ACTIVITY REPORT

October 2002

Natural Gas & Oil Technology Partnership

bringing department of energy national laboratories capabilities to the petroleum industry

Los Alamos
Los Alamos, NM 87545
(505) 667-7811

Sandia
Albuquerque, NM 87185
(505) 844-7333

Lawrence Livermore
Livermore, CA 94551
(925) 422-5196

Lawrence Berkeley
Berkeley, CA 94720
(510) 486-5085

Argonne
Argonne, IL 60439
(202) 488-2415

Brookhaven
Upton, NY 11973
(516) 344-3819

Idaho
Idaho Falls, ID 83415
(208) 526-7004

Oak Ridge
Oak Ridge, TN 37831
(865) 574-4941

Pacific Northwest
Richland, WA 99352
(509) 372-4565

To: William F. Lawson, Director
National Energy Technology Laboratory
One West Third Street
Suite 1400
Tulsa, OK 74103-3519

From: J. Albright, Los Alamos
D.J. Borns, Sandia
J. Ziagos, Lawrence Livermore
N. Goldstein, Lawrence Berkeley
D. Schmalzer, Argonne
A. Goland, Brookhaven
B. Reynolds, Idaho
J. McFarlane, Oak Ridge
B. Saffell, Pacific Northwest

cy: E. Allison, DOE Fossil Energy
L. Capitanio, DOE Fossil Energy
G. Dehoratiis, DOE Fossil Energy
A. Hartstein, DOE Fossil Energy
B. Hochheiser, DOE Fossil Energy
E. Subia-Melchert, DOE Fossil Energy
N.B. Woodward, DOE Office of Science
D. Alleman, DOE-NETL-Tulsa
J. Casteel, DOE-NETL-Tulsa
N. Comstock, DOE-NETL-Tulsa
R. Lindsey, DOE-NETL-Tulsa
R. Long, DOE-NETL-Tulsa
K. Sterling, DOE-NETL-Tulsa
D. Sutterfield, DOE-NETL-Tulsa
J. Ammer, DOE-NETL-Morgantown
H. Guthrie, DOE-NETL-Morgantown
B. Gwilliam, DOE-NETL-Morgantown
J. Rogers, DOE-NETL-Morgantown
B. Tomer, DOE-NETL-Morgantown
F. Toro, DOE-NETL-Morgantown

Note: Natural Gas and Oil Technology Partnership projects are reported according to the following schedule:

January, March, May, July, September, November	**February, April, June, August, October, December**
Drilling, Completion, and Stimulation Technology Oil and Gas Recovery Technology Diagnostic and Imaging Technology	Upstream Environmental Technology Downstream Environmental Technology Natural Gas Technology

Natural Gas and Oil Technology Partnership on the World Wide Web: http://www.sandia.gov/ngotp/

Upstream Environmental Technology

Reducing Chemical Use and Toxicity in Produced-Water Systems

(Gas Technology Institute, Southern California Gas Company, and ANL)

Highlights:

- On-line electrochemical noise analysis system successfully demonstrated.
- Final report completed.

Project researchers completed a final report detailing electrochemical noise (ECN) technology, field tests done with Southern California Gas Company, and the results of several applications of the ECN analysis system.

The new ECN analysis system was designed to identify and monitor the progress of sustained localized pitting (SLP) by analyzing the power spectral density (PSD) of the trend of the corrosion potential noise level. The ECN analysis results demonstrated that this *in situ* corrosion monitoring system could effectively identify SLP corrosion, compared to a more uniform general corrosion mechanism. Because of the successful demonstration of the on-line ECN analysis system in the laboratory, as well as in the field, a major chemical supplier and service company for corrosion control is very interested in commercializing the ECN analysis system for their clients. Evaluation of the ECN technology in their laboratory, development as a field-hardened device, and further testing in the field is under discussion.

Publications and Patents

Lin, Y.J., D.H. Pope, E.J. St. Martin, and J.R. Frank, "Application of Electrochemcial Noise Analysis in Microbially Influenced Corrosion," in *Golden Gate Material and Welding Technologies Conference*, San Francisco, CA, February 1999.

Lin, Y.J., D.H. Pope, E.J. St. Martin, and J.R. Frank, "Electrochemical Noise Measurements of Sustained Localized Microbially Influenced Pitting Corrosion in a Laboratory Flow Loop System," in *National Association of Corrosion Engineers Annual Corrosion Conference and Exposition*, San Antonio, TX, April 1999.

Lin, Y.L., E.J. St. Martin, and J.R. Frank, "Monitoring and Mitigation of Sustained Localized Pitting Corrosion," in *8th International Petroleum and Environmental Conference*, Houston, TX, November 2001.

Lin, Y.L., D.H. Pope, J.R. Frank, and E.J. St. Martin, *In situ Process for the Monitoring of Localized Pitting Corrosion*, U.S. Patent, 5,888,374, 1998.

Lin, Y.L., E.J. St. Martin, J.R. Frank, and D.H. Pope, *Novel Electrode Design for Use in the Electrochemical Noise Measurement*, U.S. Patent, 6,294,074, 2001.

Ecological Framework to Evaluate the Effect of Size and Distribution of Releases at Upstream Petroleum Sites

(American Petroleum Institute, BP Amoco, ChevronTexaco, ExxonMobil, Gas Technology Institute, Unocal, LLNL, and ORNL)

Highlights:

- Results presented at the final PERF workshop.
- Proposal prepared for continued model development using Bureau of Land Management and other Nature Conservancy sites.
- LLNL model reviewed at the University of California-Davis.

The project goal is to develop generic models to determine the threshold frequency, size, and/or distribution of habitat loss resulting from exploration and production activities that would have a significant impact on the persistence of herbivore and/or predator populations. Models are parameterized for the Tallgrass Prairie Preserve (TPP) in Osage County, OK.

Results to date were presented at the final Petroleum Environmental Research Forum (PERF) 99-01 in Washington, DC, on October 14. ORNL researchers presented results on territory acquisition and population density for the American badger. The extensive range of the badger makes them fairly resistant to disturbance. Badger population levels did decline with increasing disturbance, but no allee effect (a population crash or extinction due to the inability to find mates) was observed even at high levels of habitat loss.

LLNL presented results on the impacts of habitat loss on the prairie vole. Like the badger, population levels also declined with reduced available habitat. In the case of the vole, extinction of the population was observed in areas of small, contiguous habitat, due to overgrazing. However, extinction could be prevented or delayed if the same quantity of habitat was dispersed across the landscape (i.e. fragmented), as long as dispersal corridors were maintained.

LLNL scientists met with University of California-Davis modelers on September 18 for a review of the vole model. LLNL modified the bioenergetic component of the model to more closely mimic actual bioenergetic requirements of the vole. In addition, culling of the voles was added to the model to mimic predation by short-eared owls while the owl model is under development. Scientists at ORNL updated the spill generator model to improve simulation of the spreading brine mixture, and produced TPP landscapes with specified percentages of spill area and specified numbers of spills. The ORNL badger model was expanded to include the following capabilities: a) stochastic simulation and reporting of means and variances of results; b) sensitivity or uncertainty analysis of parameter vectors; c) separated age-dependent and habitat-related mortality; and d) implemented randomized application of mortality factors.

Estimation and Reduction of Air Quality Modeling Uncertainties (Envair, EPRI, and LBNL)

Highlights:

- Community Multi-Scale Air Quality Model installed and evaluated on two new dual processor Athlon Linux workstations.
- Emissions estimates improved for the August 1990 SARMAP ozone episode.
- Report drafted describing the air quality planning process in Central California during the 1990s.

Project researchers installed and evaluated the Community Multi-Scale Air Quality Model (CMAQ) on two new dual processor Athlon Linux workstations. Researchers also attended the Models-3 Users Workshop at the Environmental Protection Agency (EPA), Raleigh-Durham, NC, in October. Processing improved emissions estimates for the Aug 1990 SARMAP ozone episode to allow a better simulation.

Researchers prepared a draft report describing the air quality planning process in Central California during the 1990's. Findings were developed about the roles of modeling and uncertainty in the process placing special emphasis on Chapter III, which describes photochemical air quality simulation models and their uncertainties, and Chapter IV, which explains case study analysis methodology. Work also continues on a critical review paper about the evaluation of uncertainties in air quality simulation models used for regulatory compliance.

Remote Sensing for Environmental Baselining and Monitoring (ChevronTexaco, UC-Davis, and ORNL)

Highlights:

- Field data from the Jornada Experimental Range analyzed.
- New data clustering method developed.

ORNL completed an analysis of 215 measurements made at the Jornada Experimental Range. Each measurement is a vector consisting of 2151 values; the values represent reflectance at wavelengths ranging from 350–2500 nm. Each measurement is described with one or two of the following 12 labels: Bare, Litter, Aristada, Capa, Datu, Forb, Grass, Mesquite, Senna, Snakeweed, Tila, and Yucca. "Bare" represents bare soil; "Litter" represents plant litter; the other ten labels designate plant species.

The new clustering method partitions a collection of measurements into distinct groups that correspond to different stress states or species. Correlation coefficients (cij) are calculated for all of the measurement vectors. The distance (dij) between any two vectors is: cij = 1 - dij. Given a cluster radius (r), a cluster is calculated for each vector, where a cluster is a set of vectors that are neighbors of the base vector with a distance from the base vector that is less than r. The distinct groups calculated in this manner are referred to as super clusters. The first super cluster is the cluster having the largest number of neighbors.

Each subsequent super cluster is the cluster that has the largest number of neighbors that are not yet included within a super cluster. The method stops adding super clusters when the maximum number of unclustered neighbors is < 4.

The super clusters are chosen to have the largest possible number of unclustered vectors, but they can also include vectors that are members of other super clusters. For the data ORNL examined, only five of the 20 super clusters include vectors that are members of other super clusters. The new clustering method revealed 20 (almost) distinct groups that could correspond to different stress states or species.

Modeling of Water-Soluble Organic Content of Produced Water

(ChevronTexaco, Phillips Shell, Statoil, and ORNL)

Highlight:

- Produced water characterization data successfully modeled by assuming thermodynamic equilibrium between the aqueous and hydrocarbon liquid phases.

The type and amount of organics that are soluble in produced water is not well understood, leading to inefficiencies in produced water cleanup prior to its discharge into the ocean. Industry participants and ORNL embarked on a study of organic solubility in produced water, including characterization of the organic component in produced water and modeling of its solubility. The characterization of the produced water is complete and shows that the water-soluble component is primarily polar, with a discernible trend in increased solubility with increasing pH. Hence, the focus on modeling was to reproduce the trend with pH seen in the experimental results.

Aqueous-hydrocarbon systems can be modeled in a variety of ways. ORNL used a simple liquid-liquid equilibrium model with the solubility predicted by Nationally Recognized Testing Laboratory (NRTL) activity coefficients in the aqueous and hydrocarbon phases. The model was successfully used to fit the pH-dependence data that were generated in a crude-oil/simulated brine system. This model incorporates the acidity of the polar components, in this case assuming a composite pKa of 5.5. Results of calculations agree with the trend seen in the experimental results, where methylene-chloride extractable range material (particularly C_{10}-C_{20}) become more soluble as the pH increases beyond 7. This is because of increased deprotonation in the basic aqueous phase.

The advantage of a thermodynamic equilibrium model is that changing conditions, such as temperature dependence and salinity, can be incorporated into the expressions for the activity coefficients. Volatile components and the dependence of solubility on pressure can be introduced with an additional gaseous phase, represented by an equation of state. The difficulty of formulating the model is in the selection of which components that will represent the system. Uncertainties in the water characterization data preclude their use for lumped parameter properties. Questions remain as to how well binary and ternary NRTL parameters represent a multi-component system, especially one that is non-ideal. Cross-correlation—such as between salinity and pH—was also not investigated in the characterization project. Answers to such questions, as well as the investigation of correlations of solubility measurements to field parameters, will be addressed in future model development activities.

Science-Based Methods to Assess Risks Attributable to Petroleum Residues Transferred from Soil to Vegetation

(ChevronTexaco, Petroleum Environmental Research Forum, UC-Berkeley, UC-Davis, and LBNL)

Highlights:

- Results presented at a PERF workshop.
- Air filtration system for the controlled environmental chamber designed and constructed.

Project researchers selected wheat and sandy/loam as the first plant/soil scenario for the controlled exposure experiments. Wheat is an important part of the American diet; total grains make up approximately 70% of the daily per capita intake of plant-based foods, and total grain in the diet is approximately 75% wheat. In addition, wheat is a protected above-ground crop, which will help to limit exposure to atmospheric polycyclic aromatic hydrocarbons (PAHs) in the experiments. Wheat is often a crop that is relevant to exploration and production sites. Finally, wheat is a useful surrogate for investigating the transfer of soil contaminants into animal feed. Researchers selected sandy/loam soil as representative of wheat-growing soils in the United States.

Researchers from LBNL and ChevronTexaco participated in a Petroleum Environmental Research Forum (PERF) 99-13 workshop in September. Results from the literature review and model development were presented at the workshop and materials were posted on the PERF website. A draft manuscript describing the literature review and development of the revised plant uptake model phase is in preparation.

LBNL researchers designed and constructed an air filtration system for the controlled environmental chamber. The filtration system is engineered to minimize the transfer of both gas- and particle-phase PAHs from ambient air to the controlled environment. The combination of the air filtration system and the use of a protected aboveground plant is expected to improve the sensitivity and precision of the controlled exposure studies compared to earlier experiments using a similar apparatus.

Downstream Environmental Technology

Kinetics of Biochemical Upgrading of Petroleum

(Biocat, ChevronTexaco, Shell, and BNL)

No report received.

A Predictive Model of Indoor Concentrations of Outdoor $PM_{2.5}$ in Homes

(Aerosol Dynamics, Western States Petroleum Association, and LBNL)

Highlight:

- Presentation given detailing the modeling of physical loss factors, chemical transformations, and infiltration dynamics.

Project researchers completed a manuscript describing a new method for the measurement of the penetration coefficient and deposition velocity in a house as a function of particle size. The manuscript, entitled "A Concentration Rebound Method for Measuring Particle Penetration and Deposition in the Indoor Environment," was presented at a meeting of the American Association for Aerosol Research held in October.

The transient model of indoor aerosol concentrations of outdoor origin was used in a regression analysis to determine best-fit penetration and deposition rates for nitrate, sulfate, and total carbon constituents of indoor aerosols. The deviations of the model from the measured indoor aerosol concentrations were examined for statistically significant correlations existing between the deviations and building operating conditions, site meteorology, and concentrations of gas phase ammonia and nitric acid. Initial results indicate that building temperature, relative humidity, and air exchange rate are important in explaining the model-measurement differences.

The organic carbon artifact resulting from organic gases adsorbing to the quartz filter substrates during sampling was significant throughout the field study, particularly indoors where particulate phase concentrations were lower than outdoors. Backup filters were used to correct for the artifact. Corrected, filter-based total aerosol carbon concentrations were compared with carbon concentrations measured by the automated collection and vaporization cell method. A regression of the two datasets revealed that the automated method consistently underestimated total aerosol carbon concentrations. The time series data from the commercial (two wavelength Anderson) aethalometer and the "in-house" (LBNL-built) aethalometer were compared. The data reveal periods of elevated black carbon concentrations weekday mornings (i.e., ~8am) and evenings (~5pm and often lasting into early morning). The morning peak is likely due to commuter traffic, whereas the broader evening peak may be the result of both vehicle and wood burning emissions.

Data collected with the ultra-violet (UV) channel of the commercial aethalometer reveal an artifact of unknown cause, and therefore can be only qualitatively interpreted. The UV channel indicates the presence of UV absorbing material in the evening, but no increase associated with the morning traffic black carbon peak is evident. This observation is consistent with an emission source other than traffic (e.g., wood burning) in the evenings. The source of the UV channel artifact is unknown and needs further study. A manuscript is in preparation to discuss various measurements of carbonaceous aerosols.

A Predictive Model of Indoor Concentrations of Outdoor Volatile Organic Compounds in Homes

(American Petroleum Institute, Western States Petroleum Association, and LBNL)

Highlight:

- User interface of the numerical model of indoor chemical interaction, adsorption, and desorption improved.

Researchers incorporated the sink-diffusion model of chemical adsorption and desorption into a GUI-based code. The code permits the user to open a file containing time and concentration data, select a model, and find the least-squares fitted adsorption, desorption, and, if requested, diffusion rates. The code displays the measured and predicted concentrations against time and permits visual comparison between the sink and sink-diffusion models.

Researchers improved the user interface of the numerical model of indoor chemical interaction, adsorption, and desorption. The code now permits indoor temperatures and variable air-exchange and emission rates to be entered easily, thereby simplifying the modeling of experiments. Researchers tested the recently-added adsorption, desorption, and air-exchange elements of the code by fitting the sink model to the predicted concentrations. The parameters found from the best fit are identical to those used in the numerical model, with $R2 = 1.0$, thereby validating the code.

Researchers conducted two experiments to estimate adsorption and desorption rates of air toxics in furnished residential environments. The experiments were conducted in a 50-m^3 test chamber constructed of, and furnished with common indoor materials including wallboard, carpet, upholstered chairs, cotton draperies, and several wood/ laminate pieces. Experiments started with the spike injection of volatile organic compounds (VOCs) into the chamber with ventilation turned off. Air samples were collected at appropriate intervals to track the adsorption-induced decay of semi-volatile organic compounds (SVOCs) and VOCs. Samples were collected onto solid sorbents and analyzed by gas chromatography-mass spectrometry. Equilibrium partitioning between the gas- and sorbed phases was reached within one day. On Day 2, the chamber was flushed rapidly (5 air changes over 1 hour) and resealed. Air samples were collected on Day 2 to measure the desorption-induced rise of concentrations and the new equilibrium level of air toxic VOCs in the chamber air. Ventilation

was started at two air changes per hour on Day 3 to measure desorption, primarily of SVOC, under dynamic ventilation conditions. Results will be analyzed using the modeling tools described above to calculate adsorption and desorption rate constants and equilibrium partitioning values.

Developing Enzyme and Biomimetic Catalysts for Upgrading Heavy Crudes via Biological Hydrogenation and Hydrodesulfurization (ChevronTexaco and ORNL)

Highlight:

- Researchers demonstrated that production of thermostable hydrogen splitting activity for a biocatalyst developed from *D. gigas* hydrogenase is reproducible.

This project investigates the potential of enzymatic and biomimetic catalysts for hydrogenation of oil compounds with the goal of upgrading crudes via sulfur removal and potentially molecular weight reduction.

Development of the nickel-iron active center peptide was reported in the last bimonthly report. This "biocatalyst" derived from the hydrogenase enzyme was shown to have significantly greater activity and stability at elevated temperatures (60–90°C) than the enzyme itself. Project researchers confirmed these results for a second batch of biocatalyst produced from the *D. gigas* cell extract. The catalyst was shown to have about 40 times higher activity at 60°C than at 30°C, unlike the native enzyme hydrogenase. In addition, it was stable for at least 30 minutes at the higher temperature.

Two parameters, including digestion time and unfolding agent, were studied to determine their effect on production of the biocatalyst in a small batch experiment. The results indicate that a period of 25 hours is sufficient for digestion. Additionally, use of sodium dodecyl sulfate as an unfolding agent resulted in a significant activity loss and therefore is not appropriate for digestion of the enzyme. These optimized (partially) parameters are being used to produce the biocatalyst for structural characterization.

Characterization and Reaction Behavior of Sterically-Hindered Sulfur Compounds in Heavy Crudes with Nano-Sized Molybdenum Disulfide (ChevronTexaco, BNL, and ANL)

Highlight:

- Temperature programmed reduction and temperature programmed oxidation of the samples prepared by BNL are being carried out by ANL.

The present focus is on characterization of nano-sized materials that were synthesized for evaluation as potential hydrodesulfurization (HDS) catalysts.

In the last *Activity Report*, researchers reported a successful sonolysis procedure to synthesize nano-sized catalytic materials in gram quantities. This led to the production of samples of nano-sized molybdenum disulfide (MoS_2), cobalt/molybdenum disulfide (Co/MoS_2), and molybdenum disulfide/aluminum oxide ($MoS_2/\text{-}Al_2O_3$) in > 90% yields. The characterization of these nano materials is a challenging task. The samples are being characterized at BNL's National Synchrotron Light Source (NSLS) at Beam Line X-7B for collecting the x-ray diffraction data and the JEOL 2000FX, 200KV transmission electron microscope (0.16 nm resolution) to image morphology and particle size of the samples.

At ANL, temperature programmed reduction (TPR) and temperature programmed oxidation (TPO) of the samples prepared by BNL are being carried out. These profiles are being done in classical off-line instrumentation, which is fast but less informative, and at ANL's Advanced Photon Source (APS), where the oxidation state and coordination sphere of the metals can be accurately measured as a function of temperature, pressure, and reacting gasses.

The nano-scaled materials exhibit TPR reduction profiles that are about 75°C higher than the commercially available catalyst. Adding cobalt (Co) to the molybdenum has no effect on the temperature of the reduction, but does lower the overall amount of hydrogen adsorption.

The MoS_2 nanophase materials are highly reactive and susceptible to oxidation in air. Running X-ray Adsorption Near Edge Spectroscopy at the APS in TPO mode shows that the native material oxidizes at the relatively low temper-

ature of 365°C. Fortunately, addition of Co to the nanophase MoS_2 material (necessary for HDS catalytic activity) removes this oxidation instability with an oxidation temperature similar to a commercial catalyst (>500°C). Preliminary HDS runs in the presence of an olefin shows that the nano-phase Co/MoS_2 material does less olefin hydrogenation, and hence less loss in octane than a standard commercial catalyst. A more complete catalytic examination will be forthcoming.

Development of a Solid Catalyst Alkylation Process Using Supercritical Fluid Regeneration

(Marathon-Ashland and INEEL)

Highlight:

- Following improvements of the experimental system pressure control, a repeat experiment found greater catalyst stability.

Under conditions used in prior work, activity loss was too low to efficiently explore optimization of catalyst regeneration parameters. Deactivation severity was increased by increasing the olefin weight hour space velocity (OWHSV) from 0.2–0.25 g butene/g catalyst/hr. Under the higher OWHSV conditions, catalyst activity decline was approximately 10% in 30 hours. Following improvements of the experimental system pressure control, a repeat experiment found greater catalyst stability. Catalyst activity decline was reduced to approximately 10% in 70 hours. Catalyst stability was still too high for efficient optimization testing.

Improved system process control led to enhanced catalyst stability using supercritical fluid regeneration. The ability of the catalyst to maintain high levels of activity was found to be highly dependent on the reaction's OWHSV. At an isoparaffin to olefin ratio of 20:1, catalyst activity was maintained above 90% of its initial value for approximately 150, 70, and 18 hours at OWHSVs of 0.20, 0.25, and 0.30 hr^{-1}, respectively, using a one-hour regeneration. These run times correspond to approximately 25, 12, and 3 uses of each catalyst batch. Efforts in October will examine the effect of OWHSVs between 0.25 and 0.30 hr-1 in order to establish efficient operating conditions for the regeneration optimization study.

Biocatalytic Alkane Transformation for Viscosity Reduction

(ChevronTexaco and LBNL)

No report received.

Secondary Organic Aerosol Research

(Aerosol Dynamics, Western States Petroleum Association, and LBNL)

Highlights:

- Several different aerosol patterns observed.
- Results concerning the nuclei mode formation events presented at the 2002 annual meeting of the American Association for Atmospheric Research.

During October, plans were finalized for particle collection and characterization by filter analysis. These analyses will provide measures of the concentrations of particulate sulfate, nitrate, black, and organic carbon present in the atmosphere.

The aerosol data is being examined as it becomes available (typically every two weeks). Several different aerosol behavior patterns were observed:

1. Black carbon shows a strong diurnal cycle. Black carbon emissions are strongly correlated with anthropogenic emissions. The concentration of black carbon at the site increases just after noon, as the emissions from the upstream urban area begin to arrive at the site. In the evening, the concentration decreases as the wind shifts direction, bringing cleaner air masses from the forested areas east of the site. This diurnal cycle of urban upslope and rural downslope flow will allow researchers to study how the emissions from the forest are processed in each type of atmosphere.
2. There were a few fire events that occurred during the summer of 2002. These fire events are reflected in the aerosol data by an increase in absorption due to black and organic carbon, as well as larger size mode in the aerosol size distribution. Carbonaceous fire emissions are an important

source of rural visibility degradation. By correlating the aerosol data with details describing the fire event (such as location and intensity), researchers can explore the long-range transport and atmospheric impact of fire emissions.

3. The aerosol size distribution results show that on many days, afternoon formation of small nuclei model particles (< 20 nm) was observed. These formation events were strongly correlated with lower temperature, and fewer events occurred later in the summer as temperatures increased. Based on typical wind speeds and the size of the forest, it appears that the particle formation events occur in the forest. These particles are formed from a combination of biogenic processing of the anthropogenic air mass or solely by biogenic reactions.

The results concerning the nuclei mode formation events were presented at the 2002 annual meeting of the American Association for Atmospheric Research in Charlotte, NC.

Proton Exchange Reactive Membranes for Conversion of Light Alkanes to Clean Liquid Fuel (British Petroleum and INEEL)

Highlight:

- Construction of the proton exchange reactive membrane experimental system completed.

Construction of the experimental system continued in August. The majority of the system was assembled. The experimental system control unit and the reactor are still under construction. Materials for initial proton exchange membrane development were received. The reactor membrane sealing system is under development.

Construction of the proton exchange reactive membrane experimental system was completed in September. The system will allow reaction of hydrocarbons on one side of the membrane and the removal of hydrogen reaction products across the membrane. A gas chromatograph was installed that will provide on-line analysis for both sides of the membrane. A palladium membrane was built and will be used in initial system testing. The palladium membrane will serve as a surrogate for the proton conducting ceramic membrane until the ceramic membrane is available. This will allow initial system testing to take place while the proton conducting membrane is being developed. Activities in October will focus on testing the system with the palladium membrane.

The original industry participant performed a review of their research and development portfolio and believes that this project is longer term than they desire and will likely withdraw their support. Discussions have begun with a new participant and the initial results are encouraging.

Natural Gas Technology

Molecular Engineering: Next Generation of Gas Purification Technology (ChevronTexaco, Virginia Commonwealth U, and BNL)

New FY02 project: Reporting will start three months after the DOE FY02 funding arrives at the laboratories.

Coil-Tubing-Deployed Hard Rock Thermal Spallation Drill and Cavity Maker (Nextant, NM Tech, and LANL)

New FY02 project: Reporting will start three months after the DOE FY02 funding arrives at the laboratories.

Scintillating Fiber Neutron Detectors for Well Logging

(CompuLog, Precision Drilling, Technology Services Group, and PNNL)

New FY02 project: Reporting will start three months after the DOE FY02 funding arrives at the laboratories.

225° C MWD Using Silicon-On-Insulator (SOI) Electronics

(Baker Oil Tools, Eagle-Picher, Honeywell SSEC, General Atomics, Noble Engineering, Quartzdyne, and SNL)

New FY02 project: Reporting will start three months after the DOE FY02 funding arrives at the laboratories.