Introduction

NETL’s EPAct 999 Complementary R&D Program

- Overview of the 4 research areas:
  - **Drilling Under Extreme Conditions (DUEC)** - improve the economic viability of drilling for and producing from domestic deep (>15,000ft) and ultra-deep (>25,000ft) O&G resources.
  - **Environmental Impacts of O&G (EI)** - provide unbiased scientific information and analysis of the environmental impacts of O&G, and develop new technology to effectively deal with any negative environmental impacts
  - **Enhanced and Unconventional Oil Recovery (EUOR)** - develop advanced technologies that will move the status of known but recoverable oil resources to technologically and economically producible resources
  - **Resource and Technology Assessment (RTA)** - provide characterizations of emerging, underutilized, or poorly understood O&G resource elements, and use these assessments to investigate the potential impacts of technology advances on these resources.

- Technical Advisory Committees
- Budget
Drilling Under Extreme Conditions

- **Extreme Drilling Laboratory (EDL)**
  - One-of-a-kind research facility
  - Ultra-deep single cutter Drilling Simulator (UDS) via cooperative agreement with TerraTek
    - recreates bottom-hole drilling environments of ultra-deep wells, mud lab and rock lab
    - operation at up to 30 kpsi and 480 °F
    - operates with “real” drilling fluids
    - sophisticated X-Ray video system that takes images of cutting at down-hole conditions

- **Numerical Modeling**
  - Modeling rock and drill cutter behavior under HPHT conditions to explain/predict rock response to various drilling modes
    - rock strain during cutting
    - formation of shear bands
    - influence of fluids in rock pores
  - Input to UDS test plans as well as back-analysis of UDS experiments
Starting Point: Assembly of the support stand on the bottom platen. Bottom Platen shown with legs upside-down, resting on top of top platen. September 2007

Prime Mover: The UDS is controlled, hydraulically. This requires a single electric motor to pump hydraulic pressure to a moderate pressure. This hydraulic fluid powers other pumps and actuators.

Assembly of the Load Frame October 2007

Assembly of Load Frame and Pressure Vessel November 2007

Close-up of piping December 2007
Role of X-Ray Visualization

- Visualization provides
  - Specifics on rock deformation & strain as cuttings form
  - Shape of rock cutting as it forms
  - Evidence of how test parameters (e.g. fluid properties) change cutting process
Drilling Under Extreme Conditions

- **Nanofluids for HPHT Drilling**
  - Develop multifunctional, smart nanofluids with controllable rheological and thermal conductivity properties
    - unique chemical techniques and laser ablation to develop nanofluid
    - characterize thermal, rheological and magnetic properties, stability and controlability
    - scale up

- **HP/HT materials**
  - Identify technology gaps in materials performance for tubular alloys
    - environmental-induced cracking: stress corrosion cracking, sulfur stress corrosion, and hydrogen embrittlement
    - wear-corrosion
    - fatigue - modeling fatigue for HPHT applications.
  - Develop benchmark testing for quantifying susceptibility of new tubular materials against commercials materials to corrosion and wear
Environmental Impacts of O&Gas Development

- **Unbiased information for sound policy**
  - Identify, collect, manage and disseminate data pertaining to environmental impacts of O&G exploration and production
  - Catalog regulatory barriers relating to gas development
  - Assess the impacts of O&G E&P activities on air quality

- **Managing produced water (PW)**
  - Evaluate subsurface drip irrigation as a beneficial use for CBNG PWs
  - Rapid assessment of watersheds for PW disposal according to Wyoming Section
  - Cataloging effort to identify technology barriers and PW technologies
    - PWMIS as building block; upgrade to expert system
  - Modeling high-resolution topographical data to estimate the amount of PW that can be discharged to stream channels before significant flooding or erosion occurs

- **Oil Shale water-use minimization**
  - Initiate environmental assessment of next generation oil shale retort technologies
Enhanced and Unconventional Oil Recovery

- **New EOR Technologies**
  - Improve accuracy and reliability of reservoir simulations of oil recovery from fractured reservoirs
    - update simulation code with two-phase flow capability to simulate CO2 and/or water flood
    - test FRACGEN/NFFLOW
    - perform laboratory tests (CT scans of core samples) to study the effectiveness of CO2-EOR
  - Novel surfactant-based concepts for improved mobility CO2 floods
    - follow-on of UPitt work on thickeners
    - develop CO2-soluable surfactants to decrease mobility and increase viscosity of CO2.
  - Microwave conversion for EOR study
    - literature review of current state of microwave conversion
    - study kerogen structure and CO2-enhanced in situ oil shale conversion.
    - study physical properties of kerogen
    - conduct laboratory experiments to prove concept
Enhanced and Unconventional Oil Recovery

- **Reservoir Characterization**
  - Create reservoir characterization data archives from historic EOR and oil shale projects

- **Catalyst Development**
  - Initiate the development of an inexpensive, disposable, and readily dispersed catalytic agent for in situ production of oil from oil shale
    - study literature
    - define test plan
    - perform laboratory experiments
Resource and Technology Assessments

- Resource Assessment

  - Identify the most-promising resource elements for characterization within the Appalachian and/or other mature basins.
    - build on previous work that focused on Upper Devonian Reservoirs

  - Design and initiate a research effort in geologically-based resource assessments targeting the key plays identified above.
    - update USDOE 1992 Appalachian Assessment
    - final products (maps; cross-sections) will be available free on CD.
Resource and Technology Assessments

- Knowledge Management Database (KMD)
  - Recommended by the Federal Advisory Committee
  - Central repository for output generated from the Consortium, NETL Complementary R&D Programs, and other ongoing DOE O&G programs
  - Current effort is the design phase of the KMD
  - Example of data/dataset to be housed: project reports, test results, and spatial data
  - End user web interface
    - search engine
    - interactive map viewing of spatial data
    - expert systems
Technical Advisory Committee

- Assist NETL with planning and implementation of R&D program
  - Review progress, provide input to Annual Plan, and participate in annual merit reviews
  - Provide assessment of the complementary nature of the R&D program with the Consortium, the traditional program and OSAP

- Made up of four subcommittees
  - one for each research area
  - 3 to 4 members including industry and academia
  - The objectives of the subcommittees are to gather data, conduct analyses and develop recommendations for consideration by the full committee

- Status
  - Draft charter
  - Draft list of proposed members
  - Draft email to proposed members
Distribution of FY07 EPAct Complementary Program Funds

* Funds received by ORD on 12/21/07
** Funds received by ORD on 9/22/07