TECHNICAL EXCHANGE

AND

COOPERATIVE ARRANGEMENT

BETWEEN

THE UNITED STATES ATOMIC ENERGY COMMISSION

AND

THE FEDERAL MINISTRY FOR RESEARCH AND TECHNOLOGY

OF THE FEDERAL REPUBLIC OF GERMANY

IN THE FIELD OF MANAGEMENT OF RADIOACTIVE WASTES

The United States Atomic Energy Commission (AEC) and the Federal Ministry for Research and Technology (FMRT) of the Federal Republic of Germany, having a mutual interest in cooperation in the field of management of radioactive wastes hereby agree as follows:

Article 1

The subjects of cooperation are defined in Appendix "A", and can be modified or expanded, as may be mutually agreed.

Article 2

Both Parties will make available to each other information in the field of radioactive waste management which they have the right to disclose, either in their possession or available to them, from the technical areas described in Appendix "A".

Article 3

The information exchange will be reciprocal (balanced) and will be in the form of technical reports, experimental data, correspondence, visits, joint experts meetings, and such other means as the Parties agree.

Article 4

The execution of joint programs and projects, or those programs and projects under which activities are divided between both Parties, including the use of test facilities and/or computer programs owned by either Party, will be agreed upon on a case-by-case basis. Long-term assignments of personnel can be accomodated on the same basis.

Article 5

In general, information received pursuant to this Arrangement may be disseminated freely in the country of the recipient. However, privileged (private, proprietary, company confidential) information received by either Party under this Arrangement and bearing a restrictive designation may not, except as may be required by the laws of the respective Party, be publicly disseminated by the receiving Party without the prior written consent of the transmitting Party, but such information may be disseminated as follows:

(a) to persons within or employed directly by the recipient, and to other concerned government agencies;

(b) to prime or sub-contractors of the recipient Party for use only within the framework of its contract(s) with the respective Parties engaged in work relating to the subject matter of the information so disseminated;

provided that privileged information disseminated to any person under subparagraphs (a) and (b) above bear the marking "Not for dissemination outside recipient's organization without prior written approval of the _____(AEC or FMRT)". Each Party will use its best efforts to ensure that the dissemination of privileged information received under this Arrangement is controlled as prescribed herein.

Article 6

The information exchanged under this Arrangement shall be subject to the patent provisions in the Patent Addendum to this document.

Article 7

A coordinator will be designated by each Party, who will develop and control the arrangements and procedures for implementing the cooperation, in particular the effective exchange of information under this Arrangement. Approximately annually, the coordinators will organize joint working sessions at which the achievements, problems, effectiveness, future programs, etc., will be discussed with the objective of improving the cooperation.

Article 8

The application or use of any information exchanged or transferred between the Parties under this Arrangement shall be the responsibility of the Party receiving it, and the transmitting Party does not warrant the suitability of such information for any particular use or application.

Article 9

Each Party will be prepared to the best of its ability, upon specific request, to advise the other on particular questions involving the topics of this Arrangement.

Article 10

It is the intent of both Parties to assure that a reasonably balanced exchange is achieved and maintained.

Article 11

It is understood that the ability of the Parties to carry out their obligations is subject to the availability of appropriated funds.

Article 12

No provision has been made for reciprocal cost reimbursement between the Parties. Both parties shall bear the costs incurred in their area of competence, including travel expenses and subsistence allowances for their staff members and transport costs for apparatuses and other equipment transported under the cooperation program into the territory of the other Party in each case.

Article 13

This Arrangement shall also apply to Land Berlin, provided that the Government of the Federal Republic of Germany has not made a contrary declaration to the Government of the United States of America within three months from the date of entry into force of this Arrangement.

Article 14

This Arrangement shall remain in operation for five (5) years after its effective date and may be extended by mutual agreement. However, the Arrangement may be terminated at any time, at the discretion of either Party, upon six months' advance written notification by the Party seeking to terminate, to the other Party.

Article 15

This Arrangement shall enter into force on the date of signature.

Done at Bonn in duplicate in the English and German languages, each equally authentic, this twentieth day of December, 1974

FOR THE UNITED STATES ATOMIC ENERGY COMMISSION

Fred E. Ascarelli

THE FEDERAL MINISTER FOR RESEARCH AND TECHNOLOGY OF THE FEDERAL REPUBLIC OF GERMANY

Hans Matthöfer

PATENT ADDENDUM

A. With respect to any invention or discovery made or conceived during the period of, and in the course of or under, this technical exchange and cooperative Arrangement on radioactive waste management between the United States Atomic Energy Commission (AEC) and the Federal Ministry for Research and Technology (FMRT) of the Federal Republic of Germany:

(1) If made or conceived by personnel of one Party (the assigning Party) or its contractors while assigned to the other Party (recipient Party) or its contractors:

(a) The recipient Party shall acquire all right, title, and interest in and to any such invention, discovery, patent application or patent in its own country and in third countries, subject to a non-exclusive, irrevocable, royalty-free license to the assigning Party, with the right to grant sublicenses, under any such invention, discovery, patent application or patent for use in the production or utilization of special nuclear material or atomic energy; and

(b) The assigning Party shall acquire all right, title, and interest in and to any such invention, discovery, patent application, or patent in its own country, subject to a non-exclusive, irrevocable, royalty-free license to the recipient Party, with the right to grant sublicenses, under any such invention, discovery, patent application or patent, for use in the production or utilization of special nuclear material or atomic energy.

(2) If made or conceived while in attendance at meetings or when employing information which has been communicated under this exchange Arrangement by one Party or its contractors to the other Party or its contractors, the Party making the invention shall acquire all right, title, and interest in and to any such invention, discovery, patent application or patent in all countries, subject to the grant to the other Party of a royalty-free, nonexclusive, irrevocable license, with the right to grant sublicenses, in and to any such invention, discovery, patent application, or patent, in all countries, for use in the production or utilization of special nuclear material or atomic energy.

(3) It is understood that after the European Patent Conventions (Uebereinkommen ueber die Erteilung europaeischer Patente, Uebereinkommen ueber das europaeische Patent fuer den Gemeinsamen Markt) have come into force, either Party may request a modification of this paragraph A for the purpose of according equivalent rights as provided in subparagraphs 1 and 2 above under the European Patent Conventions.

B. Neither Party shall discriminate against citizens of the country of the other Party with respect to granting any license or sublicense under any invention pursuant to subparagraphs A(1) and A(2) above. It is understood that the licensing policies and practices of each Party can be affected because of the rights of both Parties to grant licenses within a single jurisdiction. Accordingly, each Party may request, in regard to a single invention or class of inventions, that the Parties consult in an effort to lessen or eliminate any detrimental effect that the parallel licensing authorities may have on the policies and practices of the Parties.

C. Each Party waives any and all claims against the other Party for compensation, royalty or award as regards any inventions or discovery, patent application, or patent, made or conceived under this Arrangement, and releases the other Party with respect to any and all such claims, including any claims under the provisions of the United States Atomic Energy Act of 1954, as amended, and the German Employees' Inventions Law (Arbeitnehmererfindergesetz) of July 1957 (BGBl.1957, Part I, page 756) as amended, and the FMRT assumes the obligation under the said German law for use of patents by or on behalf of the AEC.

APPENDIX "A"

Technical Scope

AEC-FMRT Radioactive Waste Management Exchange *

1. Disposal of radioactive waste in salt deposits

   a. Facility design and operation, including data on contamination of salt

   b. Heat generation and dissipation

   c. Rock mechanics studies

   d. Safety considerations and cleanliness standards for casks

   e. Geology and hydrology

   f. Waste product criteria

   g. Site criteria

   h. Cost evaluation

   i. Records of repositories

   j. Risk analysis

   k. Monitoring and control

   l. Public information and relations

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* Initially, the facilities involved in this exchange on the AEC side will be Oak Ridge National Laboratory (ORNL), Los Alamos Scientific Laboratory (LASL), Argonne National Laboratory (ANL), Atlantic Richfield Hanford Co. (ARHCO), Battelle Memorial Institute/Pacific Northwest Laboratory (BNWL) and the waste management facilities at the Idaho National Engineering Laboratory (INEL), and those on the FMRT side will be Gesellschaft fuer Kernforschung m.b.H (GfK), Gesellschaft fuer Strahlen- und Umweltforschung m.b.H (GSF), Kernforschungsanlage Juelich G.m.b.H. (KFA) and

2. Retrievable surface storage facilities

3. Waste management research and development

   a. Solidification of high-level waste

   b. Treatment and packaging of intermediate- and low-level waste

   c. Incineration and incorporation in bitumen

   d. Processes for removal and storage of noble gases and tritium in waste streams

   e. Development of criteria for handling and storage of all classes of radioactive waste

   f. Feasibility, safety and economic analysis for alternative long-term waste management methods adopted or under consideration

   g. Processes and methods for the partitioning of high-level waste and for the extraction of selected nuclides

4. Waste from decommissioning of nuclear installations

5. Operating aspects of storage or disposal of low- and intermediate-level wastes

   a. Methods of minimizing initial generation

   b. Current efforts on volume reduction, such as incineration and compaction

   c. Current methods and limitations for packaging, handling and storage/disposal, including existing criteria

   d. Currently identified categories requiring special or unique handling

6. Transportation of radioactive waste

a. Development of a transportation handling and shipping system for low-level waste

b. Design and approval of a high-level waste shipping package concept

c. Waste packaging technology

d. Safety evaluation techniques for waste packaging and transport systems, including a quantification of risk.

ANNEX 1

TECHNICAL PROGRAM
FOR
100 BPD DEMONSTRATION PLANT

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I. Summary

The Mobil Methanol to Gasoline Process offers a direct route for the conversion of coal to high octane gasoline. The gasification of coal and the conversion of synthesis gas to methanol are commercially proven technologies. The Mobil process is now ready for scale-up to a demonstration plant, and no major problems are foreseen. Thus, this coal conversion route to gasoline is potentially capable of earlier commercialization than other coal liquefaction processes under development.

The feasibility of the fluid bed process for the conversion of methanol to gasoline has been demonstrated in a 4 barrel-per-day (BPD) fluid bed pilot plant. Gasoline yields of 88 wt % were achieved during 5 months of successful operation. Complete methanol conversion was obtained at design conditions, and catalyst stability and regenerability were confirmed. The results have provided a design basis for a 100 BPD fluid bed demonstration plant, which is the next logical step in the scale-up of this process.

A program to design, build, and operate a 100 BPD demonstration plant for the conversion of methanol to high octane gasoline has been formulated. The primary objective is to demonstrate the scale-up of the reactor design. The use of heat exchange pipes for heat removal will be tested, and the effects of reactor diameter and baffles on the fluid bed efficiency will be determined. The feasibility of continuous regeneration and steady-state operation with constant catalyst activity will also be demonstrated. During this study the fluid bed process will be optimized, and the results will provide a sound basis for the design of a commercial size plant for the conversion of methanol to high octane gasoline.

II. Introduction

The Mobil Methanol to Gasoline Process provides a unique route to high octane gasoline from coal. It has an excellent thermal efficiency, lower capital requirements, and superior product selectivity compared to the Fischer-Tropsch process, the only coal-to-gasoline technology practiced commercially.

This process is based on catalyst invented and developed by Mobil during the past decade. Methanol is dehydrated to dimethylether which in turn is converted to high octane hydrocarbons. The reactions can be illustrated schematically as follows:

$$2\ CH_3OH \rightleftharpoons CH_3OCH_3 \longrightarrow \text{Olefins} \longrightarrow \text{High Octane Gasoline}$$

$$+\ H_2O \qquad\qquad +\ H_2O$$

The gasoline consists primarily of paraffins (branched and cyclic) and aromatics with small amounts of olefins.

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The manufacture of gasoline from coal with the Mobil process is shown conceptually in Figure 1. Synthesis gas is produced by the gasification of coal, and is then converted to methanol. The crude methanol is used as the feedstock for the Mobil process. Both the coal gasification and conversion of synthesis gas to methanol are proven commercial technology, and represent the major investment cost of this coal-to-gasoline process scheme.

Process development studies of the conversion of methanol to high octane gasoline were conducted during 1975-76 under DOE contract E (49-18)-1773 which was jointly funded by DOE and Mobil. Long-term aging tests of over 200 and 60 days were achieved in bench-scale fixed and fluid bed units, respectively. In addition to the long-term aging tests, optimum process conditions were defined, and the quality of the product gasoline was verified. Due to the high exothermicity of the conversion of methanol to gasoline, two reactors are used in the fixed bed process. Methanol is dehydrated in the first reactor to an equilibrium mixture of methanol and dimethylether which is converted to high octane gasoline over the Mobil conversion catalyst in the second reactor. Only a single reactor is required in the fluid bed process.

The results from the process development studies identified a number of potential advantages of the fluid bed process over the fixed bed process. They include:

Higher gasoline yield
Steady-state operation
Easy temperature control
Smaller recycle ratio
Lower operation costs

In view of the advantages of the fluid bed process, a 4 BPD fluid bed pilot plant was designed, built, and operated under DOE contract EX-76-C-01-2490. As before, it was jointly funded by DOE and Mobil. The details and results of this program are described in the next section.

III. 4 BPD Fluid Bed Pilot Plant

Work on a 4 BPD fluid bed pilot plant for the conversion of methanol to gasoline was started in October 1976. The program included the following tasks:

1. Flow studies in glass model reactors
2. Design and construction of pilot plant
3. Evaluation of fluid bed catalyst in bench-scale units
4. Process studies in pilot plant
5. Evaluation of product gasoline.

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The flow studies with non-reacting gases provided necessary information for the design of the pilot plant reactor. The effects of gas velocity on bed density, entrainment rate, and reactor inventory were determined.

Capacitance probe techniques were developed to measure fluidization quality. The results of the flow studies contributed significantly to the design of efficient catalyst circulation and recovery systems and feed contributors.

The construction of the 4 BPD pilot plant was completed in June 1977. After a 2-month period for checkout and debugging, methanol conversion runs were initiated in September 1977.

The reactor-regenerator system is shown in Figure 2. The 4" ID x 25' high reactor is equipped with cooling jackets and access ports for thermocouple insertion, emergency flooding with N_2, and capacitance probe insertion.

Six adiabatic zone heaters maintain a zero Δ T between the heaters and the reactor skin. The product stream passes into a disengager where the entrained catalyst is separated, collected, and returned to the bottom of the reactor via an external catalyst recirculation line. Fluidizing nitrogen is introduced at the slating face on the conical section to promote catalyst movement and recirculation.

Catalyst is regenerated isothermally in a batch mode at a rate of 10% of the reactor catalyst inventory per day. Catalyst transfer between the reactor and regenerator is controlled by maintaining a constant differential pressure between the 2 vessels, and a calibrated orifice plate.

A simplified flow diagram of the complete pilot plant is shown in Figure 3. Chemical grade methanol (99.85% pure) is stored in an 8,000 gallon railroad tank car (carbon steel) and pumped into the 400 gallon stainless steel tanks. It is blended with water at this point to simulate crude methanol which normally contains 5-30 wt % of water. The methanol feed is generally charged to the reactor as vapor; however, the pilot plant is capable of co-feeding liquid and vapor methanol simultaneously. The product stream from the disengager is filtered and passed through a three-stage condenser. The light gas for recycle is drawn from the first stage. The effluent from the third stage is separated into gas, hydrocarbon liquid, and aqueous phase.

The start-up of the pilot plant was very smooth, and target operating conditions were reached within several hours. About 109 days of successful operation were achieved in the pilot plant.

Two long-term evaluations were conducted. The first 34-day evaluation was followed by a scheduled turn-around, and the second evaluation lasted 75 days. Exceptionally smooth and continuous operation was achieved during both evaluations. The range of operating conditions were:

Temperature:	730 to 800° F
Pressure:	20 to 40 psig
WHSV, MeOH:	0.5 to 1.5
Gas Super. Vel.:	0.7 to 1.8 ft/sec
Feed Composition:	83 to 100 wt % MeOH

Complete conversion of methanol was achieved at the design conditions for gas superficial velocities of up to 1.8 ft/sec. Heat transfer, stability, and smoothness of the operation were excellent.

A typical temperature profile in the reactor is shown in Figure 4. Despite the highly exothermic nature of the methanol conversion and the unusually large aspect ratio (L/D > 75) of the reactor, a very uniform temperature profile was established. The reactants were introduced into the reactor at 300° F. Within a mixing zone of about 2 ft, back-mixing and recirculating catalyst provided sufficient heat to bring the feed up to the reactor temperature (750° F). There was a complete absence of any troublesome "hot spot". In addition, the transient temperature profiles of the reactor during heat up and cool down were also comparably uniform.

Typical product yields from the 4 BPD fluidbed pilot plant are given in Table 1. As expected, stochiometric amounts of hydrocarbons and water are produced. On a hydrocarbon basis, the raw C_5+ gasoline fraction is 60 wt %. Alkylation of propene and butenes with isobutane increases the total gasoline yield to 88 wt %, which is higher than that from the fixed bed process. As shown in Table 2, the gasoline quality is very good in terms of octane (96.8 RON clear) and distillation range. The durene content is 3.8 wt %, and would not be expected to cause any driveability problems. Previous vehicle tests with durene-doped gasoline showed that durene concentrations up to 4 wt % had no significant effects on vehicle performance.

In conclusion, the major accomplishments during the operation of the 4 BPD fluid bed pilot plant are summarized below:

- Demonstrated steady state operation with 88.0 wt % C_5+ gasoline yield
- Accomplished complete methanol conversion at design conditions
- Demonstrated excellent operability of fluid bed process
- Confirmed catalyst stability and regenerability with 22 regenerations
- Further characterized gasoline quality
- Developed design basis for a 100 BPD fluid bed pilot plant

IV. Demonstration Plant Program

A. Objectives

The broad objective of this program is to scale-up the fluid bed Methanol to Gasoline Conversion Process to a 100 BPD demonstration plant. It is the final development step which will providethe basis for the design and construction of commercial size facilities.

To accomplish the program objective, a fluid bed demonstration plant with a 2' ID x 40' high reactor will be designed and constructed in the Federal Republic of Germany. The plant will be operated for a period of about 21 months during which the essential scale-up data will be collected and analyzed. The gasoline product from the plant will be extensively evaluated, including vehicle testing. Based on these results, the design basis for a commercial-sized plant will be formulated.

B. Technical Program

1. Design and Construction of Demonstration Plant

A conceptual schematic of the 100 BPD demonstration plant is shown in Figure 5.

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The major process units are the reactor and the regenerator. The reactor will be approximately 60 cm (2') diameter by 12 m (40') high and will be operated adiabatically. The reaction heat is removed through internal or external heat exchange tubes. The tubes will also function as baffles to break up the large bubbles in the fluidized bed and reduce bypassing. To maintain catalytic activity in the bed, a continuous slipstream of catalyst from the reactor is drawn into the regenerator where coke is burned off. Regenerated catalyst is continuously returned to the reactor. With this mode of operation, steady-state operations can be achieved and optimized.

A fraction of the light gas stream will be recycled back to the reactor. Previous studies in the 4 BPD pilot plant have indicated improvements in gasoline yield by recycle. The design and construction of the 100 BPD pilot plant will be primarily the responsibility of Uhde at a site provided by URBK. Mobil will provide the design basis to Uhde. Mobil and URBK will contribute technical assistance as needed.

2. Cold Flow Model Study

Flow characterization studies will be carried out in a flow demonstration unit with non-reacting gases prior to the final design of the pilot plant reactor. These studies are required, because continuous regeneration and internal baffles were not tested in the 4 BPD pilot plant study. A "cold" flow model reactor will be constructed and employed to design the baffle configuration and reactor/regenerator catalyst circulation system. The results from the flow experiments will also be used to design feed distributors and cyclones. Mobil will conduct this study at Paulsboro, New Jersey. URBK and UHDE may participate in this effort.

3. Demonstration Plant Operation

An operating period of about 21 months is anticipated for this program. The main goal will be to operate the demonstration plant at steady state with virtually complete methanol conversion and continuous catalyst regeneration to maintain constant catalytic activity. Make-up catalyst will be added as needed. Such operation will provide information on the long-term catalyst stability, make-up requirements, attrition characteristics, and regeneration effects. The concept of internal heat exchange tubes in dissipating reaction heat and functioning as baffles will be thoroughly evaluated. External cooling and catalyst recirculation will be studied. The yield advantages of light gas recycle will also be investigated.

The effect of reactor scale-up on conversion efficiency will be determined, and process variable studies will be carried out for further process optimization.

URBK will have prime responsibility for operation of the pilot plant. Mobil and Uhde will participate in this effort.

4. Evaluation of Results and Product Testing

Hydrocarbon yield and selectivity data will be collected along with the corresponding operating data. Methanol will be determined by analyses of the aqueous products. The sensitivity of gasoline yields to key process variables and feed composition will be determined. Product quality, in particular durene concentration, will be monitored closely.

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Finished gasoline will be made by blending purchased alkylate with product from the pilot plant. The gasoline product from the demonstration plant will be evaluated by Mobil and URBK. Gasoline properties such as octane ratings and volatility will be determined and compared with the results from the 4 BPD pilot plant.

5. Design Study for a Commercial Plant

The 100 BPD demonstration plant program is the final scale-up step in the orderly development of the fluid bed Methanol to Gasoline Conversion Process. The process and engineering data from this program will provide a sound design basis for a commercial-size plant. An optimal set of operating conditions will be selected. A flowsheet for the plant will be generated. Major and ancillary process units will be identified and specified in terms of design requirements. Heat and material balance calculations and catalyst requirements will also be presented. Economic scoping of the commercial plant will be made.

This work will be conducted by Uhde with assistance from Mobil and URBK.

C. Schedule

Duration for the complete program will be about 5 1/2 years. The design and construction of the demonstration plant will take about 35 months. Shakedown and operation of the plant, along with data analyses and reporting, will span the remaining time. It will be necessary to complete the "cold" model flow studies as early as possible in the contracting period. This will eliminate unnecessary delays in finalizing designs for the reactor and regeneratory system.

TABLE 1

YIELDS FROM METHANOL

Average Bed Temperature, ° F	775
Pressure, PSIG	25
Space Velocity (WHSV)	1.0
Yields, Wt % of Methanol Charge	
Methanol + Ether	0.2
Hydrocarbons	43.5
Water	56.0
CO, CO_2	0.1
Coke, other	0.2
	100.0
Hydrocarbon Product, Wt %	
Light Gas	5.6
Propane	5.9
Propylene	5.0
i-Butane	14.5
n-Butane	1.7
Butenes	7.3
C_5+ Gasoline	60.0
	100.0
Gasoline (including Alkylate)	
(96 R+O, 9 RVP)	88.0
LP Gas	6.4
Fuel Gas	5.6
	100.0

TABLE 2

TYPICAL PROPERTIES OF FINISHED GASOLINE

Components, Wt %	
Butanes	3.2
Alkylate	28.6
C_5+ Gasoline	68.2
	100.0

Composition, Wt %	
Paraffins	56
Olefins	7
Naphthenes	4
Aromatics	33
	100

Octane	Research	Motor
Clear	96.8	87.4
Leaded (3 cc TEL/ US Gal)	102.6	95.8
Reid Vapor Pressure, PSIG	9.0	
Specific Gravity	0.730	
Sulfur, Wt %	nil	
Nitrogen, Wt %	nil	
Durene, Wt %	3.8	
Corrosion, Copper Strip	1 A	

ASTM Distillation, ° F	
10 %	117
30 %	159
50 %	217
90 %	337

TABLE 3

COST ESTIMATE

On a preliminary basis the total cost of the facility and program has been estimated to be approximately:

DM 49,000,000
or $ 27,222,000 based on the current exchange rate of
1 DM = $ 0.555
or 1 $ = DM 1.80

The total cost covers the program period of 66 months and is divided as follows:

	DM	$
1. Basic-Engineering	2,175,000	1,208,000
2. Detail-Engineering	5,825,000	3,236,000
3. Plant-Investcosts incl. Engineering, Construction, Start-up, Plantsite-preparation, Plant-Dismantling	24,290,000	13,494,000
4. Operation Concept 1 incl. Manpower, Feed, Energy and Auxiliaries	6,580,000	3,656,000
5. Operation Concept 2	4,875,000	2,708,000
6. Commercial Plant Design, Vehicle, Engine Testing, Report and Documentation	5,255,000	2,920,000
	49,000,000	27,222,000
Mobil Catalyst	14,000,000	
TOTAL	63,000,000 approximately	

TABLE 4

ESTIMATED COST-DISTRIBUTION AND SCHEDULE OF EXPENDITURE

(in Thousand DM)

	1979	1980	1981	1982	1983	1984	
Basic Engineering	940	1,145	90				2,175
Detail Engineering	575	5,250					5,825
Plant-Investcosts		4,790	15,135	1,515	2,515	335	24,290
Operation Concept 1				4,015	2,565		6,580
Operation Concept 2					1,540	3,335	4,875
Commercial Plant Design and Vehicle Engine Testing					2,610	2,645	5,255
	1,515	11,185	15,225	5,530	9,230	6,315	49,000

ANNEX 2

Information and Intellectual Property

A. The reporting, distribution, handling and protection of information and intellectual property, and rules and procedures related thereto shall be determined by the Steering Committee to the extent not covered by this Annex.

B. Subject only to temporary restrictions to enable the filing of patent applications the Contracting Parties shall have the right to use and publish (1) all information provided to or arising from the Project except proprietary information, but this paragraph B shall not grant any licenses or other rights under any patent rights to use such information except as specifically defined in this Annex and (2) all information listed in Annex 3.

C. For the purposes of this Annex, proprietary information shall mean information of a proprietary nature such as trade secrets and know-how (for example, computer programmes, design procedures and techniques, chemical composition of materials, or manufacturing methods, processes, or treatment) which is appropriately marked, provided such information:

1. Is not generally known or publicly available from other sources;

2. Has not previously been made available by the owner to others without obligation concerning its confidentiality, and

3. Is not already in the possession of the recipient Contracting Parties without obligation concerning its confidentiality.

D. Mobil, Uhde, URBK and the Contracting Parties shall take all necessary measures in accordance with this Annex, the laws of their respective countries and international law to maintain in strict confidence and to prevent unauthorized disclosure or use of proprietary information provided to or arising from the Project.

E. BMFT shall take care that information arising from or provided to the Project which qualifies as proprietary information under this Annex will be identified and ensure that it is appropriately marked. Proprietary information arising from the Project and proprietary information procured by BMFT or URBK from third parties, from Uhde or from URBK shall be the property of Mobil for the benefit of the Contracting Parties, Mobil, Uhde and URBK in accordance with and subject to the licensing requirements and other provisions of this Annex. Proprietary information shall not be accepted for or utilized in the Project without obtaining the property and licensing rights specified in this Annex, unless expressly approved by the Steering Committee.

F. 1. Each Contracting Party, Mobil, Uhde and URBK shall provide to the Project proprietary information solely owned or controlled by it or which it has the authority to license which is useful in practicing the results of the Project and shall license proprietary information it provides to the Project:

(a) to BMFT royalty-free for use in the Project;

(b) to the United States Government (including its contractors) royalty-free for use in research, development and demonstration programs in the United States in the methanol-to-gasoline field except BMFT, Uhde or URBK;

(c) to each Contracting Party, its government, Mobil, Uhde or URBK and nationals of their countries designated by the Contracting Party for commercial use in the methanol-to-gasoline field in all countries on reasonable terms and conditions with exception of licenses from Mobil to Uhde or URBK.

2. Mobil shall license proprietary information arising from the project:

(a) to BMFT royalty-free for use in the Project;

(b) to the United States Government (including its contractors) royalty-free for use in its research, development and demonstration programs;

3. It is understood that nothing in this Annex shall require Mobil to provide or license proprietary information on catalyst manufacture or catalyst compositions so long as Mobil or its affiliates or licensees shall supply Mobil catalyst suitable for the methanol-to-gasoline process in sufficient quantity and on reasonable terms and conditions (including leasing) to reasonably satisfy market needs.

G. Patents solely owned or controlled by a Contracting Party or by Mobil, Uhde or URBK which are needed for the Project shall be licensed to BMFT for use in the Project only at no cost to the Project.

H. Each Contracting Party and Mobil, Uhde and URBK shall license for use in the field of conversion of methanol-to-gasoline and on reasonable terms and conditions all patents solely owned or controlled by it prior to or during the course of the Project but outside thereof which are useful in practicing the results of the Project and have been utilized in the Project to the other organizations and to the other Contracting Parties, their Governments and nationals of their countries designated by the Contracting Parties, for use in all countries with exception of licenses from Mobil to Uhde or URBK; provided, however, that Mobil shall not be required to license its patents on catalyst manufacture or catalyst compositions so long as Mobil or its affiliates or licensees shall supply Mobil catalyst for the methanol-to-gasoline process in sufficient quantities and on reasonable terms and conditions (including leasing) to reasonably satisfy market needs.

I. 1. BMFT shall ensure that inventions made or conceived in the course of or under the Project (arising inventions) are identified promptly and reported to Mobil and the Steering Committee. Mobil shall have the first option to file patent applications and any resulting patents at its private expense, and such patent applications and patents shall be the property of Mobil or the benefit of the Contracting Parties, Mobil, Uhde and URBK in accordance with and subject to the licensing requirements and other requirements of this Annex.

2. BMFT shall, if recommended by the Steering Committee, ensure that patent applications are filed at the expense of the Project on inventions and in countries in which Mobil has not exercised its option to file or indicated its intention to file a patent application within seven (7) months from the conception or reduction to practice, whichever occurs first, of an invention reported to Mobil or indicated its intention to file within a reasonable period of time. Any patents so obtained shall be owned by BMFT or URBK for the benefit of the Contracting Parties, Uhde and URBK and any rights therein shall be apportioned as agreed on by the Steering Committee, Uhde and URBK.

J. Mobil shall license any patents obtained by it on arising inventions to:

1. BMFT royalty-free for use in the Project;

2. The United States Government (including its contractors) royalty-free for use in its research, development and demonstration programs, and

3. Each Contracting Party, its Government and nationals of its country designated by the Contracting Party for commercial use in all countries on reasonable terms and conditions provided, however, that Mobil shall not be required to license any patents relating to catalyst manufacture or catalyst compositions so long as Mobil or its affiliates or licensees shall supply Mobil catalyst for the methanol-to-gasoline process in sufficient quantities and on reasonable terms and conditions (including leasing) to reasonably satisfy market needs.

K. 1. Mobil shall grant Uhde a royalty-free license under the proprietary information of Mobil which arises from and under the Project or which is useful in practicing the results of the Project and under the patent rights of Mobil, to design and engineer plants for the Conversion of methanol-to-Gasoline with the assurance that Mobil will offer to the owners of such plants, at Uhde's request, and on reasonable terms and conditions a nonexclusive license under the aforesaid proprietary information and patent rights of Mobil to the extent necessary for the operation of such plants.

2. Mobil also shall reimburse Uhde in the amount of two and one-half (2 1/2) times the total moneys contributed by Uhde under this Agreement. Such reimbursement shall be available as accrued from 25% of the process royalties received by Mobil for licenses and rights granted third parties for the Methanol-to-Gasoline Process.

3. Furthermore, Uhde will receive a royalty share of one third of 0.1X of the process royalties (as defined in the following sentence which Mobil receives from third parties for grants to them by Mobil for the operation of the Methanol-to-Gasoline Process under arising inventions and arising proprietary information except that Uhde shall receive no royalty share on royalties which Mobil receives for the operation of the Methanol-to-Gasoline Process in the territories of the United States, New Zealand, and South Africa, and only 50% of the above described royalty share for operations within Australia. For the purpose of computing such royalties received by Mobil, if it is assumed that "X" is the royalty for licenses under Mobil patent rights and technical information which does not include rights under arising inventions and arising proprietary information, then licenses to third parties which include rights under arising inventions and arising proprietary information shall be deemed to be "1.1X".

4. It is understood that Mobil will use all reasonable efforts to maintain the separate identity of arising inventions and the proprietary information arising from the Project and will not authorize third persons to use such arising proprietary information and arising inventions commercially without extending to such third persons a license for such use and paying Uhde the royalty share of one-third of 0.1X specified above on the process royalties received by Mobil for such licence.

5. Mobil shall grant URBK a license, on reasonable terms and conditions, under the proprietary information of Mobil which arises from and under the Project or which is useful in practicing the results of the Project and under patent rights of Mobil which are useful in practicing the results of the Project for use in all countries. Such license shall be royalty-free for the production of up to one million metric tons per year of gasoline from methanol in the Federal Republic of Germany. Furthermore URBK will receive a royalty share of one-third of 0.1X of the process royalties as defined in paragraph K. 3. above for Uhde.

L. Patents owned or controlled by parties other than the Contracting Parties, Mobil, Uhde and URBK, may be procured by or licensed to BMFT to URBK only with the express approval of and under the terms and conditions stipulated by the Steering Committee.

M. Information regarding inventions on which patent protection is to be obtained shall not be published or publicly disclosed by Contracting Parties, Mobil, Uhde, or URBK, so long as such information qualifies as proprietary information as defined in paragraph C. of this Annex 2 and is not listed in Annex 3, but the temporary restrictions of paragraph B. shall apply in any case. BMFT shall take care that Project reports which disclose such inventions are appropriately marked.

N. BMFT shall take appropriate measures necessary to protect copyrightable material generated under the Project. Copyrights obtained shall be the property of BMFT or URBK for the benefit of the Contracting Parties, Uhde, URBK and Mobil, provided, however, that the Contracting Parties, their Governments, Uhde, URBK and Mobil, shall retain a royalty-free, irrevocable, nonexclusive license under any such copyright to reproduce, distribute, and publish such material.

O. Each Contracting Party, Mobil, Uhde and URBK, will, without prejudice to any rights of inventors or authors under its national laws, take all necessary steps to provide the cooperation from its authors and inventors required to carry out the provisions of this Annex. Each Contracting Party, Mobil, Uhde and URBK, will assume the responsibility to pay awards or compensation required to be paid tao its employees according to the laws of its country.

P. Mobil shall reimburse the U.S. Government in the amount of 200% of the total moneys contributed by the U.S. Government to the Project.

Suuch reimbursement shall be made out of the total process royalities that Mobil actually receives from third persons for licenses or grants of immunity under proprietary information or patent rights for practaice of the Methanol-to-Gasoline Process in the United States, but excluding any catalyst use charges or royalities received for catalyst use or manufacture. The reimbursement shall be made in the following manner:

1. The first 100% reimbursement to the U.S. Government shall be paid as accrued out of twenty percent (20%) of the above process royalities actually received by Mobil.

2. The second 100% shall be paid as accrued out of ten percent (10%) of the above process royalities actually received by Mobil.

3. Mobil shall license the Methanol-to-Gasoline Process as provided in this Annex. Any loss of royalty in responding to process guarantees (exclusive of liabilites under Mobil's contracts for catalyst supply or engineering) and patent indemnifications in connection with such licensing in the United States shall be shared by the United States Government in proporation to and out of its royalty share or reimbursement from Mobil. In computing process royalties actually received by Mobil, Mobil may deduct from royalties actually received reasonable licensing expenses associated with finding, negoitation and administration of such licenses in accordance with Mobil's standard reasonable practices.

Q. BMFT shall secure the agreement of all organizations participating in the Project to the terms of this Annex. BMFT will transfer its rights in proprietary information and patents licensed to it by DOE, Mobil, Uhde or URBK for use in the Project and its obligations pursuant to this Annex to URBK and will control in accordance with Artaicle 8, Paragraph 5 that URBK will exercise these rights and obligations.

R. The Steering Committee may establish guidelines to determine what constitutes a "national" of a Contracting Party.

S. Mobil catalyst supplied to the Project shall remain the property of Mobil or its affiliates. Mobil catalyst shall not be analyzed unless authorized by Mobil in writing, and shall not be disseminated to others outside the Project or used for any other purpose other than as outhorized by Mobil for the Project. BMFT will limit dissemination of Mobil catalyst

to those people who require it for use in the Project. At the conclusion of the Project, all such catalyst shall be returned to Mobil or its affiliates, at Mobil's request, or disposed of as instructed by Mobil.

T. As used in this Annex, the following terms shall have the meanings indicated:

1. "Methanol-to-Gasoline Process" or Conversion of Methanol-to Gasoline" shall mean a fluidized bed process for producting gasoline using a fresh feedstock consisting essentially of methanol in the presence of Mobil catalyst wherein not more than 5% by weight of the hydrocarbon product recovered from the product is ethylene.

2. "Mobil catalyst" shall mean a composition of matter of the ZSM catalyst class suitable for use as a catalyst in the Methanol-to-Gasoline Process and having a silica to alumina mole ratio of at least twelve (12) and a structure providing consitrained access to the crystalline-free space as indicated by a Constraint Index in the approximate range of one to twelve (1 to 12) wherein the term "Constraint Index" is defined in U.S. patent 4,098,836, provided that Mobil catalyst shall not include any such composition of matter to the extent it is actually used in or actually transferred for use in a process other than the Methanol-to-Gasoline Process, nor shall Mobil catalyst include any composition which contains a zeolite crystalline aluminosilicate other than as described hereinabove.

3. "Project" shall mean a program of research and development for the Methanol-to-Gasoline field.

4. As used herein, "Mobil" shall mean Mobil Research and Development Corporation, "Uhde" shall mean Uhde GmbH and "URBK" shall mean Union Rheinische Braunkohlen Kraftstoff AG.

ANNEX 3

LIST OF PUBLISHABLE DATA

1. Design of Demonstration Plant

1.1 Flowsheet and overall material balance
1.2 Process description
1.3 Utility consumption
1.4 Product composition
1.5 Equipment list giving characteristic data, e.g.
- For vessels diameter, height, design temperature, design pressure, material of construction, weight.
- For heat exchanges heat duty, design temperatures, design pressures, material of construction, weight.
- For pumps and compressors capacity, pressure difference, power consumption, RPM. design temperature, design pressure, material of construction, weight.

1.6 Electrical installations
1.7 Control equipment
1.8 Plot plan
1.9 Description of foundations, steel structures, buildings
1.10 Application to the local authorities for approval of construction (as far as publishable) giving pollution considerations regarding air, water, noise, etc.
1.11 Timing
1.12 Cost of
- equipment
- civil work and erection
- project management and engineering
- erected plant

1.13 Plant photos

2. Operation of Demonstration Plant

2.1 Review of events during start-up
2.2 Description of operating conditions
2.3 Overall results of operation
2.4 General conclusions
2.5 Control and measurement problems encountered
2.6 Results of product testing
- physical properties
- chemical properties
- motor tests

3. Feasibility Study for a Commercial Plant

3.1 Scale-up philosophy for the MTG plant
3.2 Block diagramme and process description of the total plant complex (coal to gasoline)
3.3 Flowsheets of the various process units with process description
3.4 Steam system with description
3.5 Description of utilities and offsite with flowsheets
3.6 Consumption and production figures with analyses
3.7 Estimated cost of the plant complex
3.8 Plant manning
3.9 Product cost versus various cost factors