APPENDIX C

FFTP EVALUATION BY AN OIL AND GAS INDUSTRY REPRESENTATIVE

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This Appendix presents an evaluation of the FFTP as a means for producing an oil and gas prospect in the deepwater Gulf of Mexico (GOM).

1. Developer's Assessment of FFTP in Offshore Application

It was postulated by Energy International (EI) that the judgement of a major oil company as to the merits of the FFTP would provide valuable input to the study undertaken by the subject Contract. To obtain this judgement a **Developer** was contacted by EI to determine **Developer's** possible interest in the Fischer-Tropsch (F-T) gas-to-liquids process. Initial discussions led to **Developer** suggesting to EI a range of gas stream rates and properties for which **Developer** might be interested in this type of process. This led EI to supply the **Developer** with the EI information that is presented in Section 2. of this Appendix.

Based on review of the F-T gas-to-liquids process with respect to GOM Deepwater, the following conclusions were reached by the **Developer**. First, a process like this may be applicable when the field development offset distance to a suitable gas tie-in exceeds about 215 miles. Second, the process may offer hope for a viable development if installation of a gas export pipeline involves high risk, even for short distances, e.g., if there were known active mudslide areas to be crossed. Third, the pilot scale technology of this type of gas-to-liquid process needs to be prototyped at large scale to demonstrate that it will actually work as expected. The consequences of process failure would be untenable for a high-cost, Deepwater, development. These conclusions led to the recommendation that **Developer** continue to encourage EI development of this type technology.

DISCUSSION

Based on the information provided by EI, a simple cross-plot of the cost of installing deepwater pipelines in the GOM versus offset distance and the cost of an F-T process is summarized in Figure 1. The underlying assumption would be that gas export value and the gas-to-liquids product end value would be about the same. The EI information indicates that this may be feasible and if value for higher quality liquids products can be realized, the liquids may have a higher value than the original gas stream. The 215 mile cross-over reference should be used only as an approximate guideline pending better information.

To help better understand how the F-T process might actually contribute to a Deepwater field development, two hypothetical field development schemes are configured in Figure 2. Option 1 would include the usual assumption that suitable oil and gas export pipeline tie-ins can be identified. However, the gas export pipeline must be unusually long if the F-T process is going to be of interest. Thus, it is assumed that the gas tie-in is a robust 350 miles from the field development area. Option

2 is the same field development but with the introduction of the F-T process and the use of shuttle tankers for product transport; both the oil and gas export pipelines are eliminated. The field development schedules for each Option are summarized in Figure 3. Numerous simplifications are made for the purpose of this comparison, however, overall they provide realistic results. The time to design, build, and install the F-T process on a tanker is probably the highest uncertainty item in this comparison.

Option 1 costs are summarized in Figure 4 and Option 2 costs are summarized in Figure 5. The reservoir is assumed to be developed with 12 wells, all of which would be drilled and completed while the rest of the system is being built. On-site installations would be done during the fourth year. Thus, the field would ramp-up quickly to 150 mbpd after the end of the fourth year. As shown in Figure 6, a two-year plateau would be maintained and then a 15% per year production decline would occur. Using these hypothetical assmptions, a simple cumulative net cash flow can be prepared as summarized in Figure 7.

Basically, this information demonstrates that for these assumed conditions, the early, half-billion dollar investment advantage of Option 2, the F-T system, is maintained over Option 1, the conventional pipeline field development methodology, throughout field life. In-depth ECON evaluation can be done to refine this information, but refined information will not really add much to the analysis due to the uncertainty about F-T process costs; gas-to-liquid yields, and F-T liquids value, also, respecting conventional pipeline development, the cost of deepwater pipelining and schedule maintenance thereon, i.e., the availability of suitable deepwater pipelaying vessels when requested. For this evaluation, a flat $20 per barrel was used for produced crude and for F-T liquids, and a flat $2 per mscf was used for pipelined gas. Consistent assumptions were used for field operating costs, gas-to-liquids operating costs, oil and gas pipeline tariffs, and shuttle tanker operations.

SUMMARY

In summary, if the F-T process field-scale application will perform somewhat similar to the representations made by EI, it appears that commercial interest in the F-T process/shuttle tanker field development methodology is merited.

2. Data Basis for FFTP Evaluation

This section of Appendix C presents the letter and data provided by EI to a major oil and gas company, the **Developer**, for his use in determining if, in his judgement, the Fischer-Tropsch process as mounted on an FPSO has merit in development of production from deepwater prospects in the Gulf of Mexico. The forwarding letter and supplied data follow:

To: **Developer**

Subject: **Developer's Application of EI Proprietary F-T Technology to Associated Natural Gas Production in the Gulf of Mexico**

Dear Sir:

Enclosed please find the information on EI's F-T process that we had promised to you.

As you know, from our discussions and from the information that we left with you on our earlier visit, EI is a leader in the development of leading-edge Fischer-Tropsch (F-T) technology that can provide an attractive alternative to pipelines for delivering remote associated natural gas to market. The EI position stems from a long series of activities including our recent work under DOE contract on cobalt catalyst development and on our Williams Field Service-financed development work on our proprietary slurry bubble column reactor process.

We have been awarded a contract by the Morgantown Energy Technology Center of the U.S. Department of Energy to evaluate the application of EI's F-T technology to the remote gas opportunity, and it is on this basis that we have contacted you for assistance in evaluating this application.

Using "most likely" reservoir characteristics for deepwater Gulf of Mexico oil fields with associated gas and other information received in our discussions with you, we have constructed the attached Table 1 that shows oil and gas production for a hypothetical field in the Gulf of Mexico.

Based on the weight, volume and footprint of the EI F-T process and on marine engineering consideration provided by our Waller Marine subcontractor, we have determined that a tanker conversion of the type currently being used or contemplated in the industry for Floating Production, Storage and Offloading (FPSO) applications is the appropriate "platform" for the F-T process. We have conducted a preliminary design study of mounting our F-T process on such a vessel and provide our initial evaluation herewith.

Referring to Table 2, we show the capacity and cost breakdown for the Floating Fischer-Tropsch Plant (FFTP, our acronym for the combination of the FPSO and the proprietary EI F-T process) as it applies to the Table 1 Gulf of Mexico field.

The information in Table 2 indicates that the cost of the F-T process for this application is $353 million for converting 200 mmscf/d of associated gas to approximately 25,000 bbl/day of F-T liquids. Referring to this volume of F-T product in the absence of specific natural gas compositional data, we believe that the "wet" gas that you alluded to in our conversation would produce in the neighborhood of 25,000 bbl/day of F-T liquids, compared to 20,000 bbl/day that would be produced from a typically "dry" gas. The cost of the marine structure to support and moor this plant is estimated as $137 million, a portion of which should be allocated to the F-T processing, with the remainder allocated to oil and gas production. The vessel size for the marine structure is roughly 200,000 DWT (1030 ft length by 175 ft moulded breadth), with liquid storage capacity of

approximately 1,500,000 bbls. We would characterize the accuracy of the capital costs as rough order of magnitude.

Referring to the value of the F-T product, we believe that the F-T liquids are worth in the range of $25 to $40/bbl depending on refinery and market and based on the purity of the product, i.e., the absence of heteroatoms and sulfur compounds and the complete absence of any cyclic, aromatic or ring compounds. Netting this value estimate back to the gas and using a representative 60% energy efficiency for the F-T conversion process yields about $2.40 to $3.60/million BTU of natural gas processed.

We would like to discuss this and the attached information with you and jointly endeavor to establish the costs of the conventional pipeline method for handling the produced associated gas.

I look forward to discussing this information and your subsequent analysis with you.

For your reference we are also attaching a description of EI's F-T process.

Kind regards,

Alan H. Singleton
President

Attachments

Table 1

PRODUCTION DATA:
DEVELOPER APPLICATION IN THE GULF OF MEXICO

Gas Production, MMSCFD	200
Oil Production, MBPD	75
GOR, SCF/STB	2700
Water Depth	Greater than 4000 ft

Table 2

CONCEPTUAL CAPITAL COST ESTIMATE FOR A FLOATING FISCHER-TRPSCH PLANT

Gas Consumption, MMSCFD	200
F-T Production, BPD	25,000
Vessel	VLCC (1030')
Cost Estimate Millions of Dollars	
Vessel Acquisition & Mobilization	15.60
Life Extension Measures	7.80
Engineering Systems & Structures for F-T Plant	24.00
Upgraded Ship Systems	10.50
Mooring & Internal Turret	65.00
Crude Process & Flare	16.20
Naval Architecture, Marine Engineering, Supervision	2.90
Subtotal	142
F-T Plant	420
Total FFTP/FPSO	562