

Implementing Memorandum 2

To the Memorandum of Understanding Between the
Government of the United States and the Government
of the Italian Republic Concerning Energy Research
and Development Cooperation

in

Quantitative Characterization of Reservoir
Heterogeneity - Scaling for Simulation

WHEREAS, the Government of the United States of America represented by the Department of Energy (DOE) and the Government of the Italian Republic represented by the Ministry of Industry, Commerce, and Handicraft (MOI) have entered into a Memorandum of Understanding in energy research and development signed on December 5, 1985, (hereinafter referred to as the "MOU");

WHEREAS, MOI has designated by letter of April 1, 1985, as its representative, the Italian National Oil Company (AGIP); and

WHEREAS, DOE and AGIP (hereinafter referred to as the "Parties") recognize that it would be beneficial to both Parties to cooperate in the field of enhanced oil recovery.

Therefore, the Parties agree as follows:

ARTICLE I

SCOPE

The Parties shall cooperate in a joint research effort to provide a better understanding of the behavior of oil production processes in the presence of large variations in reservoir properties.

Individual physical and chemical-geologic properties that govern subsurface fluid flow are generally spatially heterogeneous rather than homogeneous. Each level of scale in heterogeneity from microscopic (1 ft.) to gigascopic (1000 ft.) has its individual effect on hydrocarbon recovery performance at a level corresponding to its scale. The scale over which processes occur will thus determine the relative influence of each process.

It would be desirable to obtain comprehensive reservoir data on rock and hydrodynamic properties at each appropriate scale to allow proper modeling of scale dependent phenomena, but the

inaccessible nature of underground formations does not permit this detailed examination. In simulation, current practice is to represent reservoir heterogeneties as multilayered homogenous zones and effect a history match by manipulating the layer definitions and oil/water flow characteristics. In many cases, the final reservoir definition does not represent the known data e.g., data from wireline logs, conventional core analysis, and core floods.

The goal of this effort is to develop general models and methodology for obtaining an appropriately scaled quantitative description of reservoir heterogeneties for simulation from data available at the well bores. This methodology shall be based on the proposition that small scale flow (at which gradual or sudden changes in rock properties are considered) shall be derived based on the statistical properties of the microscopic distributions. When connecting small and large scale phenomenology, both analytical and numerical approaches shall be considered in developing correlations for parameters such as porosity, and permeability.

The project shall consist of the following tasks:

AGIP's Responsibilities

TASK 1 - Reservoir Selection, Data Collection Analysis

AGIP shall select a cross-section of an actual oil field as an appropriate test case for detailed study. All available data for the wells included in the cross-section shall be collected and analyzed for completeness and accuracy. AGIP shall prepare a topical report detailing the raw data, the interpreted results, and their general conclusions.

TASK 2 - Data Transfer

AGIP shall provide copies of all logs, well tests, and laboratory tests, and copies of the topical report (Task 1) to DOE for review and use.

TASK 3 - Conventional Simulation and Analysis

DOE and AGIP shall independently define a geological model from the data and, with conventional techniques, shall independently simulate the behavior of the test core wells under varying production/injection schedules. DOE and AGIP personnel shall review each others' geological interpretation and simulation results and shall jointly select a set of production/injection cases for reference in future tasks of the project. A joint topical report detailing the work performed in this task shall be prepared.

DOE's Responsibilities

TASK 4 - Develop Statistical Methodology

DOE shall develop a statistical methodology to calculate inter-well reservoir properties based on bore-hole and core analyses. The methodology shall permit calculation of the distribution of values found in bore-hole and core analyses. DOE shall prepare a topical report detailing the methodology for review and comment by AGIP.

TASK 5 - Simulator Modification

DOE shall develop the code necessary to implement the statistical methodology (as developed in Task 4) and incorporate this new code into the BOAST simulator. DOE shall then run sensitivity analyses to define major impacts of reservoir parameters on simulator results.

Joint Responsibilities

TASK 6 - Statistical Simulations

DOE and AGIP shall perform a simulation of the selected reservoir using the modified BOAST simulator and the reservoir data as delivered in Task 2. Sensitivity runs shall be performed to assure that proper accuracies in the results are achieved, and to assist in reaching a conclusion as to the effectiveness of the methodology.

TASK 7 - Comparative Analysis and Results

DOE and AGIP personnel shall compare results of the conventional and statistical simulations and shall develop a final procedure to convert macro-measured petrophysical properties in heterogeneous reservoir rocks to grid-cell scale for simulation. The methodology developed and the results obtained shall be written and published as a joint DOE/AGIP report.

ARTICLE II

MANAGEMENT

1. In order to provide guidance and technical advice to the Project, a Management Committee shall be established consisting of four members, two designated by each Party. Each Party shall inform the other Party in writing of all designations under this paragraph. The Committee shall elect a chairman and the chairmanship shall alternate between the Parties each year.

2. Up to two persons designated by each Party may, without further consent of the other Party, attend meetings of the Management Committee.
3. The Management Committee shall have the following responsibilities:
 - A. Review annually the status of the Project and adopt any changes in technical direction to the project plan relating to scientific, technical, schedule or financial items.
 - B. Consider any matters submitted to it by the Parties.
4. The Management Committee shall carry out its responsibilities in accordance with the following procedures:
 - A. The Management Committee shall meet at least once each year. A special meeting shall be convened upon the request of any member which can demonstrate the need for such a meeting. The first meeting of the Management Committee shall take place within eight (8) weeks after signing this Implementing Memorandum.
 - B. One member of each Party shall be present to produce a quorum for the transaction of business in meetings of the Management Committee.
 - C. The Management Committee shall make all its decisions by unanimity. This shall require the agreement of each member or alternate member present and voting at the meeting at which the decision is made.
 - D. The Management Committee shall report annually to the Joint Working Group established under the MOU regarding the status of the Project.

ARTICLE III

EXPENSES

- A. Each Party shall bear its own costs in carrying out its task activities including travel expenses of its representatives and the costs of preparing reports.
- B. The cost of organizing and hosting meetings shall be borne by the host Party.

ARTICLE IV

INFORMATION

1. DOE shall provide to AGIP and AGIP shall provide to DOE publicly available information concerning quantitative characterization of reservoir heterogeneity scaling for simulation.
2. DOE and AGIP shall exchange all information provided to or arising from the tasks set forth in Article I.
3. The Parties support the widest possible dissemination of information provided, exchanged, or arising from this Annex, subject to the provisions of Article V. Such information may be made available to the public by either Party through customary channels and in accordance with normal procedures of the Parties.

ARTICLE V

INVENTION OR DISCOVERY

1. With respect to any invention or discovery made or conceived in the course of or under this Implementing Memorandum:
 - A. MOI shall acquire all right, title and interest in and to any such invention or discovery in its own country, subject to a nonexclusive, irrevocable, royalty-free license to DOE, its Government and its nationals designated by it; and
 - B. DOE shall acquire all right, title and interest in and to any such invention or discovery in its own country and third countries, subject to a nonexclusive, irrevocable, royalty-free licenses to MOI, its Government and its nationals designated by it.
2. Information regarding inventions on which patent protection is to be obtained by a Party shall not be published or publicly disclosed by the other Party until a patent application has been filed, provided, however, that this restriction on publication or disclosure shall not extend beyond six months from the date of receipt of such information. It shall be the responsibility of the inventing Party to appropriately mark reports which disclose inventions that have not been appropriately protected by the filing of a patent application.

3. Each Party shall, without prejudice to any rights of inventors under its national laws, take all necessary steps to provide the cooperation from its inventors required to carry out the provisions of this Article. Each Party shall assume the responsibility to pay awards or compensation required to be paid to its own nationals according to its own laws.

ARTICLE VI

Articles 3, 7, 8 and 9 of Annex I to the Memorandum of Understanding are hereby incorporated by reference.

ARTICLE VII

TERM

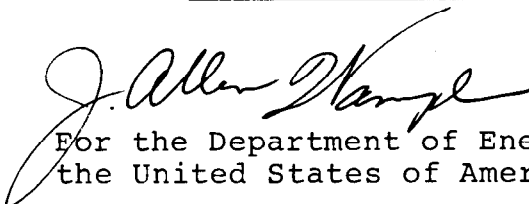
This Implementing Memorandum shall enter into force upon signature and shall remain in force until December 31, 1990. It may be amended or extended by mutual written consent of the Parties.

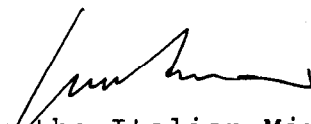
ARTICLE VIII

TERMINATION

This Implementing Memorandum may be terminated at any time at the discretion of either Party, upon six (6) months advance notification in writing to the other Party by the Party seeking to terminate the Implementing Memorandum. Such termination shall be without prejudice to the rights which have accrued under this Implementing Memorandum to either Party up to the date of such termination.

Done at Rome in duplicate this 8th
day of July, 1987.


For the Department of Energy
the United States of America


For the Italian Ministry of
Industry, Commerce and Crafts