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### MEMORANDUM OF UNDERSTANDING

#### BETWEEN THE

# DEPARTMENT OF ENERGY OF THE UNITED STATES OF AMERICA AND

#### L'INSTITUT FRANCAIS DU PETROLE

#### CONCERNING AN EXCHANGE OF ENERGY-RELATED INFORMATION

IN THE AREA OF ENHANCED OIL RECOVERY

WHEREAS The United States Department of Energy (DOE) and l'Institut Francais du Petrole (IFP), (hereinafter referred to as the Parties), are jointly interested in furthering the development of research in the area of enhanced oil recovery;

WHEREAS the Parties desire to complement and reinforce energy research and development activities in their respective countries; and

WHEREAS the Parties desire to accelerate the achievement of their objectives through an orderly exchange of energy-related information in the area of enhanced oil recovery;

The Parties therefore, have reached the following Memorandum of Understanding:

## ARTICLE 1 - OBJECTIVE

The objective of cooperation under this Memorandum of Understanding (hereinafter referred to as the "MOU") is to establish for the mutual benefit of the Parties, a reasonably balanced exchange of energy information resulting from research and field testing undertaken by each of the Parties to increase the know-how on certain mechanisms occurring during the application of specific enhanced oil recovery techniques and an eventual integration of the results of the laboratory evaluations into field operations.

In order to meet the objective as set forth above, the Department of Energy intends to utilize the services of the Stanford University Research Institute (SUPRI) to carry out the tasks under this MOU.

## ARTICLE 2 - SCOPE

Pursuant to this MOU three specific Tasks shall be undertaken. These Tasks

and specific responsibilities of each of the Parties are listed as follows:

1. Task 1. Steam with Foaming Additives A.

**DOE** Responsibilities

Laboratory experiments shall be performed aiming at understanding foam flow in porous media. These experiments shall be in micromodels and in sandpacks of differing geometries, both at high temperature and pressure and at room temperature. The experiments shall include: (1) tests of surfactants of various compositions, (2) observation of foam generation and breakage, (3) the study of foam pressure gradients with and without inert gases, (4) the effect of oil on foam propagation mechanisms and pressure drop, and (5) the determination of the transient flow behavior of foam at room temperature in linear systems. A study of the relationship between interfacial and surface properties of aqueous solutions of surfactant with their foamability and stability shall be initiated.

B. IFP Responsibilities

Laboratory experiments shall be performed aimed at understanding the behavior of foam outside and inside the porous media and at evaluating the efficiency of different additives on oil recovery under reservoir conditions.

Studies shall be conducted to determine and follow the evolution of foam efficiency from ambient conditions up to 300 degrees centigrade and 100 bar, corresponding to high pressure steam, and in the presence of a hydrocarbon phase. During the experiments, including tests of various surfactants affected or not by the oil phase, the pressure drop in the porous medium during foam injection shall be monitored. Increase in oil recovery due to foam injection shall be determined during displacement tests performed in cores with crude oil at steamflood conditions.

- 2. Task 2. In-Situ Combustion
  - A. DOE Responsibilities

A study shall be made of the effect of metallic additives on the kinetics of the reactions occurring during in-situ combustion. If the results of the kinetics experiments warrant further study, combustion tube runs shall be made for comparison.

Investigation of the PVT properties of CO2/steam/heavy oil mixtures shall be started. This information relates to both

high oxygen combustion and to the possibility of using CO2 as an additive in steam injection. Again, if the results warrant it, experiments of heavy oil displacement by steam and carbon dioxide shall be performed and oxygen enriched in-situ combustion runs shall be made.

Analytical and numerical studies complementing the two above mentioned experimental programs shall be continued and extended.

B. IFP Responsibilities

Research on the specific characteristics of in-situ combustion with oxygen-enriched air as compared to conventional combustion with air shall be performed. The effect of the gas rich CO2 produced by the combustion with pure oxygen and the influence of the oil gravity shall be determined.

Laboratory experiments on the pyrolysis of oil and of oil components shall be performed to investigate qualitatively and quantitatively the thermal alteration of crude oils. The effect of the presence of a mineral matrix and of water shall be evaluated.

- 3. Task 3. Carbon Dioxide Flooding
  - A. DOE Responsibilities

The role of heterogeneity@y in determining the scale of nonuniform flow features such as viscous fingers shall be explored in simulations and in flow experiments. A study shall be made of the effect of the interaction of phase behavior with nonuniform flow caused by viscous instability and/or heterogeneity. The problem of detection of the most important length scales of nonuniform flow shall also be explored.

B. IFP Responsibilities

The thermodynamic behavior of supercritical gas (light hydrocarbons, CO2, N2, flue gas...) and oil mixtures shall be studied in order to underline the effect of associated gas composition and content, as well as stock tank oil composition on the phase diagram and M.M.P. To that end, IFP shall study the precipitation of heavy ends and the stripping effect of the supercritical gas phase.

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ARTICLE 3 - EXCHANGE OF INFORMATION

The Parties will observe the following principles in conducting the information exchange under this MOU:

- 1. Information generated under Article 2 of this MOU shall be transmitted in the English language to the other Party in a format to be mutually agreed upon by the Parties.
- 2. No proprietary information shall be exchanged.

Definitions as used in this Memorandum of Understanding:

- i) The term "information" means scientific or technical data, results or methods of research and development, and any other information intended to be provided or exchanged under this Memorandum of Understanding.
- ii) The term "proprietary information" means information developed prior to or outside this Memorandum which contains trade secrets or commercial or financial information which is privileged or confidential, and may only include such information which:
  - .a) has been held in confidence by its owner;
  - b) is of a type which is customarily held in confidence by its owner;
  - c) has not been transmitted by the transmitting Par@y to other entities (including the receiving Party) except on the basis that it be held in confidence; and
  - d) is not otherwise available without restriction on its further dissemination.
- 3. Each Party shall have the right to reproduce and distribute the information received under this MOU in accordance with its normal procedures and through its normal channels subject to its laws and regulations.
- 4. Information transmitted by one Party to the other Party under this MOU shall be accurate to the best knowledge and belief of the Transmitting Party, but the Transmitting Party does not warrant the suitability of the information transmitted for any particular use or application by the Receiving Par@y or by any third party.

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#### ARTICLE 4 - MANAGEMENT

To supervise the execution of this MOU, the Parties shall establish a Joint Coordinating Committee (JCC) that shall be composed of at least two representatives from each Par@y. Each Party shall designate one Program Manager who will serve as a member of the JCC. It shall be the responsibility of each Program Manager to designate a Project Coordinator for his side. In addition, each Program Manager may invite at his discretion, technical support personnel to these meetings. The JCC shall meet semi-annually in the United States and France on an alternative basis. The Program Manager of the receiving Party shall act as the Chairman during meetings of the JCC.

At its meetings, the JCC shall evaluate the status of cooperation under this MOU. This evaluation shall include an assessment of the balances of exchanges in the various Tasks listed in Article 2 and a consideration of measures required to correct any imbalances. Any new proposals for cooperation from the JCC must receive written approval of the Parties in the form of amendments to this MOU prior to being initiated.

Project Coordinators shall be responsible for the day-to-day handling of activities under the MOU including the transmission of information to each other. The Project Coordinators shall coordinate their activities with their respective Program Managers.

## Article 5 - GENERAL PROVISIONS

Cooperation under this MOU shall be in accordance with the laws and regulations of the countries of the Parties. All questions arising during the term of the MOU shall be settled by the Parties by mutual agreement.

#### ARTICLE 6 - FINANCE

Except when otherwise agreed, all costs resulting from cooperation under this MOU shall be borne by the Party that incurs them. Cooperation under this MOU shall be subject to the availability of appropriated funds.

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## ARTICLE 7 - ENTRY INTO FORCE AND TERMINATION

This MOU shall enter into force upon the later date of signature and shall continue for a three-year period. This MOU may also be extended or amended by written consent of the Parties.

Done in duplicate in both the English and French languages, both texts being equally authentic.

FOR THE DEPARTMENT OF ENERGY THE UNITED STATES OF ANERICA

(Signature)

Marvin I. Singer (Printed Name)

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Deputy Assistant Secretary for Oil, Gas, Shale and Special Technologies (Title)

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FOR L'INSTITUT FRANCAIS DU PETROLE -	
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(Signature)	
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J.C. BALACEANU	
(Printed Name)	

General Manager (Title)

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(Date)