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Natural Gas Product and Strategic Analysis

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Product and strategic analysis at the Department of Energy (DOE)/Morgantown Energy Technology Center (METC) crosscuts all sectors of the natural gas industry. This includes the supply, transportation, and end-use sectors of the natural-gas market. Projects in the Natural Gas Resource and Extraction supply program have been integrated into a new product focus. Product development facilitates commercialization and technology transfer through DOE/industry cost-shared research, development, and demonstration (RD&D). Four products under the Resource and Extraction program include Resource and Reserves; Low Permeability Formations; Drilling, Completion, and Stimulation; and Natural Gas Upgrading.

Product and strategic analysis involves technical evaluation of engineering processes, economic assessment, risk/sensitivity analysis, and product plan development. Engineering analysis is conducted to evaluate the performance of natural-gas supply technologies and to identify design improvements. Economic evaluation and risk/sensitivity analysis measure the commercialization potential of the products and determine barriers to market entry. Product plan development (1) assists in integrating technologies into products, (2) coordinates METC strategic planning activities with the DOE Natural Gas Program, (3) guides program direction through resource allocation and product development implementation strategies, and (4) coordinates the planning activities of funding organizations such as the Gas Research Institute. Figure 1 depicts the relationship between product

and strategic analysis, the budget development process, and program planning.

Engineering process analyses have been performed for the Slant Hole Completion Test project. These analyses focused on evaluation of horizontal-well recovery potential and applications of slant-hole technology. Figures 2 and 3 depict slant-well in situ stress conditions and hydraulic fracture configurations. Figure 4 presents Paludal Formation coal-gas production curves used to optimize the hydraulic fracture design for the slant well. Economic analyses have utilized data gathered from vertical test wells to evaluate the profitability of horizontal technology for low-permeability formations in Yuma County, Colorado, and Maverick County, Texas.

Figures 5 and 6 describe the methodologies used to evaluate horizontal well profitability and select horizontal well sites. Evaluations are based on a probabilistic approach, with distribution curves similar to Figure 7 used for input into the methodology. Figure 8 depicts the location of the Vernon field study site for the horizontal well in the Niobrara Formation. Figures 9 and 10 are net-present-value graphs used to evaluate the profitability of horizontal well technology for the Niobrara Formation. Figure 9 depicts the first evaluation case for the Niobrara Formation. Figure 10 depicts the second evaluation case, where the Niobrara Formation permeability is lower than that shown in Figure 9. The product planning process has provided guidelines for development of new

supporting projects and integration of existing projects into products.

Future efforts will focus on evaluation of technology applications for naturally fractured reservoirs with stochastic-reservoir and natural/induced hydraulic-fracture simulators, economic assessments for existing and new products, and evaluation of a gas-systems-analysis model. Natural fractures play a significant role in determining the flow potential of low-permeability reservoirs. A stochastic reservoir model is currently being developed by DOE/METC to better understand the impact of natural fractures on the flow mechanisms in low-permeability reservoirs.

A user friendly and transportable version of FEFFLAP (Finite Element Fracture Flow Analy-

sis Program) will be evaluated by industry and METC in-house personnel. A description of the physical situation simulated by FEFFLAP is given in Figure 11, and Figure 12 is the numerical representation of this situation as simulated by FEFFLAP.

A schematic of the Gas Systems Analysis Model (GSAM) is shown in Figure 13. This model is being developed to provide a tool for industry and government agencies to evaluate the resource-technology and economic interactions of a natural-gas system. Product plan development will continue to be an ongoing activity, providing annual updates for program RD&D, budgets, and direction.

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Figure 1. Product and Strategic Analysis Program Relationships

Figure 2. Schematic of Inclined and Vertical Wellbores

Figure 4. Stimulating Well Performance to Optimize Fracture Design

Figure 3. Hydraulic Fracture Propagation From an Inclined Wellbore

Figure 5. Methodology for Horizontal Well Site Selection

Figure 6. Horizontal Well Profitability Analysis Methodology

Figure 7. Gas Price Probability Distribution

Figure 8. Yuma County, Colorado, Horizontal Well Site

Figure 9. Net Present Value (NPV), Niobrara Horizontal Well, Case I

Figure 10. Net Present Value (NPV), Niobrara Horizontal Well, Case II

Figure 11. In-Situ Description of a Naturally Fractured Reservoir

Figure 12. FEFFLAP Representation of a Hydraulic Fracture in a Naturally Fractured Reservoir

Objective:

Assess impact of changes in overall natural gas system components on gas supply and demand

Figure 13. Gas Systems Analysis Model (GSAM)

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