, and Operations of Facilities**
**46.**
Not applicable

**Goal 3.0 Provide Effective and Efficient Science and Technology Program Management**

**Objective 3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision**

**Power Electronics Program Plan Developed**
ORNL led an effort to develop a draft program planning document that will be a foundation for input from industry, academia and other national laboratories. Through its expertise in the field, the Lab outlined the need for an electric grid power electronics program, identified technical challenges for high power devices and outlined key research areas needed for further analysis.

**Objective 3.2 Provide Effective and Efficient S&T Project/Program Planning and Management**

**Completion of DE Research and Subcontracts:** Significant progress was made in FY 2008 in completing research in reciprocating engines, thermally activated technologies, combined heat and power, and materials areas. Many of the remaining research projects were completed with oral presentations at technical meetings and/or final reports. Subcontracts in the areas were closed after completion of final reports and deliverables.

**Objective 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs**

**All major FY 2008 ORNL OE Program milestones have been met or exceeded:** As in past years, ORNL has met or exceeded its annual performance goals and milestones. In the planning and execution of these milestones, adjustments were made based on critical needs, latest scientific information and insights, reviewers' suggestions as well as available budget. These milestones have been reported to DOE program managers.

**Annual Operating Plan** - ORNL consistently meets annual performance goals and milestones as outlined in their Annual Operating Plan. Progress toward milestones is reported at least quarterly and in some programs monthly, in addition, ORNL staff is available on an as needed basis for technical support. ORNL provides significant technical resources for program planning and long term goals and milestones. ORNL met all FY 2008 program milestones described in the AOP and related FWPs.

# APPENDIX 5

# ASSISTANT SECRETARY FOR NUCLEAR ENERGY

# PERFORMANCE EVALATION SURVEY DATA

# Laboratory Year-End Performance Assessment Report

Headquarters Program Office FY 2008 Evaluation of UT-Battelle, LLC for Management and Operation of the Oak Ridge National Laboratory

Agency: **U.S. Department of Energy**

Program Office: **Office of Nuclear Energy**
Generation IV Nuclear Energy Systems (GEN IV)
Nuclear Hydrogen Initiative (NHI)
Advanced Fuel Cycle Initiative (AFCI)
Isotopes Program (Isotopes)
Mixed-Oxide Fuel (MOX) – not evaluated
Radioisotope Power Systems (Space)

FY Funding Level: **Total 40,117K**

| |
|---|
| • $1,375K - GEN IV |
| • $92K - NHI |
| • $23,000K - AFCI |
| • $11,000K - Isotopes |
| • $400K - MOX (not evaluated) |
| • $4,250K - Space |

## 1.1 Science and Technology Results Provide Meaningful Impact on the Field

- (Isotopes Program – 3.9) ORNL exceeded expectations in meeting customer demand for isotope products and services. This enabled advancements to continue in research and medical applications. The ORNL staff was invited and participated in several isotope conferences and workshops that fostered the use of isotopes in medical applications.

- (Space Program – 3.9) ORNL published reports on materials used in the production of Radioisotope Power Systems (RPS). These technical reports were published in journals and available to researchers outside the DOE complex. They continue to provide successful stewardship in material related research areas.

- (Nuclear Hydrogen Initiative – 4.0) ORNL consistently challenged the hydrogen R&D community to look for improved synergies to expand role of nuclear hydrogen in meeting U.S. energy needs.

- (Advanced Fuel Cycle Initiative – 4.0) ORNL has established the Coupled-End-to-End separation project and developed experimental capabilities to collect and quantify volatile radioactive emissions associated with the head-end of essentially all aqueous reprocessing systems. Particularly for tritium emissions, these developments have the potential to significantly reduce the environmental impact of world-wide commercial-scale reprocessing plants.

- (GEN IV/NGNP – 3.7)
  - The characterization and evaluation effort of the AGR TRISO fuel for the AGR-2 fuel development has been outstanding, and has included extra work scope related to the US/French International Nuclear Energy Research Initiative TRISO characterizations, IAEA Coordinated Research Program (CRP—6), characterization round-robin work with multi-national TRISO fuel surrogates, and the IAEA Fact Book information.

  - The compacting effort has met expectations. A staff member working with the Idaho National Laboratory (INL) team and Babcock and Wilcox (B&W) subcontractors on the TRISO fuel manufacturing scale-up planning efforts has been working beyond contracted scope-of-work to assist the entire AGR fuel team.

**1.2 Provide Quality Leadership in Science and Technology**

- (Isotopes Program – 3.8) The ORNL Isotopes Program team demonstrated superb leadership through proactive interaction with customers, and timely, accurate updates to analyses and business data useful to both the public and DOE. The ORNL team engaged in numerous customer visits, responded rapidly to all inquiries, and continues to enhance the Isotope Newsletter with a distribution of 3,000 worldwide. This outreach has helped to significantly expand the program's influence on isotope use for research and medical applications.

- (Space Program – 4.0) ORNL provides the best work in fabricating products used in unique environments to power our customers' mission applications. Their efficiency and effective work allows close collaborations with scientists in other national laboratories and other government agencies.

- (Nuclear Hydrogen Initiative – 4.0) ORNL are key participants at highest levels of scientific dialog on hydrogen issues.

- (Advance Fuel Cycle Initiative – 3.8) Separations staff members at ORNL participate through multi-laboratory integration programs. The staff has made substantial contributions to the collective leadership. These contributions have gradually increased during the past year when there were tendencies toward competition rather than cooperation. Because of internal changes in leadership, the most recent experience has been exemplary.
- (GEN IV/NGNP – 4.2)
  - The Characterization Team has exceeded expectations related to developing improved measurement techniques, exacting methods for superior examination methods. The Characterization Team also won a prestigious R&D 100 award for the anisotropy measurement device known as the 2MGEM. (see website http://www.ornl.gov/info/press_releases/get_press_release.cfm?ReleaseNumber=mr20080701-00)

  - The lead principal investigator for the AGR TRISO characterization effort was specifically requested by the IAEA for his expertise in TRISO fuel characterization

for developing the chapter on characterization methods for the IAEA TRISO fuel fact book that is now being completed.

- The ORNL AGR team published several journal articles this year as well as peer-reviewed conference papers for the 2008 High Temperature Reactor International Meeting, held in Washington, DC, September 2008, in the areas of compacting, coating, and characterization and presented their results at the meeting. The ORNL materials specialists involved with Silicon Carbide (SiC) has earned the 2007 Literary Award from the Materials Science and Technology Division of the American Nuclear Society for their "Handbook of SiC Properties for Fuel Performance Modeling" documentation and paper.

**1.3 Provide and Sustain Science and Technology Outputs that Advance Program Objectives and Goals**

- (Isotopes Program –3.5) ORNL demonstrated progress against HQ guidance, and has developed technology information to ensure the production of research isotopes can be achieved.

- (Space Program – 3.7) ORNL developed a database of materials properties and the effect of impurities on mechanical properties for our unique mission and published them in a manner that was suitable to the outside world protecting national security. They reported their progress in monthly and annual reports and tracked their cost and progress in Project Information Center (PICS) reports.

- (Nuclear Hydrogen Initiative – 4.0) ORNL consistently has a large number of high-quality peer reviewed articles and presentations.

- (Advance Fuel Cycle Initiative – 3.7) Sustained outputs that advance program objectives have been difficult for ORNL's Couple End-to-End (CETE) program this past year. Although many of the program delays have been the result of circumstances beyond the control of laboratory management, the original schedule was overly ambitious since such start-up difficulties are often encountered in relatively new program activities. Sustained efforts near the end of the fiscal year appear to have overcome the major problems, giving promise to more productivity in FY 2009.

- (GEN IV/NGNP – 3.5)
  - All of the AGR TRISO reports and summary of data for the ORNL produced materials and the B&W TRISO fuel independent characterization studies have been of extremely high quality.

  - The compacting studies have been very good. The lead ORNL investigator has brought his experience to the INL and B&W team working on the larger scale fabrication process development and has provided his comments about the possible use of the "ADMIX" compacting process used by the French company CERCA for the French AREVA gas cooled reactor fuel development program.

**1.4 Provide for Effective Delivery of Science and Technology**

- (Isotopes Program – 3.7) The ORNL Isotopes Program Team maintained over 95 percent on-time delivery and met 100 percent of contract/sales orders terms. Based on interactions with isotope customers and the isotope community, the ORNL staff is developing new isotope processing techniques that will improve product yields and activity.

- (Space Program – 4.3) ORNL has meet all of our goals and milestones documented in annual guidance letters within cost and delivery dates. The results were documented in PICS and monthly reports. ORNL has received passing reviews at Program Office reviews.

- (Nuclear Hydrogen Initiative – 4.0) ORNL commitments consistently met or exceeded.

- (Advance Fuel Cycle Initiative – 3.5) Although ORNL is the "customer" for many of the CETE products, several other laboratories need to receive samples and in some cases the total CETE output of certain products in order to expand the knowledge to be gained from the experiments. Due to delays in the program and administrative issues related to laboratory-to-laboratory transfers, product delivery has been one of the least successful parts of CETE's first full year of operations.

- (GEN IV/NGNP – 4.2) All of the ORNL AGR TRISO fuel program deliverables and reports have been excellent and have been provided on time, or even early. Some additional reports and extra information were sent to the entire AGR team as new issues come up, so that everyone involved understand and discuss the data, and find ways of solving the issues. Good examples of this are the "Soot inclusion" characterization findings and the extremely detailed, carefully written characterization reports.

**2.1 Provide Effective Facility Design(s) as Required to Support Laboratory Programs**

N/A

**2.2 Provide for the Effective and Efficient Construction of Facilities and/or Fabrication of Components**

N/A

**2.3 Provide Efficient and Effective Operation of Facilities**

- (Space Program – 4.1) ORNL has operated the facility and met the operability index for essential equipment for 100 percent of FY 2008. They have met the operating budget requirements and have assisted several students from the nearby university to obtain their advance degrees.

- (Nuclear Hydrogen Initiative – 2.3) Operations were efficient and effective during time period assigned.

**2.4 Utilization of Facility to Grow and Support Lab's Research Base and External User Community**

- (Space Program – 3.8) ORNL has provided input into the material design selection for both reactor and RPS systems in various technical publications.

**3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision**

- (Space Program - 3.9) ORNL has participated in all of our quarterly meetings, weekly teleconferences and attended various international conferences to publicize DOE's capabilities to attract and retain qualified staff. They have proposed several studies to advance our technical knowledge, but were limited by our reduced funding levels.

- (Advanced Fuel Cycle Initiative – 4.1) ORNL has world-class actinide chemists and a history of innovation in separations chemistry and technology. These scientific and engineering capabilities are particularly evident in the field of americium and curium radiochemistry where decades of production of californium-252 has made the Radiochemical Engineering Development Center (Building 7920 and 7930) a center of excellence. Those capabilities have been effectively applied to the CETE program and to ORNL's contributions to the AFCI Program.

- (GEN IV/NGNP – 4.1)
  - The AGR TRISO team at ORNL has sought to have the AGR TRISO lab used for the project and for other DOE programs, including the Russian Plutonium-burning TRISO Gas Turbine Modular Helium Reactor (DOE NA) effort, and international Nuclear Energy Research Initiative projects

  - The AGR TRISO team has made sure that the lab technicians and personnel are cross-trained and kept qualified for their tasks, so that the operations of the TRISO lab is run efficiently, maximizes throughput, and allows for good personnel training and utilization for the various tasks. As an example, and extra leach-burn-leach station and other characterization stations were added to make sure that there were no choke-points in the work activities.

**3.2 Provide Effective and Efficient Science and Technology Project/Program Planning and Management**

- (Isotopes Program – 4.0) The Isotope Team at ORNL played an active key role in the development of Isotope Program proactive business strategies for filling customer orders. In FY 2008, ORNL staff assumed the responsibility for the isotope exhibit booth and coordinating the logistics for conferences. ORNL also redesigned the booth and public media handouts. The ORNL contribution significantly exceeded expectations and helped the program respond to changing fiscal conditions.

- (Space Program – 4.0) ORNL efforts in R&D has produced strategic plans to develop quality plans to reduce the technical risks for future customer's missions with advanced state-of-the–art material testing equipment. They maintained an elevated mission responsive team effort in the current reduced funding level.

- (Nuclear Hydrogen Initiative – 4.0) ORNL did their best to comply with NHI needs with limited resources. Program planning and management was effective.

- (Advanced Fuel Cycle Initiative – 3.4) As has been evident from significant CETE program delays, ORNL planning and management in this area has not been first rate. In addition to the lack of allowance for the unexpected, senior program management has on more than one occasion negatively impacted negatively sensitive litigations after having those concerns clearly articulated. FY 2009 will need to be free of such activities in order for the program to fulfill its promise.

- (GEN IV/NGNP – 3.5)
  - The AGR TRISO team at ORNL has used and input data into the NE PICS system on time and provided timely information regarding budget, schedule, and deliverables.

  - The ORNL team provided information on a weekly basis as part of the AGR weekly teleconferences so that the DOE NE manager and the INL lead PI is aware of activities.

  - The compacting area has provided information for the INL and B&W fuel fabrication scale-up studies as requested; however, the official statement of work for the Memorandum Purchase Order (MPO) did not explicitly include these tasks, so that the inter-laboratory communications and logistics were strained and inefficient. The lead ORNL PI should have addressed this problem sooner by discussing this with the INL technical manager immediately, and having the INL MPO modified as soon as possible. It should be noted that the INL staff member working on the scale-up studies made last-minute requests and often failed to seek the advice of the ORNL PI who has compacting experience and could have worked with B&W directly.

### 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs

- (Isotopes Program – 4.0) The Isotope Team at ORNL employed innovative measures to ensure that accurate and timely information was available to HQ and customer organizations; provided information on a real-time basis where necessary; and were very responsive to customer inquiries, efficiently answering over 1,100 requests in FY 2008.

- (Space Program – 4.3) ORNL has always responded to our request for information with quality, accuracy, and timely information. In fact, they are the best national laboratory in responding to NE-34 needs. ORNL continues to provide timely status reports that allow us to adjust our mission needs.

- (Nuclear Hydrogen Initiative – 4.2) ORNL kept me informed of progress and plans to facilitate effective program management.

- (Advanced Fuel Cycle Initiative – 3.6) Communications at the CETE working level has been generally good during the fiscal year and specific short term assignments have been acted upon with alacrity and effectiveness. Written report deadlines have been met and at inter-laboratory meetings, CETE staff has made significant contributions. At higher management levels, occasional miscommunications have somewhat reduced ORNL's overall satisfactory performance in this area.

- (GEN IV/NGNP – 3.0)
  - The TRISO characterization PI has provided very effective and efficient communications to DOE NE, INL, and his entire AGR TRISO team in a superlative manner. Information has been promptly especially as technical issues arose (e.g. soot inclusions).

  - The results and deliverables related to the activities for the PIE task planning and facility upgrades, which included the TRISO fuel examination vault for the IMGA device, have been superior. The ORNL team has worked extremely well with the INL lead and has provided information promptly and served to help the entire effort go very smoothly.

  - The compacting work at ORNL has met expectations for the TRISO fuel that ORNL was charged to fabricate; however, communications between the ORNL compacting PI need to improve with respect to the fabrication scale-up planning effort lead by INL. This communication needs to be done in a timely, efficient manner and based on the MPO listed tasks. Any issues with particular INL staff members must be brought directly to the INL AGR technical director's attention.

## SUMMARY TABLES – NE INPUTS TO EVALUATION OF ORNL FY 2008 PERFORMANCE

| **GOAL 1** | ***Provide for Efficient and Effective Mission Accomplishment*** | | | | | | **3.87/A** | |
|---|---|---|---|---|---|---|---|---|
| *Program* | *AFCI* | *Isotopes* | *Gen IV/NGNP* | *Space* | *NHI* | *MOX (not evaluated)* | | |
| *Funding* | *23,000K* | *$11,000K* | *$1,375K* | *$4,250K* | *$92K* | *$400K* | *Weight* | *Objective Score/Grade* |
| **Objective 1.1: *Science and Technology Results Provide Meaningful Impact on the Field*** | **4.0** | **3.9** | **3.7** | **3.9** | **4.0** | | **$39,717K** | **3.9** |
| **Objective 1.2: *Provide Quality Leadership in Science and Technology*** | **3.8** | **3.8** | **4.2** | **4.0** | **4.0** | | **$39,717K** | **3.96** |
| **Objective 1.3: *Provide and Sustain Outputs that Advance Program Objectives and Goals*** | **3.7** | **3.5** | **3.5** | **3.7** | **4.0** | | **$39,717K** | **3.68** |
| **Objective 1.4: *Provide for Effective Delivery of Products*** | **3.5** | **3.7** | **4.2** | **4.3** | **4.0** | | **$39,717K** | **3.94** |

| **GOAL 2** | ***Provide for Efficient and Effective Design, Fabrication, Construction and Operation of Research Facilities*** | | | | | | **3.92/A** | |
|---|---|---|---|---|---|---|---|---|
| *Program* | *AFCI* | *Isotopes* | *Gen IV/NGNP* | *Space* | *NHI* | *MOX (not evaluated)* | | |
| *Funding* | *23,000K* | *$11,000K* | *$1,375K* | *$4,250K* | *$92K* | *$400K* | *Weight* | *Objective Score/Grade* |
| **Objective 2.1:** ***Provide Effective Facility Design(s) as Required to Support Laboratory Programs*** | | | | | | | **N/A** | **N/A** |
| **Objective 2.2:** ***Provide for the Effective and Efficient Construction of Facilities and/or Fabrication of Components*** | | | | | | | **N/A** | **N/A** |
| **Objective 2.3:** ***Provide Efficient and Effective Operation of Facilities*** | | | | **4.1** | **2.3** | | **$4,342K** | **4.05** |
| **Objective 2.4:** ***Utilization of Facility to Grow and Support Lab's Research Base and External User Community*** | | | | **3.8** | | | **$4,250K** | **3.8** |

| GOAL 3 | *Provide for Efficient and Effective Science and Technology Program Management* | | | | | | 3.89/A | |
|---|---|---|---|---|---|---|---|---|
| *Program* | *ACFI* | *Isotopes* | *Gen IV/NGNP* | *Space* | *NHI* | *MOX (not evaluated)* | | |
| *Funding* | *$23,000K* | *$11,000K* | *$1,375K* | *$4,250K* | *$92K* | *$400K* | *Weight* | *Objective Score/Grade* |
| **Objective 3.1: *Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision*** | **4.1** | | **4.1** | **3.9** | | | **$28,625K** | **4.03** |
| **Objective 3.2: *Provide Effective and Efficient Science and Technology Project/ Program Planning and Management*** | **3.4** | **4.0** | **3.5** | **4.0** | **4.0** | | **$39,717K** | **3.78** |
| **Objective 3.3: *Provide Efficient and Effective Communications and Responsiveness to Customer Needs*** | **3.6** | **4.0** | **3.0** | **4.3** | **4.2** | | **$39,717K** | **3.88** |

# APPENDIX 6

# NATIONAL NUCLEAR SECURITY ADMINISTRATION

# PERFORMANCE EVALUATION SURVEY DATA

## NA-10 Deputy Administrator for Defense Program

### 1.1 Science and Technology Results Provide Meaningful Impact on the Field

ORNL is a world leader in the field of Nuclear Methods development in the field of criticality safety. Additionally ORNL met 18 of 18 milestones in Nuclear Methods on schedule and on budget. ORNL technical staff presented invited papers and led international working groups in this field.

Additionally, ORNL continues to be a world leader in the area of neutron cross-section measurements in the unresolved resonance region and below by operating the Oak Ridge Electron Linear Accelerator (ORELA) and producing new nuclear data evaluations. ORNL met 7 of 7 milestones for ORELA and exceeded the expected beam time of 700 hours by operating ORELA for 1700 hours during the FY.

### 1.2 Provide Quality Leadership in Science and Technology

ORNL Technical Staff are recognized internationally and sought after in the international technical community in the areas of Sensitivity and Uncertainty Analysis Methods as well as in the field of evaluations of nuclear data files and development of methods to analyze nuclear reaction cross-sections. In the subtask elements of Nuclear Data and Nuclear Methods ORNL met 13 out of 14 and 18 out of 18 milestones, respectively, on time within budget.

### 1.3 Provide and Sustain Science and Technology Outputs that Advance Program Objectives and Goals

- Prepared two ORNL papers for *Nuclear Data Sheets* as presented Brookhaven National Laboratory (BNL) Workshop on Neutron Covariances held in Port Jefferson, NY.
- Published two nuclear data papers via ANS Transactions (June)
- Completed and submitted five nuclear data papers for publication at PHYSOR-2008.
- Prepared two papers on TSUNAMI methods and applications for publication in *Nuclear Data Sheets*. Papers presented at the BNL Workshop on Neutron Covariances.
- Prepared PHYSOR-2008 paper on capability development and validation for new version of KENO with continuous energy.
- Invited presentation made on TSUNAMI tools and covariance data library at OECD/NEA Working Party on Scientific Issues of Reactor Systems expert group meeting on Uncertainty Analysis in Best-Estimate Modeling (UAM) for Design, Operation and Safety Analysis of LWRs – Second Workshop (UAM-2)

**1.4 Provide for Effective Delivery of Science and Technology**

45 of 50 Milestones completed on schedule and within budget. Those that were missed had some extenuating circumstances beyond ORNL's direct control. ORNL provides excellent responsiveness to NNSA NCSP requirements and works closely with NNSA to adapt work scope throughout the FY as needed while still completing set milestones.

**2.1 Provide Effective Facility Design(s) as Required to Support Laboratory Programs**

N/A

**2.2 Provide for the Effective and Efficient Construction of Facilities and/or Fabrication of Components**

N/A

**2.3 Provide Efficient and Effective Operation of Facilities**

N/A

**2.4 Utilization of Facility to Grow and Support Lab's Research Base and External User Community**

N/A

**3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision**

ORNL has planned for technical succession for key internationally recognized leaders in the field of Nuclear Methods (i.e., the sole SAMMY code expert). ORNL provides leadership on international working groups in criticality safety in the fields of nuclear data, cross-section evaluations, differential neutron cross-section measurements, and nuclear methods such as the Sensitivity and Uncertainty capability in SCALE developed under the auspices of the NNSA NCSP. ORNL has made a commitment to keep ORELA functioning and has done an excellent job of making beam in a budget constrained environment.

**3.2 Provide Effective and Efficient Science and Technology Project/Program Planning and Management**

ORNL NCSP Management is adaptable, maintains frequent communication with NNSA NA-171.1 program sponsors, works within established budgets to extract additional work product throughout the FY as negotiated with the NNSA NA-171.1 NCSP Manager. ORNL NCSP Management is responsive to questions about work

progress and is consistently a high performer in producing the quarterly quad charts required by the NNSA NCSP. ORNL maintains flexibility and adaptability in meeting NCSP needs and has worked to establish contingencies to ensure technical capability is maintained in the area of differential measurements.

### 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs

ORNL NCSP Management is adaptable, maintains frequent communication with NNSA NA-171.1 program sponsors, works within established budgets to extract additional work product throughout the FY as negotiated with the NNSA NA-171.1 NCSP Manager. ORNL NCSP Management is responsive to questions about work progress and is consistently a high performer in producing the quarterly quad charts required by the NNSA NCSP. The quad charts are always timely, always of excellent quality meeting NNSA NCSP expectations, and ORNL NCSP Management always follows-up on questions posed by NNSA promptly. Customer communication and customer responsiveness are an outstanding attribute of ORNL Management.

## NA-20 Deputy Administrator For Defense Nuclear Nonproliferation

### 1.1 Science and Technology Results Provide Meaningful Impact on the Field

- ORNL provided expert scientific and technical advice to staff at the Salaspils Research Reactor in Latvia as well as experts visiting from Poland, Belarus, and Russia on behalf of GTRI's Russian Research Reactor Fuel Return program. His work with this diverse international group not only ensured successful completion of GTRI's Latvia shipment, but also helped prepare the Polish and Belarusian personnel for future GTRI shipments from those countries.

- ORNL has provided excellent programmatic support on the BN-350 Spent Fuel Program. ORNL staff Snipes fills a critical need as the Chairman of the Cask and Transport Working Group, and other ORNL staff have led the Phase III Permanent Disposition effort. (NA-21)

- Provided senior technical support for monitoring visits to Russian facilities.

- Maintained the Blend Down Monitoring Systems at three sites in Russia and helped trouble shoot issues as they arise with aging systems housed in harsh operating environments in Russian facilities. (NA-24)

- Expertly conducted monitoring activities while staffing the Transparency Monitoring Office in Novouralsk, Russia on month-long assignments. (NA-24)

- Provided excellent support for on-the-ground disablement verification activities in Democratic Peoples Republic of Korea (DPRK). (NA-24)

- Played a key role in completing the analysis of T-Genie samples and writing the final report on the findings of the T-Genie experiment. (NA-24)

- Met all ONWP performance measurements and insured Bratislava agreements met. (NA-25)

- ORNL has done an excellent job of developing of analyzing the results of radiation portal data from SLD deployments all over the world and providing information back to the program about monitor performance and issues related to deployed monitors. (NA-25)

- The laboratory has developed a set of automated tools that allows the program to have a "quick look" when the portal data comes in to understand whether the portals have been operating normally and whether any significant alarms have occurred. (NA-25)

- All of these efforts are key components of the program for ensuring sustainability of SLD deployments. (NA-25)

**1.2 Provide Quality Leadership in Science and Technology**

- In addition to providing leadership and advice on scientific and technological issues to GTRI's international partners, ORNL staff showed leadership in this area by sharing his experiences from the Latvia shipment during GTRI's May 2008 Lessons Learned Workshop in Prague. This, too, allowed numerous international partners of GTRI to learn from the staff's extensive experience. (NA-21)

- Provided leadership and technical skills for troubleshooting equipment problems during several special monitoring visits to Russia, including visits to change radioactive sources at two sites. (NA-24)

- Provided strong leadership in their participation as team leader or technical leader in several visits to these sites each year. (NA-24)

- Initiated work with another laboratory to develop a flow and enrichment monitor for safeguards applications in a uranium gas centrifuge enrichment plant. (NA-24)

- Provided outstanding support for Physical Security upgrades for Russian nuclear weapons storage sites. (NA-25)

- ORNL provided excellent support to SLD in the areas of expertise on radiation detection equipment and processes as well as in data analysis. (NA-25)

- ORNL scientists have provided technical leadership and liaison to the IAEA in the area of radiation detection, ensuring that SLD remains current in this fast-

growing area and that the program's interests are represented in the international community. (NA-25)

### 1.3 Provide and Sustain Science and Technology Outputs that Advance Program Objectives and Goals

- ORNL has met and/or exceeded all BN-350 Spent Fuel Program milestones, objectives and goals in FY 2008. (NA-21)
- ORNL has met and/or exceeded all Russian Research Reactor Fuel Return Program milestones, objectives, and goals in FY 2008. (NA-21)
- Provided innovative ideas and identify efficiencies for monitoring activities and for scheduling maintenance for the Blend Down Monitoring System maintenance schedule. (NA-24)
- ORNL team was proactive in discussions with Russian contractors to ensure program goals and objectives were being met. (NA-25)
- Both contracting and Gregg Services subcontractors provided outstanding products along the lines of contracting documentation and multiple products related to the evaluation, analysis and negotiation of upgrade requirements at both sites. (NA-25)
- ORNL provided and sustained excellent outputs to the TSP and NTTS that advance NA-25 program objectives and goals. (NA-25)
- ORNL provided and sustained excellent outputs to the ICL, ICL Assurances, and NA-25 travel and financial data. (NA-25)
- ORNL managed a set of data on monitor performance from which the program gets outputs that advance program goals. (NA-25)

### 1.4 Provide for Effective Delivery of Science and Technology

- ORNL support, with technical expertise and management, to GTRI field teams has been instrumental in GTRI achieving its metrics for FY 2008. ORNL has provided instrumental support to GTRI in forging international partnerships to provide technical guidance and demonstrating its execution for GTRI partner countries. Of particular note are the consultancies to the IAEA that ORNL supports bringing not only the GTRI perspective, but also that of the U.S. government to the international community. ORNL expertise is specifically requested by IAEA on multiple occasions, both for planning Agency-level recommendations and for delivering guidance to member States on implementing those recommendations. This has made ORNL a recognized expert in the international community. (NA-21)

- ORNL has provided the technical expertise to effectively manage the complex procurement and effective delivery of TUK-123 dual-use (transportation and storage casks) for the BN-350 Spent Fuel Program. (NA-21)
- Submitted all deliverables on time and well-written. (NA-24)
- Coordinated the distribution of bulk samples and analysis data associated with the U.S. DOE Net Work of Analytical Laboratories bulk analysis activities in support to the IAEA. (NA-24)
- Provided extremely reliable support, especially under tight deadlines. (NA-24)
- ORNL effectively met or exceeded product delivery. (NA-25)
- Deliverables from both ORNL contracting and Gregg Services have always been timely. (NA-25)
- ORNL provided excellent delivery of products in support of the TSP, NTTS, ICL, ICL Assurances, and NA-25 travel and financial data. (NA-25)
- ORNL has developed a system for displaying and disseminating data analysis results that is highly useful to the program. (NA-25)
- The laboratory has also worked with Russian customs to develop and deliver effective training tools. (NA-25)

**2.1 Provide Effective Facility Design(s) as Required to Support Laboratory Programs**

N/A

**2.2 Provide for the Effective and Efficient Construction of Facilities and/or Fabrication of Components**

N/A

**2.3 Provide Efficient and Effective Operation of Facilities**

N/A

**2.4 Utilization of Facility to Grow and Support Lab's Research Base and External User Community**

N/A

### 3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision

- Maintained a cadre of technically competent experts who provide ongoing support for the maintenance and operation of the Blend Down Monitoring System, and successfully troubleshoot equipment issues that arise. (NA-24)

- Provided Blend Down Monitoring System training to experts from other labs to support program mission. (NA-24)

- Provided technical support for special reports. (NA-24)

- Performed excellent in support of INSEP (*e.g.*, the technical software support provided by Mr. Ron Caine in development of INSEP's Additional Protocol outreach activities). (NA-24)

- ORNL staff supporting the Material Protection, Control, and Accounting Program consistently demonstrated a commitment to the Program and an interest in understanding and implementing the vision set forth by DOE/NNSA for its implementation. (NA-25)

- Products from Gregg Services technical leads and technical support staffers were always strictly attuned to the vision of the Material Protection, Control, and Accounting program. (NA-25)

### 3.2 Provide Effective and Efficient Science and Technology Project/Program Planning and Management

- *Operation McCall,* in which ORNL repatriated from Iraq to Canada four high activity irradiators deemed to pose a threat to U.S. forces, planned and executed with extraordinary efficiency and effectiveness under very trying physical and security circumstances. It required extensive and fast turn-around planning and management for removal activities under hostile conditions and laboratory and interagency coordination. ORNL's planning and management for the execution of this removal activity required intense coordination with the Canadian government and private industry, the military services and the Department of State. (NA-21)

- ORNL has delivered outstanding results in the area of project management information system development, maintenance, and administration. ORNL is responsible for the project management and contract administration of multiple subcontractors who work together to develop a custom, state-of-the-art information system for GTRI. In FY 2008, ORNL was able to consistently deliver on time system upgrades and were very flexible in managing evolving priorities and short turn-around development activities. ORNL's budget and contract management on this project exceeded expectations as all project funding

was costed or committed by FY 2008 year-end on approved project work scope. High-level deliverables for FY 2008 were all met on time and within budget. The G2 system was repeatedly recognized as a best-in-class system by DOE and industry experts. (NA-21)

- Provided stellar support in planning and management of technical tasks for the HEU Transparency Program. (NA-24)

- Contributed to overall Program planning on technical measurements of conversion of highly enriched uranium to low enriched uranium. (NA-24)

- Demonstrated superb project management during the Fieldable Nuclear Material Information System conceptual design process. (NA-24)

- Always provided the right personnel available at the right time for INSEP activities (e.g., ORNL staff has been a consistently superior performer in managing resources required by INSEP safeguards activities in the South American region, and has been a key contributor in INSEP Focus Team efforts). (NA-24)

- Provided excellent work planning and executing several INECP events, particularly in Russia. Led INECP's first joint seminar with Russia's space agency, Roskosmos that went very well. Managed its funding well, with extra care to double check for HQ approval when unusual work requests arose. (NA-24)

- ORNL representatives provided leadership in management of nuclear material security projects at VNIIEF (Arzamas-16), VNIITF (Chelyabinsk-70), MCC (Krasnoyarsk-26), and the DOE/NNSA-Rosatom Working Group that promotes the development of tamper indicating device programs at Russian sites. (NA-25)

- Without exception, ORNL program staff have been reliable, thorough, organized, and demonstrated exceptional technical competency. (NA-25)
  Please see response to 3.0. (NA-25)

### 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs

- ORNL has been among the most responsive laboratories with which GTRI works. The staff assigned to support GTRI are attentive in listening to GTRI management needs and very quick in their responses. The input to the program is couched in the framework established by the GTRI program framework, concise, clear and provides the essential elements of information that enable GTRI management to make decisions quickly and effectively. (NA-21)

- The ORNL team has effectively communicated with NA-21 on the work status and has been extremely responsive to HQ needs for the BN-350 Spent Fuel and Russian Research Reactor Fuel Return Programs. (NA-21)

- Provides timely response to Program needs and tasks; keep HQ well-informed of issues as they arise. (NA-24)

- Provides outstanding coordination and cooperation with headquarters staff as well as with counterparts at other laboratories. (NA-24)

- Prepared an extremely useful report on the fuel fabrication facility at Yongbyon, DPRK. (NA-24)

- Provided excellent support from the M&O contractor at Headquarters, who has consistently exceeded expectations in his role for INSEP as Senior Technical Advisor, both in his analysis of technical merit of INSEP activities, and in his leadership of technical teams on visits to our foreign partners, such as Indonesia and Thailand. (NA-24)

- Provided support from ORNL staff as a proactive coordinator of INSEP's international meetings, who ensured timely and efficient responses to INSEP queries and requests for project status and other key information. (NA-24)

- Provided very responsive and extremely dedicated support, for example, one individual was responding by Blackberry while in the intensive care unit. (NA-24)

- Provided excellent communications by being meticulous in making sure that HQ needs are correctly understood and providing information accordingly. (NA-24)

- ORNL ensured all communication with HQ was accomplished in a timely and effective manner. (NA-25)

- ORNL staff have been conscientious and responsive to taskings and demonstrated a commitment to ensuring that Federal managers are satisfied with their support. (NA-25)

- ORNL contracting has provided the highest level of responsiveness to HQ, and ensured that communication with HQ is unfailing. ORNL's subcontractor has provided outstanding support to NA-25 work in Russia. (NA-25)

- Overall, ORNL travel support has been good, but one area for improvement might be staffing of the travel department. ORNL is much easier to deal with in terms of logistics than the other labs, so it's great to use them, but their travel staff seems consistently overworked. They may need to hire more staff. (NA-25)

- Oak Ridge provided excellent, efficient, and effective communications and responsiveness to TSP and NTTS needs and in terms of the ICL, ICL Assurances, and NA-25 travel and financial data. (NA-25)

# APPENDIX 7

# ASSISTANT SECRETARY FOR FOSSIL ENERGY

# PERFORMANCE EVALUATION SURVEY DATA

## 1.1 Science and Technology Results Provide Meaningful Impact on the Field

- The USC program is receiving a lot of attention now because of the ability of the program to increase power plant efficiency and reduce emissions. Given that the funding was received late in the FY and was much reduced from what was anticipated, ORNL was still able to contribute to the USC steam turbine program. (FE-69)

- Results are promising and are well-aligned with Fossil Energy's goals for the Coal Utilization Science (CUS) Program. Work was performed as proposed in the FY2008 FWP. However, there were no external publications or any other broad external recognition of the research. (FE-31)

- The science and technology results of the researchers have provided high and meaningful impact on the field. The following achievements are noted as support. The researchers have continued their outstanding contributions to DOE's Carbon Sequestration Program that supports the Global Climate Change initiative by conducting field and lab studies that focus on the GHG mitigation technology of geologic storage of carbon dioxide. This effort is a Presidential Initiative. ORNL researchers are investigating the use of isotopes and tracers to monitor the fate and transport of carbon dioxide injected into subsurface reservoirs. This work is vital to the Program mission because safe, permanent, and accountable storage of carbon dioxide is a requirement for the successful use of technology.

- The researchers continue to be in the forefront of this research on the use of tracers, isotopes and reservoir geochemistry, and are part of international teams conducting field studies of carbon dioxide injection at DOE's Regional Partnership, SECARB, Cranfield, Mississippi site and the now completed Frio Formation, Texas brine pilot site. Both are endorsed as Carbon Sequestration Leadership Forum projects, and have international recognition. The ORNL researchers are providing field support and analyses in their specialty area of tracers, isotopes and reservoir geochemistry. Their research has high impact on DOE's Carbon Sequestration Program mission, and is resolving critical questions that is allowing the research area to move forward. As part of the Frio pilot team, their research generated huge interest both within the U.S. and internationally, and led to a invitation to participate in the SECARB Cranfield injection demonstration.

- The researchers' publications have generated high impact on the field. The following lists cumulative publications and presentations.

  David R. Cole and Eric H. Oelkers (Editors), 2008, Carbon Sequestration, *Elements,* Oct. 2008 issue.

  Eric H. Oelkers and David R. Cole, 2008, Carbon Sequestration: An Introduction. *Elements*, Oct. 2008 issue.

  Sally M. Benson and David R Cole, 2008, Carbon dioxide sequestration in deep sedimentary formations, *Elements*, Oct. 2008 issue.

Yousif K. Kharaka, James J. Thordsen, Susan D. Hovorka, H. Seay Nance, David R. Cole, Tommy J. Phelps and Kevin G. Knauss (2008) Potential environmental issues of CO2 storage in deep saline aquifers: Geochemical results from the Frio-I Brine Pilot test, Texas, USA. (accepted by *Applied Geochemistry*)

Cole, D.R., Phelps, T.J., Kharaka, Y.K., Horita, J., Hovorka, S.D., Knauss, K.G., Thordsen, J.J., and Nance, H.S, 2008, Application of Gas and Fluid Chemistry, Stable Isotopes, and Perfluorocarbon Tracers as Monitoring, Measurement and Verification (MMV) Tools in Assessing Water-Rock Interaction during the Frio CO2 Injection Tests, Proceedings of the Seventh Annual Conference on Carbon Capture and Sequestration, May 5-8, 2008, Pittsburgh, PA.

Phelps, T.J., and Cole, D.R., 2008, Monitoring and Verification of Geologically Sequestered Carbon Dioxide Using Suites of Perfluorocarbons and Other Inert Tracers, Joint EPA-Groundwater Protection Council Meeting, Jan. 14-16, 2008.

Kharaka, Y. K., Thordsen, J. J., Hovorka, S. D., Nance, H. S., Cole, D. R., Phelps, T. J. and Knauss, K. G. (2007) Subsurface monitoring of anthropogenic CO2 injected in sedimentary basins: Results from the Frio-I brine test, Texas, USA. In: Proceedings of the 12th International Symposium on Water-Rock Interaction.

Kharaka, Y. K., Cole, D. R., Thordsen, J. J. and Kakouros, E. (2007) Application of stable isotopes and fluid chemistry to understanding anthropogenic CO2-brine-rock interactions in sedimentary basins: Results from the Frio brine pilot tests, Texas, USA. In: Proceedings of the International Symposium on Advances in Isotope Hydrology and its Role in Sustainable Water Resources Management, (Praveen Agarwal, editor), IAEA.

Kharaka, Y. K., Thomas D. Bullen, T. D., Hovorka, S. D., Cole, D. R., Knauss, K. G., and Freifeld, B. M. (2007) Mobilization of metals as a result of CO2 injection into sedimentary basins: Results from the Frio-II Brine test, Texas, USA. In: Proceedings of the 6th Annual Conf. Carbon Capture and Sequestration, Pittsburgh, PA May 7-10, 2007.

Hovorka, S. D., Daley, T. M., Freifeld, B. M., Kane, J., Kharaka, Y. K., Benson, S. M., Phelps, T. J., Pope, G., and Doughty, C. A. (2007) Testing interactions of buoyancy, multiphase flow, and geochemical interactions: Preliminary results from the Frio II test. In: Proceedings of the 6th Annual Conf. Carbon Capture and Sequestration, Pittsburgh, PA May 7-10, 2007.

Phelps, T. J., McCallum, S. D., Cole, D. R., Kharaka, Y. K. and S.D. Hovorka, S. D. (2006) Monitoring geological CO2 sequestration using perfluorocarbon tracers and isotopes. Fifth Annual Conference on Carbon Sequestration. May, 2006.

Kharaka, Y., K., Cole, D. R., Thordsen, J. J., Kakouros, E., and Nance, H.S. (2006) Gaswater-rock interactions in sedimentary basins: CO2 sequestration in the Frio Formation, Texas, USA. J. Geochem. Explor. 89, 183-186.

Kharaka, Y. K., Cole, D. R., Hovorka, S. D., Gunter, W. D., Knauss, K. G., and Freifeld, B. M. (2006) Gas-water-rock interactions in the Frio formation following CO2 injection: Implications to the storage of greenhouse gases in sedimentary basins. Geology 34, 577-580.

Kharaka, Y. K., Cole, D. R., Thordsen, J. J., Karouros, E., Pfiffner, S. and Hovorka, S. D. (2006) Environmental implications of toxic metals and dissolved organics released as a result of CO2 injection into the Frio Formation, Texas, USA. PROCEEDINGS, CO2SC Symposium 2006. Lawrence Berkeley National Laboratory, Berkeley, California, March20-22, 2006

Kharaka, Y. K., Cole, D. R., Hovorka, S. D., Phelps, T. J., and Nance, H. S. (2006) Potential environmental impacts of CO2 storage in sedimentary basins: Results from the Frio brine test, Texas, USA. Amer. Geophys. Union Fall Meeting Program with Abstracts.

McCallum, S. D., TJ Phelps, DE Riestenberg, DR Cole, BM Freifeld, RC Trautz, and SD Hovorka. 2005 Monitoring geologically sequestered CO2 during the Frio Brine Pilot Test using perfluorocarbon tracers. Proceedings of the Fourth Annual Conference on Carbon Sequestration.

- The researchers are making high-quality data available to the scientific community. This achievement is demonstrated by ORNL's teamwork in the DOE Regional Partnership, SECARB, carbon dioxide injection at Cranfield, Mississippi and the Frio, Texas brine pilot carbon dioxide injection project - both are endorsed as Carbon Sequestration Leadership Forum projects and have international participation and recognition. Results of these studies are being provided to the U.S. and international community. Also see list of publications provided above.

- Other special recognition includes the following:

  The ORNL researchers' efforts were cited in the EPA UIC Program for CO2 geologic sequestrations wells. The rule was signed July 15, 2008, by the EPA Administrator, and the rule recommends tracers and isotope as MMV measurement criteria. The proposed rule is available at the following website:
  http://edocket.access.gpo.gov/2008/pdf/E8-16626.pdf

  ORNL staff was invited Co-editor (with staff from Univ. Toulouse) of a special *Elements* issue on Carbon Sequestration (publication date, Oct. 2008).

  ORNL staff was invited to participate in the Alfred P. Sloan workshop on "Deep Carbon Cycle" held at the Geophysical Laboratory, Washington, D.C., May 15-17, 2008.

  The researchers were invited speakers at the January 2008 Groundwater Protection Council meeting, New Orleans, LA.

The researchers were invited participants in the EPA Public workshop on CO2 Geologic Sequestration, New Orleans, LA, January, 2008

The researchers were invited to join the DOE Regional Partnership SECARB team to support the carbon dioxide injection demonstration at Cranfield, Mississippi and monitor with isotopes, tracers, and reservoir geochemistry. This year their contributions have included a research plan to monitor the injection plume with isotopes and tracers. The plan was accepted and will be implemented in FY09. (FE-45)

- This ORNL team has submitted several papers in 2008, derived from work on this project. These are in first-rate, peer-reviewed journals, relevant to the field of fossil energy and multiphase flow. They range from papers on Open-Source software development to multi-scale simulation to simulation of specific fuel conversion devices. They have had a significant international impact on simulation methodology (de Wilde in Belgium, Pugsley in Canada, Ocone in UK, U Toulouse in France, Los Alamos Natl. Lab, etc.); their work has impacted a very broad range of other areas which exhibit multi-phase flows (Discrete Element Method, multi-scale chemistry, subgrid scale modeling, reduced order modeling, volcanism, lunar regolith, etc.). They have greatly extended the functionality of the web-based tools for the development software and the distribution of this technology. (FE-46)

- The work at ORNL has continued to establish the materials testing methodologies required by the SECA Industry Teams to test/characterize their unique material sets – important to their cell/stack modeling and design efforts. ORNL has provided vital data on the behavior of SOFC cell materials under wide-ranging conditions relevant to actual SOFC operation. (FE-66)

- Significant performance has been made in this project:

- Oxidation testing was continued on coated superalloy substrates and the effect of superalloy composition and oxidation temperature on alumina scale growth and adhesion were understood. Coated specimens were prepared for commercial YSZ coating. (FE-70)

    - The project results for this year impacts the research community as expected and is well regarded in the community.

    - The project completed all of it research goals for the year. (FE-49)

- The ORNL group that supports the Office of Petroleum Reserves is wildly recognized as a world leader in energy security research. Studies completed by ORNL are often sited by public and private entities when performing studies on global energy security. (FE-02)

- ORNL researchers produce a multitude of papers, give numerous presentations and

participate in technology transfer throughout the world. They have had significant impact on industry in developing new alloys for use in boiler tubes, super heaters, reheaters, etc. for sub- and supercritical pc-fired coal combustion plants. (FE-28)

- The USC program is receiving a lot of attention now because of the ability of the program to increase power plant efficiency and reduce emissions. The work that ORNL is performing is critical to the success of DOE's USC program. Scientist from other countries who have similar programs are also interested in the results being generated. (FE-61)

**1.2 Provide Quality Leadership in Science and Technology**

- ORNL demonstrates leadership in this effort through their constant communication with the USC Consortium members to discuss test results and provide guidance on program direction. ORNL's expertise in materials is highlighted through their work for the USC steam turbine program. (FE-69)

- The subject research is considered high-risk and high-payoff. Novel approaches are being utilized which have, to-date, provided some interesting results and reasonable payoff. The staff members and their collaboration are first-rate. Although the PI left the laboratory during this performance period, the research continued at a high level and all proposed work was completed. (FE-31)

- The researchers have provided quality leadership in science and technology for the DOE/FE Carbon Sequestration Program. The following achievements are noted as support.

- The scientific research pursued is unique and a challenge with respect to monitoring geologic storage of GHG as a mitigation technology. The lab has continued to be a trendsetter in the field with respect to the scientific approach and application of geochemistry; work conducted on use of isotopes, tracers, and reservoir geochemistry to monitor the fate and transport of carbon dioxide injected into a subsurface reservoir is proving to be a critical tool to verify safe and permanent storage in the subsurface. They have continued a leadership role in this specialized study and their excellence is demonstrated in numerous ways described in 1.1, including the following:

- The ORNL researchers' efforts were cited in the EPA UIC Program for CO2 geologic sequestrations wells. The rule was signed July 15, 2008, by the EPA Administrator, and the rule recommends tracers and isotope as MMV measurement criteria. The proposed rule is available at the following website: http://edocket.access.gpo.gov/2008/pdf/E8-16626.pdf

- ORNL staff was invited Co-editor (with staff from Univ. Toulouse) of a special *Elements* issue on Carbon Sequestration (publication date, October 2008).

- The researchers were invited to join the SECARB CO2 injection demonstration at Cranfield, Mississippi by Dr. Sue Hovorka, Texas Bureau of Economic Geology, Project

Principal Investigator.

- Weyburn Enhanced Oil Recovery and Storage Operations (Canada) project geochemists have used the ORNL researchers' stable isotope technique (reported in an ORNL publication, Kharaka et al., 2006) to estimate mass proportions of fluid and CO2 (as reported in conference proceedings, May 2008).

- Evidence of pursuit of novel approaches includes this year's study of small angle neutron scatter to assess adsorption behaviors of SF6 and CO2 in nanoporous solids (shared with DOE's Office of Science).

- Staff members are visible in leadership positions in the scientific community as supported in descriptions provided in 1.1. Most noteworthy are their roles in the Frio, Texas brine pilot study and the new supportive role in DOE's Regional Partnership, SECARB, and their carbon dioxide injection demonstration at Cranfield, Mississippi. (FE-45)

- The leadership that the ORNL team has shown in the development of the DEM capabilities of Mulitphase Flow with Interphase Exchanges (MFIX) has now made this a widely used component of this software package. This was a high-risk/high payoff/long-term research approach that ORNL committed to several years ago is now provided significant results in terms of applications and use in other development activities. The ORNL staff is committed to multi-scale modeling, sub-grid-scale model development, reduced-order (Proper Orthogonal Decomposition) modeling, and other advanced research concepts, which will have significant benefit to the future development of fossil fuel simulation capabilities. These activities are in close collaboration with NETL scientist and other groups at prestigious research institutions across the country: Iowa State University, U of Colorado, Princeton University, PSRI (Chicago), San Diego State, ... The project leader involved informulation of DOE SC program goal. He is deeply involved in the advancement of High Performance Computing capabilities in the DOE and academia. The action of the ORNL staff has been essential to the success of current Device-Scale Simulation activity funded by the DOE SC High Performance Computing Program. (FE-46)

- ORNL staff is the leader in the field of SOFC material properties and characterization, and has leadership roles in relevant professional societies. Has established and maintained good working relationships with the SECA industry Teams as well as Core Technology Program peers. The project is currently characterizing specific SOFC sealing glasses, a high priority within the SECA program. (FE-66)

- ORNL has shown leadership in this new bond coat materials based on g-g'-based Pt-rich aluminide coatings and the YSZ top coatings experiments in a real turbine environment will demonstrate its feasibility. This result will further prove their leadership in the development of materials for turbines. (FE-70)

- The ORNL work in this area is recognized as a national asset on the use of by products for land restoration. They continue to publish sound scientific results, which are referenced by many in the academic community. (FE-49)

- In addition to what has been stated above, the ORNL staff are always working with Office of Petroleum (OPR) staff to advance the field of energy security studies. This requires continuously working to expanding current theories and modeling capabilities. (FE-02)

- ORNL provides leadership in finding solutions to the materials challenges facing the power generation industry. They are called on to consult on problems associated with current power plants as well and known to be a leader in the development of advanced materials for the extreme environments that the advanced power generation plants will have. Of particular note at this point in time is their superior efforts in working with powder manufacturers, boiler tube makers and others to make usage of oxide dispersion-strengthened materials, iron aluminides, coatings and claddings, potentially useful in super- and ultrasupercrital boiler systems as well as advanced high-temperature steam. (FE-28)

- ORNL demonstrates leadership in this effort through their constant communication with the USC Consortium members to discuss test results and provide guidance on program direction. ORNL's expertise in materials is highlighted through their work for the USC program. (FE-61)

**1.3 Provide and Sustain Science and Technology Outputs that Advance Program Objectives and Goals**

- Even though ORNL had a late start in the FY, they were able to make meaningful contributions to the USC steam turbine program. Having been unable to work on this task in FY 2007 because of lack of funding, ORNL continued to stay abreast of the UCS activities and was able to have an immediate impact once funding was restored. (FE-69)

- This research effort effectively addresses the FE program goals. Sensors and Controls is a major element within the CUS program area. This effort is focused on a unique approach to measuring SO2 and NH3. (FE-31)

- This research provides and sustains science and technology outputs that advance program objectives and goals. This is demonstrated by:

    - The number of publications in peer-reviewed journals (see list provided in 1.1).

    - The quantity of output from experimental and theoretical research. The ORNL researchers participated in the benchmark Frio, Texas pilot study that has led to their support for the SECARB carbon dioxide injection demonstration at Cranfield, Mississippi; both are Carbon Sequestration Leadership Forum endorsed project and have international participation and recognition. Their expertise continues to be sought after for participation in other key carbon dioxide geologic storage projects.

- Demonstrated progress against peer reviewed recommendations. As part of the Frio, Texas pilot team, and the SECARB Cranfield, Mississippi demonstration team, the researchers collaborate extensively with their peer researchers in the design and conduct of the fieldwork, analyses of the field data, and publications that resulted. (FE-45)

- The ORNL personnel on this project have made major contributions to the advancements of the program objectives, the development of simulation capabilities for multi-phase flows related to fossil energy conversion processes. They have taken leadership roles in DEM development, multi-scale simulation, Lagrangian numerics, etc. ORNL staff has continued to contribute to the development of the future plans for this program.

- Their publication list in 2008 is very significant (this is a large number of publications for a small-scale project):

  "Multifluid Eulerian Modelling of Dense Gas-Solid Fluidized Bed Hydrodynamics: Influence of the Dissipation Parameters," N. Reuge, L. Cadoret, C. Coufort, S. Pannala, M. Syamlal and B. Caussat, Chemical Engineering Science (Accepted Manuscript), 2008.

  "Filtered two-fluid models for fluidized gas-particle suspensions," Yesim Igci, Arthur Andrews, Sankaran Sundaresan, Sreekanth Pannala, and Thomas O'Brien, AIChE Journal, 54(6), 1431-1448, 2008.

  "Open-Source Software in Computational Research: A Case Study," M. Syamlal, T. J. O'Brien, S. Benyahia, A. Gel, and S. Pannala, Modelling and Simulation in Engineering, Vol. 2008, 937542, 2008. doi:10.1155/2008/937542.

  "Effects of using two- versus three-dimensional computational modeling of fluidized beds: Part II, analysis," Nan Xie, Francine Battaglia and Sreekanth Pannala, Powder Technology, 182, 14–24, 2008.

  "Effects of using two- versus three-dimensional computational modeling of fluidized beds: Part I, hydrodynamics," Nan Xie and Francine Battaglia and Sreekanth Pannala, Powder Technology, 182,
  1–13, 2008.

  "Discriminating characteristics for simulation-based design and scaling of spouted beds," C. E. A. Finney, S. Pannala and C. S. Daw, Computational Fluid Dynamics in Chemical Reaction Engineering V, Whistler, BC, Canada, June 15-10, 2008. {URL: http://www.cfdcre5.org/cfdcre5-Finney.pdf}

  "Understanding the interactions between hydrodynamics and chemistry in coal gasifier simulations," S. Pannala, C. Guenther, J. Galvin, M. Syamlal and A. Gel, Computational Fluid Dynamics in Chemical Reaction Engineering V, Whistler, BC, Canada, June 15-10, 2008. {URL: http://www.cfdcre5.org/cfdcre5-Pannala.pdf} (FE-46)

- The project has met or exceeded all programmatic milestones. Output has been appropriate for level of funding. Work and output continues to generate SECA Industry Team interest. (FE-66)

- Testing on bond coated on superalloys with PVD YSZ in collaboration with GE will be very useful information for understanding the YSZ coatings durability on these newly developed bond coats. Based on a recent discussion with ORNL we understood that there is no segregation information from real MCrAlY bond coatings used in land-based turbines. One of the critical areas that could be addressed in TBC research is the location of minor elements in the TBC. For example, location of Ti from CMSX4 in oxide. Both GE and Siemens are interested in adding low levels of rare earths to superalloys to improve their coating performance. More tests on the above work and tests on the TBC coated on to the newly developed bond coat materials by ORNL will advance this program objectives and goals. (FE-70)

- The work performed by ORNL is helping DOE attain it programmatic goals of reducing the cost of indirect sequestration. The results of laboratory, field, and planning document show that the economics and potential for using these technologies to reduce carbon in the atmosphere is very promising. (FE-49)

- ORNL are often asked to assist other governments in energy security analytical work. They are also frequently asked to present their papers and studies to professional and trade organizations. (FE-02)

- ORNL does manage to produce a number of technical, peer reviewed publications that are cited in many prestigious journals. Yet in the Advanced Materials Program, the only real reporting and tech transfer that comes to those of us in FE or to the public are made during the Annual FE Materials Conference and Project Review Meeting. In the earlier years of the Program, Quarterly Status Reports were written and the cognizant NETL COR could keep up with the project fairly well. In recent years this requirement had slipped to almost nothing more than an Annual Report, which can make it difficult to measure and monitor significant breakthroughs or where problems have arisen. ORNL, this year, started to send quarterly reports again. (FE-28)

- ORNL is well-known for their materials expertise and, as such are often asked to participate in industry forums. ORNL has continued to meet the program goals and objectives and is responsive to the USC consortium member's needs and concerns. The work at ORNL is critical to the success of the USC program. ORNL has published numerous articles from this work that have generated international interest. There have been several inquiries from international organizations regarding participation in the USC program based on ORNL presentations and publications. (FE-61)

### 1.4 Provide for Effective Delivery of Science and Technology

- ORNL has met goals and milestones consistent with the amount of funding that has been provided. (FE-69)

- Although the milestones and deliverables for this project were minimal, all were met and effectively communicated to the project monitor. (FE-31)

- The researchers have been very effective and efficient in the delivery of the science. This has been demonstrated by the following.

    - Effective in meeting goals and milestones such as the FY 2008 FWP quarterly project milestones.
    - Effective in FY 2008 FWP reporting and providing necessary DOE documents for planning.
    - Effectively transmitting results to the scientific community as supported by numerous peer-reviewed publications, conference proceedings, and extensive collaboration with peer-researchers in carbon sequestration. (FE-45)

- The ORNL team has always been extremely productive. All program goals/milestones have been exceeded and met in a very timely fashion. They have been very responsive in providing reports. Requests for information were very rapid, almost anticipated. Deliverables were all provided on time; they were all of high quality. Results of the total project have been made available at www.mfix.netl.doe.gov. The ORNL team was essential to the development of this capability. (FE-46)

- The ORNL team has met or exceeded all programmatic milestones for FY 2008. Data used from the characterization of typical cathode contact aids and associated interfaces is being used by other SECA participants in the creation and validation of finite element analysis models that will be used for failure analysis. ORNL's continued work on the ASME SOFC Design Basis has produced a solid document of programmatic value. (FE-66)

- All the milestones described in FWP have been completed. Since there was a delay in money last year as well as this year some of the testing will be delayed (Bond coatings on superalloys will be sent to GE for PVD YSZ coatings in October)

- Oxidation testing on coated superalloy substrates to study the effect of superalloy composition and oxidation temperature on alumina scale growth and adhesion were performed. Newly coated specimens were prepared for commercial YSZ coating.

- Results from this program were presented at the Superalloys 2008 meeting in Champion, PA in September. PI had numerous interactions with coating and superalloy researchers relevant to the project. (FE-70)

- All of the products that were negotiated were delivered on time during the projects performance. Products were well written and communicated the scientific findings of the research. They keep DOE updated on the projects performance throughout the year. (FE-49)

- Work products are completed on time and ORNL staff are regularly able to work with

changing priorities from OPR. (FE-02)

- Members of the FE Materials Program make an earnest effort to meet milestones as planned or come up with alternative ways to approach the problem. But as in any "research" program, oftentimes the results obtained are not expected, and setbacks can occur. Materials which often look promising for an application, when put under the microscope, turn out not quite as what was expected, may require further development, or substitutions. ORNL is excellent in this regard, and know when to "give up" and go in another direction if required. (FE-28)

- ORNL has met goals and milestones consistent with the amount of funding that has been provided. (FE-61)

**2.1 Provide Effective Facility Design(s) as Required to Support Laboratory Programs**

N/A

**2.2 Provide for the Effective and Efficient Construction of Facilities and/or Fabrication of Components**

N/A

**2.3 Provide Efficient and Effective Operation of Facilities**

N/A

**2.4 Utilization of Facility to Grow and Support Lab's Research Base and External User Community**

N/A

**3.1 Provide Effective and Efficient Stewardship of Scientific Capabilities and Program Vision**

- ORNL maintains a highly-qualified, well-regarded staff of scientists who are world renowned for their materials expertise. (FE-69)

- Project monitor is unaware of any joint planning or workshops with the outside community in connection with this research effort. There does seem to be an ability by the laboratory to attract highly qualified staff – the researchers on this effort are first-rate. (FE-31)

- The researchers have provided effective and efficient stewardship of scientific capabilities and program vision. This is supported by the following achievements.

  - Efficiency and effectiveness of joint planning with outside community.
  - Articulation of scientific vision.

- Development of core competencies.

- Highly efficient and effective joint planning with the outside scientific community is exemplified by their participation in the research teams for the Frio pilot and SECARB Cranfield, Mississippi projects. Both are endorsed as a Carbon Sequestration Leadership Forum projects and have international participation and recognition; results are being provided to the U.S. and international community. Other supportive examples of joint planning are provided in 1.1.

- The researchers have articulated scientific vision well with respect to their specialty of use of isotopes, tracers, and reservoir chemistry as a monitoring tool for geologic storage of carbon dioxide. They are world leaders in this area as supported by their unique participation in the CSLF Frio pilot and SECARB Cranfield, Mississippi injection demonstration, as well the invitations to participate in similar geologic storage projects. Their articulation of the science is supported by the numerous publications as provided in 1.1.

- Core competencies have been developed in this research area of the application of tracers, isotopes, and reservoir chemistry for monitoring geologic storage of carbon dioxide as a GHG mitigation technology. (FE-45)

- ORNL staff has provided leadership in the development of simulation capabilities for multiphase flow and multi-scaled coupling. He has assisted in the development of work plans for these programs, making significant contributions, e.g., the first draft of most position papers. He has severed as a connection point between scientific research in DOE SC and DOE FE. He has facilitated the development of giga-scale computational simulations of FE interest. He has carried these ideas to research group around the globe (e.g., US, Canada, France). This has elicited an international interest in this FE project. (FE-46)

- Technical capabilities and results are valued by SECA Program Management. Relevant core competencies are well-established. (FE-66)

- ORNL PI is an excellent researcher. He coordinates the research in a timely manner. He has been active in publishing scientific papers, conference presentations, organizing meetings in ceramic society based on the research performed. (FE-70)

- The ORNL staff works closely with NETL and FE to define the goals of the work for the year and maintain the research focus to help with the programmatic goals. The personnel are considered experts in their field and have maintained their work over several years on this project. (FE-49)

- The ORNL staff supporting the Strategic Petroleum Reserve are generally regarded as experts in the field of energy security and policy analysis. Their collective reputations allow access to other researchers, providing opportunities for collaboration on a variety of projects. (FE-02)

- The ORNL Materials Program is working with both European groups (COST Program) and with EPRI, and as part of the Consortium for development of Ultrasupercritical Boilers and Turbines they are providing a supporting role in evaluating novel materials. ORNL is also highly regarded in the academic and research community for their ability to attract some of the most skilled and highly qualified experts in the world to their facility. However, ORNL continues to express concerns about reduced budgets, and how it will be difficult to keep up a coherent FE Materials program with such experts, if budgets continue to dwindle to the point where skills will be lost to other competing entities such as Universities or other National Labs. (FE-28)

- ORNL maintains a highly-qualified, well-regarded staff of scientists who are world renowned for their materials expertise. (FE-61)

### 3.2 Provide Effective and Efficient Science and Technology Project/Program Planning and Management

- ORNL works with the consortium to define the test plan and provides input on how and when things should be done in order to achieve results that will be valuable to the program. (FE-69)

- The work in this research effort rigorously followed the FWP as approved for FY 2008. (FE-31)

- Highly effective and efficient science and technology project/program planning and management have been provided by the researchers. This is supported by the high quality Field Work Proposal and Project Management Plans submitted, the annual reporting of project status, and the leveraging/synergy with other areas of research such as the Frio injection pilot study and the SECARB Cranfield, Mississippi demonstration. In addition, the researchers have been able to meet milestones under FY budget constraints. (FE-45)

- This ORNL project has consistently over-performed, considering its funding level. The number of significant publications has been large. They have developed strong interactions with other groups (Princeton, Los Alamos, ORNL, U Toulouse, U British Columbia, ...), which have greatly extended the scope of the effort. They have shown significant technical innovation in, e.g., multi-scale simulation and high performance computing. Program plans have been robust and flexible, providing for
- long-range stability of the program. (FE-46)

- R&D work is of the excellent quality, and is managed well. The ORNL team accomplishes what it states it will do. (FE-66)

- Good research plan for the program areas. Plans are consistent with known budgets and well aligned with DOE interests. (FE-70)

- The principle researchers are members of other research programs such as with the office of science and other professional societies. The work is reviewed at several technical

conferences to ensure it is relevant to programmatic goals and of the highest quality research. (FE-49)

- The extensive model and energy experience of the ORNL staff are an invaluable resource in planning and executing studies. This experience allows for efficient study design and execution while minimizing errors and reworks. (FE-02)

- The Materials Laboratory and High-Temperature Materials Lab at ORNL are one-of-a-kind, and their instrumentation, such as advanced electron microscopes, X-ray Diffraction units, high temperature test rigs, are unparalled. They effectively utilize such uniqueness in leveraging activities with other organizations, through the use of User Facility Programs. (FE-28)

- ORNL works with the consortium to define the test plan and provides input on how and when things should be done in order to achieve results that will be valuable to the program. (FE-61)

### 3.3 Provide Efficient and Effective Communications and Responsiveness to Customer Needs

- ORNL is responsive to the needs and issues of the USC consortium. ORNL seeks feedback on their test results and makes sure that everyone has a clear understanding of the results and the impact of the results on the program. (FE-69)

- Communication is excellent. Staff members are eager to provide any information requested and do so in a timely manner. (FE-31)

- Highly efficient and effective communications, as well as high responsiveness to the DOE customer, is provided. The researchers provide high quality, accurate, and timely responses to DOE and other stakeholder requests. Examples include timely and high quality responses to calls for annual Field Work Proposals and special requests for project status information.

- Communications channels are well-defined and there is good interaction between researchers and the DOE Project Manager with respect to project status and project planning. (FE-45)

- Communication between the NETL staff and this ORNL team is extremely tight. They participate very actively in weekly web-based conferences. Their response to e-mail or phone requests, is extremely timely, almost always within minutes. (FE-46)

- Responses to DOE requests for information are generally timely and of high-quality. ORNL is very responsive to programmatic direction. (FE-66)

- NETL has developed an efficient and effective communication with ORNL. Responses to requests for information are provided in a timely manner. (FE-70)

- The ORNL staff is proactive in providing updates to FE on the status of the project and responsive to requests for information about budget, accomplishments, and schedule for the project. The communications are clear and concise. (FE-49)

- ORNL staff maintain the flexibility to effectively adapt to the changing needs of the SPR and the DOE and respond well to input and comments. They also maintain to ability to respond quickly to changing program needs. (FE-02)

- Most of the Task CORs that oversee the AR Materials work have a good line of verbal communications with the ORNL PIs and written communication, in particular, Quarterly written reports, which allow us to track goals, progress, or areas where problems exist, is improving. (FE-28)

- ORNL is responsive to the needs and issues of the USC consortium. ORNL seeks feedback on their test results and makes sure that everyone has a clear understanding of the results and the impact of the results on the program. (FE-61)

# APPENDIX 8

# U.S. DEPARTMENT OF HOMELAND SECURITY

# PERFORMANCE EVALUATION SURVEY DATA

### 3.2 Provide Effective and Efficient Science and Technology Project/Program Planning and Management

Very effective relationship between ORNL staff in executing the Southeast Region Research Initiative program.

Department of Homeland Security Scores:

| | | |
|---|---|---|
| 1.1 Impact | 3.8 | A |
| 1.2 Leadership | 3.8 | A |
| 1.3 Output | 3.3 | B+ |
| 1.4 Delivery | 3.3 | B+ |

| | | |
|---|---|---|
| 3.1 Effective/Efficient Stewardship | 3.8 | A |
| 3.2 Project Program Planning & Management | 3.5 | A- |
| 3.3 Communications and Responsiveness | 3.3 | B+ |

# APPENDIX 9

# U.S. NUCLEAR REGULATORY COMMISSION

# PERFORMANCE EVALUATION SURVEY DATA

**Office of Nuclear Reactor Regulation (NRR)**

**None**

**Office of New Reactors (NRO)**

**JCN: J3316**

Although interactions with ORNL were generally excellent, the report itself required several rounds of editing to ensure that the report accurately document the scope of the project. The contractor was always available for consultation and was very helpful in explaining the work that was done.

**JCN: Q4018**

Timing is everything. The NRC placed this task during the staging phase to prepare qualified technical resources to assist the NRC in upcoming license review activities for new reactor projects. ORNL participated effectively in preparing for these assignments; this included classroom as well as field activities as ORNL staff familiarized them selves with the NRC's regulatory framework and its conduct of operations during the reviews. During this staging phase, ORNL staff has integrated itself into the NRC asset pool of technical resources and the leadership candidates. The results of ORNL's efforts speaks for itself. Two projects have been placed at ORNL because the UT-Battelle team has adequately demonstrated that it is capable of leading technical professionals and managing the work effort necessary to assist the NRC. We have every expectation that ORNL can rise to take on this challenge to provide high quality, timely, and cost effective support for these projects. This overall assessment is not limited to the individuals providing support; clearly, it extends to the management team at ORNL who have demonstrated the organizational commitment to the culture that provides for quality service to its clients, and to the mission of energy security for out nation.

**Office of Nuclear Regulatory Research (RES)**

**JCN: N6080**

ORNL was very responsive to all requests made from me. To date it has been very effective in meeting the objectives of the project. Good quality of technical preparation of draft RG revisions and good communications.

**JCN: N6115**

Good communications and tracking of deliverables by the ORNL.

**JCN: N6176**

The project was late by one year, and the initial draft product was not satisfactory. Additional effort was required to analyze the information in order to determine the value of the product. Despite being given another 2 months to address the substantive comments, the revised draft

NUREG was late by over another month. The ORNL project manager appeared to be spread too thin to address this project. There were several conferences and other travel that kept the project manager away from this project. The project manager is knowledgeable and the data developed from the project will be useful with additional effort on the part of the NRC staff. The recovery efforts by ORNL to correct the issues with the initial product were substantial and demonstrated ownership of the problem.

**JCN: N6217**

Products have shown high technical quality though have not always been received according to schedule, for the most part due to scheduling constraints of the principal investigator.

**JCN: N6346/N6433**

The ORNL technical staff working on this project are internationally-recognized leaders in their field and provide high quality work products. ORNL and UT-Battelle should take proactive measures to ensure that the Center for Biokinetic and Dosimetric Research maintains its resident expertise for future USNRC needs.

**JCN: N6351**

Funding difficulties on the part of the continuing resolution early in this project resulted in loss of contractor staff. The loss of contractor staff due to the funding issues has delayed the completion of this project. The Principal Investigator has provided support and continued to work on this project to the extent possible. Additional staff have been added to the project this year. ORNL Project Management has been diluted by a number of competing tasks. Monthly status reports and billing have been delivered on time.

**JCN: N6471**

Products received thus far have shown high technical quality and have been received according project schedule (factoring in necessary period of performance extension due to scheduling conflicts of key personnel).

**JCN: N6571**

ORNL staff have taken the timely initiative to update the technical basis for uranium bioassays in a scientifically sound and thorough manner that takes into account changes in the industry, detailed primary references to provide the bases for assumptions, and contemporary models and methods. They have been promptly responsive to probing questions from the NRC PM, even when additional research and reviews were required. These efforts are expected to be practically applicable while also advancing the accuracy of bioassays.

**JCN: Y6475**

This project lasted about 5 years with 4 deliverables. The products were generally sound.

**JCN: Y6962**

ORNL has provided excellent services with regard of project deliverables, communication and responsiveness. There are very few technical glitches in its products. The overall rating is good. Some improvement in contract cost estimating/cost control is needed.

**Office of Nuclear Material Safety and Safeguards (NMSS)**

**JCN: J5609**

ORNL demonstrated an outstanding level of technical quality and excellence in supporting the SCALE Development and Technical Assistance contract. Examples of contract achievements in the past year include:

- Draft report for B0009 Task 33 Couple Neutron – Gamma Shielding Library.
- Technical assistance for the TN-40 and VSC-24 burnup credit criticality reviews.
- Developed and implementation of agency – wide burnup credit training.
- Published NUREG/CR on criticality analysis of assembly (misload in a PWR BNL cask)
- Represented NRC at IAEA TRANSSC and ISO meeting.

**Office of Federal and State Materials and Environmental Management (FSME)**

**JCN: E7044**

ORNL has performed very well on this contract, especially considering the constant changes required by NRC web site design team. They have been very flexible in accepting the changes in timing and details to accomplish the mission. ORNL has also proposed process efficiencies, which reduced costs. Communication between ORNL and NRC has been excellent. ORNL performed its web site activities in an outstanding manner. ORNL made the transition to the follow-on contract without any interruption in service.

**JCN: J5527**

ORNL has performed very well on this contract. They have been very flexible in accepting the changes in timing and details to accomplish the mission. Communication between ORNL and NRC has been excellent.

**JCN: F1040**

ORNL has performed very well on this contract, especially considering the constant changes required by NRC web site design team. They have been very flexible in accepting the changes in timing and details to accomplish the mission. ORNL has also proposed process efficiencies, which reduced costs. Communication between ORNL and NRC has been excellent. ORNL continues to perform its web site activities in an outstanding manner.

# APPENDIX 10

# FEE CALCULATION

# FY 2008 Performance Fee Calculation

| Metric | Letter Grade | Score | Weight (Goal) | Weight (Obj.) | Weight (Meas.) | Weighted Score |
|---|---|---|---|---|---|---|
| **SCIENCE & TECHNOLOGY** | **A-** | **3.7** | 100.0% | | | 3.71 |
| 1.0 Mission Accomplishment | A- | 3.7 | 39.2% | | | 1.45 |
| 2.0 Facilities | A- | 3.7 | 30.0% | | | 1.10 |
| 3.0 S&T Project/Program Management | A- | 3.7 | 30.9% | | | 1.16 |
| **MANAGEMENT & OPERATIONS** | **A-** | **3.6** | 100.0% | | | 3.57 |
| 4.0 Leadership & Stewardship | A- | 3.7 | 15.0% | | | 0.56 |
| 4.1 Vision | A | 3.9 | | 40.0% | | 1.56 |
| 4.1.1 Adequacy of Vision | A | 3.9 | | | 25.0% | 0.98 |
| 4.1.2 Partnerships | A | 3.9 | | | 25.0% | 0.98 |
| 4.1.3 Community Standing | A | 4.0 | | | 25.0% | 1.00 |
| 4.1.4 Cost of Doing Business | A- | 3.6 | | | 25.0% | 0.90 |
| 4.2 Leadership | A- | 3.6 | | 30.0% | | 1.08 |
| 4.2.1 Integrated Perf. Management | A- | 3.7 | | | 50.0% | 1.85 |
| 4.2.2 Progress - Commitments/Actions | B+ | 3.4 | | | 50.0% | 1.70 |
| 4.3 Corporate Support | A- | 3.6 | | 30.0% | | 1.08 |
| 4.3.1 Safety Management | A- | 3.7 | | | 50.0% | 1.85 |
| 4.3.2 Assurance System | B+ | 3.4 | | | 50.0% | 1.70 |
| | | | | | | |
| 5.0 ES&H Protection | A- | 3.7 | 30.0% | | | 1.10 |
| 5.1 Work Environment | A- | 3.6 | | 45.0% | | 1.62 |
| 5.1.1 DART | A | 4.0 | | | 20.0% | 0.80 |
| 5.1.2 TRC | B- | 2.7 | | | 10.0% | 0.27 |
| 5.1.3 Safety Leadership | A | 4.0 | | | 15.0% | 0.60 |
| 5.1.4 10 CFR 851 Program | A+ | 4.1 | | | 10.0% | 0.41 |
| 5.1.5 ALARA | A- | 3.7 | | | 10.0% | 0.37 |
| 5.1.6 Environmental Requirements | B+ | 3.4 | | | 10.0% | 0.34 |
| 5.1.7 Natural Phenomena Actions | B | 3.0 | | | 10.0% | 0.30 |
| 5.1.8 PAAA | B+ | 3.3 | | | 10.0% | 0.33 |
| 5.1.9 Occurrence Reporting System | B | 3.0 | | | 5.0% | 0.15 |
| 5.2. ES&H Management | A- | 3.6 | | 40.0% | | 1.44 |
| 5.2.1 ES&H Validation - External | A | 3.8 | | | 50.0% | 1.90 |
| 5.2.2 ES&H Validation - Internal | B+ | 3.4 | | | 50.0% | 1.70 |
| 5.3 Waste Management | A | 4.0 | | 15.0% | | 0.60 |
| 5.3.1 Accumulation/Disposition | A | 4.0 | | | 33.3% | 1.33 |
| 5.3.2 Pollution Prevention | A | 4.0 | | | 33.3% | 1.33 |
| 5.3.3 Transfer of New Waste | A | 4.0 | | | 33.3% | 1.33 |
| | | | | | | |
| 6.0 Business System & Resources | B+ | 3.4 | 20.0% | | | 0.67 |
| 6.1 Financial Management System | B- | 2.5 | | 25.0% | | 0.63 |
| 6.1.1 Systems & Processes | B+ | 3.2 | | | 20.0% | 0.64 |
| 6.1.2 Financial Reports | B- | 2.6 | | | 20.0% | 0.52 |
| 6.1.3 Prompt Efficiency | C | 1.8 | | | 20.0% | 0.36 |
| 6.1.4 A-123 Compliance | B+ | 3.2 | | | 15.0% | 0.48 |
| 6.1.5 Adequacy of Systems | C | 1.8 | | | 25.0% | 0.45 |
| 6.2 Acquisition/Property Mgmt. | A | 3.9 | | 10.0% | | 0.39 |
| 6.2.1 Acquisition/Contract Mgmt. | A | 3.8 | | | 50.0% | 1.90 |

| Metric | Letter Grade | Score | Weight (Goal) | Weight (Obj.) | Weight (Meas.) | Weighted Score |
|---|---|---|---|---|---|---|
| 6.2.2 Property Management | A | 3.9 | | | 50.0% | 1.95 |
| 6.3 Human Resources Mgmt. | B+ | 3.4 | | 20.0% | | 0.68 |
| 6.3.1 Total Compensation | B+ | 3.3 | | | 20.0% | 0.66 |
| 6.3.2 Benefits Valuation Analysis | B+ | 3.4 | | | 20.0% | 0.68 |
| 6.3.3 Management Performance | B+ | 3.3 | | | 20.0% | 0.66 |
| 6.3.4 Healthy Labor Relations | A- | 3.5 | | | 20.0% | 0.70 |
| 6.3.5 Sound HR Practices | B+ | 3.3 | | | 20.0% | 0.66 |
| 6.4 Internal Audit | A- | 3.6 | | 30.0% | | 1.08 |
| 6.4.1 Planning & Execution | A | 4.0 | | | 33.3% | 1.33 |
| 6.4.2 Independent Assessment | B+ | 3.3 | | | 33.3% | 1.10 |
| 6.4.3 Self-Assessment Program | A- | 3.6 | | | 33.3% | 1.20 |
| 6.5 Technology Transfer - 6.5.1 | A | 3.9 | | 15.0% | | 0.59 |
| | | | | | | |
| 7.0 Facility/Infrastructure Portfolio | A- | 3.6 | 20.0% | | | 0.72 |
| 7.1 Optimize Use/Minimize Costs | A | 3.8 | | 35.0% | | 1.33 |
| 7.1.1 Reduce Nuclear Footprint | B+ | 3.4 | | | 12.5% | 0.43 |
| 7.1.2 System Design Descriptions | A- | 3.5 | | | 12.5% | 0.44 |
| 7.1.3 Deferred Maintenance | A | 4.0 | | | 12.5% | 0.50 |
| 7.1.4 Aging Infrastructure | A | 4.0 | | | 12.5% | 0.50 |
| 7.1.5 TEAM Initiative for Improvement | A | 4.0 | | | 12.5% | 0.50 |
| 7.1.6 Energy Eff. Improvement | A | 4.0 | | | 12.5% | 0.50 |
| 7.1.7 Unneeded Materials/Chemicals | A | 3.8 | | | 12.5% | 0.48 |
| 7.1.8 Excess Facility Disposition | A | 4.0 | | | 12.5% | 0.50 |
| 7.2 Support Future Programs | A- | 3.5 | | 65.0% | | 2.28 |
| 7.2.1 Vision for Infrastructure | A- | 3.7 | | | 16.7% | 0.62 |
| 7.2.2 Capital Planning Base | B+ | 3.3 | | | 16.7% | 0.55 |
| 7.2.3 Tailoring Plan for MLF | B+ | 3.3 | | | 16.7% | 0.55 |
| 7.2.4 Develop West Campus | B+ | 3.4 | | | 16.7% | 0.57 |
| 7.2.5 Develop Utility Systems | A- | 3.6 | | | 16.7% | 0.60 |
| 7.2.6 Effective Project Management | B+ | 3.4 | | | 16.7% | 0.57 |
| | | | | | | |
| 8.0 ISSM/Emergency Management | A- | 3.5 | 15.0% | | | 0.52 |
| 8.1 Emergency Mgmt. System | A- | 3.7 | | 20.0% | | 0.74 |
| 8.1.1 Full Participation Exercise | A- | 3.7 | | | 50.0% | 1.85 |
| 8.1.2 Emergency Mgmt Drills | A- | 3.7 | | | 50.0% | 1.85 |
| 8.2 Cyber-Security | B | 2.8 | | 25.0% | | 0.70 |
| 8.2.1 Cyber Security Program | B- | 2.7 | | | 50.0% | 1.35 |
| 8.2.2 Site Assist Visit | B | 2.8 | | | 50.0% | 1.40 |
| 8.3 Protect SNM, Classified Mat. | A- | 3.7 | | 25.0% | | 0.93 |
| 8.3.1 DBT Requirements | A | 3.9 | | | 33.3% | 1.30 |
| 8.3.2 Corrective Actions | B+ | 3.4 | | | 33.3% | 1.13 |
| 8.3.3 Implement New Technology | A- | 3.7 | | | 33.3% | 1.23 |
| 8.4 Prot. Classified/Sensitive Info. | A- | 3.7 | | 30.0% | | 1.11 |
| 8.4.1 Information Security Programs | A- | 3.6 | | | 20.0% | 0.72 |
| 8.4.2 Random OSPEC Reviews | B+ | 3.4 | | | 20.0% | 0.68 |
| 8.4.3 Prevention of Violations | B+ | 3.3 | | | 20.0% | 0.66 |
| 8.4.4 Effective CI Program | A | 4.0 | | | 40.0% | 1.60 |

## FEE CALCULATION:

| | |
|---|---|
| **$10,700,000.00** | **(AVAILABLE FEE)** |
| **0.94** | **(S&T MULTIPLIER)** |
| **1.00** | **(M&O MULTIPLIER)** |
| **$10,058,000.00** | **(OVERALL EARNED FEE)** |
| **94.0%** | **(PERCENT FEE EARNED)** |

# APPENDIX 11

# FY 2008 EXTERNAL ASSESSMENT EFFORTS AT ORNL

| FY 08 Major External Assessment Efforts At ORNL | Onsite Person Days | Date |
|---|---|---|
| **DOE-Headquarters- 355 Person Days** | | |
| Continuous Monitoring Assessment | 10.0 | 10/22/07 |
| ORNL-Personal Property & Cyber Security Policy Compliance Assessment | 20.0 | 01/28/08 |
| Continuing Qualification Audit of the ORNL UT-Battelle Radioactive Materials Analysis Laboratory (RMAL) | 9.0 | 02/12/08 |
| DOE Laboratory Accreditation Program (DOELAP) onsite Assessment of Personnel Dosimetry | 4.0 | 02/26/08 |
| DOE Office of Science Audit of the Innovative and Novel Computational Impact Theory and Experiment (INCITE) Program | 4.0 | 03/31/08 |
| Annual Communications Security (COMSEC) Inspection | 1.0 | 04/10/08 |
| Office of Emergency Management Oversight (OEMO) Participation in the Conduct of Composite Performance Tests (CPTs) for Emergency Preparedness and Security/Drill Exercise ProgramHS-63 | 119.0 | 08/04/08 |
| HS-64 ISM Audit | 188.0 | 08/04/08 |
| **DOE-ORO - 336.7 Person Days** | | |
| DOE Participation in OAP Walk-throughs and Performance Observations | 28.6 | 11 visits |
| Laboratory Directed Research and Development (LDRD) Certification | 8.0 | 01/07/08 |
| Biennial Review of Prices Charged for Materials ad Services | 8.0 | 01/14/08 |
| Annual Financial Management System Review | 20.0 | 02/04/08 |
| ORNL Hoisting and Rigging Operations/Activities | 20.0 | 02/11/08 |
| ORNL Software Quality Assurance Program | 24.0 | 02/25/08 |
| DOE Annual Assessment of the Unneeded Materials and Chemicals Program | 6.0 | 03/31/08 |
| Annual DOE-ORO Security Inspection at ORNL | 140.0 | 04/21/08 |

| | | |
|---|---|---|
| Related Party Transactions | 0.6 | 05/05/08 |
| Effectiveness Review of OA-30 Corrective Actions | 3.0 | 06/09/08 |
| Emergency Management Review-selected items) | 3.0 | 06/23/08 |
| Safety Basis Implementation - | 40.0 | 07/28/08 |
| Transportation Management (TMO) Transportation Security Plan | 0.5 | 08/19/08 |
| Contractor Assurance / ISM Review at ORNL | 35.0 | 9/22/08 |
| **Government Accountability Office and Office of Inspector General - 155 Person Days** | | |
| GAO Review of the Environmental and Economic Impact of Increasing Biofuels Production in U. S. | NR | 9/17/08 |
| OIG Audit of ITER (International Thermonuclear Experimental Reactor Project)/cancelled | NR | 10/15/07 |
| OIG Audit of Department's Nuclear Material Provided to Domestic Licenses: Loan Leases Submitted by ORNL NMC&A to NMMSS | 3.0 | 10/22/07 |
| OIG Audit of ORNL Handling of Excessed Unclassified Hard Drives | 3.0 | 11/07/07 |
| OIG Audit of ORNL Handling of Excess Unclassified Hard Drives | 1.0 | 12/21/07 |
| OIG Audit of DOE's Certification and Accreditation of Classified Information Systems | 3.0 | 01/14/08 |
| OIG Investigation on allegation related to sanitization of sanitization of unclassified photo copiers. | 1.0 | 02/01/08 |
| OIG Review of the Department's Telecommunications Infrastructure/IG-34 | 3.0 | 02/01/08 |
| OIG Review of Annual Risk Assessments - NNSA Activities performed by ORO Contractors (CMPC) | 1.0 | 03/10/08 |
| OIG Office of Internal Review/Office of Chief Financial Officer Compliance Review | NR | 03/10/08 |
| OIG Inspection of Classified Matter Protection and Controls (CMPC) at Y-12 and ORNL | 12.0 | 03/20/08 |
| OIG Audit of Fines, Penalties and Other Legal Costs Incurred by the Department's Management Contractors | NR | 04/15/08 |
| OIG Audit of Contractors Cost Review | NR | 05/29/08 |

| | | |
|---|---|---|
| OIG Audit of the Assessment of Changes to the Internal Control Structure and Their Impact on the Allowability of Costs Claimed by and Reimbursed to UT-Battelle, LLC (DE-AC05-00OR22725) for FY 2007." | 1.0 | 06/23/08 |
| OIG Audit of Contractor Severance Plans at the DOE | NR | 07/07/08 |
| OIG Audit of the DOE's Use of Energy Efficient Products, Materials and Systems in it's Buildings. | 1.0 | 07/22/08 |
| OIG FY 2007 Financial Statement Audit of the Isotope Programs | 36.0 | 01/14/08 |
| OIG IT Full Scope audit of ORNL General & Application Controls. Includes unclassified cyber security, full scope IT Penetration Testing, Limited Scope FISMA policy/procedure compliance review | 90.0 | 04/14/08 |
| **Tennessee Department of Environment and Conservation - 142.5 Person Days** | | |
| Pre-scheduled: FY 08 TDEC Hazardous Waste Audit (ORNL-Y12) | 5.5 | 11/07/07 |
| Pre-scheduled: FY 08 External Audit of ORNL Clean Air Act (CAA) Compliance | 6.0 | 02/20/08 |
| Prescheduled: ORNL RCRA Inspection | 15.0 | 05/12/08 |
| Prescheduled: State of Tennessee Hazardous Waste Compliance Inspection | 4.0 | 05/20/08 |
| Pre-Scheduled: TDEC Observe RATA | 0.5 | 09/25/08 |
| Summary of TDEC Minor Administrative Visits & Sampling Activities (333 visits) | 111.5 | FY08 |
| **Assessments performed by OTHER organizations – 114.3 Person Days** | | |
| CVSA (Com. Vehicle Safety Alliance) Inspection/as part of TOA (Tn. Oversight Agreement) between DOE-TEMA - by Tn. Dept. of Safety's Highway Patrol | 36.0 | 12 visits |
| Annual Registration Assessment ISO 9001 | 1.0 | 04/25/08 |
| U.S. Department of Agriculture/TN Dept of Agriculture | 1.0 | 02/28/08 |
| 10 CFR 830 Implementation - TSR/DSA Implementation | 4.0 | 04/09/08 |
| Assessment of ORNL External Dosimetry Program per DOELAP Standard DOE-EH-0026 | 1.0 | 07/22/08 |
| Assessment of Dosimetry Program per DOELAP Standard 1112-98 | 1.0 | 9/16/08 |

| | | |
|---|---|---|
| EP/PCB Visit to ORNL | 2.5 | 01/09/08 |
| DOT Compliance Review | 11.5 | 08/11/08 |
| Benefits Valuation Study | NR | 06/01/08 |
| Knox County Pollution Control Board Visit to NTRC | 2.0 | 11/11/07 |
| Impromptu Surveillance of the Oak Ridge National Laboratory Low-Level and Mixed Low-Level Radioactive Waste Certification Program | 3.0 | 04/09/08 |
| FY08 ISO 14001:2004 EMS Conformance Audit | 8.0 | 07/22/08 |
| OFCCP On-site Audit | NR | 6/1/08 |
| Annual Environmental Management (EMS) Assessment : ISO-14001: 2004 Standard | 8.0 | 03/31/08 |
| OHSAS 18001 Worker Safety and Health Management System Audit | 20.0 | 09/08/08 |
| Voloxidation Processing Review of 3525 | 10.0 | 9/30/08 |
| Tennessee Regulatory Agency Visit to View Natural Gas Systems | 0.3 | 11/13/07 |
| External TN Dept of Health Division Emergency Medical Operations of Ambulance | 1.0 | 04/01/08 |
| Sandia National Lab/ Lead Laboratory Quality Assurance (QA) Supplier Audit of ORNL Office of Civilian Radioactive Waste Management (OCRWM) Project | 4.0 | 09/24/08 |

NR = no on-site visit time reported