NETL Complementary Research Program[1]

The NETL Complementary Research Program FY 2013 Portfolio

Title IX, Subtitle J, Section 999H of the Energy Policy Act of 2005 (EPAct 2005) authorizes $50 million per year of federal oil and gas royalties, rents and bonus payments for the Department of Energy (DOE) to establish the *Ultra-Deepwater and Unconventional Natural Gas and Other Petroleum Resources Research Program*. Section 999A prescribes four program elements for the effort, one of which is the National Energy Technology Laboratory (NETL) Complementary Research Program. This document summarizes the research to be conducted using fiscal year (FY) 2013 funding.

The NETL Complementary Research Program consists of two portfolios focused on domestic resources: ultra-deepwater research and unconventional oil and gas resources research portfolio (focused on hydrocarbons in shale reservoirs). This work is designed to provide information on the nature of various geologic and engineering processes. This information provides environmental, health, and safety (EHS) risks as key inputs to the DOE's efforts to mitigate such risks through science and technology development.

Ultra-Deepwater (UDW)

The objective of UDW research is to develop a scientific base for predicting and quantifying potential risks associated with exploration and production in extreme offshore environments. This includes i) experimental studies to improve understanding of key parameters (e.g., properties and behavior of materials) tied to loss-of-control events in deepwater settings, ii) compiling data on spatial variability for key properties used to characterize and simulate the natural and engineered components involved in extreme offshore settings, and iii) utilizing findings from i) and ii) in conjunction with integrated assessment models to simulate worst-case scenarios, as well as assessments of most likely scenarios relative to potential risks associated with flow assurance and loss of control.

Unconventional Natural Gas and Other Petroleum Resources (UCR)

The objective of UCR research is to develop a sufficient scientific base for predicting and quantifying potential risks associated with the oil/gas resources in shale reservoirs that require hydraulic fracturing and/or other engineering measures to produce. The major areas of focus include: i) improving predictions of fugitive methane and greenhouse gas emissions; ii) predicting the composition and volume of waters produced during shale gas development; iii) predicting subsurface fluid and gas migration, and iv) application of field measurements and observations towards predicting subsurface phenomena (geophysical and geomechanical responses).

The research includes building an understanding of i) spatial variations in reservoir properties that impact risk, ii) wellbore integrity (particularly for pre-existing wellbores), iii) fracture propagation dynamics, iv) groundwater geochemistry and hydrogeology, and v) air quality.

UDW NETL Complementary Research Portfolio (FY13 Funds):

[1] Energy Policy Act of 2005, Title IX, Subtitle J, Section 999A(b)(4)

The NETL Complementary Research Program UDW portfolio will use FY13 funds to build on prior accomplishments and will continue to coordinate with the research outcomes from the Section 999 DOE-RPSEA[2] research portfolio.

Improved Science-Base for Materials & Wellbore Integrity

- Expand the science information base related to the longevity and integrity of metallic materials used under extreme conditions in relation to these new surface treatments and alloys.
- Characterize experimentally the properties and behavior of foam cement samples at in situ conditions, providing key data that will greatly improve the safe use and emplacement of these barriers in deep offshore settings.
- Evaluate the interaction and potential for failure between the in situ formation (and fluids), cement, and casing, including the physical, chemical, and temporal integrity of lithology:cement:casing systems used in extreme offshore settings at in situ conditions.

Reducing Risks & Mitigating Impacts Associated with Extreme Geologic and Hydrologic Systems in Offshore Environments

- Expand the experimental database on critical fluid properties for hydrocarbons at high pressure and temperature, extending the current work to multi-phase and multi-component fluids (hydrocarbons, etc), which is key to predicting their behavior in situ conditions in the deep subsurface.
- Develop a coordinated platform to allow for the rapid evaluation and assessment of risks and potential impacts associated with offshore deepwater operations for the Gulf of Mexico to produce science-based predictions.

Improving Safety through Rapid Detection & In Situ Characterization

- Develop an ROV-deployable tool to rapidly determine hydrocarbon composition and volume of leaks at high pressures and low temperatures (UDW seafloor conditions).
- Evaluate the feasibility of using existing geophysical measurements for rapid identification of fluid influx into the borehole near the bit to reduce loss-of-control risks associated with drilling into over-pressured intervals.

[2] Research Partnership to Secure Energy for America (RPSEA)

UCR NETL Complementary Research Portfolio (FY13 Funds):

The NETL Complementary Research Program UCR portfolio will use FY13 funds to build on prior accomplishments and will continue to coordinate with the research outcomes from the DOE-RPSEA research portfolio.

Improving fugitive emission factors and estimates for shale gas greenhouse gas life cycle analyses

- Quantify a variety of fugitive air emissions through field-based point-source and ambient air monitoring measurements in the Appalachian Basin.
- Develop methods for extrapolating the acquired field data into statistically-robust regional emissions estimates for use in improving life cycle assessments of fugitive methane and greenhouse gas emissions for the Appalachian region.

Predicting the composition and volume of water produced during shale gas development

- Evaluate the geochemical and microbiological composition of shale gas produced water and solid wastes.
- Refine capabilities to predict the volume and composition of flowback water as a function of reservoir, stimulation, and fluid properties.

Predicting subsurface fluid and gas migration to better understand natural versus development-related causes of fluid and gas migration

- Characterize the density and distribution of legacy wells located within the areal extent of shale gas plays in Pennsylvania, and determine the potential of those wells to provide pathways between unconventional oil and gas reservoirs and shallow groundwater resources.
- Evaluate the risks that gas and fluids from shale-gas reservoirs might impact groundwater via natural migration pathways such as faults and fractures.
- Evaluate impacts to cement integrity resulting from exposure to high-pressure gas with a focus on coupling experimental results to flow modeling to improve understanding of system behavior under different conditions.
- Use results from field efforts focused on quantifying gas migration from shallow gas formations during drilling to develop and calibrate integrated assessment models.

Application of field measurements and observations towards predicting subsurface phenomena (geophysical and geomechanical responses)

- Quantify trends in maximum fracture propagation during hydraulic fracturing as a function of depth and variations in rock properties for reservoirs and overlying strata, using field and laboratory data to calibrate and constrain models.
- Develop a science-based methodology for predicting magnitude of induced seismic events associated with waste injection.

Cross-cutting field and experimental data needs, data management, and modeling needs

- Document baselines for key environmental signals and any subsequent changes in response to shale gas operations, with a focus on continued monitoring at sites during the active development, fracturing, and production stages.
- Develop a science-based prediction methodology for potential contamination of flowback water during shale formation stimulation, based on geochemical reactions and variations in the Appalachian Basin chemostratigraphy.
- Develop science-base and analytical methods for use of natural tracers to fingerprint the sources of fluids in order to determine if fracturing fluids have impacted groundwater.