CRUDE OIL & REFINING
THE ECONOMICS
THE POLITICS

SPONSORED BY
PLATT'S OILGRAM NEWS AND
THE PETROLEUM INDUSTRY RESEARCH
FOUNDATION, INC.

FEBRUARY 23–24, 1981
WALDORF ASTORIA HOTEL
NEW YORK CITY
CRUDE OIL & REFINING: THE ECONOMICS, THE POLITICS

A conference sponsored by

Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City

SUNDAY, FEBRUARY 22

7:00 - 9:00 p.m.  PRE-REGISTRATION & COCKTAIL RECEPTION
East Foyer (3rd floor)

MONDAY, FEBRUARY 23

8:00 - 8:40 a.m.  REGISTRATION
East Foyer (3rd floor)

8:45 - 9:00 a.m.  OPENING REMARKS
Grand Ballroom (3rd floor)

Onnic Marashian
Editor-in-Chief
Platt's Oilgram News
McGraw-Hill Publications Company

9:00 - 10:00 a.m.  CONVENTIONAL CRUDE OIL: QUALITY TRENDS
AND POLITICAL AVAILABILITY
Grand Ballroom

Philip K. Verleger, Jr. -- Moderator
Lecturer and Senior Research Scholar
School of Organization and Management
Yale University

Richard R. Dickinson
Vice President, Strategic Planning
Texaco Inc.

G. Henry M. Schuler
Director, International Affairs
Conant and Associates, Ltd.
10:00 - 10:20 a.m.  COFFEE INTERMISSION  
West Foyer (3rd floor)

10:20 - 11:50 a.m.  NONCONVENTIONAL CRUDE: SUPPLIES, COSTS, RECOVERY TECHNOLOGIES  
Grand Ballroom

Cheryl J. Trench -- Moderator  
Senior Economist  
Petroleum Industry Research Foundation, Inc.

SHALE  
Morton M. Winston  
President and Chief Executive Officer  
Tosco Corporation

VENEZUELAN HEAVY CRUDE  
Angel H. Behrends  
Refining Coordinator  
Petroleos de Venezuela S.A.

CANADIAN SYNTHETICS AND HEAVY CRUDE OIL  
Robert M. Scarborough  
Manager, Heavy Oil Operations  
Dome Petroleum Limited

COAL LIQUIDS  
George R. De Vaux (substituting for Bronek Dutkiewicz)  
Executive Vice President  
Hydrocarbon Research, Inc.

11:50 - 12:20 p.m.  INTERMISSION -- Cash Bar  
West Foyer

12:20 - 2:00 p.m.  LUNCHEON KEYNOTE ADDRESS  
U.S. GOVERNMENT REFINING POLICY  
Grand Ballroom

The Honorable J. Bennett Johnston  
U.S. Senate

2:00 - 2:20 p.m.  INTERMISSION
2:20 - 4:00 p.m.  OCTOBER 1981: IMPLICATIONS OF U.S. 
CRUDE OIL PRICE DECONTROL 
Grand Ballroom 

Lawrence J. Goldstein -- Moderator 
Director of Research 
Petroleum Industry Research Foundation, Inc. 

William F. Burke 
President 
Powerine Oil Company 

John R. Hall 
Vice Chairman and Chief Operating Officer 
Ashland Oil, Inc. 

James H. McDonald 
Vice President, Business Analysis 
Gulf Oil Company - U.S. 

Lucian S. Pugliaresi 
Acting Deputy Assistant Secretary for Oil and Gas 
Policy and Evaluation 
U.S. Department of Energy 

Lawrason D. Thomas 
Executive Vice President 
Amoco Oil Company 

4:00 - 4:10 p.m.  INTERMISSION 

4:10 - 5:30 p.m.  CONCURRENT WORKSHOPS 

- CONVENTIONAL CRUDE OIL: QUALITY TRENDS 
AND POLITICAL AVAILABILITY 
Conrad Suite (4th floor) 

Philip K. Verleger, Jr. -- Moderator 
Lecturer and Senior Research Scholar 
School of Organization and Management 
Yale University 

Richard R. Dickinson 
Vice President, Strategic Planning 
Texaco Inc. 

G. Henry M. Schuler 
Director, International Affairs 
Conant and Associates, Ltd.
• NONCONVENTIONAL CRUDE: SUPPLIES, COSTS, RECOVERY TECHNOLOGIES
West Foyer

Cheryl J. Trench -- Moderator
Senior Economist
Petroleum Industry Research Foundation, Inc.

Angel H. Behrends
Refining Coordinator
Petroleos de Venezuela S.A.

George R. De Vaux (substituting for Bronek Dutkiewicz)
Executive Vice President
Hydrocarbon Research, Inc.

Robert M. Scarborough
Manager, Heavy Oil Operations
Dome Petroleum Limited

Morton M. Winston
President and Chief Executive Officer
Tosco Corporation

• GOVERNMENT REFINING POLICY AND CRUDE OIL PRICE DECONTROL
East Foyer

Lawrence J. Goldstein -- Moderator
Director of Research
Petroleum Industry Research Foundation, Inc.

William F. Burke
President
Powerine Oil Company

John R. Hall
Vice Chairman and Chief Operating Officer
Ashland Oil, Inc.

James H. McDonald
Vice President, Business Analysis
Gulf Oil Company - U.S.

Lucian S. Pugliaresi
Acting Deputy Assistant Secretary for Oil and Gas
Policy and Evaluation
U.S. Department of Energy

Lawrason D. Thomas
Executive Vice President
Amoco Oil Company
TUESDAY, FEBRUARY 24

9:00 - 9:40 a.m. CRUDE OIL AND ITS ALTERNATIVES: THE FINANCING OUTLOOK
Starlight Roof (18th floor)
Closed-circuit viewing -- West Foyer (3rd floor)

Frank G. Zarb
General Partner
Lazard Freres & Co.

9:40 - 10:40 a.m. Refined Product Requirements: Demand-Side Perspectives
Starlight Roof
Closed-circuit viewing -- West Foyer

Gary N. Ross -- Moderator
Director of Research
Petroleum Industry Research Associates, Inc. (PIRA)

John H. Lichtblau
Executive Director
Petroleum Industry Research Foundation, Inc.

Walter L. Newton
Managing Director
Petroleum Economics Limited

10:40 - 11:00 a.m. COFFEE INTERMISSION
Gold Room & West Foyer

11:00 - 12:00 noon REFINING TECHNOLOGY: THE STATE OF THE ART
Starlight Roof
Closed-circuit viewing -- West Foyer

Michaele Noble -- Moderator
International Editor
Platt's Oilgram News

Charles A. Campbell
Vice President
Chem Systems Inc.

James R. Murphy
Manager of Process Technology
Pullman Kellogg
Division of Pullman Incorporated

12:00 - 12:30 p.m. INTERMISSION -- Cash Bar
Gold Room
12:30 - 2:20 p.m. LUNCHEON KEYNOTE ADDRESS
OPEC AND SAUDI REFINING POLICY
Starlight Roof (18th floor)
Closed-circuit viewing -- West Foyer (3rd floor)

His Excellency Abdulhady Hassan Taher
Governor of Petromin

2:20 - 3:40 p.m. CONCURRENT WORKSHOPS

- REFINED PRODUCT REQUIREMENTS
  Starlight Roof

  Gary N. Ross -- Moderator
  Director of Research

  John H. Lichtblau
  Executive Director
  Petroleum Industry Research Foundation, Inc.

  Walter L. Newton
  Managing Director
  Petroleum Economics Limited

- REFINING TECHNOLOGY: THE STATE OF THE ART
  Basildon Room (3rd floor)

  Michaele Noble -- Moderator
  International Editor
  Platt's Oilgram News

  Charles A. Campbell
  Vice President
  Chem Systems Inc.

  James R. Murphy
  Manager of Process Technology
  Pullman Kellogg
  Division of Pullman Incorporated
CRUDE OIL & REFINING: THE ECONOMICS, THE POLITICS

+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

A conference sponsored by

Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City

SPEAKERS

ANGEL H. BEHRENDs

Mr. Behrends is Refining Coordinator of Petroleos de Venezuela S.A.,
where he is responsible for planning and control of the refining
sector in the parent company of the state-owned Venezuelan petroleum
industry. He has been associated with refining activities in Vene-
zuela for 33 years, the last five of which have been spent in his
present position. Mr. Behrends holds a B.S. in Chemical Engineering
from the Akademie fur Technik, Chemnitz, Germany, 1944.

WILLIAM F. BURKE

Mr. Burke is President and Chief Operating Officer of Powerine Oil
Company. Under his direction, Powerine is undertaking a major heavy
oil conversion project in anticipation of the problems which the small
refiner will encounter with decontrol. Mr. Burke has previously held
a variety of other positions with Powerine and was affiliated with
CONOCO for 13 years. He is on the Executive Committee of the Committee
for Equitable Access to Crude Oil, Vice President of the American Petro-
leum Refiners Association, and a member of the Board of Directors of the
Western Oil and Gas Association. Mr. Burke holds a Bachelor of Science
degree in Engineering, a Bachelor of Civil Engineering, and a Bachelor
of Business Administration degree, all from the University of Minnesota;
and an M.B.A. from IMEDE in Lausanne, Switzerland.

CHARLES A. CAMPBELL

Mr. Campbell is a Vice President of Chem Systems Inc., a worldwide con-
sulting organization to the oil refining, petrochemical and energy
industries. As a consultant he has been involved in numerous domestic
and foreign refinery evaluations, expansion programs, and grass-roots
plans covering a wide variety of operational, technical, economic, and
strategic planning situations. His experience prior to consulting
covered foreign and domestic operation as well as administrative, planning
and executive assignments with major oil companies in refining and petro-
chemicals. His education was as a Chemical Engineer with graduate studies
in Economics and Business Management.
JOHN H. LICHTBLAUB

Mr. Lichtblau has been Executive Director of the Petroleum Industry Research Foundation, Inc., since 1961, and President of Petroleum Industry Research Associates, Inc., since 1976. He is a widely known lecturer on petroleum economics and author on oil imports, energy policy, oil taxation, and related subjects. Mr. Lichtblau has also been a consultant in petroleum economics to many government agencies. In 1968 he was appointed to the National Petroleum Council, where he continues to serve. He is a member of the Council on Foreign Relations. Mr. Lichtblau is a graduate of the College of the City of New York and holds an M.A. in Economics from New York University.

ONNIC MARASHIAN

Mr. Marashian is Editor-in-Chief of Platt's Oilgram News at McGraw-Hill, Inc., where he is responsible for overall supervision of production, policy, and content. He has previously served as Bureau Chief for Oilgram News in Washington, as a correspondent for McGraw-Hill World News in Washington, London, Beirut, and Cairo, and is a past President of the Association of Petroleum Writers. Mr. Marashian holds a B.A. degree from The American University in Cairo and an M.A. from Syracuse University.

JAMES H. MCDONALD

Mr. McDonald is Vice President, Business Analysis, with Gulf Oil Company - U.S. He is responsible for business and economic analysis, including Information Systems, for evaluations of current operations and trends, and the development of plans for the optimum mode of operation for Gulf's refining and marketing business. Mr. McDonald's previous positions with Gulf include the coordination of refining activities for Corporate, Western Hemisphere; Refining Vice President, Latin America; and Vice President - Supply, Transportation and Refining Coordination. He received a B.S. degree in Chemical Engineering from Louisiana Polytechnic Institute in 1952.

JAMES R. MURPHY

Mr. Murphy is Manager of Process Technology with Pullman Kellogg, a division of Pullman Incorporated. His duties involve seeing that all Pullman Kellogg proprietary technologies are up to date and following current trends in process technology. Mr. Murphy supervises a group of five experts in the areas of organics, inorganics, synfuels, polymers, and refining. He was previously affiliated with Gulf Research and Development Company. He is a member of the American Institute of Chemical Engineers and the National Petroleum Refiners Association and is the author of many technical articles. Mr. Murphy holds a B.S. in Chemical Engineering from the Carnegie Institute of Technology.
WALTER L. NEWTON

Mr. Newton is Managing Director of Petroleum Economics Limited, an independent organization providing consultancy services on economic aspects of the international petroleum industry. Clients include governments, international organizations, oil companies, chemical companies, utilities and financial institutions. Mr. Newton is the author and co-author of many technical articles. He graduated from Cambridge University in 1942 with a degree in Economics.

MICHAELLE NOBLE

Ms. Noble is International Editor of Platt's Oilgram News and acts as publication liaison for foreign correspondents. She also has responsibility for the daily Oilgram News/Wire, which is telexed to subscribers. Ms. Noble has previously served as a correspondent in the Washington bureau of Platt's Oilgram News, where she covered Congress, government agencies and the courts on such topics as refining and leasing policies and imports. She holds a B.A. degree in English from the University of Florida.

LUCIAN S. PUGLIARISI

Mr. Pugliarisi is Acting Deputy Assistant Secretary for Oil and Gas Policy and Evaluation, with the U.S. Department of Energy. He has previously been affiliated with the U.S. Environmental Protection Agency, the U.S. Department of Interior, and the University of California. Mr. Pugliarisi has had extensive experience in economic studies and policy analysis, including oil policy development and national refinery policy. He has directed numerous staff reports on major petroleum issues. Mr. Pugliarisi received an A.B. degree in Economics (with Great Distinction in General Scholarship) from the University of California in 1970.

DR. GARY N. ROSS

Dr. Ross is the Director of Research of Petroleum Industry Research Associates, Inc. (PIRA), a New York-based petroleum economics consulting company specializing in crude oil and petroleum products supply, demand and pricing. Before joining PIRA he was the energy economist for Chem Systems, Inc., and a petroleum economist with Walter J. Levy Consultants Corp. Dr. Ross is a member of the International Association of Energy Economists. He has presented numerous papers dealing with petroleum products supply/demand, the energy situation and federal energy policy. Dr. Ross has a Ph.D. in Economics from the City University of New York Graduate School and University Center.
ROBERT M. SCARBOROUGH

Manager, Heavy Oil Operations, with Dome Petroleum Limited, Mr. Scarborough is responsible for all heavy oil acquisitions, primary and secondary development, drilling operations, engineering design, reservoir engineering planning, and operational supervision. He has had 22 years of heavy oil production experience in Southern California and Canada, managing design and field application of steam and in-situ combustion processes. Mr. Scarborough holds B.S. degrees in Petroleum Engineering and Geological Engineering from Texas Agricultural and Mechanical University.

G. HENRY M. SCHULER

Mr. Schuler is an independent consultant associated with a firm (Conant and Associates, Ltd.) specializing in the analysis of political, economic and national security factors involved in access to strategic raw materials, especially primary energy sources. He has previously served with Union Pacific Corporation and Champlin Petroleum Company, and was a member of the oil industry negotiating team during OPEC negotiations in the early 1970s. Mr. Schuler is a member of the Board of Editors of the monthly newsletter, Geopolitics of Energy. He received an A.B. degree from Princeton University in 1956 and an L.L.B. from the University of Pennsylvania Law School in 1962.

HIS EXCELLENCY DR. ABDULHADY HASSAN TAKER

His Excellency Dr. Taher is a Minister of State of the Saudi Arabian government and the Governor of the General Petroleum & Mineral Organization (Petromin). In addition, he is Chairman and Managing Director of the Jeddah Oil Refinery Company. His Excellency has also served as Director General of the Ministry of Petroleum and Mineral Resources. His Excellency Dr. Taher is a member of the Board of Directors of the Arabian American Oil Company (Aramco) and its executive committee, and is an honorary member of the American Society of Petroleum Engineers and the American Management Association (CEO) Club. His Excellency received his education at the University of Cairo, University Ain Shams, and the University of California.

LAWRASON D. THOMAS

Mr. Thomas is Executive Vice President of Amoco Oil Company, the domestic petroleum refining, transportation, and marketing subsidiary of Standard Oil Company (Indiana). His previous positions include Managing Director of Amoco International Oil Company's Australian operation; Administrative Manager of Amoco Oil's Southern marketing region; and Vice President in charge of operations planning and transportation. Mr. Thomas received a Bachelor of Science degree in Chemical Engineering and a Master's degree in Business Administration, both from the University of Michigan.
CHERYL J. TRENCH

A Senior Economist with the Petroleum Industry Research Foundation, Inc., Ms. Trench most frequently examines petroleum product markets in the United States—forecasting supply and demand, analyzing trends in consumption patterns and interfuel competition, and assessing the impact of government policy and regulations. She is also involved in analyzing and forecasting OPEC's prices and production policies, and the overall U.S. energy situation. Before joining the Foundation, Ms. Trench worked for the City of New York in its energy office. A member of the International Association of Energy Economists, she holds a degree from the City University of New York.

PHILIP K. VERLEGER, JR.

Mr. Verleger is a Lecturer and Senior Research Scholar at the Yale School of Organization and Management at Yale University. He is researching and writing on strategies for managing disruptions in oil imports and on the economics of the oil industry, particularly as it is affected by regulation. Mr. Verleger was previously a Technical Special Assistant to the Assistant Secretary for Economic Policy in the U.S. Department of the Treasury, where he was involved with crude oil price decontrol and the general effect of oil price controls. He received an A.B. degree from Cornell University in 1966 and a Ph.D. from the Massachusetts Institute of Technology in 1971, both in Economics.

MORTON M. WINSTON

Mr. Winston is President and Chief Executive Officer of the Tosco Corporation, where he has previously served as Vice President and Executive Vice President. He has also been a Director and member of Tosco's Executive Committee since 1966. Mr. Winston was earlier associated with Cleary, Gottlieb, Steen & Hamilton in Washington, D.C., and New York. He is also a Director of Baker International Corporation and a member of the Council for Energy Studies. Mr. Winston is a graduate of the University of Vermont and Harvard Law School (magna cum laude).

FRANK G. ZARB

Mr. Zarb is a General Partner with Lazard Frères & Co., where he supervises a broad range of international investment banking activities and acts as an advisor to the United States Congress, the State of Alaska, international corporations, and a number of foreign governments. Mr. Zarb previously held three positions in the U.S. government, concurrently: Administrator, Federal Energy Administration; Executive Director of the Cabinet-level Energy Resources Council; and Assistant to the President of the United States for Energy Affairs. He received B.B.A. and M.B.A. degrees from Hofstra University in 1957 and 1962, respectively.
Vice President, Strategic Planning, with Texaco Inc., Mr. Dickinson is responsible for corporate planning, corporate computer modeling, government affairs policy, intercompany coordination and diversification matters. His career has involved various engineering and management positions in refining, international supply and distribution, corporate planning, alternate energy, and marketing. Prior to assuming his present position, Mr. Dickinson formed and headed up Texaco's recently-created Alternate Energy Department. He holds B.S. and M.S. degrees in Chemical Engineering from the California Institute of Technology and the University of Southern California, respectively.

Mr. Dutkiewicz is Manager of Special Projects with the Dynaelectron Corporation, where he is involved in the development and analysis of investment opportunities in energy and processing industries. He has previously been affiliated with Butcher and Singer, Inc., Chem Systems, Inc., and Stone and Webster Engineering/Lummus Engineering. He is a member of the National Association of Petroleum Industry Financial Analysts. Mr. Dutkiewicz is a graduate of Ecole du Petrole, France, and Rand University, South Africa.

Mr. Goldstein is Director of Research of the Petroleum Industry Research Foundation, Inc., and Vice President of Petroleum Industry Research Associates, Inc. His work covers all aspects of energy supply and demand economics, including worldwide and regional balances, interfuel competition, consumption trends and government policy in both consuming and producing countries. Mr. Goldstein is currently serving on the Coordinating Subcommittee of the National Petroleum Council's study of Emergency Preparedness. He is a member of the International Association of Energy Economics. Mr. Goldstein was educated at City College of the City University of New York and at New York University.

As Vice Chairman and Chief Operating Officer of Ashland Oil, Inc., Mr. Hall's responsibilities include direction of all operations of the Corporation working through seven division presidents. The largest division is Ashland Petroleum Company, the nation's largest independent refiner. He has also served as Chief Executive Officer for petroleum and chemical operations and as Senior Vice President in charge of refining, supply, and transportation. Mr. Hall was Chairman of the National Petroleum Refiners Association and Task Group Chairman on the National Petroleum Council study on refinery flexibility. He received a B.S. degree in Chemical Engineering from Vanderbilt University in 1955.

Elected to the U.S. Senate in 1972 and re-elected in 1978, Senator Johnston is one of the senior members of the Committee on Energy and Natural Resources. He is the ranking Democrat on both the Energy Regulation Subcommittee and the Appropriations Subcommittee on Energy and Water Development. During the 96th Congress, Senator Johnston was one of the principal architects of U.S. energy policy, his efforts leading to the enactment of the Energy Security Act and the Emergency Energy Conservation Act. His Nuclear Waste Policy Act was the first comprehensive nuclear waste bill ever to be passed in either House of Congress.
CONVENTIONAL CRUDE OIL:
QUALITY TRENDS AND POLITICAL AVAILABILITY

Richard R. Dickinson
Vice President, Strategic Planning
Texaco Inc.

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
The changing quality of the free world's crudes during the next decade is a topic of much concern to refiners everywhere. It is generally accepted that sulfur contents will increase and that the residual yields from crudes will be higher. Quantifying the magnitude of these changes in quality and determining what the impact will be on refiners can best be predicted by looking at the current free world crude situation.

Crude characteristics by producing region are shown in Figure 1 and average quality characteristics are shown in Figure 2. It is difficult to make any generalized statement on the quality of North American crude since most types are represented. Crudes from Latin America are generally high sulfur and have high residual yields. European and African crudes are generally low sulfur and low residual yield. Crudes from the Persian Gulf are characteristically high in sulfur and intermediate in residual yield, while crudes from the Far East have low sulfur and wide variations in residual content.

Due to environmental restrictions and refinery metallurgical limitations, sulfur is certainly an important quality characteristic. The topped crude yield is also important when considering the yield patterns and the crude running penalty that can be associated with processing a high residual yield crude in a refinery designed for light crudes. Gravity gives an indication of residual yield, but in itself really isn't that significant.

Free world crude reserves by region are shown in Figure 3. North American reserves have declined substantially since 1970. Even with today's ambitious exploration program supported by higher prices, the decline in reserves will no doubt continue. Based on this reserve situation, we foresee most increases in production during the next decade coming from Mexico, the North Sea and the Persian Gulf. Most forecasters of free world petroleum supplies expect crude oil production to increase by 1% to 2% per year during the next few years and then peak near the end of the decade. Concurrent with this growth will be a shift towards production that is more consistent with the overall qualities of the world's total proven reserves. This will result in a crude mix containing more medium and heavy crudes of higher sulfur.

Actual crude oil production as well as projected crude production for the years 1985, 1990 and 1995 are shown
in Figure 4. There is little doubt that the free world petroleum supply is now and will continue to be dominated by the Persian Gulf region which produces over 40% of the free world total. Due to the growing tendency for producing nations to control production for price protection and the uncertainty of petroleum demand due to the high prices, a range of future production has been considered. The low production estimate (Scenario A) is based on (1) proved developed and undeveloped reserves, (2) new areas indicated to be productive from successful wildcat wells and (3) improved recovery techniques. You will note that under this scenario free world crude production actually peaked in 1979. The high production estimate (Scenario B) includes production from new reserves extrapolated to be found at historical exploration and success ratios. Scenario B also assumes adequate sources of capital, manpower and equipment, a positive political climate and realistic environmental constraints. Under this scenario free world crude production peaks between 1985 and 1990. We feel that actual free world crude production will fall somewhere between these two scenarios. As stated earlier, most forecasters expect a crude production increase of around 1% per year before peaking before 1990. Projected average crude quality changes over this period are shown in Figure 5. Over the next 15 years crude sulfur content is expected to increase two tenths of a weight percent, topped crude residual yield is expected to increase one and one-half percent and residual oil sulfur is projected to increase three tenths of a percent. These projected changes in quality aren't as dramatic as many refiners might expect. While it is true that more high sulfur heavy Middle East crudes are being produced, this is offset somewhat by the additional low sulfur light North Sea and intermediate sulfur Mexican crudes coming on during the same period. What effect will these crude quality changes have on the refining industry? We see the need for much greater refinery flexibility as to the type of crude that can be processed. With the exception of producing countries few refiners are going to be able to afford the luxury of being able to refine only a narrow range of better quality crudes. Specific changes required can be identified by reviewing the worldwide refining situation and product demands. We forecast only minimal growth in petroleum demand in the years ahead. In fact, gasoline consumption is expected to decrease due to improve mileage and the increasing tendency to switch to diesel engines. Fuel oil demand is also expected to decline due to the substitution of coal, nuclear power and synfuels for oil in power plants and other industrial installations. Middle distillates is about the only expected growth area.
A typical refinery is shown in Figure 6. Due to the surplus of crude stilling capacity in the world today, we don't foresee additional growth in crude stilling capacity except for refinery capacity being built in producing countries. Due to the declining gasoline demand, we don't project much need for additional reformer capacity. However, due to the increase in crude sulfur, additional desulfurization capacity and refinery upgrading to accommodate more sour crude will certainly be needed. Without an increase in reformer capacity, which is the primary source of hydrogen for desulfurization, hydrogen generation will often be required for additional desulfurization capacity.

The U.S. refining industry generally has sufficient cracking and coking capacity to maximize clean product yields when running light sweet crudes. However, this is not the case in the rest of the world, and the recent growth in cracking capacity in Europe can be expected to continue. As the residual oil sulfur content and yield increase, the need for residual processing to convert the growing volumes of high sulfur fuel oil into more profitable light products becomes increasingly apparent. The basic residual upgrading processing options are shown in Figure 7.

Visbreaking is a mild thermal cracking process which lowers the viscosity of the residual oil but has only a small conversion to lighter products. This process is the least expensive and normally the first step in lowering fuel oil products from hydroskimming refineries.

Solvent deasphalting is a process that utilizes a light hydrocarbon solvent such as propane or butane to selectively extract desirable oil from residual bottoms. These oils can be used directly as lube oil components or run on conventional cracking units to obtain a significant conversion to lighter products.

In the fluid catalytic cracking of residuum, the residual carbon is deposited on the catalyst and consumed as process heat. In this way, carbon is selectively removed and the hydrogen to carbon ratio improved, resulting in a better fuel oil conversion than obtained with visbreaking or deasphalting. However, residual catalytic cracking is not without problems. Cracking of raw residual can unfavorably impact refinery utility systems due to the large volumes of gas and steam produced. This, together with high catalyst deactivation rates and low yields of liquid products, favors combining the solvent deasphalting and catalytic cracking processes.

Fluid or delayed coking is another process that removes carbon from the residual, improving the hydrogen to
The coke produced in this thermal process is recovered as a merchantable product. However, due to its sulfur content, it will probably be increasingly difficult to find a market for the coke produced from processing sour crudes. Some refiners are having to resort to residual hydodesulfurizing ahead of coking to solve this coke quality problem.

Residual hydroprocessing upgrades residuum through catalytic hydrogenation. The fixed bed hydodesulfurization version of this process produces primarily low sulfur fuel oil with only a small yield of gasoline and middle distillates. When more severe hydroprocessing conditions and ebullating catalyst beds are utilized hydrocracking of the residual is achieved. Of the various residual upgrading processes available residual hydrocracking offers the greatest upgrading to lighter liquid products while at the same time removing sulfur.

Which residual upgrading process is best? There is of course no easy or single answer to this question. Each refiner has his own unique requirements and objectives to consider in the context of his existing processing equipment. Texaco USA several years ago undertook a major program to upgrade its U.S. refining system so as to be able to replace light sweet crude running with heavier high sulfur crudes. The greater availability and lower cost of the high sulfur crudes was, of course, the major driving force for this change. Even without residual upgrading this conversion showed a good return on investment so long as there wasn't too large a price differential between the lighter products such as furnace oil and high sulfur fuel oil. Or to put it another way, straight conversion to high sulfur crudes requires a reasonably high sulfur fuel oil market price. This can be seen in Figure 8. However, without further residual upgrading substantial losses in desirable light products were projected from the processing of heavier high sulfur crudes. From a long-term marketing strategy this wasn't believed to be desirable.

After many months of exhaustive engineering and economic studies involving the various residual upgrading options Texaco U.S.A. chose residual hydrocracking combined with partial oxidation of high sulfur residuum for hydrogen production as the optimum processes for their requirements. Hydrocracking gave both the best yield pattern from a long-term marketing standpoint and the best economics.

The first of these new units will be constructed at Texaco's Convent, LA refinery. Additional units at another refinery are being actively considered.
The key economic driving force for residual hydrocracking is the price differential between lighter products and high sulfur fuel oil. Figure 9 shows the effect of this variable on the economics of residual hydrocracking in Texaco U.S.A.'s studies. It is interesting to note, however, that decent DCF's were obtained at even relatively low differentials because of the excellent yield patterns and desulfurization of the products that are provided by hydrocracking.

It was also very interesting to note that when Texaco U.S.A combined the economics of converting to high sulfur crudes and residual hydrocracking of the high sulfur residuum, very attractive economics that were relatively insensitive to the price differential between light products and high sulfur fuel oil were obtained. This can be seen in Figure 10.

Major refinery investments today run into the hundreds of millions or even billions of dollars. When undertaking investments of these magnitudes it is reassuring that your projected economics are relatively insensitive to such a major and hard to predict variable as the price differential between high sulfur fuel oil and light products. While processing equipment and the marketing situation aren't the same for all refineries, this residual upgrading conclusion should be generally applicable to others as well.

In summary, 64% of the free world crude reserves are located in the Middle East and crude oil production will continue to be dominated by that region. As additional medium and heavy crudes are produced to approach a mix more consistent with reserves, crude oil available to refiners will contain more sulfur and residual yields will be higher. Concurrent with this change in crude quality will be a declining residual fuel oil demand due to pressure from coal and synfuels. To be competitive, refiners will have the need for greater flexibility to process a wider variety of crudes and at the same time upgrade residual into lighter products. The residual hydrocracking process combines desulfurization and cracking in a single process and offers the highest conversion to desirable light products. Residual hydrocracking has an attractive rate of return and when combined with sour crude processing, the economics for the combined project becomes insensitive to price fluctuations between middle distillates and high sulfur fuel oil which is the key economic variable.
<table>
<thead>
<tr>
<th>Region</th>
<th>Gravity (°API)</th>
<th>Sulfur (WT%)</th>
<th>Topped Crude (V%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latin America</td>
<td>28</td>
<td>1.4</td>
<td>53</td>
</tr>
<tr>
<td>Western Europe</td>
<td>37</td>
<td>0.3</td>
<td>35</td>
</tr>
<tr>
<td>Africa</td>
<td>36</td>
<td>0.2</td>
<td>34</td>
</tr>
<tr>
<td>Middle East</td>
<td>33</td>
<td>1.6</td>
<td>43</td>
</tr>
<tr>
<td>Far East</td>
<td>35</td>
<td>0.1</td>
<td>35</td>
</tr>
</tbody>
</table>
FREE WORLD OIL RESERVES
BILLION BARRELS END OF YEAR

<table>
<thead>
<tr>
<th>Region</th>
<th>1970</th>
<th>1980</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>48</td>
<td>33</td>
<td>(31)</td>
</tr>
<tr>
<td>Latin America</td>
<td>26</td>
<td>69</td>
<td>165</td>
</tr>
<tr>
<td>Western Europe</td>
<td>4</td>
<td>23</td>
<td>475</td>
</tr>
<tr>
<td>Africa</td>
<td>75</td>
<td>55</td>
<td>(27)</td>
</tr>
<tr>
<td>Middle East</td>
<td>344</td>
<td>362</td>
<td>5</td>
</tr>
<tr>
<td>Far East</td>
<td>14</td>
<td>20</td>
<td>43</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>511</td>
<td>562</td>
<td>10</td>
</tr>
</tbody>
</table>
CHANGES IN CRUDE QUALITY

2.5
2.4
2.3
2.2
2.1

47
46
45
44

1.5
1.4
1.3
1.2

TOPPED CRUDE SULFUR (WT%)

TOPPED CRUDE YIELD (V%)

CRUDE SULFUR (WT%)

SIMPLIFIED REFINERY FLOW DIAGRAM

CRUDE

CRACKING

DESULFURIZATION

REFORMER

GASOLINE

MIDDLE DISTILLATES

FUEL OIL
COKE

RESIDUAL UPGRADING
RESIDUAL UPGRADING OPTIONS

RESIDUAL

- VISBREAKING → LOWER VISCOSITY FUEL OIL
- SOLVENT DEASPHALTING → CRACKING STOCK
  → FUEL OIL
- CATALYTIC CRACKING → CONVERTED PRODUCTS
- COKING → CONVERTED PRODUCTS
  → COKE
- HYDRO DESULFURIZATION → DESULFURIZED FUEL OIL
- HYDROCRACKING → DESULFURIZED CONVERTED PRODUCTS
HIGH SULFUR CRUDE RUNNING SENSITIVITY ANALYSIS

FURNACE OIL MINUS H.S. FUEL OIL DIFFERENTIAL ($/BBL)

DCP RATE OF RETURN (%)
RESIDUAL CONVERSION SENSITIVITY ANALYSIS

FURNACE OIL MINUS H.S. FUEL OIL DIFFERENTIAL ($/BBL)

DCF RATE OF RETURN (%)
RESIDUAL CONVERSION PLUS HIGH SULFUR CRUDE RUNNING
SENSITIVITY ANALYSIS

FURNACE OIL MINUS H.S. FUEL OIL DIFFERENTIAL ($/BBL)

DCF RATE OF RETURN (%)
CONVENTIONAL CRUDE OIL:
QUALITY TRENDS AND POLITICAL AVAILABILITY

G. Henry M. Schuler
Director, International Affairs
Conant and Associates, Ltd.

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
In discussing the geopolitics of energy, I propose to present a tour d'horizon of thorny strategic, political, military and economic issues which the Reagan Administration inherited on January 20, 1981. Among the issues which could have significant consequences for world oil supplies are the following:

- The Saudi request for additional wing tanks and bomb racks for the F-15's which they are purchasing.
- Kuwaiti-led efforts to increase the involvement of the Palestine Liberation Organization (PLO) in international organizations.
- Precedents which are created by Iranian terms for the hostage release.
- The Algerian demand for higher LNG prices tied to crude oil values.
- Colonel Qaddafi's adventurism and challenge to the United States.
- The Nigerian commitment to Zimbabwe, Namibia and the end of white rule in South Africa.
- Negotiations over an American presence in Somalia.
- The policies of Mexico and Venezuela toward the ruling regimes in El Salvador, Nicaragua and Guatemala.
- The Canadian constitutional crises.
- The World Bank's proposal to expand its energy loan program to $25 billion over five years and to lodge it in a new lending facility.
Charting a response to these challenges will not be easy. Although the new administration is relatively free of commitments on these issues, there are plenty of competing considerations, for they involve fundamental principles and attitudes as well as energy supplies. The helmsman who ignores the political components in international oil relationships runs the risk of battering the ship of state on a rock, but he who is paralyzed by fear of those political components risks equally disastrous results from drifting onto the shoals. We have seen all too much of both excesses in the past -- policies which at one time ignore legitimate Saudi interests in the course of the Middle East peace process and then slavishly heed less than legitimate Saudi concerns about filling our Strategic Petroleum Reserve. Surely, the proper course will reflect a relationship of mutual respect, not reciprocal coercion.
NONCONVENTIONAL CRUDE: SUPPLIES, COSTS, RECOVERY TECHNOLOGIES--SHALE

Morton M. Winston
President and Chief Executive Officer
Tosco Corporation

CRUDE OIL & REFINING: THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
INTRODUCTION

Tosco Corporation has experienced oil shale's frustrated history and bright promise for all 25 years of the Company's existence. Founded as the Oil Shale Corporation, the company dedicated itself to perfecting a viable retorting process for the recovery of petroleum liquids from the vast western U. S. oil shale deposits. Once the process had been successfully demonstrated at pilot scale, Tosco broadened its horizon - starting in 1961 - and began to acquire high quality domestic shale reserves and to plan for commercialization of the technology, first with a 1,000 ton-per-day field demonstration of mining, retorting, and revegetation; and second, by having engineering contractors complete the designs and cost estimates for a full-scale 44,600 barrels-per-stream-day project. Those designs are now being implemented in construction work underway at the Colony Project in northwestern Colorado, where Tosco and Exxon are partners.

In the past decade, in addition to work in oil shale, Tosco also has become a large independent refiner - in fact the second largest independent gasoline refiner in the nation - with two refineries in California and one each in Arkansas and Oklahoma. Total rated capacity is 261,500 barrels per day. As a refiner, Tosco is especially cognizant of the decreasing availability of light, sweet crudes and the increasing prevalence of heavy, sour crudes in worldwide supplies. The Company has, in fact, configured its refining business to handle just such crudes, which contain less light ends than the average crudes run by U. S. refiners and which thus require more refinery conversion capacity to produce the same amount of finished motor gasoline.

OIL SHALE'S ROLE AS A SYNFUEL

Where does shale oil fit into this picture? On the level of the value of oil shale as an in-place resource, it is a step down from petroleum. It is a relatively "low grade" resource which, with sufficient dedication and advanced technology, can replace the "black gold" no longer available.

On a product level, this low-grade resource can yield the same high-grade products as petroleum. It is, preeminently, the one secure, domestic liquid energy source which can provide the United States a steadily increasing, dependable share of the transportation fuels we need in the next two decades and on through the 21st century.
The 17,000 square mile Green River Formation of Colorado, Utah and Wyoming is estimated to contain at least several trillion barrels of in-place oil shale. Colorado's 1,300 square mile Piceance Creek Basin is the richest portion, with an estimated 85% of the resource. The Piceance Creek Basin could yield as many as 400 billion barrels using today's technology from oil shale seams 10 feet or more in thickness and with a richness of 25 gallons per ton (gpt) or more.

Just at the Colony site, Tosco and Exxon estimate recoverable barrels to exceed 600 million barrels of oil from shale averaging about 35 gallons per ton. The veritable bonanza of hydrocarbons locked in these western U. S. oil shale deposits can supply a significant percentage of the nation's liquid energy needs - especially for transportation fuels - for more than a century just with existing technology; and that technology is certain to improve in application.

For its electricity requirements, the U. S. has many non-petroleum options, including coal, natural gas, nuclear and, eventually, perhaps the sun. But for its transportation fuel needs, only liquid hydrocarbons will serve. Today, the average U. S. crude barrel, in the average U.S. refinery, yields approximately 50% as transportation fuel, and that amount decreases as the average crude barrel becomes heavier. But a barrel of upgraded shale oil in the same refinery will yield transportation fuels virtually in its entirety. Moreover, upgraded shale oil requires no special handling and can move directly into existing refinery streams. It is, in short, a premium refinery feedstock, fully compatible with existing refining, transportation, storage and distribution facilities. Products refined from it may be freely substituted for conventionally derived products. (Table 1 shows the properties of hydrotreated shale oil.) As discussed below in more detail, Tosco and Exxon will produce about 43,500 barrels per calendar day of upgraded shale oil at the plant site.

Because upgraded shale oil in refineries can produce, almost exclusively, transportation fuels (gasoline, diesel, propane and jet fuel), one barrel of upgraded shale oil is the transportation equivalent of about two barrels of average imported crude oil.

Currently, a number of other oil shale projects are said to be in various advanced stages of development looking to the production of commercial
quantities of shale oil by the late-1980's. Table 2 summarizes the projects which appear to have the greatest potential for shale oil production before 1990. If all of these announced projects are completed on schedule, they would produce a total of 250,000 to 300,000 barrels per day. The likelihood of such a total being reached, however, is based on their current level of project activity, on their existing permit status, and on the availability of government incentives. Absent from the list are the White River Shale Project, and efforts by Superior and Chevron, all of which are active, but limited either by resource position or permit considerations. Should these projects be developed on a fast track, another 200,000 barrels per day of oil could be expected. There is therefore some potential for up to 500,000 barrels per day of shale oil by 1990.

THE COLONY PROJECT

For the Colony Shale Oil Project, which is now under construction and which Tosco and Exxon currently estimate will start up in late 1985, it is estimated that total capital costs will be approximately $1.5 billion in June 1980 dollars. Colony is owned 60% by Exxon and 40% by Tosco. Exxon is the project operator. Tosco has been selected by the Department of Energy and has entered into final negotiations for a loan guarantee to cover three quarters of its 40% investment. Exxon is not seeking government financial support for its share.

When completed, the Colony project will include an underground room-and-pillar mine in a 60-foot mining horizon, producing 66,000 tons per stream day of crushed oil shale. The crushed shale will be fed to six retort trains using the TOSCO II retorting process, followed by an upgrading section containing facilities for hydrotreating, including dearsenation, and coking. The complex will produce 44,600 barrels of upgraded shale oil per stream day (almost 15 million barrels per year), another 3,700 barrels or so of LPG, and byproduct sulfur, ammonia and coke. The upgraded shale oil will be a 40-plus gravity bottomless sweet syncrude without sulfur or nitrogen. Colony's reserves dedicated to this project - on private fee lands - will last in excess of 20 years and throughout that time production levels and product quality will be continuous and uniform, a level of dependability previously unknown in liquids production.

Colony is the most advanced commercial oil shale project in the world. It is the only project to have
received a final Environmental Impact Statement from the Department of Interior and all critical permits necessary for construction.

The total on-site construction work force will peak at about 3,300 workers, and the permanent plant and mine labor force will be just over 1,200. In conjunction with the Colony Project, Tosco and Exxon are developing a planned new community able to accommodate a population influx of more than double the work force associated with the project, their families, and the new residents expected to be attracted to the region to provide support services or participate in secondary industrial development. The new community will be independent and not a "company town."

To transport the upgraded shale oil to a refining center, Colony's plans have called for construction of a 16-inch underground pipeline from the plant site to Lisbon Valley, Utah. From that point, the oil would be transported via existing common carrier crude oil pipelines to the south-central and southern sections of the country. Alternatively, application has been made for a new pipeline routed via Rangely, Colorado north to the Casper, Wyoming area, and thence by existing lines to refining centers in the Midwest.

As the Colony Project comes on stream in 1985, a number of other commercial projects will be encouraged to follow both in the U. S. and abroad - some using the combination of underground mining and surface TOSCO II retorts, others perhaps using different schemes. While the pace of U. S. oil shale development depends a great deal on the rapidity and effectiveness of the government's synthetic fuels program, internationally, the large commercial deposits of oil shale known to exist outside this country - in Australia, Brazil, and Morocco among others - are already the subject of development interest by private industry and governments, and could begin to be exploited on a large scale within the decade. In addition to providing much needed premium feedstocks for refiners around the world, even modest international production of upgraded shale oil could contribute to restraint in OPEC's future pricing policies.

OIL SHALE ECONOMICS

The frustration in oil shale's history has been largely a function of the economic risk inherent in
financing and building the pioneer plants - and
misdirected government energy policies which stifled
rather than encouraged private development. The
Colony Project is economically sound at current costs
and oil prices, and needs no subsidy; however, Tosco
seeks a loan guarantee because conventional, secured,
project debt financing is not available for a
pioneering project of this scale, though it will be
for successor facilities.

Expressed in constant (1980) dollars, the capital
costs for the Colony Project are estimated at
approximately $1.5 billion. Tosco estimates that in
the same dollars operating costs, including
depreciation, will be $16 per barrel of upgraded oil
produced. These costs are estimated to be accurate
respectively, within 10 percent and 20 percent, based
on the advanced ("definitive") stage of the long
Colony estimating effort.

Estimates of constant dollar costs do not present
the whole picture by any means, however. Inflation,
interest during construction for leveraged projects,
and the costs of delay all may add greatly to the
actual costs as funds are expended. The Colony
Project is a massive undertaking which, though
already under construction, is not scheduled to begin
its start-up phase until late in 1985. Cost
escalation could have a substantial effect over the
long construction period. Our "worst case" estimate
is that capital costs could amount to over
$3 billion, which is arrived at by including
contingencies for inflation, interest during
construction and unexpected delays. Thus, factors
over which the developer has no control can more than
double the constant dollar estimates of capital
costs. Operating costs may be similarly affected.

With all of these costs included, however, the
revenue of the plant is confidently expected to be
sufficient to provide an adequate rate of return,
somewhat above 15%. This analysis is based on the
very conservative assumption that capital costs will
escalate more rapidly than oil prices. There are, of
course, substantive indications that oil price
escalation will instead outstrip cost inflation
during construction and continue to escalate
thereafter, and in that event the economics of the
first commercial oil shale project will steadily
improve.

The prospect of producing oil from oil shale
should not be viewed in isolation, however. A
comprehensive DOE publication (Historical Review of
Domestic Oil and Gas Exploratory Activity, Oct. 1979)
indicates that over the 1966-78 period hydrocarbon reserves added per-foot-drilled declined by more than half, at a rate of almost 6% per year. For new field wildcat exploration, the decline in finding rates was about 4% per year over the same period. Over the longer 1946-78 period, crude oil reserves added per successful foot drilled have declined by over 3% per year. (These figures exclude revisions and for obvious reasons, the Prudhoe Bay Field.) Proved reserves of oil, including the 10 million barrels found at Prudhoe Bay, peaked in 1971. Excluding North Alaska, proved reserves peaked in 1967. Meanwhile, the cost of drilling and equipping per-foot-drilled offshore increased by about 13% per year between 1966 and 1977, or at greater than 7% per year in real terms.

These figures offer an ominous prediction for the future of U. S. conventional petroleum resources. The recent elimination of wellhead price controls (although accompanied by the "windfall" profits tax) will spur exploration activities, and might for a time modify some of these dismal trends in exploration productivity. But, the only provident conclusion one can draw today from this unquestionable data, is that the most rapid reasonable evolution of commercial shale oil production in the United States, is an indispensable bulwark against a disabling growth of our dependence on others.

All of the evidence points in the same direction. Finding and development costs per barrel have increased steadily in the U. S. Recent transactions for proved reserves have averaged from $8-$12 per barrel and offshore drilling and development costs continue their precipitate rise. While oil shale operating costs are greater than new crude oil lifting costs, conventional exploration costs are quite sufficient to more than balance the ledger. In sum, Tosco is confident of shale oil's competitive viability both today and for the foreseeable future.

**UPGRADING RAW SHALE OIL**

The principal reason for upgrading raw shale oil in the production process is its high nitrogen content. Other factors such as sulfur, hydrogen, and carbon levels are all within the range found in conventional petroleum. But oils from Colorado and other shales contain approximately 2 wt % nitrogen, or nearly an order of magnitude higher than that ordinarily found in conventional petroleum, which contains an average of only about 0.3 wt % nitrogen. Nitrogen compounds can poison the catalysts used in
many petroleum refining processes, such as FCC's, naphtha reformers, and hydrocrackers. They can also cause instability in diesel and jet fuels and gasoline and, depending on burning methods used, could contribute to an increase in combustion emissions of NOx. Hydrotreating to remove nitrogen compounds from the raw shale oil is therefore obviously necessary at some point in the process of utilization.

Currently, there is no U. S. refinery configured to take nitrogen-bearing raw shale oil as a direct feedstock to its crude units, except for quite small amounts diluted in much larger petroleum streams. Therefore, if upgrading facilities aren't located at the plant site - as they will be at Colony - they must be installed at the refining center where crude shale oil is delivered. Because the hydrogen needed for hydrotreating can also be readily produced from gas streams available in a TOSCO II process shale oil plant, it is obviously desirable in the initial phase to incorporate upgrading facilities on-site in the production process. As the industry develops, the location of upgrading will be determined by many factors, including by-product prices, hydrogen availability and cost, geographic location, and environmental needs.

Raw shale oil also contains approximately 50 ppm of arsenic, a catalyst poison, and 0.6 wt % sulfur, which is low, but high enough to warrant desulfurization prior to refining. Therefore, all three steps - hydrotreating, dearsenation, and desulfurizing - are included in the upgrading facilities at the Colony plant site.

Raw shale oil from the TOSCO II Process contains 1-2% shale fines. The removal of shale solids from the whole oil can be accomplished by a variety of methods, of which the application of conventional electrostatic desalting is thus far the preferred option.

Pour point and viscosity reduction are desirable if the raw shale oil is to be transported by pipeline for any significant distance. The pour point can be reduced by several methods; pour point depressants, a mild thermal treatment developed by Tosco which is similar to vis breaking, and coking of 900-plus material. Pour point depressants, while effective in reducing pour, do not reduce viscosity and the associated pumping costs. Thermal treatment, too, though very low in cost, has only limited impact on viscosity. In coking, the pour point and viscosity
are reduced significantly, at the cost of some liquid yield.

**BOTTOMS TREATMENT ALTERNATIVES**

While most of the previous discussion has been related to delayed coking, there are other alternatives to consider with respect to the bottom of the barrel material. The typical alternatives are coking, vacuum distillation, and deasphalting.

Coking of shale oil bottoms can be accomplished by delayed, fluid, or flexicoking techniques. Although the liquid yield from fluid or flexicoking would be 20% higher than from delayed coking, the resulting distillates would be more heavily cracked.

Solvent deasphalting of the heavy shale oil fraction would yield a high quality gas oil and a residue, assuming the deasphalting of asphaltenes. Deep vacuum distillation could be employed to reject hydrogen deficient material. However, neither deasphalting nor deep distillation has any evident advantage over coking unless methods can be demonstrated to make effective use of the residue, for example, via partial oxidation to produce hydrogen.

**HYDROTREATING**

The hydrotreating of shale oil is much like conventional hydrocracking. Hydrotreating will remove olefins, oxygen, and sulfur, as well as nitrogen. While conventional equipment can be utilized, higher pressures and hydrogen consumption are required for nitrogen removal than for desulfurization. The addition of hydrogen to the bottom fraction is an alternative to the bottoms processing options discussed above.

The hydrotreating of the naphtha fraction must be sufficient, to less than about 2 ppm, to prepare reformer feed. If whole oil hydrotreating were utilized, say as a pre-refining step, then some additional hydrotreating would probably be required for gasoline or jet fuel production. A product slate with primary emphasis on fuel oil will require less severe hydrotreating.

Hydrogen consumption is a critical factor in the choice of the processing sequence, since, if sufficient light ends are not available for both the refinery complex and a hydrogen unit, liquid products would have to be diverted to refinery fuel use.
FLUID CATALYTIC CRACKING (FCC)

Conventional FCC facilities can be utilized to produce more valuable, lower-boiling transportation fuels from the hydrotreated oil boiling above the diesel range. The removal of the major amounts of sulfur and nitrogen reduces the emissions burden from the FCC regenerator. Work by Chevron indicates that product yields and properties from catalytic cracking of hydrotreated shale oil are similar to those from Arabian gas oil.

PRODUCT SLATE CONSIDERATIONS

In composition and utility, raw shale oil is within the range of properties established by the heavy, sour crudes for which typical U.S. refineries are now gradually being modified. Since the quantities of shale oil potentially available are very large, and because it will fit easily and readily into the existing complex refining, distribution and consumption system for conventional crude oil, hydrotreated shale oil is an excellent substitute for imported oil in producing all refined light products.

However, it is of particular importance that military jet fuel and distillates can readily be produced from it. JP-4, the primary fuel of the Air Force for more than a quarter of a century, now accounts for nearly half of the Department of Defense's (DOD) petroleum requirements. As the availability of domestic crudes most suitable for producing jet fuel decreased over the years, the shortfall was met by imports. But the jarring supply interruptions of the 1973 Oil Embargo and the subsequent uncertainties and price increases have caused the Air Force to question all of its assumptions about the cost and availability of jet fuel. It is quite apparent that a secure, long-term domestic source of distillates is essential to security. In 1974 the Air Force Aero Propulsion Laboratory (APAPL) initiated programs to evaluate the feasibility of increasing jet fuel availability and minimizing future cost increases. Oil from shale has emerged as the most promising new domestic source of jet fuel to that important end.

Morton M. Winston
President and Chief Executive Officer
Tosco Corporation
TABLE 1

PROPERTIES OF HYDROTREATED TOSCO II PROCESS SHALE OIL

<table>
<thead>
<tr>
<th>Full Range Product</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield, Vol %</td>
<td></td>
</tr>
<tr>
<td>Gravity, ° API</td>
<td>41.4</td>
</tr>
<tr>
<td>Distillation, vol.% TBP,</td>
<td></td>
</tr>
<tr>
<td>IBP</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>180</td>
</tr>
<tr>
<td>30</td>
<td>340</td>
</tr>
<tr>
<td>50</td>
<td>475</td>
</tr>
<tr>
<td>70</td>
<td>615</td>
</tr>
<tr>
<td>90</td>
<td>785</td>
</tr>
<tr>
<td>EP</td>
<td>975</td>
</tr>
<tr>
<td>Hydrocarbon Characterization, wt. %</td>
<td></td>
</tr>
<tr>
<td>Paraffins</td>
<td>44.2</td>
</tr>
<tr>
<td>Olefins</td>
<td>0.0</td>
</tr>
<tr>
<td>Naphthenes</td>
<td>35.5</td>
</tr>
<tr>
<td>Aromatics</td>
<td>20.3</td>
</tr>
<tr>
<td>Elemental Analyses, wt.%</td>
<td></td>
</tr>
<tr>
<td>Carbon</td>
<td>85.7</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>14.2</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.01</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.05</td>
</tr>
<tr>
<td>Gross Properties</td>
<td></td>
</tr>
<tr>
<td>Flash Point, ° F</td>
<td>--</td>
</tr>
<tr>
<td>Pour Point, ° F</td>
<td>+55</td>
</tr>
<tr>
<td>Viscosity, Cs @ 100 F</td>
<td>1.80</td>
</tr>
<tr>
<td>Viscosity, Cs @ 210 F</td>
<td>0.85</td>
</tr>
<tr>
<td>Reid Vapor Pressure, Psi</td>
<td>6.0</td>
</tr>
<tr>
<td>Conradson Carbon, wt.% on 10% bottoms</td>
<td>0.04</td>
</tr>
<tr>
<td>Gross Btu/Lb.</td>
<td>19,800</td>
</tr>
<tr>
<td>Water &amp; Sediment</td>
<td>Trace</td>
</tr>
<tr>
<td>Metals, ppm</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>0.10</td>
</tr>
<tr>
<td>Potassium</td>
<td>0.10</td>
</tr>
<tr>
<td>Vanadium</td>
<td>0.01</td>
</tr>
<tr>
<td>Nickel</td>
<td>0.11</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.07</td>
</tr>
<tr>
<td>Lead</td>
<td>0.40</td>
</tr>
<tr>
<td>Heating Value (HHV)</td>
<td>5.67MM BTU/Bbl</td>
</tr>
</tbody>
</table>
### TABLE 2

**PRODUCTION ESTIMATE BY PROJECT**

<table>
<thead>
<tr>
<th>Company</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Union Long Ridge Project</td>
<td>9,000 - 50,000 BPD</td>
</tr>
<tr>
<td>Cathedral Bluffs Shale Oil Company</td>
<td>57,000 BPD</td>
</tr>
<tr>
<td>Rio Blanco Oil Shale Company</td>
<td>76,000 BPD</td>
</tr>
<tr>
<td>Colony Project</td>
<td>48,000 BPD</td>
</tr>
<tr>
<td>Tosco Sand Wash Project</td>
<td>50,000 BPD</td>
</tr>
<tr>
<td>Paraho Development Corporation</td>
<td>10,000 BPD</td>
</tr>
</tbody>
</table>
NONCONVENTIONAL CRUDE: SUPPLIES, COSTS, RECOVERY TECHNOLOGIES--VENEZUELAN HEAVY CRUDE

Angel H. Behrends
Refining Coordinator
Petroleos de Venezuela S.A.

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
VENEZUELAN HEAVY CRUDES

THE SUBJECT OF MY PRESENTATION THIS MORNING IS "VENEZUELAN HEAVY CRUDES". I PLAN TO COVER SOME BACKGROUND ON OUR OIL PRODUCTION AND RESERVES, OUR REFINING INDUSTRY, AND LAST BUT NOT LEAST OUR PLANS FOR THE DEVELOPMENT OF THE HEAVY CRUDE RESOURCES OF THE ORINOCO OIL BELT.

SLIDE N° 1

THIS SLIDE SHOWS A MAP OF VENEZUELA WITH THE LOCATION OF OUR PRINCIPAL OIL PRODUCTION AREAS, AS WELL AS THE ORINOCO OIL BELT.

FOR SOME TIME, VENEZUELA HAS BEEN AN IMPORTANT PRODUCER OF HEAVY CRUDES, WHICH WE DEFINE AS CRUDES HAVING A GRAVITY OF LESS THAN 22° API. DURING 1980 WE PRODUCED APPROXIMATELY 800,000 B/D OF SUCH CRUDES OF WHICH 630,000 B/D WERE EXPORTED. THESE CRUDES ARE PRODUCED BOTH IN THE AREA OF LAKE MARACAIBO, AS WELL AS IN EASTERN VENEZUELA, IN THE AREA NORTH OF THE ORINOCO OIL BELT.

OF OUR PROVEN RESERVES OF 19,6 BILLION BARRELS ROUGHLY 11.1 BILLION BARRELS, OR 57% CORRESPOND TO HEAVY CRUDES. IN THIS NUMBER WE INCLUDE ONLY A SMALL VOLUME OF CRUDE FROM THE ORINOCO OIL BELT SINCE OUR LARGE SCALE EXPLORATION AND EVALUATION PROGRAM IN THIS AREA WAS INITIATED DURING 1979. UP TO DECEMBER 1980 A TOTAL OF 427 WELLS HAVE BEEN DRILLED.

THE ORINOCO OIL BELT WHICH COVERS AN EXTENSION OF ROUGHLY
TWICE THE STATE OF MASSACHUSETTS, CONTAINS ONE OF THE LARGEST ACCUMULATIONS OF HEAVY CRUDE OIL IN THE WORLD. INITIAL RESULTS FROM EXPLORATION AND PRODUCTION TEST ARE VERY ENCOURAGING, SINCE BOTH WELL PRODUCTIVITY AND VOLUME OF ACCUMULATION EXCEED EXPECTATIONS. AT PRESENT OUR ESTIMATE OF OIL IN PLACE IS IN THE ORDER OF 1 TRILLION BARRELS OF WHICH WE EXPECT 20% TO BE RECOVERABLE WITH CURRENT ON HAND TECHNOLOGY. IF WE ADD THIS VOLUME TO OUR PROVEN RESERVES, AND TAKING INTO ACCOUNT OUR EXPECTATIONS FOR FINDING ADDITIONAL LIGHT AND MEDIUM CRUDES, WE CAN SEE THAT AT LEAST 90% OF VENEZUELA'S PETROLEUM RESOURCES ARE REPRESENTED BY HEAVY CRUDES AND OUR PRODUCTION WILL HAVE TO FOLLOW THE SAME TREND.

OUR REFINERIES WERE DESIGNED TO PROCESS MAINLY LIGHT AND MEDIUM CRUDES, WHICH WERE ABUNDANT AND CHEAPER TO PRODUCE AND PROCESS AT THAT TIME. THEIR PRODUCT SLATE ALSO REFLECTS THE PRE 1973 SITUATION, WHERE THE MAIN PRODUCT WAS, AS STILL TODAY, RESIDUAL FUEL DESTINED FOR THE U.S. EAST COAST. IN CONSIDERATION OF THIS WE ARE UNDERTAKING AN AMBITIOUS REFINERY UPGRADING PROGRAM WITH THE OBJECTIVES OF PARTIAL REPLACEMENT OF LIGHT AND MEDIUM CRUDES BY HEAVY CRUDES IN OUR REFINERY RUNS WHILE ALSO INCREASING THE PRODUCTION OF LIGHT PRODUCTS, TO SUPPLY OUR RAPIDLY GROWING LOCAL MARKET, AND IMPROVING THE QUALITY OF THE FUEL OIL PRODUCED WHICH, AS I MENTIONED BEFORE, IS MAINLY FOR EXPORT. THIS UPGRADING EFFORT, ONCE COMPLETED, WILL REPRESENT AN INVESTMENT IN THE ORDER OF FOUR BILLION DOLLARS.
THE REFINING INVESTMENT PROGRAM PROVIDES FOR THE INSTALLATION OF THE FOLLOWING ADDITIONAL SECONDARY CAPACITY SHOWN ON THIS SLIDE:

SLIDE N° 2

<table>
<thead>
<tr>
<th>Process</th>
<th>MB/D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacuum Distillation</td>
<td>260</td>
</tr>
<tr>
<td>Catalytic Cracking</td>
<td>175</td>
</tr>
<tr>
<td>Alkylation</td>
<td>70</td>
</tr>
<tr>
<td>Hydrocracking</td>
<td>50</td>
</tr>
<tr>
<td>Deasphalting</td>
<td>25</td>
</tr>
<tr>
<td>Flexicoking</td>
<td>50</td>
</tr>
<tr>
<td>Visbreaking</td>
<td>50</td>
</tr>
</tbody>
</table>

SLIDE N° 3

IT'S EFFECTS ARE SHOWN ON THIS SLIDE WHICH COMPARES OUR OPERATIONS IN 1977 TO OUR FORECAST FOR 1986, WHICH REPRESENTS ONLY ONE OF A NUMBER OF POSSIBLE CASES.

WHILE TOTAL CRUDE RUNS ARE ANTICIPATED TO INCREASE BY 175,000 B/D, STILL WITHIN OUR CURRENT CAPACITY OF 1.4 MILLION B/D, LIGHT AND MEDIUM CRUDES IN OUR REFINERY DIET WOULD BE CUT BY A SIMILAR VOLUME WHILE HEAVY CRUDES WOULD INCREASE BY 351,000 B/D. ON THE REFINERY OUTPUT SIDE, GASOLINE YIELD WOULD INCREASE BY 205,000 B/D, DISTILLATES BY 83,000 B/D, WHILE FUEL OIL WOULD DROP BY 93,000 B/D.

SO MUCH FOR OUR REFINING ACTIVITY. LET US DISCUSS NOW OUR PLANS FOR THE DEVELOPMENT OF THE ORINOCO OIL BELT.
First we should point out that the gravity of the crude varies between 6 and 20° API, the bulk being less than 10° API with a fairly high metals content in the order of 400 ppm vanadium and nickel and 3.5 to 4.0% sulphur. The oil is liquid at reservoir conditions enabling us to obtain cold production rates of between 30 and 700 b/d per well by traditional pumping.

In view of this we are planning an initial primary production phase before steam injection becomes a requirement to maintain the productivity of the wells. Initially the steam soak method would be applied, which represents the periodic injection of some 5000 tons of steam into the producing well which heats the reservoir. Thereafter the well will be produced for some 18-24 months before a new injection cycle is initiated. After several cycles we will have to switch to steam drive, which represents continuous injection, converting some of the producing wells into steam injection wells to drive the oil toward the producing wells. Energy consumption for production and upgrading, of which steam generation is a major contributor, is estimated to vary between 20 and 50% of the oil produced depending mainly on whether we are in the steam soak or steam drive phase which in turn depends among other things
ON THE STATE OF DEVELOPMENT OF EACH AREA.

ONCE THIS HEAVY VISCOUS OIL REACHES THE SURFACE AND COOLS DOWN IT BECOMES VERY DIFFICULT TO PUMP. SOME FORM OF DILUTION OR HEATING WILL BE REQUIRED FOR TRANSPORTATION AND REMOVAL OF THE ASSOCIATED WATER AND SEDIMENT.

WE ARE CURRENTLY PLANNING TWO PROJECTS, ONE CALLED GUANIPA 100, ASSIGNED TO OUR SUBSIDIARY, S.A. MENEVEN, WHICH HAS AS OBJECTIVE THE PRODUCTION OF 100,000 B/D OF HEAVY OIL BY 1988.

THE PROJECT WILL USE LIGHT CRUDE AS DILUENT TO PRODUCE A BLENDED CRUDE OF 16-18° API WHICH WILL BE TRANSPORTED THROUGH EXISTING SYSTEMS TO PUERTO LA CRUZ ON THE NORTH EAST COAST. THE INVESTMENT IN THIS PROJECT IS ESTIMATED AT 1.3 BILLION DOLLARS.

THE OTHER PROJECT, PRESENTLY IN THE PLANNING STAGE, IS ASSIGNED TO OUR SUBSIDIARY LAGOVEN. IT IS TO BE IMPLEMENTED IN THE CERRO NEGRO AREA SOUTH OF EXISTING HEAVY CRUDE PRODUCTION IN THE JOBO/PILON OILFIELDS. THE OBJECTIVE IS TO PRODUCE BY 1988 IN A FIRST MODULE 125,000 B/D OF UPGRADED CRUDE WITH THE POSSIBILITY OF EXPANSION TO 500,000 BARRELS PER DAY BY THE YEAR 2000 IN THE SAME AREA.

CARBON REJECTION OR HYDROGEN ADDITION PROCESSES CAN BE USED FOR THE UPGRADING OF THE CERRO NEGRO CRUDE. LAGOVEN HAS SELECTED A CARBON REJECTION PROCESS, DELAYED COKING,
AS THE PRIMARY UPGRADING PROCESS FOR THE FIRST STAGE OF THE PROJECT, DELAYED COCKING LIQUID PRODUCTS WILL BE HYDROTREATED FOR STABILIZATION AND FINAL IMPROVEMENT OF CERTAIN IMPORTANT PROPERTIES LIKE SULFUR CONTENT, CETANE NUMBER AND NITROGEN CONTENT. A COMPARISON OF THE PROPERTIES OF RAW, UPGRADED AND A CONVENTIONAL MEDIUM CRUDE IS SHOWN ON THE NEXT SLIDE.

SLIDE N° 4

AS YOU WILL NOTE THE UPGRADED CRUDE WILL NOT HAVE A BOTTOMS CUT AND IN SULPHUR CONTENT, CONRADSON CARBON, AS WELL AS METALS CONTENT, WILL BE FAR SUPERIOR TO OUR CONVENTIAL MEDIUM CRUDES SUCH AS TIA JUANA MEDIUM.

THE UPGRADING PLANT WILL BE LOCATED NEAR THE PRODUCTION SITE AND DELAYED COKE FROM THE UPGRADER WILL BE USED TO GENERATE STEAM FOR THE REFINERY AND ELECTRICITY FOR BOTH THE PRODUCTION OPERATIONS AND THE REFINERY. THE CRUDE WILL BE TRANSPORTED BY A NEW PIPELINE TO A DEEPWATER PORT ON THE VENEZUELAN NORTH COAST.

AT THIS TIME WE HAVE NOT YET DEFINED WHETHER FUTURE MODULES WILL ALSO PROVIDE FOR UPGRADING OR AT LEAST UPGRADING TO THE EXTEND PLANNED FOR THE FIRST MODULE.

THE INVESTMENT REQUIRED FOR THE FIRST MODULE, INCLUDING THE NECESSARY INFRASTRUCTURE, IS ESTIMATED AT ABOUT SEVEN BILLION DOLLARS.
THE INFRASTRUCTURE WILL BE AT LEAST IN PART SERVE THE FUTURE MODULES TO BE DEVELOPED.

TOTAL PRODUCTION FROM THE ORINOCO OIL BELT COULD REACH 1 MILLION BARRELS PER DAY BY THE YEAR 2000.

TECHNOLOGY CURRENTLY EXISTS TO ACHIEVE OUR OBJECTIVES OF PRODUCING, TRANSPORTING AND CONVERTING HEAVY CRUDE OIL INTO LIGHT CRUDE OIL FOR REFINING TO PROVIDE TRANSPORTATION FUELS, HOWEVER, WE ARE INTERESTED, AND HAVE A MAJOR RESEARCH PROGRAM UNDERWAY, TO SECURE IMPROVEMENTS IN THIS TECHNOLOGY WITH THE AIM OF OBTAINING MORE ATTRACTIVE ECONOMICS. THIS WORK IS BEING CARRIED OUT OR COORDINATED BY INTEVEP, OUR RESEARCH AFFILIATE.

IN THE AREA OF PROCESSING WE ARE CONSTRUCTING A 2500 B/D DEMONSTRATION PLANT OF THE SHELL HIDRODEMETALIZATION PROCESS, EXPECTED TO REDUCE THE METALS CONTENT OF RESIDUES WHILE ALSO ADDING HYDROGEN. THIS SHOULD PERMIT FURTHER PROCESSING OF THE PRODUCT BY CONVENTIONAL TECHNOLOGY. A DEMONSTRATION PLANT OF UOP/S AURABON PROCESS IS ALSO UNDER CONSIDERATION.

IT IS THE VENEZUELAN GOVERNMENTS POSITION THAT THE RESPONSIBILITY FOR CARRYING OUT THE PROJECTS OF THE OIL INDUS-
TRY WILL BE IN THE HANDS OF STATE OWNED PETROLEOS DE VENEZUELA AND ITS 100% OWNED SUBSIDIARIES. FOR THIS REASON THERE WILL BE NO POSSIBILITY OF JOINT VENTURES IN THE DEVELOPMENT OF THESE PROJECTS.

VENEZUELA WILL EMPLOY WELL QUALIFIED CONTRACTORS FOR PROJECT EXECUTION, WHILE MAXIMIZING THE VENEZUELAN PARTICIPATION IN THE VARIOUS FIELDS OF ENGINEERING, PROCUREMENT AND MANUFACTURING OF EQUIPMENT AND OTHER MATERIALS AS WELL AS CONSTRUCTION.

WHILE WE HAVE NOT YET FULLY DEFINED THE EXTENT TO WHICH WE WILL UPGRADE OUR HEAVY CRUDE RESOURCES, AND HOW MUCH WILL BE DONE BY OURSELVES, THE MAGNITUDE OF THE TASK IS SUCH THAT WE DO NOT FORESEE OUR CONVERSION CAPACITY BEING ENOUGH TO TURN ALL OF OUR HEAVY CRUDE PRODUCTION INTO HIGH QUALITY CRUDE OIL READILY ACCEPTABLE TO REFINERS WHICH DO NOT HAVE BOTTOM OF THE BARREL CONVERSION CAPACITY.

ONE SHOULD ALSO CONSIDER THAT THE REST OF THE WORLD INCLUDING YOUR OWN COUNTRY, ARE RELYING INCREASINGLY ON RESERVES OF HEAVIER AND HIGHER SULFUR CRUDES, WHILE THE DEMAND WILL BE MAINLY FOR LIGHTER PRODUCTS.

THEREFORE, THERE SHOULD BE AMPLE OPPORTUNITIES FOR CONSUMING COUNTRIES TO INSTALL HEAVY CRUDE UPGRADING PLANTS AND TO MODIFY THEIR REFINERIES FOR THE CONVERSION OF HEAVY CRUDE.
SUMMARIZING MY PRESENTATION WE MAY CONCLUDE THAT OUR FUTURE IS DEFINITELY LINKED TO OUR MORE AMPLE HEAVY HYDROCARBON RESOURCES. THE PROJECTS WE ARE PRESENTLY EXECUTING OR PLANNING REPRESENT A MAJOR CHALLENGE FOR THE VENEZUELAN PETROLEUM INDUSTRY, HOWEVER, THE PROGRESS WE HAVE ACHIEVED SO FAR ALLOWS US TO BE OPTIMISTIC TOWARDS THE FUTURE OF OUR ENDEAVORS.
# ADDITIONAL SECONDARY PROCESSING CAPACITY

## FOR VENEZUELAN REFINERIES

<table>
<thead>
<tr>
<th>Process</th>
<th>Capacity (MB/D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VACUUM DISTILLATION</td>
<td>260</td>
</tr>
<tr>
<td>CATALYTIC CRACKING</td>
<td>175</td>
</tr>
<tr>
<td>ALKYLATION</td>
<td>70</td>
</tr>
<tr>
<td>HYDROCRACKING</td>
<td>50</td>
</tr>
<tr>
<td>DEASPHALTING</td>
<td>25</td>
</tr>
<tr>
<td>FLEXICOKING</td>
<td>50</td>
</tr>
<tr>
<td>VISBREAKING</td>
<td>50</td>
</tr>
</tbody>
</table>

CARACAS, 14 DE ENERO DE 1981

COORDINACION DE REFINACION
PETROLEOS DE VENEZUELA, S.A.

IMPACT OF UPGRADING PLANS ON REFINERY FEED AND YIELD

<table>
<thead>
<tr>
<th>TYPE OF CRUDE</th>
<th>1977</th>
<th>1986</th>
<th>DELTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIGHT</td>
<td>387</td>
<td>341</td>
<td>(46)</td>
</tr>
<tr>
<td>MEDIUM</td>
<td>472</td>
<td>342</td>
<td>(130)</td>
</tr>
<tr>
<td>HEAVY</td>
<td>108</td>
<td>459</td>
<td>351</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>967</td>
<td>1142</td>
<td>175</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MB/D</th>
<th>REFINERY PRODUCTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1977</td>
</tr>
<tr>
<td>GASOLINE AND NAPHTHA</td>
<td>185</td>
</tr>
<tr>
<td>KERO/JET FUEL</td>
<td>47</td>
</tr>
<tr>
<td>GASOIL /No. 2 F.O.</td>
<td>135</td>
</tr>
<tr>
<td>LOW SULPHUR F.O. BELOW 1%S</td>
<td>148</td>
</tr>
<tr>
<td>HIGH SULPHUR F.O. ABOVE 1%S</td>
<td>401</td>
</tr>
</tbody>
</table>
### Properties of Upgraded, Non-Upgraded and Conventional Medium Crudes

<table>
<thead>
<tr>
<th></th>
<th>Cerro Negro</th>
<th>Upgraded Cerro Negro</th>
<th>Tia Juana Medium</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gravity °API</strong></td>
<td>8.0</td>
<td>34</td>
<td>24.2</td>
</tr>
<tr>
<td><strong>Sulfur, Wt%</strong></td>
<td>3.7</td>
<td>0.5</td>
<td>1.7</td>
</tr>
<tr>
<td><strong>Con Carbon, Wt%</strong></td>
<td>13.3</td>
<td>1.0</td>
<td>6.3</td>
</tr>
<tr>
<td><strong>Vanadium, Wt. PPM</strong></td>
<td>485</td>
<td>Nil</td>
<td>225</td>
</tr>
<tr>
<td><strong>Yields, Vol% of Crude</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5 - 650 °F</td>
<td>15</td>
<td>45</td>
<td>41</td>
</tr>
<tr>
<td>650 - 975 °F</td>
<td>27</td>
<td>55</td>
<td>28</td>
</tr>
<tr>
<td>975 °F PLUS</td>
<td>58</td>
<td>0</td>
<td>31</td>
</tr>
</tbody>
</table>

CARACAS, 14-01-81

COORDINACION DE REFINACION
NONCONVENTIONAL CRUDE: SUPPLIES, COSTS, RECOVERY TECHNOLOGIES--CANADIAN SYNTHETICS AND HEAVY CRUDE OIL

Robert M. Scarborough
Manager, Heavy Oil Operations
Dome Petroleum Limited

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
CANADIAN SYNTHETICS and HEAVY CRUDE OIL

Canada is one of the few Western world nations which has the reserve potential of not only becoming energy self sufficient but also becoming a major energy exporter. Certainly we all realize that the time frame for this immense development directly depends on the Canadian economic climate which we all realize is considerably clouded at this moment.

TAR SANDS RESERVES
As shown in Figure 1 (Map showing general locations of synthetic and heavy oil reserves-in-place) the tar sands are situated in the central to north half of the province of Alberta. In total the Bitumen in place is estimated at approximately 982 Billion barrels. The currently existing Mega projects (Syncrude plant and Suncor plant) and the proposed Alsands and Cold Lake projects are oriented at development of these reserves. Projected productivity levels of these plants are 900,000 BOPD.

HEAVY OIL RESERVES
As shown in Figure 1 the principal heavy oil reserves lie in the Lloydminster area both in Alberta and Saskatchewan. Current heavy oil total estimated reserves amounts to less than a billion barrels. These reserves are mainly under primary production but a number of secondary methods are being applied like waterflooding. Tertiary or EOR methods including steam displacement and in situ combustion projects are being applied in increasing numbers. With EOR projects these reserves could be significantly increased.

CANADIAN CRUDE OIL DEMAND AND SUPPLY
Figure 2 shows a possible maximum demand for Canada of two and one-half million barrels per day by the year 2000.
Canada is one of the few Western world nations which has the reserve potential of not only becoming energy self sufficient but also becoming a major energy exporter. Certainly we all realize that the time frame for this immense development directly depends on the Canadian economic climate which we all realize is considerably clouded at this moment.

TAR SANDS RESERVES
As shown in Figure 1 (Map showing general locations of synthetic and heavy oil reserves-in-place) the tar sands are situated in the central to north half of the province of Alberta. In total the Bitumen in place is estimated at approximately 982 Billion barrels. The currently existing Mega projects (Syncrude plant and Suncor plant) and the proposed Alsands and Cold Lake projects are oriented at development of these reserves. Projected productivity levels of these plants are 900,000 BOPD.

HEAVY OIL RESERVES
As shown in Figure 1 the principal heavy oil reserves lie in the Lloydminster area both in Alberta and Saskatchewan. Current heavy oil total estimated reserves amounts to less than a billion barrels. These reserves are mainly under primary production but a number of secondary methods are being applied like waterflooding. Tertiary or EOR methods including steam displacement and insitu combustion projects are being applied in increasing numbers. With EOR projects these reserves could be significantly increased.

CANADIAN CRUDE OIL DEMAND AND SUPPLY
Figure 2 shows a possible maximum demand for Canada of two and one-half million barrels per day by the year 2000.
Figure 1
Locations of Tar Sands/Oilsands and Heavy Oil Deposits

- Tarsands/Oilsands
- Lloydminster Type Heavy Oil
Figure 2

Forecast of Crude Oil Demand

Canada

2000
1990
1980
1970
1960
1950
1940
1930
1920
1910
1900
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Thousands of Cubic Metres per Day

Thousands of Barrels per Day

Motor Gasoline
Light Fuel Oil
Diesel Fuel
Heavy Fuel Oil
Other Products
Refinery Loss/Use
Total Demand (forecast)

Total Demand (maximum 1.5% per year)
From presentations made by Dome to regulatory bodies in Canada like the NEB and ERCB, the above demand can easily be covered by 2.2 million barrels per day from oilsands and heavy oil, 600,000 barrels per day from EOR light and medium crude and 1.6 million barrels per day from frontier-sources like the Beaufort and the East coast; which in total represents a surplus for export.

SYNTHETIC AND HEAVY OIL PRODUCTIVITY
With sufficient netback to the producer about $25/Bbl. (1980 $), over 2 million barrels per day can be produced from tar sands and heavy oils. By primary infill drilling and concurrent implementation of EOR methods, the Lloydminster heavy oil fields can provide 400,000 BOPD. The balance of the 2 million barrel per day, can be supplied by the existing oilsands plant and construction of six (6) additional plants.

INVESTMENT REQUIREMENTS
In the tar sands, the Suncor plant cost $280 Million in 1967 for a 48,000 Bbl./day plant; the Syncrude plant amounted to $2.5 Billion in 1976 dollars. With pending delay, projected costs of the Alsands is now $11 Billion. The same cost is now expected for the Cold Lake project.

In Lloydminster, the development cost requirement of a typical section (640 acres) under a steam in-situ combustion process is $20 million in 1980 dollars.

To briefly summarize the investment requirements to attain this productive capacity from the oilsands and heavy oil areas, an investment of 30 to 40 Billion dollars will be required to produce 360,000 BOPD of heavy oils. The tar sands development requirement is between 300 to 350 Billion dollars. These estimates of investments assume an early resolution of the present impasse between the producing provinces and the Federal Government.
THE POLITICS

To address the Politics currently at play in Canada I have briefly summarized Dome Petroleum Limited's President Mr. Bill Richards comments made during NEB hearing in Vancouver, British Columbia November 19, 1980. I quote Mr. Richards:

"I would, however, like to comment upon the Budget on my own assessment of its impact. First of all, I think it might be fairly characterized, in general terms, to be a Budget that is nationalistic and interventionist, in terms of its general thrust.

We in Dome, support very strongly the nation that we should encourage the increase of Canadian ownership of our oil and gas industry. However, we have some concern about the methods that are implicit in this budget.

It is our view perhaps a better approach to the increased Canadianization of our industry might have been to give more encouragement to Canadians to purchase Canadian stock.

I mention as well it is generally interventionist, in the sense that the Budget depends upon the payment of substantial incentives. It would appear, from the wording of the Budget Papers, that there is significant discretion in the awarding of the incentives, and this would create a degree of uncertainty which will make planning difficult in addition to creating a substantial administration cost.

There are four major items worthy of attention those being:

1. Heavy tax on existing Oil, Gas, and Nat. Gas Liq.
2. Tertiary Recovery Incentive
3. Exploration Incentives
4. Petro Canada 25% take of Frontier Permits.
All of these items are badly in need of resolving. The atmosphere of uncertainty is extremely detrimental to development.

Already, decisions have been deterred and time has been lost, and so we have to ask ourselves in Canada, 'Are we really serious about oil and gas self-sufficiency?'

In summary if Canada is serious about self-sufficiency in petroleum hydrocarbons, that its important that we first of all identify policies that will enable this to happen, and secondarily, if we decide upon radical changes as seem to be suggested by the recent budget, it is important that our governments act quickly and relieve the uncertainties that we're currently faced with, because one of the most important factors in any business decision is to have some understanding of the knowledge of the circumstances under which you operate. We have to meet with many uncertainties, but I think we should try as best we can to eliminate the man made causes of the uncertainties."
NONCONVENTIONAL CRUDE: SUPPLIES, COSTS, RECOVERY TECHNOLOGIES--COAL LIQUIDS

Bronek Dutkiewicz
Manager of Special Projections
Dynalectron Corporation

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
Coal Liquids

Bronek Dutkiewicz
Manager of Special Projects

The coal liquefaction industry while still in its embryonic stage is moving out of the Research and Development stage into the realm of demonstration and commercialization. As in the past decade, many uncertainties are still prevalent. Any forecast of the speed with which this industry will grow and how large the synthetic liquids production will be in the coming years is difficult to forecast.

The uncertainties are now less of a technological nature than institutional. Coal liquefaction plants are capital intensive, very large and continue to be faced with environmental and regulatory hurdles. This poses a risk to potential private industry participants beyond that of other conventional energy sources.

Nevertheless, the last year has seen the acceleration of many serious full-scale commercial projects.
GOVERNMENT REFINING POLICY AND CRUDE OIL PRICE DECONTROL

William F. Burke
President
Powerine Oil Company

CRUDE OIL & REFINING: THE ECONOMICS, THE POLITICS

A conference sponsored by Platt's Oilgram News and The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
The word "decontrol" conjures up a vision of the "good old days" where a "free market" dictates prices and allocations without the problems and frustrations of government controls. I submit to you that if a free market in crude oil ever did exist, it is gone forever. Worldwide scarcities of crude oil, particularly high gravity low sulfur crude oil, together with the international cartel of OPEC, have destroyed any possibilities of anything like a free market. We must, therefore, examine the problems and the possibilities resulting from the removal of current regulations and determine what, if any, role the government should play in the future.

Two of the most serious problems facing the small independent refiner are adequate crude oil supplies and a reasonable market for residual fuel. Crude oil decontrol will exacerbate both of these problems, with the most serious and immediate impact falling on the small, crude-short, West Coast refiner. This is not to say that existing controls should be continued. Existing controls and other government laws and regulations have actually, over the past years, worsened the problem and made it even more difficult to fashion a long-term solution.

West Coast crude oils, including Alaska North Slope crude, yield high proportions of high-sulfur residual fuel. The actual yield, of course, is dependent upon the particular crude oil, with the low gravities yielding a very high proportion and the medium gravity crude oils yielding somewhat less. The market for this material is very limited. Environmental laws and regulations prohibit it being burned as boiler fuel in most areas of the West Coast. Government regulations discourage the export of this material, even to Mexico or Canada. Other government regulations and the Jones Act requirements make it economically impractical to ship to the East Coast where, in some areas, environmental regulations would allow West Coast resid to be burned as boiler fuel. There has been little expansion of conversion facilities, such as cokers, during the last twenty years. And not nearly enough additional capacity has been built to handle the increasing production of resid fuel. The only remaining market for this material is, therefore, sale as ship's bunker fuel. This market, too, is limited.
At the same time the demand for this material has been decreasing, the supply has been increasing. As West Coast refiners, both large and small, substitute California and Alaska North Slope crude for high priced, scarce, high-gravity foreign crude oil, the percentage yield of high sulfur resid increases. In order to compensate for the lower yield of gasoline, jet fuel, diesel and other light materials, it is also necessary for refiners to run more barrels of crude oil in order to maintain the current output of light materials. This, in turn, increases the production of high sulfur resid even more. To entice ship owners to purchase ever-increasing amounts of bunker fuel, it has been necessary to offer the material at cut-rate bargain prices as compared to the world market. Current estimates are that between 150,000 barrels and 250,000 barrels a day of bunker fuel are sold in the Los Angeles and Long Beach harbors alone.

Residual fuel, at least on the West Coast, almost always sells at a price lower than the free market price of crude oil. After all, if the market value of residual fuel oil rises above price-exempt heavy crude oil, heavy crude oil, for which there is an abundant supply, will be sold directly as residual fuel. The refiner, therefore, must make enough margin on his production of light transportation fuels to pay his operating costs and to offset the losses on his sales of residual fuel. With the soft market for gasoline and other transportation fuels, this has been more difficult to achieve, particularly by the small unsophisticated refiner such as the under 10,000 barrel a day topping plant. The economic consequences have been partially offset recently by two factors. First of all, the Middle Eastern war has decreased the international supply of bunker fuel, with the result that prices on the West Coast for bunkers have been relatively high.

The other factor is the effect of price controlled crude oil. Under the Entitlements Program a portion of the economic benefits of price controlled crude oil has been distributed among all refiners in the form of entitlement run credits. This has had the effect of reducing the cost of crude oil to all refiners, large and small, below what the cost would have been had there not been price controls. In some cases, particularly for the very small refiners, effective crude costs have been decreased even more as a result of special programs such as the Small Refiner Bias or, in some cases, Exception Relief.

With decontrol, the average crude cost of all refiners, regardless of size, will increase by the amount of the
run credit. Since the average crude costs of all refiners will increase by the same amount and since refining margins are slim at best, it is almost certain that this cost increase will be passed on to domestic consumers via higher product prices, particularly for light transportation fuels. In the case of resid fuel and bunker fuels, there is, however, a completely different situation. Here the West Coast refiners are competing on the world market and the mere fact that their crude costs increase will not produce an equivalent increase in the price of bunkers, since the ship owner has alternate sources of supply outside the United States.

Even for the large integrated refiners, the negative margin on bunker fuel and resid fuel will increase by at least an amount equal to the current run credit. The situation will be even worse for the small refiner who is the beneficiary of some of the special programs. His costs will go up even more than the run credit without any resulting price increase in the selling price of resid. Under these circumstances, low gravity heavy crudes will be uneconomical for most refiners to process. The refiner will have to either reduce runs or replace heavy domestic crude oils with light crude oils that produce only small amounts of residual fuel. This, in turn, will produce heavy downward pressure on both the demand and the price of low gravity crude oil while increasing the demand for light crude oils, both foreign and domestic, which have low residual fuel content. It should produce some upward pressure in gasoline and other transportation fuels as refiners attempt to recover their losses on resid through higher prices on transportation fuels.

Under these circumstances, any refiner who has control of high gravity domestic crude oil will make every attempt to retain this material for use in his own plant. With decontrol, the supplier-purchaser rule will disappear, as will the buy/sell program, even in areas where these controls still provide some assistance to the independent. The large oil companies who control high gravity crude oil, therefore, will no longer have any legal obligation to sell this material to the crude-short small independent refiner. This, in turn, will force most independent refiners into the international spot market for high gravity crude oil, either for direct use in their plants or as trading material for high gravity domestic crude oil. This, in turn, will exert strong upward pressure in the spot market for foreign crude oil, probably to the point where it, too, will not be economical for the small refiner to run. The larger, more sophisticated independents will
suffer less since they probably will be able to offset part of their losses on resid fuel with their margin on light products such as gasoline, diesel and jet fuel. Without some assistance, either in the form of subsidy or in the form of mandated access to high gravity crude oils, many of the small topping plants will probably be forced to shut down entirely.

It should be pointed out here that the problem of disposal of high sulfur residual fuel is not a problem unique to the West Coast. The world supply of light, sweet crude oils is rapidly diminishing. Saudi Arabia, for example, reports that in recent years 60 percent of its production has been high gravity crude oil, while only 20 percent of its reserves qualify as high gravity. With air pollution becoming more and more of a severe problem in all parts of the world, it is probable that more and more areas will outlaw burning high sulfur residual fuel in boilers. Increased supply of natural gas will also tend to decrease the market for residual fuels. With air pollution becoming a worldwide problem, it is likely that more and more countries will adopt stringent air pollution controls, even to the point of perhaps regulating the sulfur content of fuels burned aboard ships on the high seas. In fact, the situation on the West Coast can be taken as a preview of what will happen in the remainder of the United States and, perhaps, the world.

If no action is taken, it seems probable that a large proportion of the independent refining industry in the United States will cease operations. As we become more and more dependent upon the limited world supplies of light, sweet crude oil, costs of our energy needs will rise dramatically, while at the same time we will become more and more dependent, both economically and politically, on the few foreign countries which have substantial supplies of light, sweet crude. The only other alternate would be to relax air pollution laws to permit burning high sulfur fuel oil in factories and electric generating plants, which, in turn, would probably produce an unacceptably high level of air pollution.

Is the situation hopeless? Is the doomsday scenario I've described inevitable? I think not. If, however, we are to avoid very adverse consequences, we must move promptly with a positive program.

The long-term solution is heavy oil conversion. Using known technologies such as delayed coking, flexi-coking fluid coking, hydro-desulfurization and heavy oil cracking, the materials that are now being sold at cut-rate prices as bunker fuel could be converted into
environmentally acceptable fuels needed by our domestic economy. These processes are proven and, once in operation, are economically viable and would require no subsidization. The cost in terms of investment and/or environmental damage would be far less than some of the more exotic synfuels. It makes little sense to expend tremendous amounts of money and effort to develop tar sands or to find and develop additional reserves of heavy crude oil if we do not have the facilities for converting them into environmentally acceptable fuels. Resid conversion facilities should certainly be given the same encouragement and public assistance as synfuel projects such as oil shale, tar sands and coal conversion.

As a starting point, I would suggest the following steps:

1. Tax relief should be provided to refiners to help bear the cost of design, construction and start up of heavy oil conversion facilities. This tax relief could take the form of fast tax write offs and/or investment tax credits and should be applied to both existing and to new heavy oil conversion facilities. Such relief would also help the refiner to attract additional financing, since both his profit and loss and his balance sheet would be improved. It should be noted that, over time, accelerated depreciation would not represent a net cost to the taxpayer, since taxes would be simply delayed rather than forgiven.

2. The government could also assist via direct financial assistance, such as loan guarantees. The basis for granting such guarantees would, however, have to be changed from the traditional requirements of most government programs. To qualify for a guarantee by the federal government, most existing programs require that the project not be economically viable. In other words, if the project, when built, can earn a profit then it is not eligible for any assistance. Heavy oil conversion programs can, and should, be economically viable once they are build. The difficulty is that, because of the time and the tremendous investment costs, many smaller companies cannot attract sufficient outside financing, nor can they bear the very high operating and interest expense costs during construction. The mere fact that they will ultimately earn a profit should not disqualify a company or project from a government guaranteed loan.

Most programs require that a loan guaranteed by the government be secured by the company's fixed assets. In the case of a grass roots project, this may be a tolerable requirement. In the case of an existing company, however, where the conversion facility will
environmentally acceptable fuels needed by our domestic economy. These processes are proven and, once in operation, are economically viable and would require no subsidization. The cost in terms of investment and/or environmental damage would be far less than some of the more exotic synfuels. It makes little sense to expend tremendous amounts of money and effort to develop tar sands or to find and develop additional reserves of heavy crude oil if we do not have the facilities for converting them into environmentally acceptable fuels. Resid conversion facilities should certainly be given the same encouragement and public assistance as synfuel projects such as oil shale, tar sands and coal conversion.

As a starting point, I would suggest the following steps:

1. Tax relief should be provided to refiners to help bear the cost of design, construction and start up of heavy oil conversion facilities. This tax relief could take the form of fast tax write offs and/or investment tax credits and should be applied to both existing and to new heavy oil conversion facilities. Such relief would also help the refiner to attract additional financing, since both his profit and loss and his balance sheet would be improved. It should be noted that, over time, accelerated depreciation would not represent a net cost to the taxpayer, since taxes would be simply delayed rather than forgiven.

2. The government could also assist via direct financial assistance, such as loan guarantees. The basis for granting such guarantees would, however, have to be changed from the traditional requirements of most government programs. To qualify for a guarantee by the federal government, most existing programs require that the project not be economically viable. In other words, if the project, when built, can earn a profit then it is not eligible for any assistance. Heavy oil conversion programs can, and should, be economically viable once they are build. The difficulty is that, because of the time and the tremendous investment costs, many smaller companies cannot attract sufficient outside financing, nor can they bear the very high operating and interest expense costs during construction. The mere fact that they will ultimately earn a profit should not disqualify a company or project from a government guaranteed loan.

Most programs require that a loan guaranteed by the government be secured by the company's fixed assets. In the case of a grass roots project, this may be a tolerable requirement. In the case of an existing company, however, where the conversion facility will
be an integral part of an existing plant and where the company probably already has outside financing secured by these existing facilities, the security requirement makes a guaranteed loan impractical. The concern of many would-be investors in providing funds for the construction of conversion facilities is the uncertainty of total costs as the result of inflation and other unforeseen factors. The government could provide important assistance to a company in obtaining private financing by acting as a backup. In other words, the government could guarantee subordinated loans if the total cost of the project should exceed the private financing. This should result in no net cost to the taxpayer, since it is unlikely that government loans would be called upon in a well-planned project, and, even if it were, it would be repaid at current interest rates.

3. One of the major difficulties in heavy oil conversion projects is obtaining the necessary environmental permits. Many of the candidates for building heavy oil conversion projects are located in areas which require emission trade-offs. In order to obtain permits, the applicant must be able to prove that total emissions will be reduced by 125 percent to 200 percent from existing sources of every new emission that would come from the new facilities. This puts a very severe limitation on the size and number of new conversion facilities which can be built. On the other hand, with pollution being as large a problem as it is, some restrictions on emissions must be maintained. I would suggest, as a compromise solution, that new facilities which have the effect of providing more environmentally acceptable fuels to the public should not be subject to any more severe environmental requirements than existing facilities of the same type and should not be subject to the emissions trade-off requirement.

Construction of heavy oil conversion facilities requires a great deal of time; to design, build and start up such facilities would require, at the very least, two years and more likely five years or more. Unless some assistance is given in the short term, many small refiners will be out of business long before any new facilities would come onstream. To help them survive during the interim, I would suggest the following steps:

1. Assist the West Coast refiner to move heavy residual fuels to the East Coast to replace current imports from foreign refiners in the Caribbean. To accomplish this, the terminal operator on the East Coast should receive the same benefits on materials brought
from California or the West Coast as he does from materials which he imports from the Caribbean.

2. Direct subsidies should be given to the American Merchant Marine such that, freight costs to the West Coast refiner shipping oil to New York and New England be no greater than the transportation costs on a foreign flag ship between the Caribbean and the same New York/New England area. Besides providing assistance to the West Coast refiner, this would also provide assistance to the American shipyards and the American Merchant Marine.

3. Exports of high sulfur residual fuel oil should be encouraged and assisted, particularly to our neighboring countries of Mexico and Canada. It might be worthwhile even to subsidize these exports rather than discourage them.

4. The small refiner must have access to high gravity crude oil on an equitable basis. Most small refiners are simply not equipped to go out and find appropriate quantities of light crude oil in the international spot market. Even if they were able to do so, the result would be to simply bid up the price of these supplies, with the resultant increase in the cost of OPEC prices on all of our imports. There are a number of different ways this problem could be handled. One possible way would be for a major oil company to act as purchasing agent for one or more independents, much as they would do for their own subsidiaries. Another way would be the establishment of a commodity market, under which all crude oil, imports or domestic production, would be offered on sale similar to our grain or other commodity markets. Another possibility would be the establishment of a quasi-government cartel, which would purchase all imports and perhaps domestic crude oils as well and then resell them to all refiners. Finally, and perhaps the least desirable, would be divestiture.

At Powerine Oil Company we are well along with a heavy oil conversion project. We began our economic studies over five years ago and went into definitive engineering over three years ago. Our applications for environmental permits were filed in July of 1979 and we obtained our permits in October, 1980. We are presently in the process of finalizing our financial package. If everything proceeds on schedule, we expect to complete construction by July 31, 1982, and be in full operation by November 1, 1982. Included in our program is a delayed coker, a hydro-treater, a hydro-cracker, a hydrogen plant, a Unisar
unit and various offsites, such as coke storage, coke loading racks, etc. We have had an advantage over many of the smaller independents, in that we built our reformers and our FCC unit in the late 60's and have continued to invest heavily in downstream equipment since that time. It is our belief that without some sort of public assistance it would be virtually impossible for any less sophisticated or smaller company than ourselves to proceed with a heavy oil conversion project.

With the right sort of public program such as I have described above, we believe that it would be possible for other small refiners to follow the same path. In some cases, rather than each small refiner building a separate facility, a co-op venture might be more appropriate, where one coker is built to service two or more independent refiners. Another option is to build coking facilities, say on the West Coast, and then ship a high gravity, perhaps low sulfur, synthetic crude oil to the mid-continent area via pipelines to replace the diminishing supply of light crude oil. Again, a coker facility on the West Coast, converting heavy California and Alaska crude oil, could provide a reasonable substitute to the mid-continent refiner for the light, sweet crude for which his plant is designed.

In summary, I suggest that the problems the West Coast refining industry is likely to experience with decontrol are merely a forerunner of what will probably occur in the remainder of the United States. Mid-continent and East Coast refiners should take heed and start making plans while there is still time available. I am convinced that it is in the national interest to encourage, support and, if necessary, subsidize construction of heavy oil conversion facilities.

* * *
OCTOBER 1981: IMPLICATIONS OF U.S. CRUDE OIL PRICE DECONTROL

John R. Hall
Vice Chairman and Chief Operating Officer
Ashland Oil, Inc.

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
DECONTROL WILL AFFECT THE U.S. REFINING INDUSTRY IN MANY DIFFERENT WAYS. THE IMPACT ON VERY SMALL REFINERS WILL BE QUITE DIFFERENT FROM THE IMPACT ON LARGE INDEPENDENT AND MAJOR REFINERS. THERE IS OFTEN A LOT OF CONFUSION IN THE INDUSTRY ON THE DIFFERENCE BETWEEN SMALL AND INDEPENDENT REFINERS.

DECONTROL WILL BRING MORE FOREIGN COMPETITION INTO THE U.S. MARKET. IT WILL GENERALLY RAISE DOMESTIC REFINERS' AVERAGE CRUDE OIL COSTS AND PRODUCT PRICES. WE CAN ALSO EXPECT DECONTROL TO PROVIDE MORE COMPETITION DOMESTICALLY, BOTH FOR CRUDE OIL SUPPLIES AND PRODUCT MARKETS.

IN OUR PRESENTATION, WE WILL TRY TO EXAMINE THE BACKGROUND AND OUTLOOK FOR THE U.S. REFINING INDUSTRY NOW THAT DECONTROL HAS BEEN ANNOUNCED BY PRESIDENT REAGAN.
OCTOBER 1981: IMPLICATIONS OF U.S. CRUDE OIL PRICE DECONTROL

James H. McDonald
Vice President, Business Analysis
Gulf Oil Company - U.S.

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
IMPACT OF DECONTROL ON REFINING INDUSTRY

I. WHAT IS HAPPENING WITH DECONTROL? (Slide 1)
   A. Domestic Crude Prices Meet or Exceed World Prices
   B. Crude Buy/Sell Program Disappears
   C. Crude Supplier/Purchaser Relationships Expire
   D. Lose Funding for Programs Subsidized by Entitlements Program
      1. Small Refiner Bias
      2. Office of Hearings and Appeals Rulings
      3. Strategic Petroleum Reserve
   E. Gasoline and Propane Price and Volume Decontrol
   F. Lose Advantage of Entitlement Throughput Credit vs. Offshore Refiners
   G. Increased Domestic Production Incentive

II. VOLUME/PRICE IMPLICATIONS
   A. Cost of Products Effect
      1. Reduction Rate of Controlled Oil (Slide 2)
      2. Increased Average Cost of Crude (Slide 3)
         a. Consumer Conservation
            1) Increased Use of Natural Gas or Substitute for No. 2 Fuel
            2) Increased Coal Usage
            3) Increased Mass Transportation
         b. Refiner Conservation
            1) Fuel Conservation Investments
            2) Substitute Fuels
            3) Upgrade Residual
         c. Domestic Crude Quality Differentials—Premium Crude More Uncompetitive—Upgrading Projects
         d. Beneficiaries of Decontrol (Slide 4)
II. VOLUME/PRICE IMPLICATIONS (Cont'd)

A. Cost of Products Effect (Cont'd)

2. Increased Average Cost of Crude (Cont'd)
   e. Feedstock Substitutes Promoted
      1) Shale Oil
      2) Coal Fuels
      3) Tar Sands
      4) Refinery Investments Required

B. Crude Redistribution

1. Increased Competition for Crude
2. Domestic Refiners-"Haves" and "Have Nots"
   a. Need for Supplier Rules?
   b. Allocation During an Emergency

III. OFFSHORE REFINERIES MORE COMPETITIVE

A. Status of World-Wide Industry

1. Caribbean
2. European
3. Produce Export Refineries

B. Economic Advantages of Domestic Refiners (Slide 5)

1. Entitlements Throughput Credit
2. Product Mix

C. Economic Advantages of Offshore Refiners

1. Labor
2. Environmental
   a. OSHA
   b. High Sulfur Plant Fuel
3. Freight
4. Taxes
5. Financing

D. Impact of Imported Products

1. Idling a Part of U.S. Industry
2. Chemical Industry
3. National Security Implication
OCTOBER 1981: IMPLICATIONS OF U.S. CRUDE OIL PRICE DECONTROL

Lucian S. Pugliaresi
Acting Deputy Assistant Secretary for Oil and Gas Policy and Evaluation
U.S. Department of Energy

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
SESSION TITLE: OCTOBER 1981: IMPLICATIONS OF U.S. CRUDE OIL PRICE DECONTROL

OUTLINE OF REMARKS BY: Lou Pugliaresi
Director,
Office of Oil,
Department of Energy

A. A Short Review of a Long History of Government Intervention in the Refining Industry

1. Mandatory Oil Import Program
3. Small Refiner Bias

B. The Implications of Decontrol of the Domestic Refining Industry—DOE's Assessment

1. Domestic Utilization Rates
2. Product Imports
3. Refinery Flexibility

C. Is There a Rationale for Government Intervention in the Refining Industry in the Post-decontrol Period—An Assessment

1. National Security
   - OPEC
   - Refinery Flexibility During an Interruption in World Crude Supplies
2. Economic Efficiency
3. Crude Oil Access Issues

D. Prospects for the Future and Lessons of the Past.
OCTOBER 1981: IMPLICATIONS OF U.S.
CRUDE OIL PRICE DECONTROL

Lawrason D. Thomas
Executive Vice President
Amoco Oil Company

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
A conference like this one on the economics and politics of refining demonstrates a need. But the need is not for an abstract discussion of politics or economics. The need is for a consistent domestic refining policy that will insulate this country as much as possible from the effects of another disruption of crude oil supplies.

The title of my remarks today is "Between Crises," because I think that phrase reflects the current environment. To put the necessity of a refining policy in a more urgent perspective, I'd first like to spend a minute on the background of today's problems.

Before 1973, there had never been a significant disruption in this country's crude oil supplies -- either domestically or from abroad. American companies largely handled the production, sale, and transportation of crude oil from what we now call the OPEC countries.
IN THOSE DAYS, A LARGE PART OF OUR TOTAL SUPPLY CONSISTED OF THE BEST LIGHT SWEET CRUDES, WHICH WERE PRODUCED DOMESTICALLY. IMPORT VOLUMES WERE NOT SIGNIFICANT. SO IT WAS LOGICAL TO DESIGN THE BULK OF OUR REFINERY SYSTEM TO RUN LIGHT SWEET CRUDES.


THESE WERE THE THREE ELEMENTS OF THE PRE-1973 REFINING SITUATION: SUFFICIENT DOMESTIC SUPPLIES OF THE BEST CRUDES; A REFINING SYSTEM GEARED TO PROCESS THOSE CRUDES; AND ADEQUATE SUPPLIES FOR THE CONSUMER.

THERE IS NO QUESTION THAT TODAY WE ARE WORSE OFF IN EVERY RESPECT THAN WE WERE SEVEN YEARS AGO:

WE IMPORT MORE CRUDE THAT WE DID THEN.
THE SOURCES OF THAT CRUDE ARE NOT AS STABLE AS THEY WERE THEN.
FOREIGN PRODUCTION HAS BEEN NATIONALIZED AND U.S. COMPANIES NO LONGER CONTROL SALES OR END DESTINATIONS.
SIGNIFICANT PRICE DIFFERENTIALS NOW EXIST AMONG CRUDE TYPES. THESE DIFFERENTIALS FLUCTUATE AS A FUNCTION OF BOTH ECONOMICS AND POLITICS. UP UNTIL A MONTH AGO WE KEPT DOMESTIC PRODUCTION SUBJECT TO CONTROLS. THESE ENCOURAGED CONSUMPTION AND DISCOURAGED CONSERVATION. REFINERS CANNOT BE SURE OF CONSISTENTLY OBTAINING CRUDES THEY ARE EQUIPPED TO PROCESS. AND, ALTHOUGH THERE ARE NO GAS-LINES AT SERVICE STATIONS TODAY, THE CONSUMER HAS NO ASSURANCE THAT THERE WON'T BE TOMORROW.

IN THIS CONTEXT, I BELIEVE IT IS ONLY PRUDENT TO PROCEED AS IF THE U.S. WERE BETWEEN CRISES. WE NOW KNOW HOW BAD EVEN A LIMITED SHORTAGE CAN BE FOR THE INDUSTRY AND THE ECONOMY. WE HAVE HAD SEVEN YEARS TO GET READY FOR FUTURE SHORTAGES. BUT LET'S ASK THE IMPORTANT QUESTIONS:

ARE WE AS A NATION BETTER PREPARED TO WITHSTAND THE NEXT SHORTAGE THAN WE WERE THE FIRST?

DO WE HAVE CRUDE SOURCES TO REPLACE ANY WE LOSE?

IS OUR REFINING SYSTEM GEARED TO PROCESS ANY KIND OF CRUDE WE CAN GET IN AN EMERGENCY?

CAN WE SERVE THE CUSTOMER WITH THE PRODUCTS HE NEEDS TODAY?
BETWEEN 1973 AND 1979 THIS COUNTRY ENJOYED A GRACE PERIOD. BUT INSTEAD OF PREPARING FOR FUTURE DISRUPTIONS, WE TREATED IT AS "BUSINESS AS USUAL." WHILE THE REST OF THE WORLD LET OIL RISE TO WORLD PRICES, WE SHIELDED CONSUMERS HERE AT HOME FROM HARD ECONOMIC FACTS. CONSEQUENTLY, WHEN WE EXPERIENCED OUR SECOND DISRUPTION IN 1979, WE HAD NOTHING BUT GAS-LINES TO OFFER CONSUMERS -- AND NOTHING BUT HIGHER PRICES TO OFFER OPEC.

IF WE ARE TO MAKE THE BEST USE OF THE PRESENT GRACE PERIOD, WE WILL HAVE TO PUT ASIDE INDIVIDUAL DIFFERENCES AND CONCENTRATE ON THE GOOD OF THE COUNTRY. WE WILL HAVE TO FOCUS ON THREE ELEMENTS: ONE, ACCESS TO CRUDE OIL; TWO, MAINTAINING AND STRENGTHENING OUR REFINING SYSTEM; AND THREE, SERVING THE MARKETPLACE.

I'D LIKE TO CONSIDER EACH OF THESE POINTS INDIVIDUALLY.

THE AREA THAT HAS CAUSED THE GREATEST CONCERN IS PROBABLY THAT OF ACCESS TO CRUDE OIL. FORMER DOE ASSISTANT SECRETARY JOHN O'LEARY RECENTLY TESTIFIED THAT WITHOUT GOVERNMENT REGULATION, DECONTROL WOULD LEAD TO INCREASED CONCENTRATION OF POWER AMONG THE LARGER COMPANIES. OTHERS HAVE ECHOED THAT CONCERN.
I disagree for several reasons. First, with all respect to Mr. O'Leary, government officials have the habit of assuming that regulations preceded and created the marketplace and competition. Often, they don't believe that either the marketplace or competition can survive without regulation.

Arguments parallel to Mr. O'Leary's were raised before airline deregulation: The large companies would prosper; the small companies would go out of business; routes would be closed; consumers would lose service.

In fact, just the opposite has happened in nearly every case. Ease of entry for small companies has increased. Competition for routes has increased. Consumers have benefitted from the deregulation.

The oil industry has many more companies and much more diversity in competition than the airline industry had at the time of its deregulation. I think we can look forward to even more intense competition upon deregulation at the end of March than we have seen in other industries.

And competition in refining will do what it always does: It will reward the companies that serve the diverse needs of consumers with the best products at the lowest price.
I disagree for several reasons. First, with all respect to Mr. O'Leary, government officials have the habit of assuming that regulations preceded and created the marketplace and competition. Often, they don't believe that either the marketplace or competition can survive without regulation.

Arguments parallel to Mr. O'Leary's were raised before airline deregulation: The large companies would prosper; the small companies would go out of business; routes would be closed; consumers would lose service.

In fact, just the opposite has happened in nearly every case. Ease of entry for small companies has increased. Competition for routes has increased. Consumers have benefitted from the deregulation.

The oil industry has many more companies and much more diversity in competition than the airline industry had at the time of its deregulation. I think we can look forward to even more intense competition upon deregulation at the end of March than we have seen in other industries.

And competition in refining will do what it always does: It will reward the companies that serve the diverse needs of consumers with the best products at the lowest price.
SECONDLY, WE'LL FIND COMPETITION NOT ONLY IN THE MARKETPLACE BUT ALSO IN OBTAINING CRUDE SUPPLY. LARGE AND SMALL COMPANIES WILL VIGOROUSLY COMPETE FOR CRUDE -- ESPECIALLY FOR MARKET PRICED DOMESTIC CRUDE WHICH WILL COMPRISE HALF OF OUR TOTAL SUPPLY.

AND COMPETITION FOR CRUDE OIL WILL DO WHAT IT ALWAYS DOES: IT WILL PROMOTE NEW EXPLORATION. IT WILL PROMOTE NEW TECHNOLOGY FOR KNOWN FIELDS. AND IT WILL ULTIMATELY DRAW INVESTMENT INTO SYNTHETIC FUELS THAT CAN MOST EASILY COMPETE WITH CONVENTIONAL CRUDE FEEDSTOCKS.

 THEREFORE, WE CAN CONCLUDE THAT ENDLESS REGULATIONS ARE NOT NEEDED. WE CAN ALSO CONCLUDE THAT DEREGULATION WAS ONE OF THE MOST CONSTRUCTIVE STEPS THAT COULD BE TAKEN IN A COUNTRY THAT KNOWS IT IS "BETWEEN CRISES."

I DO NOT FORESEE ANY GREAT JOLT TO THE OIL INDUSTRY OR ANY SEGMENT OF IT. AS A PRACTICAL MATTER, DEREGULATION HAD ALREADY LARGELY TAKEN PLACE. ONLY A FRACTION OF ALL THE CRUDE RUN TO STILLs REMAINED UNDER CONTROLS AS OF JANUARY. ON THE PRODUCT SIDE, DISTILLATE HAS BEEN DEREGULATED FOR FOUR YEARS. GASOLINE WAS STILL CONTROLLED THEORETICALLY. BUT THE PRICE HAD BEEN SET ON THE DRIVEWAY BY THE MARKET.
BASICALLY, WE HAVE TO REMEMBER THAT THE REGULATIONS IN EFFECT DURING THE LAST TWO SHORTAGES SIMPLY MOVED CRUDE OIL AROUND AMONG REFINERS. THEY DID NOT ADD A SINGLE BARREL TO EXISTING INVENTORIES. IN MANY CASES, THEY ACTUALLY EXERCISED A REVERSE ALCHEMY, TURNING GOLD INTO LEAD. THIS HAPPENED WHEN THE BEST SWEET CRUDE WAS ALLOCATED TO REFINERS WHO COULDN'T PROCESS ANYTHING ELSE, BUT WHO ALSO COULDN'T GET THE OPTIMUM HIGH VALUE PRODUCTS FROM IT. AS A RESULT, GASOLINE PRODUCTION DECLINED WHILE LINES FORMED AT RETAIL OUTLETS ACROSS THE NATION. THERE HAD TO BE NON-REGULATORY ALTERNATIVES TO THIS.

IN THE SHORT TERM, THE BEST ALTERNATIVE WOULD BE THE STRATEGIC PETROLEUM RESERVE -- OR THE SPR FOR SHORT. THE SPR WOULD ACTUALLY REPLACE BARRELS LOST DURING A DISRUPTION. SAD TO SAY, HOWEVER, WE HAVE ONLY RECENTLY STARTED FILLING THE SPR AFTER A LAYOFF OF MORE THAN A YEAR. IT MADE SENSE TO STOP FILLING IT DURING THE 1979 SHORTAGE. BUT FOR THE GREATER PART OF 1980 -- WHEN CRUDE AND PRODUCT INVENTORIES WERE AT RECORD LEVELS -- IT WOULD HAVE MADE SENSE TO FILL IT AGAIN.

THE CURRENT LEVEL IS SOMEWHAT MORE THAN 100 MILLION BARRELS...BUT FAR SHORT OF THE ONE BILLION BARREL GOAL THAT CONGRESS SET. I SHOULD STRESS THAT AN SPR FULL TO THE BRIM COULD BE USED TO ASSURE EQUAL ACCESS TO CRUDE AMONG ALL REFINERS. BY CONTRAST, GOVERNMENT INTERVENTION DURING A SHORTAGE OFTEN REDUCES THE INCENTIVE OF EACH COMPANY TO GO OUT AND GET AS MUCH CRUDE AS IT CAN ON ITS OWN. IN A DISRUPTION, WE CAN'T AFFORD COUNTERPRODUCTIVE REGULATIONS.
IN THE LONG TERM, THE ANSWER IS TO GO ALL OUT EXPLORING FOR NEW RESERVES AROUND THE WORLD AND ESPECIALLY HERE AT HOME; ALL OUT FOR FINDING ENVIRONMENTALLY SAFE WAYS OF USING COAL; ALL OUT FOR DEVELOPING SYNTHETIC FUELS; AND ALL OUT FOR DEVELOPING SAFE NUCLEAR AND VIABLE SOLAR SOURCES. ACTIONS SUCH AS THESE WILL BE OUR ONLY LASTING GUARANTEE OF ENERGY INDEPENDENCE.

BUT OF PARALLEL IMPORTANCE WITH CRUDE OIL DECONTROL IS A SOUND REFINING POLICY. LET ME BEGIN WITH THE QUESTION, "WHAT STEPS CAN WE TAKE TO SEE THAT U.S. REFINERIES CAN MEET ANY FORESEEABLE EMERGENCY?

LET ME BEGIN THE ANSWER BY NOTING THAT THE U.S. PRESENTLY HAS ABOUT THREE MILLION BARRELS A DAY OF EXCESS PIPESTILL CAPACITY. SO WE DON'T NEED ADDITIONAL CAPACITY. BUT WE DO NEED:

ONE, TO UPGRADE EXISTING FACILITIES TO HANDLE HEAVIER AND SOUR CRUDES;

TWO, TO CONVERT BOTTOM PRODUCTS TO MORE DESIRABLE FUELS;

AND THREE, TO BRING ONSTREAM MORE OCTANE-BOOSTING CAPACITY AS LEAD ADDITIVES ARE PHASED OUT OF GASOLINE.
IN SHORT, WE HAVE TO BE SURE THAT THIS COUNTRY CAN MAKE THE BEST USE OF EVERY PART OF EVERY BARREL WE CAN GET IN TIME OF SUPPLY DISRUPTION. IF WE DON'T HAVE THAT GOAL, THEN WE DON'T HAVE A RATIONAL DOMESTIC REFINING POLICY.

WE SHOULDN'T NEED A POTENTIAL SUPPLY EMERGENCY TO PUSH US INTO UPGRADING FACILITIES TO PROCESS CHEAPER CRUDES. THE U.S. MERCHANDISE TRADE DEFICIT THIS YEAR WILL BE ABOUT $25 BILLION. ANY INVESTMENT THAT REFINERS COULD MAKE THAT WOULD CUT THAT FIGURE WOULD BE IN THE NATIONAL INTEREST.

ONE IMPORTANT STEP WOULD DO THREE THINGS SIMULTANEOUSLY. THE STEP IS THE PASSAGE OF THE CAPITAL COST RECOVERY ACT NOW BEFORE BOTH THE SENATE AND THE HOUSE. THIS LEGISLATION WOULD:

ONE, HELP IMPROVE THE BALANCE OF PAYMENTS DEFICIT;

TWO, PREPARE THE COUNTRY FOR FUTURE SUPPLY EMERGENCIES;

AND THREE, IMPROVE THE ABILITY OF THE DOMESTIC REFINING INDUSTRY TO COMPETE.
IN FACT, PASSAGE OF THIS BILL WOULD HELP REVITALIZE ALL AMERICAN INDUSTRIES THAT CURRENTLY FACE CAPITAL FORMATION PROBLEMS. AUTO AND STEEL ARE TWO.

BUT SUCH TAX LEGISLATION -- IMPORTANT AS IT IS -- WILL NOT DO AWAY WITH ALL THE PROBLEMS REFINERS HAVE. EVEN IF IT IS PASSED, DOMESTIC REFINERS WILL STILL FACE COMPETITIVE DISADVANTAGES.

WE WILL STILL COMPETE AGAINST FOREIGN COMPANIES, WORKING UNDER MORE FAVORABLE TAX STRUCTURES.

WE WILL STILL HAVE TO MEET EPA RESTRICTIONS THAT DON'T APPLY TO COMPETITION ABROAD.

WE WILL STILL BE RESTRICTED BY THE JONES ACT TO SHIPPING DOMESTIC PRODUCT IN AMERICAN VESSELS AT MUCH HIGHER COSTS THAN IN FOREIGN TANKERS.

AND WE WILL STILL COMPETE WITH COMPANIES THAT HAVE ACCESS TO MORE ECONOMICAL CRUDE SHIPMENTS VIA DEEP DRAFT TANKERS. EVEN AFTER THE LONG AWAITED GULF COAST DEEP WATER PORT IS COMPLETED, WE WILL STILL HAVE NO PORT CAPABLE OF RECEIVING THE LARGEST TANKERS FULLY LOADED.
Some people have looked at these problems and become very pessimistic. They have concluded that the U.S. refining industry will either shut down in the face of foreign competition or migrate to some country where it’s cheaper to do business.

There may be some danger along those lines. But U.S. refining is a large and diversified industry. And I don’t think you have to be too gloomy about the future. There will be changes. But we must remember that our industry has been frozen in place since 1973 -- since 1971 if we go clear back to President Nixon’s wage price freeze.
During that period of controls things have changed. Demand for refined products has shifted and declined. In returning to a free marketplace, the industry must undergo a shake-out. Some capacity will be shut down. But that will happen for small and large refiners -- as customers decide who can meet their needs most economically. All these changes that will take place now are changes that could have taken place gradually in a decontrolled industry.

Consequently, I do not advocate government protection for any refiner or any class of refiners. I firmly believe that the interest of both the nation and consumers will be best served by returning to a free marketplace.

This brings me to the third element of a national refining policy: Serving the marketplace. Consumers are meeting higher energy costs by changing their patterns of consumption. They are converting to other forms of energy. They are cutting back on driving. They are dialing down their thermostats.
Demand is declining. Overall demand for products was down by about 8 per cent in 1980. Demand for gasoline alone is down by about 6 per cent. For diesel and home heating oil, it's down by almost 13 per cent from 1979 levels. And 1979 levels were considerably lower than 1978 levels.

Marketers who compete for customers in a period of declining demand may have to change their marketing strategies. The customer is telling us he wants quality products — but as economically as possible. And service stations in the future will reflect that desire.

They will be large, they will operate on low margins and high volumes. Stations will be up-to-date facilities that deliver both the convenience and the product the customer wants.
Now with decontrol, the marketplace will again be the means of letting the customer decide what to buy and from whom to buy it. I believe the consumer has the right to get the best deal for his money. I do not believe this right should be abridged by forcing him to pay hidden subsidies to inefficient companies. A refining policy that is based on subsidizing uneconomical companies will undercut the sacrifices and conservation efforts that consumers are making.

The petroleum consuming public should be served by economic efficiency -- and not by the political allocation of its resources to special interests.

By way of summary, we believe deregulation will spur competition in production, refining and marketing. It is a giant step in getting the whole economy back on its feet -- and in reducing vulnerability to foreign countries.

There will be change. But these changes will be the natural result of returning to the marketplace for the first time in ten years. In the long run, far more significant changes will come about as the result of decline in product demand, changing crude quality, and a shifting product slate.
FOR THE FUTURE, I FAVOR A POLICY THAT WILL INQUIRE SHORT TERM SUPPLIES BY A STRATEGIC RESERVE PROGRAM...AND LONG TERM INDEPENDENCE BY DEVELOPING DOMESTIC RESOURCES OF CONVENTIONAL AND SYNTHETIC FUELS.

IT IS ESSENTIAL THAT THE U.S. ENACT COST RECOVERY LEGISLATION THAT WILL PERMIT NECESSARY INVESTMENTS IN TOMORROW'S REFINING SYSTEM TODAY.

AND FINALLY, I BELIEVE THAT THE CUSTOMER WILL BE WELL SERVED IN THE MARKETPLACE WHERE HE CAN FREELY DECIDE FOR HIMSELF HOW TO ALLOCATE HIS RESOURCES.

I'LL BE HAPPY TO DEVELOP ANY OF THESE THEMES IN THE WORKSHOP PART OF THIS SESSION. THANK YOU VERY MUCH.
CRUDE OIL AND ITS ALTERNATIVE:
THE FINANCING OUTLOOK

Frank G. Zarb
General Partner
Lazard Freres & Co.

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
Many years ago, I came to know a well seasoned chief clerk who worked on the floor of the New York Stock Exchange. At the end of one heavy trading day, he came off the exchange, sat in my office and with his own salty expletives, said "my trouble is the harder I work the backer I go."... Sometimes I think that sentence is a good summary of the status of our national energy debate. After six years of intensive work - Washington still seems to produce many instant experts and few important answers.

We don't have much time together today so I have constructed my comments into twelve facts about oil and its alternatives. In the interests of full disclosure let me hasten to add that these facts are "according to Frank Zarb" and if you find yourself disagreeing with some of them please be assured that you have a fair amount of high class company.

**Fact One**

*The world is running out of oil.*

There are major uncertainties as to how much oil remains from conventional sources. What evidence we do have points to about thirty years of production from proven reserves in the non-communist world. There are some valid predictions related to probable new discoveries which could add as much as thirty more years of crude oil at current rates of production. Thirty years or sixty years,
its running out and it is unlikely that daily production will exceed current levels at any time in the future.

Fact Two

Dominance of available oil supply by the mid-east will continue. A substantial portion of the world's new additions to reserves are likely to occur in the mid-east. It is probable that oil production in the U.S. will decrease by at least three million barrels a day, even with new reserves and secondary recovery. This estimate assumes that the U.S. government eliminates counter productive measures such as price controls.

Fact Three

The price of crude oil by the year 2000 should be at least $225 per barrel. The average price of gasoline in the United States should be no less than $10 per gallon. The entire debate related to how much oil is left and where it will come from is important only because it helps to predict oil values and price - both of which are going up.

Fact Four

Most nations which are now net importers of crude oil will continue to import oil for the next twenty years. How much each imports will depend on a number of variables. For some countries the size of their oil import burden will be the overriding influence controlling their political destiny.
Fact Five

The U.S.S.R. is not likely to increase its crude exports. Soviet reserve data is very soft and it is not possible to predict her position in the world oil market between 1981 and 2000. However, there is some evidence to support the conclusion that the Russians will not be able to continue to meet the needs of their East European clients. Should that situation materialize the added demand for oil from OPEC suppliers will put added upside pressure on oil prices.

These first five facts add up to this - oil is finite, its supply will continue to be dominated by a select group of countries. Its price will climb in response to limited availability and thus reflect its real value. Thus the search for alternatives to oil will take an increasing importance.

Fact Six

Conventional natural gas reserves are finite and found in selected regions of the world.

New estimates of natural gas reserves tell us that conventional natural gas reserves will continue to decline. Unconventional gas stimulated by higher prices will provide an important additional resource the extent of which is not known. Exported gas from a small group of nations will be available to those who are willing to pay for it.
Fact Seven

Natural gas prices are going up.

Given its finite character and clean burning properties, the price of natural gas should rise to the BTU equivalent of world crude oil. The capital intensity of liquifaction systems will limit availability to those who can pay. The U.S. will be helped by gas derived from domestic non-conventional sources, imports from Canada and Mexico and a new pipeline from Alaska. These sources are secure and will provide limited help to offset a severe decline rate of domestic crude oil. Industrial countries will not find balance of payments relief through imported LNG. Developing economies will be priced out of the LNG market.

Fact Eight

Coal will represent the most important oil substitute over the next twenty years.

Steam coal consumption will at least triple over the next twenty years. Conversion of existing oil burning facilities to coal is reasonably capital intensive and is further limited by poor transportation, and environmental restrictions.

The U.S. will benefit from coal expansion, other industrial nations will substitute for oil with imported coal at considerable expense. Developing nations without coal reserves will be able to utilize coal but only to a limited extent. Advancing technologies using coal as a feed stock offer some hope toward reducing the costs and other obstacles related to coal movement and coal fueled power systems.
Fact Nine

Nuclear power is an essential increment to the world's energy requirements over the next twenty years.

Extraordinary obstacles have limited growth of nuclear capacity worldwide. The United States has lagged far behind in its desperately needed nuclear expansion. Most developing economies will get a little help from nuclear power over the next twenty years...

Facts six, seven, eight, nine - natural gas, coal and nuclear power are all we currently have to displace shrinking, costly oil reserves. The limited transition to these fuels over the next twenty years will not be cheap, and... will help only a select portion of the world. As things stand now, gas, coal and nuclear will not develop in sufficient size and distribution to significantly stem the dollar hemorrhage from industrial nations. The transfer of wealth to oil producers will continue to escalate. Over the near term, energy costs per unit of output will continue to go up and productivity will decline further. The U.S. will fare better than Japan and most of Western Europe but developing economies will not grow at acceptable rates. Please remember that forty-eight of the seventy-five developing countries which import oil depend on it for 90% of their energy needs. The economic burden of imported oil has often been accompanied by deforestation (for firewood) leading to top soil loss and limited regrowth.
Recognizing that gas, coal and nuclear will not provide immediate or permanent relief has led the move toward advanced energy technologies. Although over-sold, over-promoted and over-promised by governments and special interests, there appears to be - over the very long term - real potential in the energy systems of tomorrow which could include heavy oil, tar sands, oil shales, black shales, methonal from natural coal seams, devonian shales, geopressurized methane, biomoss, fusion, wave, wind and tidal energy, earth or space based solar energy, ocean-thermal systems, advanced geothermal, commercial size coal liquifaction, and hi BTU coal gasification... and that leads me to my last three facts -

Fact Ten
These next generation technologies will not begin to produce measurable amounts of energy until after 1995.

Fact Eleven
The industrial world is entering an era of advanced energy without a thoughtful concept of which technologies will come first and how to best speed their development.

The best effort thus far has come from the United States and it has stumbled into a program which has been grounded in press releases and over promise. The lack of joint activities between industrial nations to support these early stages, underscores the narrow and shallow base upon which this effort now rests.
Fact Twelve

Developing economies cannot hope to sponsor their own advanced fuels program and since there is no global effort for them to participate in - they are simply left out.

Well, there you have it - twelve basic facts which simply spell out the conclusions that:

- oil will run out, it is valuable and its real price will continue to go up.
- gas, coal, and nuclear are the only near term alternatives. Coal and, to a more limited extent, gas will be important substitutes between now and 2000. But, they are not moving on a growth path which is fast enough or broad enough to make the needed global difference. Nuclear growth continues to follow a slow pace for all the wrong reasons and its needed contribution remains allusive.
- Industrial nations have started into phase one of an era of new technology without a sense of direction or unity of purpose.
- Developing nations will be slow to develop, and face greater poverty and social unrest. Social unrest which may not leave industrial nations or oil producing countries of the mid-east untouched.

What to do? There are no simple answers but here are a few ideas:

1. Set up a climate which will support a maximum development effort. Eliminate remaining price controls and other regulatory obstacles which yield a low level of benefits relative to the cost of reduced energy development. To
put the price control question another way - if the United States and all other oil producers of the world had announced in 1961 that the price of oil would be raised $2 per barrel each year thereafter, and there were no price controls on oil or natural gas, we would now be ten years ahead of our present level in producing alternatives to oil.

2. With the right economic and regulatory climate non-conventional gas and coal will expand at a reasonable pace. But nuclear will need more help. A fast track program to quickly expand the light water reactor and give new life to the breeder reactor must be high on Washington lists this year. U.S. leadership here is essential for the sake of the entire free world.

3. Advancing Technologies
Give up the notion that this sector will provide real volumes of energy over the next twenty years. The program envisioned by the United States is bold when viewed from today's level of effort, but when it is measured against what is needed it can only be described as negligible.

If the world is to regain the twenty years lost, it must join the industrial west and Japan, the oil producing mid-east, and maybe even the communist east... Pooling science, financial and natural resource strength would assist real progress toward completing the first generation in new energy systems. The political obstacles
to such an effort represent a sizable challenge. But, there is a way to do it.

4. Developing Countries

I don't have answers for the desperate position of those under-developed economies that would have a better chance to develop if it were not for their oil payments - oil payments which sometimes exceed total export revenues. Financial aid and loan rescheduling are essential but only to hold off complete collapse and permit survival. Until these nations can bring their energy costs down to a level which will support reasonable economic growth they will continue to lose ground. The poverty and massive unequal distribution of declining wealth can only lead to social unrest and disruption. There are possible ways to deal with this difficult area which I won't take the time to detail today. However, oil producing countries and industrial powers east and west should take note, their own stability can be threatened if the LDC community explodes.

Well - there you have it - oil - its alternatives in the real world of the 1980s. It's not the simple picture to which politicians like to point - it's not the one issue problem some special interests like to sell.

There is some evidence that selected parts of the international body politic are beginning to understand that the economic shocks of energy transition could be dangerous.
The stakes are high especially for the Free World - in writing on the three sources and three constituent parts of Marxism - Lenin said "political institutions are a superstructure resting on an economic foundation." Maybe he saw the 1980s clearer in 1913 than we gave him credit for,... I hope not.

# # #
REFINED PRODUCT REQUIREMENTS: DEMAND-SIDE PERSPECTIVES

John H. Lichtblau
Executive Director
Petroleum Industry Research Foundation, Inc.

CRUDE OIL & REFINING: THE ECONOMICS, THE POLITICS

A conference sponsored by Platt's Oilgram News and The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
U.S. OIL DEMAND IN THE 1980's

Synopsis of John H. Lichtblau's presentation on Demand-Side Perspectives

The U.S. economy (GNP) is expected to grow at an average annual rate of slightly more than 2% during the 1980's. Energy demand will grow at a substantially slower rate because of continued improvements in its relative efficiency. Through much of the decade energy demand will increase at less than half the forecast GNP rate.

Nuclear power and coal demand will both grow at a high multiple of the energy growth rate. The demand for natural gas will remain approximately unchanged throughout the period while oil demand is expected to decline significantly from the average annual level of the last several years.

The decline in oil demand is already under way. It was registered in 1979 and 1980 and is expected to continue in 1981. We may see a modest reversal of this trend for 2-3 years starting in 1982. But the more than 18 million B/D average annual demand of the second half of the 1970's is unlikely to be reached again in any future year. In the second half of the 1980's U.S. oil demand is expected to fluctuate within 200,000-300,000 B/D around 17 million B/D which was the consumption level registered in 1980.

Regarding individual oil products, the following changes are tentatively projected for the 1980's:

- Gasoline demand, which amounted to 6.6 million B/D in 1980, will decline volumetrically more than any other major oil product in the 1980's. By 1985 demand will be 5.6-6.0 million B/D and by 1990 it may be below 5.5 million B/D. All of the decline
Demand for unleaded gasoline will rise throughout the decade and will account for 85-90% of all gasoline by 1990.

Demand for middle distillate oils will rise moderately from last year's level of 2.9 million B/D. By 1985 it will be slightly above 3 million B/D and by 1990 it may approach 3.5 million B/D. The increase will be due principally to the increased use of diesel oils in the transportation market.

Heating oil consumption, on the other hand, will decline significantly throughout the period.

Jet fuel demand which amounted to 1.1 million in 1980 is expected to rise by 100,000-200,000 B/D over the next ten years.

Residual fuel oil demand has dropped every year since 1977 when it reached a peak of 3.1 million B/D. Last year's demand was 2.5 million B/D. Demand will probably be slightly above 2 million B/D in 1985 and slightly below that volume in 1990. The decline will be sharpest in the electric utility market where consumption might drop by 40-50% between 1980 and 1990. A more modest decline will be registered in the industrial market for fuel oil.

The decline in oil demand will keep U.S. refining capacity significantly in excess of throughput requirements in the 1980's. At the same time, refinery yields will have to be adjusted to meet the changing demand pattern.

Net imports of refined products other than residual fuel oil will remain insignificant throughout the decade. Residual fuel oil imports will decline by 30-40% from last year's level of about 920,000 B/D.
REFINED PRODUCT REQUIREMENTS:
DEMAND-SIDE PERSPECTIVES

Walter L. Newton
Managing Director
Petroleum Economics Limited

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
Energy demand in the world outside the U.S.A. and the Soviet Bloc has increased from 42.4 million b/d in 1970 to 58.3 million b/d in 1980, and is expected to increase further to 66 million b/d in 1985 and 75.4 million b/d in 1990 (Graph 1). It thus constituted 56% of total world energy demand in 1970 and is likely to be in the range of 61% - 63% in the 1980s.

The share of oil in the energy market outside the U.S.A. and the Soviet Bloc, after reaching a peak of 61% in 1973, is declining and was 55% in 1980 and is expected to be around 50% in 1990.

Thus, total energy demand of this area grew at a rate of 3½% p.a. in the 1970s and is estimated to increase by 2.7% p.a. in the 1980s; the corresponding figures for oil are 2.7% p.a. and 1.7% p.a. respectively. The forecast for the 1980s is based on an assumption of a GDP growth in the area of just under 3½% p.a.

Looking back for a moment, the 1970s must be considered as consisting of two distinct growth periods: 1970 - 1973 when the energy demand of the area increased by 5½% p.a. and that of oil by 7% p.a., and the 1973 - 1980 period when energy demand grew at 2½% p.a. and oil demand at less than 1% p.a.

The countries comprising this area are at greatly different stages of development and therefore the trends of energy and oil demand in the area have been, and will be, by no means uniform. On the one hand there are the industrialised countries of Western Europe, Japan, Canada, Australia, New Zealand and South Africa, and on the other hand the developing countries of Asia, Africa and Latin America.

It is proposed in this paper to focus on Western Europe, which is a region accounting for almost half of the energy and oil demand of the world outside the U.S.A. and the Soviet Bloc. Before doing so, it is however appropriate to mention in a more general way the developments in the other principal industrial country - Japan - and in the developing world.
In Japan energy demand increased by about 3.5% p.a. during the 1970s and is expected to rise by about 2.3% p.a. during the 1980s. The corresponding figures for oil are 2.8% p.a. and 1.6% p.a. The slower growth in energy and oil demand can be attributed to Japan having reached a plateau in development and that henceforth economic and energy demand growth will be at a much lower rate than in the period up to 1973. At the same time Japan, which is almost entirely dependent on imported energy, in an attempt to diversify its sources of supply and its energy base, is turning to an increasing extent to imports of gas and coal, which account for the lower rate of growth in oil demand as compared with energy demand. Japan currently represents 13.6% of energy demand outside the U.S.A. and Soviet Bloc and 15.5% of oil demand. The corresponding figures for 1990 are expected to be 13.1% and 15.6% respectively.

Turning now to the developing countries, their energy demand increased by almost 6½% p.a. between 1970 and 1980 and is expected to rise by 4% p.a. in the 1980s, the corresponding figures for oil being 6% p.a. and 3% p.a. respectively. Their share of the energy demand of the area outside the United States and the Soviet Bloc has risen from 21% in 1970 to 29% in 1980 and is expected to reach 33% in 1990. It is appreciated that estimates from other sources, and particularly those compiled by OPEC, suggest a higher growth rate in energy, and in particular in oil, demand for the developing world than is indicated by the figures just mentioned. The difference is believed to lie in the assessment of the relationship of growth in the industrialised world and in the developing world. The expansion of the economies of the developing countries, which will ultimately determine their energy requirements, will depend partly on the amount of aid, both economic and technical, which they receive. Even more significant for their development will be world demand for the raw materials which they produce, which in turn is dependent on the level of economic activity in the industrialised world. Therefore, if economic growth and energy growth are limited in the industrial world this must inevitably have an effect on the developing areas. This approach is supported by the trends of the 1970s when energy demand in the LDCs rose by about 8% p.a. between 1970 and 1973 but by only about 5½% p.a. between 1973 and 1980, with the corresponding figures for oil being 9% p.a. and 5% p.a. respectively.
It is now proposed in the limited time available to focus on the problems of Western Europe.

West European energy demand in 1980 is estimated at about 26 million b/d of oil equivalent. Growth of energy demand in Western Europe, as elsewhere, will be dictated by the rate of economic growth and by the degree of efficiency with which energy is used, which will determine the primary energy co-efficient, i.e. the relationship of energy demand to economic growth.

This year economic growth in Western Europe will be minimal and it is not expected to pick up before 1982 at the earliest. It is, however, anticipated that the average growth throughout the decade will be less than 2 1/2% p.a. compared with 3% p.a. in the 1970s as a whole and 1.7% p.a. in the time span 1973 - 1980.

Although the energy co-efficient in the period 1973 - 1978 had fallen to 0.5 and there was, in spite of a 2% p.a. economic growth between 1978 and 1980, no growth in primary energy demand, it is expected that during the 1980s the energy co-efficient, in Western Europe, will once again increase. This is due to:

1. the renewed growth in economic activity assumed from 1982 onwards, and
2. the impact of the increasing use in electricity generation of coal and nuclear power, which are less efficient in terms of conversion of fuel input than are oil and natural gas.

Taking these factors into account, we would anticipate an energy co-efficient in Western Europe of 0.85 in the period 1980 - 1985 and 0.70 in 1985 - 1990. On this basis, West European energy demand is expected to grow at less than 2% p.a. through the decade to 28.7 million b/d oil equivalent in 1985, and 31.4 million b/d oil equivalent in 1990.

Dealing first with non-oil forms of energy, Graph 2 shows the change in the West European energy balance between the different forms of energy during the period to 1990. The most significant development is the share of nuclear power. Although in the late 1970s nuclear plans were curtailed in a number of West European countries, as a result of anticipation of lower electricity demand growth and
environmental concern, the investment in development of nuclear power continues in particular in France, Sweden, F.R. Germany and the U.K. Significant new capacity is therefore expected to come on stream in the mid-1980s.

Little change is expected in the supply of hydro-electric power.

Although consumption of solid fuels is expected to increase slightly in absolute terms between 1985 and 1990, its share in overall energy supply is likely to decline from 21% to 19% during the decade. The use of coal is expected to be limited by two factors:

1. low electricity demand growth;
2. the growing use of nuclear power already referred to.

It will be appreciated that any increase in solid fuel supplies which would take place after 1985 would be largely based on imports but the lack of adequate port and other logistic facilities is likely to be a limiting factor.

The share of natural gas in the energy balance is expected to grow as a result of increased indigenous supplies from the North Sea and rising imports, in particular from the U.S.S.R. and Algeria.

Oil demand will grow at less than 1% p.a., rising from 13.8 million b/d in 1980 to 14.2 million b/d in 1985, after a decline to 13.1 million b/d in 1981, and then further to 14.6 million b/d in 1990. Oil's share in primary energy consumption is however expected to decline from 53% at present to 46% in 1990.

Oil Products Demand Pattern

The development of the demand for individual products is shown in Graph 3. The following comments can be made:

Naphtha: The demand for petrochemical feedstock is expected to grow by under 3% p.a. in the decade. Increased use of natural gas liquids as a feedstock by the petrochemical industry will have its repercussions on naphtha demand for this purpose.
Motor Gasoline: Increases in fuel efficiency can be anticipated but as motor cars in Western Europe are already smaller than in the United States, the scope for this in Europe is much more limited. Furthermore, there is likely to be continued growth of the car population. Demand for motor gasoline is therefore expected to rise at a rate of around 2% p.a. over the next ten years. This is the highest growth rate for any main petroleum product.

Kerosene/Jet Fuel: A small growth in jet fuel for civil aviation purposes is expected.

Gas/Diesel(Distillate)Fuel Oil: It is anticipated that diesel use for transportation purposes will increase but will be offset by a declining demand for distillate fuel oil for domestic heating, resulting in a fairly constant level of demand for this group of products throughout the period. The decline in the demand for distillate fuel is a result of both conservation and increased penetration of natural gas in the domestic/commercial sectors. If such penetration by gas is not realised for reasons of infra-structure or pricing, it is possible that more natural gas would be diverted into the industrial market, in which case the demand for distillate fuel oil would be greater but that for residual fuel oil lower than shown.

Residual Fuel Oil: The decline of almost 20% during the decade is largely due to the reduced demand in the industrial sector. This can be attributed to:

1. low energy growth in this sector associated with weak economic activity and the impact of conservation measures, and
2. the penetration of electricity and natural gas in this market.

The demand for residual fuel oil will also be influenced by the fact that fuel oil use for electricity generation is already at low levels in many West European countries, the principal exception being the Netherlands where residual fuel oil use is likely to increase owing to declining supplies of indigenous natural gas. Also, some new oil-fired electricity generating plant has in fact been, or is about to be, brought on stream in a number of countries - for instance the United Kingdom - based on investment programmes initiated some years ago.
Other Products: The growth in other products demand reflects the increasing consumption of natural gas liquids both from the North Sea and imported from OPEC countries.

The result of the developments just outlined indicates a considerable lightening of the barrel because the share in overall demand of distillate products, i.e. naphtha, motor gasoline, kerosene and distillate fuel oil, will rise from 58% in 1980 to 62% in 1985 and 63% in 1990. At the same time that of residual fuel oil is expected to decline from 28% currently to 23% in 1985 and 21% in 1990, with other products, including natural gas liquids, rising from 14% to 16% of total.

Products Imports

Before discussing the effect of these developments on the refining sector in Western Europe it is necessary to discuss the likely trend of products imports into Western Europe (Graph 4).

On the basis of preliminary figures it is estimated that in 1980 Western Europe imported about 1.2 million b/d of products, of which 650,000 b/d, or over half, came from the Soviet Union and Eastern Europe, 330,000 b/d originated from OPEC countries and the balance from the Caribbean and other sources. 65% of the products imports were distillate products and little more than one quarter was residual fuel oil. Significant changes in this products import pattern can be expected during the next few years. The subject of OPEC refineries has been dealt with by another speaker. According to our estimates, after allowing for increased consumption in OPEC countries, the export surplus from OPEC refineries is likely to rise to over 3 million b/d. It is assumed that if there were to be a continued absence of a crude oil surplus OPEC countries would have no difficulties in placing the additional products available for export, by tying them to the supply of crude oil. Should there be a crude oil surplus the position could well be different and the export of petroleum products could become a competitive factor between OPEC countries.

If the former hypothesis is correct, additional exports from OPEC countries are likely to go to those countries which are the main purchasers of crude oil. On this approach products imports
from OPEC countries to Western Europe can be expected to double between 1980 and 1985, and increase further to over 800,000 b/d by 1990 assuming some further expansion of OPEC refining capacity in the post-1985 period.

The increased import of petroleum products by Western Europe from OPEC countries is, however, likely to be counterbalanced by an expected decline in the products export availability from the U.S.S.R. and Eastern Europe. Although this trade is not likely to be completely eliminated for political and commercial reasons, a substantial reduction is likely in view of the energy and oil outlook in the U.S.S.R. and Eastern Europe. It is thus anticipated that the exports of petroleum products from the U.S.S.R. and Eastern Europe to Western Europe will be little more than half in 1985 of what they were in 1980 and are unlikely to exceed greatly 200,000 b/d, or about one sixth of Western Europe's products imports, in 1990. Some increased competition from Caribbean refineries in the West European products market must also be expected as U.S. imports of products decline and some products from OPEC refineries will have to be absorbed in that market.

As a result of these developments, although there will be little change in the overall level of products imports into Western Europe, an important shift in the sources of origin of these imports must be expected. These will at the same time result in a change in the import pattern by types of products. The imports from the U.S.S.R. were predominantly distillate products, but those from OPEC refineries include and are expected to continue to include a much higher proportion of residual fuel oil, owing to the limited market for this product in the OPEC countries themselves. Consequently, the proportion of distillate products imported is expected to decline from 65% in 1980 to about half in 1990 and, simultaneously, that of residual fuel oil will increase from about one quarter to almost 40% in this period.

In 1980 Western Europe exported about 400,000 b/d of petroleum products so that net imports were only about 800,000 b/d. Some of these exports represent crude oil imported from OPEC countries for processing with the products being returned to some extent to the country of the origin of the crude oil. With the growth of refining capacity in OPEC countries,
this trade is likely to decline and therefore products exports from West European refineries are likely to become less over the years. Although the overall gross imports of products into Western Europe are not changing to any considerable extent, the net imports are likely to rise to about 1 million b/d over the decade.

On the basis of demand and net imports as outlined in this paper, the development of refinery throughput and the yield pattern required can be established. This is shown in Graph 5.

This shows that refinery throughput in Western Europe is likely to remain at about 13 million b/d, or only 62% - 63% of distillation capacity, throughout the decade. The yield pattern required from West European refineries will, however, have to undergo a change similar to that of the demand pattern, the yield of distillate products increasing by some 7%, from 58½% in 1980 to 63½% in 1985 and 65½% in 1990, with a commensurate decline in the yield of residual fuel oil.

The ability of West European refineries to meet this yield pattern will be influenced by the changes in the crude oil supply by origin and quality which are likely to take place over the next decade, and also by the construction of downstream processing capacity in West European refineries.

Regarding the former, (Graph 6), the dependence on the Middle East will remain unchanged at around 60%. As for the other sources of supply, indigenous, i.e. mainly North Sea, crude oil is likely to rise from 18½% of total in 1980 to 23% in 1985 but decline to 21½% by 1990. With the increase in the supply of low-sulphur North Sea crude oil, the proportion of similar quality crude of African origin is likely to go down, as is also the supply from "other" sources, i.e. the U.S.S.R. Some increases are, however, expected in the shipment of Mexican and heavy Venezuelan crude to Western Europe, which explains the increase in the imports from the Caribbean/Latin American area.

These changes in crude oil origin will also affect the balance between light, medium and heavy crude oils (Graph 7). Although this balance will be influenced to some extent by changes in the proportion of Arab Light and Arab Heavy crude oil produced in Saudi Arabia, the trend would indicate
a sharp decrease in the proportion of medium quality
crudes, with some increase in light crudes but
principally in heavy crude oils.

The development of conversion capacity
is shown in Graph 8. It indicates that over the
last three years conversion capacity in Western Europe
has increased by one third and that in the period end-
1977 to end-1985 it is likely to almost double, from
1.7 to 3.2 million b/d, on the basis of plants
currently under construction or which can be con-
sidered as firm projects. On these figures con-
version capacity will rise from about 8% to 15% of
distillation capacity by 1985. It is believed that
there are plans for other plants which have not yet
been officially announced.

It must be added that, if the distillation
capacity is only used to about two-thirds of rated
capacity whilst the conversion capacity is likely to
operate at a considerably higher rate, the ratio of
conversion capacity to crude oil capacity in 1985
would in practice be around 20%. This, of course,
is still considerably less than in the United States,
where the ratio of conversion capacity to distillation
capacity is almost 40%, but even in 1990 the demand
pattern in Western Europe, although moving in the
direction of that of the U.S.A., will still be con-
siderably heavier than in the United States.

The aggregate conversion capacity is,
however, not the only relevant factor. The degree
to which residual fuel oil can be converted into
distillate products will also be determined by the
type of conversion capacity built and, having regard
to the concentration of cracking operations in Western
Europe in certain refineries, by the availability of
suitable feedstock.

In this context it is important to note
that the share in total capacity of those processes
which involve a high rate of conversion, i.e. catalytic
cracking, hydrocracking, coking, is in fact declining,
whereas visbreaking/thermal cracking, which result in
a comparatively low rate of conversion, are actually
rising. This will to some extent be compensated by
the greater efficiency of the more modern plants now
being installed but nevertheless the rate of conversion
is unlikely to be increased.
On the basis of the conversion capacity likely to be installed by 1985, and taking into account also changes in crude oil quality, it is estimated that in 1985 the output from Western European refineries will still not be quite in line with that of the output pattern expected to be required from West European refineries. It would appear there will be a surplus of about 130,000 b/d of residual fuel oil with a comparable shortage of distillate products.

It is of course possible that more conversion capacity will come on stream by 1985, and there is certainly ample time for the construction of more conversion plants by 1990. However, on the basis of present projects, the deficit of distillates and surplus of residual fuel oil in Western Europe can be expected to be of the order of 400,000 b/d in 1990.

To summarise:

1. Energy demand in the rest of the world outside the U.S.A. and the Soviet Bloc will rise more slowly in the 1980s. Almost half the increase will be accounted for by the developing countries.

2. Oil demand in the area is expected to increase by only 18% during the decade. Almost two thirds of the growth will be in the developing countries, oil demand in the industrialised countries rising by less than 1% p.a. Oil's share in the overall energy balance will decline throughout the period.

3. In the principal region of the area - Western Europe - although the level of oil demand will be relatively stable, there will be a change in the demand pattern for individual petroleum products with the proportion of distillate products of total demand increasing and that for residual fuel oil declining.

4. The current surplus of distillation refining capacity will continue throughout the decade but additional conversion capacity will be needed to meet the changing products demand. Indications are that, on the basis of the present construction programme, the industry is well on the way towards meeting these demands in the first half of the 1980s and there is
adequate time for such further projects as may be required in the period 1985 - 1990.

Finally, the following conclusions may be drawn:

A. In stable conditions, and assuming that the trend away from oil towards other energy forms continues, the supply problems appear manageable.

B. However, it seems most likely that the uncertainties of the last few years are likely to prevail and the possibility of disruptions in the supply chain is, therefore, always present.

C. In order to solve some of the problems inherent in such a troubled scenario, and to cope with future crises, it can be assumed that a certain number of companies will consider the additional cost of investing in refinery flexibility will be justified in order to protect their markets, or even to provide themselves with a competitive position. Other companies may rely on the anticipation of an allocation "safety net" in times of declared crisis, but experience to date suggests that given the attitude of most consumer-country governments the latter could prove costlier than investing in flexibility.
WORLD EXCLUDING USA - PRIMARY ENERGY DEMAND ESTIMATES 1973-1990

Graph 1

SOLID FUELS
HYDRO
NUCLEAR
GAS
OIL

MILLION B/D O.E.

80

70

60

50

40

30

20

10


49.9

58.3

66.0

75.4

20%

18%

18%

18%

9%

9%

9%

7%

3%

5%

16%

13%

15%

50%

20%

19%

10%

9%

1%

61%
WESTERN EUROPE - OIL PRODUCTS CONSUMPTION ESTIMATES 1973-1990

MOTOR GASOLINE/NAPHTHA
MIDDLE DISTILLATES
RESIDUAL FUEL OIL
OTHERS

MILLION B/D

15

14.9

3.0 m b/d

20%

10

5.2 m b/d

35%

5.3 m b/d

36%

3.8 m b/d

28%

2.3 m b/d

21%

1.9 m b/d

14%

1.9 m b/d

15%

2.1 m b/d

16%

1973

1980

1985

1990
WESTERN EUROPE - IMPORTS OF PETROLEUM PRODUCTS 1980-1990

Graph 4

- MOTOR GASOLINE/NAPHTHA
- MIDDLE DISTILLATES
- RESIDUAL FUEL OIL
- OTHERS

000 B/D
1,500
1,000
500

1,180
1,255
1,280

1980
1985
1990

OPEC
28%
26%
27%
55%
65%
25%
28%
38%

USSR ETC.
39%
31%
16%

CARIBBEAN AND OTHERS
17%
17%
19%

8%
8%
9%
### WESTERN EUROPE - REFINERY OUTPUT TARGETS 1980-1990

<table>
<thead>
<tr>
<th></th>
<th>1980</th>
<th>1985</th>
<th>1990</th>
</tr>
</thead>
<tbody>
<tr>
<td>NAPHTHA/GASOLINE</td>
<td>23</td>
<td>25½</td>
<td>27½</td>
</tr>
<tr>
<td>MIDDLE DISTILLATES</td>
<td>35½</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>HEAVY FUEL OIL</td>
<td>27½</td>
<td>22½</td>
<td>20</td>
</tr>
<tr>
<td>OTHERS</td>
<td>7</td>
<td>7</td>
<td>7²</td>
</tr>
<tr>
<td>REFINERY FUEL/LOSS</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

**MILLION B/D THROUGHPUT**
- 1980: 12.9
- 1985: 13.0
- 1990: 13.3

**% OF DISTILLATION CAPACITY**
- 1980: 62
- 1985: 62
- 1990: 63
### Western Europe - Crude Oil Supply by Source 1980-1990

<table>
<thead>
<tr>
<th>Source</th>
<th>1980</th>
<th></th>
<th>1985</th>
<th></th>
<th>1990</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MILLION B/D</td>
<td>%</td>
<td>MILLION B/D</td>
<td>%</td>
<td>MILLION B/D</td>
<td>%</td>
</tr>
<tr>
<td>Indigenous</td>
<td>2.4</td>
<td>18%</td>
<td>3.0</td>
<td>23</td>
<td>2.9</td>
<td>21%</td>
</tr>
<tr>
<td>Middle East</td>
<td>7.5</td>
<td>58%</td>
<td>7.6</td>
<td>58%</td>
<td>8.1</td>
<td>61%</td>
</tr>
<tr>
<td>Africa</td>
<td>2.0</td>
<td>15%</td>
<td>1.7</td>
<td>13</td>
<td>1.7</td>
<td>13%</td>
</tr>
<tr>
<td>Caribbean/Latin America</td>
<td>0.3</td>
<td>2%</td>
<td>0.4</td>
<td>3%</td>
<td>0.5</td>
<td>3%</td>
</tr>
<tr>
<td>Others</td>
<td>0.7</td>
<td>5%</td>
<td>0.3</td>
<td>2%</td>
<td>0.1</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>12.9</td>
<td>100%</td>
<td>13.0</td>
<td>100%</td>
<td>13.3</td>
<td>100%</td>
</tr>
</tbody>
</table>
### WESTERN EUROPE - CRUDE OIL SUPPLY BY API GRAVITY 1980-1990

<table>
<thead>
<tr>
<th></th>
<th>1980</th>
<th></th>
<th>1985</th>
<th></th>
<th>1990</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MILLION</td>
<td>%</td>
<td>MILLION</td>
<td>%</td>
<td>MILLION</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>B/D</td>
<td></td>
<td>B/D</td>
<td></td>
<td>B/D</td>
<td></td>
</tr>
<tr>
<td>OVER 36.9° API</td>
<td>3.6</td>
<td>28</td>
<td>4.1</td>
<td>31%</td>
<td>4.0</td>
<td>30</td>
</tr>
<tr>
<td>32 - 36.9° API</td>
<td>6.0</td>
<td>46%</td>
<td>5.1</td>
<td>39%</td>
<td>5.0</td>
<td>37%</td>
</tr>
<tr>
<td>UNDER 32° API</td>
<td>3.3</td>
<td>25%</td>
<td>3.8</td>
<td>29</td>
<td>4.3</td>
<td>32%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>12.9</td>
<td>100</td>
<td>13.0</td>
<td>100</td>
<td>13.3</td>
<td>100</td>
</tr>
</tbody>
</table>
WESTERN EUROPE ESTIMATED DEVELOPMENT OF CONVERSION CAPACITY

<table>
<thead>
<tr>
<th>Total Conversion Capacity, 000 B/D:</th>
<th>1,720</th>
<th>2,345</th>
<th>3,220</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS % of Crude Distillation Capacity:</td>
<td>8</td>
<td>11</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>End Year</th>
<th>% Coking</th>
<th>% Hydro</th>
<th>% VISBR/Thermal</th>
<th>% Catalytic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>8</td>
<td>4</td>
<td>6</td>
<td>51</td>
</tr>
<tr>
<td>1980</td>
<td>7</td>
<td>4</td>
<td>6</td>
<td>50</td>
</tr>
<tr>
<td>1985</td>
<td>7</td>
<td>4</td>
<td>39</td>
<td>50</td>
</tr>
</tbody>
</table>
A Framework For Discussing The State Of The Art Of Refining Technology

By: Charles A. Campbell

It is not practical in a brief address to adequately define the state of the refining art - even from one man's viewpoint. Crude oil refining is a relatively mature industry. While the principles of many of its processing technologies have been in use for over 30 years, there has been, and continues to be, a steady flow of improvements in hardware, catalysts, and process control techniques which produce more cost effective operations. There are also new approaches some of which are nearing the demonstration plant stage of development, and some of which are still in the laboratory.

My objective in the next 15 minutes, therefore, is to set a framework from which topics of most interest to this audience can be discussed in more depth at the workshop session this afternoon.

We can start with a premise that there is one or more proven technologies that can technically handle any of the known refining problems of the next decade or so. Proven in this sense means that one or more commercial size plants have been operated successfully enough so that licensors/designers/constructors/planners can estimate new units within tolerable error limits. For these proven technologies, then, discussion of the state-of-the-art revolves around known technical limitations, any near term probable improvements, and whether these are or will be economical within our planning horizon.

For technologies that are not yet proven we can examine how they may be better than present technologies, or how they may extend refinery capabilities, and whether they may be more economical.

The fundamental trends which the U.S. refining industry must prepared to handle are:

1. That crude available to process will, on average, be:
   - heavier, that is contain more residual oil,
   - more sour (higher sulfur content),
   - and contain more heavy metals.

2. That total U.S. demand for petroleum products will be more or less flat for a decade, but that
   - Gasoline and residual fuel oil demand will fall, while
   - Jet fuels, diesel and other middle distillates, and petrochemical feedstock will rise.
3. The quality of refinery products blending streams needed will generally rise (not fall).

- Gasoline pool octane will rise with increasing demand for unleaded and premium grades.
- To meet quality requirements for jet fuels and diesel will require more processing as the volume of naturally occurring high quality blending streams decreases.
- More desulfurization will be needed throughout the whole spectrum of refinery products.

4. Acceptable recovery levels of contaminant by-product streams (H₂S, SOx, NOx, metals, etc.), that is refinery emissions control, will likely be more stringent, and there will be greater volumes to handle.

The forecasting community is in basic agreement on these trends. Where individual forecasters differ is in degree or rates of change. This paper will not add another forecast.

Primary attention in our trade press, trade association meetings, and symposia like this meeting has, for the past year or two, been devoted to how the industry will handle the first trend, that is the heavier, more sour, more contaminant containing crude mix. Our industry jargon has adopted the term "bottoms upgrading" by which is loosely meant breaking up the increasing supply of contaminated heavy hydrocarbon molecules into the smaller molecules most needed, decontaminating these to acceptable levels, and rearranging their hydrogen to carbon content.

Before examining the technical structure of this "bottoms upgrading" industry requirement, we should first also note that this is not a new technical problem. The refining industry has been doing this in many locations for many years, and U.S. refiners have done it more than in the rest of the world. What is new is the rapidly increasing magnitude of the job to be done and a lessening ability to "blend off" the problem crude oils with better than needed crude oils in order to minimize processing, and total costs. The U.S. refining industry certainly believes it is a real problem; over 25 projects with a nominal heavy oil input capacity approximating 650,000 barrels per day have already been announced, and more are being planned. Announcement of this many projects also indicates that enough is known by industry practitioners about the state of this "bottoms upgrading" art to make decisions to commit billions of investment dollars to technical success; such commitments also imply an expectation of profitable operations.

The economic driving force for profitability is the expected spread in product market value between residual oils and lighter products compared to the conversion and process costs, including recovery of investment capital. For those refiners who concentrate their marketing efforts on
different light products, the market price spreads between individual light products is equally important. Unfortunately, it can be quite misleading to divorce the state of the technical art from the state of the commercial (or business, or economic) art. Successful business requires careful assessment of their probable interrelationships, at least over the assumed recovery period of the investment.

Now let's define some technical structure for use in later discussion:

1. Molecular breakup is achieved by "cracking". This may be done via high temperature at low to high operating pressures. It may occur with or without the presence of hydrogen at low or high partial pressures, and with or without the presence of catalysts.

Processes range from coking (thermal, low pressure, noncatalytic) to maximum conversion hydrocracking (thermal, high pressure, catalytic,) with numerous variations in between, and equally high conversion heavy oil cat cracking (thermal, catalytic, low pressure, no specific hydrogen addition). For each main route, there is more than one hardware approach; for example, fixed, moving, ebulating, and fluidized beds; choice of catalysts; balance between conversion, amount of decontamination, on-stream time, turn-around time, reliability and equipment life, and ultimately cost.

There are many processes, frequently proprietary or licensed, and there are many design variations within processes. Each has its own practical limits, and associated costs.

2. Raising the hydrogen to carbon (H/C) ratio of the "cracked products is the usual general problem. If measured within a total crude oil refining system most of the rise in H/C is obtained by rejecting carbon. Examples are: coke as a product, and coke deposited on catalyst (much of whose energy value may be recovered in some processes). Another form of carbon rejection is solvent deasphalting which produces a low H/C asphalt product.

Alternatively, hydrogen may be added. A few processes such as catalytic reforming and pyrolysis steam cracking produce by-product hydrogen as these processes dehydrogenate feedstocks to aromatics or olefinic products. A small amount of hydrogen may come from process reactions with water (steam). However, most hydrogen is obtained by steam reforming methane or heavier gases, or light liquid hydrocarbons. An alternate process, not yet widely practiced, is partial oxidation of heavy oils (or coke) followed by a shift reaction. Note that both of these processes produce carbon dioxide as a by-product (often a waste product) which is just another form of carbon rejection from the total refining system.

To repeat, we obtain most of the desired improvement in H/C by rejecting carbon although we often think of it as adding hydrogen.
3. **Removing contaminants** (sulfur, nitrogen and heavy metals) *is* necessary both to meet finished product specifications, and in some cases to permit processes to operate in an economically useful range.

   a. Some sulfur and nitrogen compound bonds are broken by any cracking process, and these appear in process gas streams mainly as hydrogen sulfide, or ammonia with some mercaptans and thiophenes. Almost any degree of desulfurization can be obtained by successively more severe catalytic hydrodesulfurization; the same holds for nitrogen. The sour process gases can be handled with well proven processes.

   Sulfur in catalytic cracking feedstocks is more an irritant than a severe limitation as far as product yield structure and quality is concerned. The problem is controlling SOx emissions from the stack gas of the catalyst regenerator within acceptable levels. The cost effectiveness for any chosen degree of desulfurization and emission is still an open question among three main routes:
   
   - Hydrotreating feedstocks,
   - So-called SOx catalysts, and
   - Stack gas scrubbing

   b. Heavy metals removal is less clear cut. At one extreme, coking leaves almost all the metals in the coke product. Solvent deasphalting can, by judicious use of operating conditions, reject the metals to the asphalt product to any degree necessary.

   For feedstocks containing small amounts of metals, say less than about 30 ppm, there are metals tolerant catalysts which allow economical operation for either catalytic cracking or hydrocracking.

   Higher degrees of metals contamination, up to several hundred ppm, can be handled by proper sequencing of differing catalysts in fixed bed units performing a combined desulfurization demetallization. These sequences can be used as a pretreatment step before more severe cracking. In ebulating bed processes the ability to add or remove catalysts reduces the problem to the economics of catalyst costs.

   For higher amounts of metals, say over 500 ppm, the process routes are more obscure. If you cannot blend down problem feedstocks like Mexican Maya or Venezuelan Boscan which have well over 1000 ppm, and cannot stand the catalyst cost, the only proven technologies are coking or deasphalting.
A number of technologies appear to be emerging, but have not been proven yet, for high metals feedstocks. Among these are processes being developed by Shell, UOP, HRI, and Chiyoda and perhaps others.

Most discussion of heavy metals refers to nickel and vanadium compounds present in crude oils. Another equally troublesome heavy metal is sodium. This arises mainly in the water phase, present as BS&W, in most crude oil deliveries. It is usually removed by crude desalting processes, and until a few years ago if a little sodium got by the desalters it caused little harm, ending up as ash in residual fuel oils. With the advent of Residual Oil feeds to catalytic cracking units, traces of sodium became a real problem. With high temperature catalyst regenerator operations, sodium can react with the base material and destroy its catalytic properties. Two stage desalters, or combinations of chemical and electric desalting were used to improve sodium removal. One problem that remains comes from those crude oils recovered with the aid of surfactant chemicals. These surfactants cause less than best operation in desalting processes.

There are a number of indices which have become useful in comparing process technologies, or sequences of processing steps. Let me define several for our use in the workshop discussion.

- It is convenient to have some measure of the quantity of heavy oil that is present. The easiest concept is Nondistillables, by which is usually meant material boiling above conventional vacuum gas oil. We use 1050°F, a TBP type cut point.

- For investment comparisons, it is useful to use dollars per barrel of battery limits process equipment capacity. This is sound enough if the range of capacity comparisons is not too great, and if you remember that associated investment outside battery limits may sometimes be as great as within battery limits.

- Some measure of the degree of upgrading is necessary. We prefer the value difference between products and feedstock expressed as dollars per barrel of feed. Quantifying this can be tricky unless the system goes all the way to finished products.

- Hydrogen used can be the most critical cost factor. The industry is accustomed to expressing its use in processes as SCF/B of feedstocks. For more complex systems we have found it more convenient to use weight percent hydrogen to feedstock.

Cost of hydrogen is another matter. Do you purchase hydrogen, or natural gas to make it? Do you consume a part of the feedstock (or by-products) and build a hydrogen plant? Be careful to specify the details.
While engineers, especially designers, are usually careful to establish material balances around their system, refinery planners and operators in the U.S.A., at least, think so much in volume units that weight balances are often ignored. Conversion of residual oils to light products produces such major changes in specific gravity that liquid product volume yields can easily exceed 100 percent of input. Weight balances are essential to understand what is happening.

Please note that in the foregoing definitions of some useful indices for comparative discussion purposes, no index of profitability, project payout, or cost effectiveness has been mentioned. While such an index becomes the main object of most investigations, it is our experience based upon numerous studies for different companies in different refining/marketing/crude supply situations that what is best for one situation may be a very poor choice in another situation. It is not likely that our workshop discussion this afternoon will develop enough specific criteria for any situation discussed to permit meaningful, quantitative relative profitability comparisons. However, we will provide qualitative or directional comparisons as appropriate to illustrate the state of the art.

Finally, we look forward to your questions this afternoon at the workshop session. Whether they be general or specific, or whether they question some of the statements made or implied in setting forth this framework, we expect to flesh out the state of the refining art via the interplay of question, answer, and comment.

Thank you.
REFINING TECHNOLOGY: THE STATE OF THE ART

James R. Murphy
Manager of Process Technology
Pullman Kellogg
Division of Pullman Incorporated

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
REFINING TECHNOLOGY: THE STATE OF THE ART

James R. Murphy
Manager of Process Technology
Pullman Kellogg
Division of Pullman Incorporated

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
THE UNITED STATES REFINER IS FACED THIS YEAR WITH MAKING MAJOR DECISIONS ON HIS FUTURE COURSE OF ACTION. THE PROPOSED PHASING OUT OF GOVERNMENTAL PRICE CONTROLS IN 1981 NECESSITATES THE SMALL REFINER DECIDING WHETHER HE WILL STAY IN THE REFINING BUSINESS OR NOT. MAJOR OIL COMPANIES ARE FACED WITH THE DECISION WHETHER OR NOT THEY SHOULD CONTINUE TO MAKE RESIDUAL FUEL OILS OR TO MAKE MAJOR CHANGES IN THEIR REFINERIES TO ALLOW THEM TO PROCESS THE HIGHER SULFUR AND POORER QUALITY FOREIGN CRUDES. THIS DECISION IS BECOMING EVEN MORE COMPLEX SINCE THE REFINER SEES A NUMBER OF COMPANIES MAKING DECISIONS TO COMPLETELY ELIMINATE RESIDUAL FUEL OIL WHILE AT THE SAME TIME PROJECTIONS FOR THE FUTURE INDICATE A CONTINUING DEMAND FOR THE RESIDUAL FUELS, CLEAR UP TO THE YEAR 2000. THE REFINER WHO DECIDES TO MODIFY HIS REFINERY TO PERMIT PROCESSING THE HEAVIER CRUDES MUST CHOOSE THE PREFERRED PROCESSING STEPS. ADDITIONALLY THE FLUCTUATIONS IN CRUDE PRICES AND THE INABILITY TO MAKE LONG RANGE PLANS ON CRUDE QUALITY REQUIRES A CONSIDERABLY GREATER FLEXIBILITY IN PROCESSING CAPABILITIES THAN WAS NECESSARY IN PREVIOUS OPERATIONS.

A REVIEW OF DECISIONS MADE BY THE REFINERS TO DATE IS PRESENTED. FACTORS INVOLVING THE PREFERRED PROCESSING SEQUENCE AND THE FACTORS AFFECTED BY DESIRED FLEXIBILITY ARE DISCUSSED. IN ADDITION, THE NEEDED IMPROVEMENTS TO PERMIT MORE EFFICIENT REFINING IN THE FUTURE ARE TO BE PRESENTED.
OPEC AND SAUDI REFINING POLICY

His Excellency Abdulhady Hassan Taher
Governor of Petromin

CRUDE OIL & REFINING:
THE ECONOMICS, THE POLITICS

A conference sponsored by
Platt's Oilgram News and
The Petroleum Industry Research Foundation, Inc.

The Waldorf-Astoria
New York City
THE INTRODUCTION WILL CONSIST OF SOME GENERAL COMMENTS ON THE
SUBJECT MATTER OF THE CONFERENCE AS A WHOLE "CRUDE OIL AND
REFINING: THE ECONOMICS AND THE POLITICS" AS SEEN FROM A SAUDI
AND OPEC VIEWPOINT.

THE SECOND PART OF THE PRESENTATION WILL CONSIST OF SOME PICTURES
OR SLIDES TO ILLUSTRATE VARIOUS FEATURES OF THE SAUDI OIL AND
GAS SECTOR WITH PARTICULAR REFERENCE TO REFINERIES, BOTH EXISTING
AND NEW ONES. PARTICIPANTS WILL BE GIVEN SOME APPRECIATION OF THE
SCALE AND DIVERSITY OF THE SAUDI INDUSTRY THROUGH SLIDES SHOWING
CRUDE, PRODUCT AND GAS PIPELINES, GAS PLANTS AND LUBRICATING PLANTS.

A BRIEF STATISTICAL OUTLINE WILL BE GIVEN OF SAUDI, MIDDLE EAST
AND THE OPEC REFINING SECTOR IN A WORLDWIDE CONTEXT AND IN RELATION
TO CRUDE OIL PRODUCTION AND CONSUMPTION OF REFINED PRODUCTS. A
GENERAL REVIEW WILL BE MADE OF DEVELOPMENTS IN THE OIL, GAS AND
REFINING SECTORS.

THE FOURTH SECTION OF THE PRESENTATION WILL CONSIST OF AN EXPLANATION
OF THE RATIONALE FOR THE DEVELOPMENT OF SAUDI REFINING POLICY. THIS
IS SEEN AS A KEY PART OF ECONOMIC AND SOCIAL DEVELOPMENT IN GENERAL,
AND OF THE INDUSTRIALIZATION PROCESS IN PARTICULAR. IT PROVIDES A
MOST IMPORTANT MEANS OF DIVERSIFYING THE ECONOMIC BASE OF ANY OIL
EXPORTING DEVELOPING COUNTRY. APART FROM CONVENTIONAL OIL PRODUCTS,
THE USE OF VALUABLE GAS LIQUIDS WHICH WERE FORMERLY WASTED PROVIDES A MEANS FOR SAUDI ARABIA TO MOVE INTO ENERGY INTENSIVE SECTORS SUCH AS PETROCHEMICALS AND IRON AND STEEL. AT THE SAME TIME IT IS MAKING AN EFFECTIVE CONTRIBUTION TO THE OPTIMAL USE OF THE WORLD'S INCREASINGLY SCARCE AND DEPLETING HYDROCARBON RESOURCES. A FEW OPEC MEMBER COUNTRIES ARE NOW RELATIVELY RICH IN TERMS OF INCOME PER CAPITA COMPARED WITH MOST INDUSTRIALIZED COUNTRIES, THOUGH WITHOUT EXCEPTION THEY ALL REMAIN RELATIVELY POOR IN TERMS OF OUTPUT PER PERSON FROM THE MANUFACTURING AND THE MODERN SERVICE SECTORS OF THE ECONOMY. THUS THEY HAVE AN URGENT NEED TO DEVELOP AND DIVERSIFY THEIR ECONOMIES OVER THE NEXT DECADE OR TWO IN ORDER TO ACHIEVE LONG TERM SUSTAINED AND BALANCED GROWTH BEFORE THEIR OIL RESERVES TO PRODUCTION RATIOS DECLINE TO A VERY LOW LEVEL.

THE FIFTH PART OF THE PRESENTATION WILL EXAMINE SPECIFIC FEATURES OF SAUDI PLANS FOR NEW REFINING CAPACITY OVER THE NEXT FIVE YEARS TOGETHER WITH THE WORLDWIDE IMPLICATIONS. THE DETAILS OF BOTH NEW DOMESTIC AND EXPORT REFINERIES WILL BE DISCUSSED WITH SOME EXPLANATION OF THE CONFIGURATION AND YIELD PATTERNS OF INTEREST TO TECHNICAL PARTICIPANTS AT THE CONFERENCE. SPECIAL EMPHASIS WILL BE GIVEN TO THE FACT THAT REVIEWS OF LIKELY TRENDS IN THE WORLD PRODUCT MIX SUGGEST THE NEED FOR CONVERSION CAPACITY TO YIELD A RELATIVELY HIGH PROPORTION OF LIGHT-END PRODUCTS IN NEW REFINERIES. THIS IS, OF COURSE, COMPATIBLE WITH THE LONG ESTABLISHED OPEC POLICY OF RECOGNIZING THAT, AS PETROLEUM BECOMES RELATIVELY SCARCE, SO PRODUCT USE WILL BE CONCENTRATED IN THE PREMIUM SECTORS WHERE THERE ARE NO ALTERNATIVES IN PROSPECTS, OR WHERE THEY REMAIN
UNECONOMIC. AS NEW SAUDI EXPORT REFINERIES COME ON STREAM, THERE WILL BE SOME SUBSTITUTION AT THE MARGIN OF EXPORT TRADE OF PRODUCTS FOR CRUDE, BUT WORLD TRADE IN OIL PRODUCTS WILL REMAIN RELATIVELY SMALL IN VOLUME COMPARED TO THE WORLD TRADE CRUDE OIL VOLUME. TOTAL OIL AVAILABILITY WILL REMAIN UNAFFECTED.

THE PRESENTATION WILL CONCLUDE WITH SOME OBSERVATIONS REGARDING THE INTRODUCTION OF REFINED PRODUCTS FROM NEW EXPORT REFINERIES IN SAUDI ARABIA AND MAYBE OTHER OPEC COUNTRIES, AND THE RELATIONSHIP TO MARKET PRICES.
Angel H. Behrends
Refining Coordinator
Petroleos de Venezuela S.A.
Caracas, Venezuela

William F. Burke
President
Powerine Oil Company
Santa Fe Springs, California

Charles A. Campbell
Vice President
Chem Systems, Inc.
New York, New York

Richard R. Dickinson
Vice President, Strategic Planning
Texaco, Inc.
White Plains, New York

George R. De Vaux
Executive Vice President
Hydrocarbon Research, Inc.
Lawrenceville, New Jersey

Lawrence J. Goldstein
Director of Research
Petroleum Industry Research Foundation, Inc.
New York, New York

John R. Hall
Vice Chairman and Chief Operating Officer
Ashland Oil, Inc.
Ashland, Kentucky

The Honorable J. Bennett Johnston
U.S. Senate
Washington, D.C.

John H. Lichtblau
Executive Director
Petroleum Industry Research Foundation, Inc.
New York, New York

Onnic Marashian
Editor-in-Chief
Platt's Oilgram News Service
McGraw-Hill, Inc.
New York, New York

James H. McDonald
Vice President, Business Analysis
Gulf Oil Company - U.S.
Houston, Texas

James R. Murphy
Mgr. of Process Technology
Pullman Kellogg
Houston, Texas

Walter L. Newton
Managing Director
Petroleum Economics Limited
London, England

Michaele Noble
International Editor
Platt's Oilgram News Service
McGraw-Hill, Inc.
New York, New York

Lucian S. Pugliaresi
Acting Deputy Assistant Secretary for Oil and Gas Policy and Evaluation
U.S. Department of Energy
Washington, D.C.

Dr. Gary N. Ross
Director of Research
New York, New York

Robert M. Scarborough
Mgr., Heavy Oil Operations
Dome Petroleum Limited
Calgary, Alberta, Canada

G. Henry M. Schuler
Director, International Affairs
Conant and Associates, Ltd.
Washington, D.C.
H.E. Abdulhady Hassan Taher  
Governor of Petromin  
General Petroleum & Mineral Organization (Petromin)  
Riyadh, Saudi Arabia

Lawrason D. Thomas  
Executive Vice President  
Amoco Oil Company  
Chicago, Illinois

Cheryl J. Trench  
Senior Economist  
Petroleum Industry Research Foundation, Inc.  
New York, New York

Philip K. Verleger, Jr.  
Lecturer and Senior Research Scholar  
School of Organization and Management  
Yale University  
New Haven, Connecticut

Morton M. Winston  
President and Chief Executive Officer  
Tosco Corporation  
Los Angeles, California

Frank G. Zarb  
General Partner  
Lazard Freres & Company  
New York, New York
In order to better enable us to offer meaningful and informative programs, we request that you take a moment to consider and evaluate the conference you have just attended and give us your comments.

Conference personnel will be happy to accept this completed evaluation. Of course, if you prefer, you may mail this to us at your earliest convenience.

NAME (Optional): ______________________ TITLE: ______________________

ORGANIZATION: ______________________

HOW DID YOU HEAR ABOUT THIS CONFERENCE? ______________________

WHAT WERE YOUR EXPECTATIONS? ______________________

WERE THEY MET? ______________________

IF NOT, HOW COULD YOUR EXPECTATIONS HAVE BEEN MET? ______________________

PLEASE GIVE US YOUR COMMENTS REGARDING FACILITIES, MEETING ADMINISTRATION, ETC. ______________________

PLEASE RATE EACH SPEAKER FOR DELIVERY AND CONTENT ON A SCALE OF 1-10 (10 being the highest):

<table>
<thead>
<tr>
<th>Date</th>
<th>Delivery</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>MONDAY, FEBRUARY 23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RICHARD R. DICKINSON (Conventional Crude Oil)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G. HENRY M. SCHULER (Conventional Crude Oil)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MORTON M. WINSTON (Nonconventional Crude—Shale)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANGEL H. BEHRENDTS (Nonconventional Crude—Venezuelan Heavy Crude)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROBERT M. SCARBOROUGH (Nonconv. Crude—Canadian Synthetics)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BRONISLAW DUTKIEWICZ (Nonconventional Crude—Coal Liquids)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hon. J. BENNETT JOHNSTON (U.S. Government Refining Policy)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WILLIAM F. BURKE (Crude Oil Price Decontrol)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JOHN R. HALL (Crude Oil Price Decontrol)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>JAMES H. McDONALD (Crude Oil Price Decontrol)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LUCIAN S. FUGLIARESI (Crude Oil Price Decontrol)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LAWRAHEON D. THOMAS (Crude Oil Price Decontrol)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
TUESDAY, FEBRUARY 24

FRANK G. ZARB (Crude Oil and its Alternatives)
JOHN H. LICHTBLAUL (Refined Product Requirements)
WALTER L. NEWTON (Refined Product Requirements)
CHARLES A. CAMPBELL (Refining Tech.—The State of the Art)
JAMES R. MURPHY (Refining Technology—The State of the Art)
H.E. ABDULHADY HASSAN TAKER (OPEC and Saudi Refining Policy)

PLEASE RATE THIS CONFERENCE AS A WHOLE, USING A SCALE OF 1-10
(10 being the highest):______________________

SHOULD THIS CONFERENCE BE HELD AGAIN? ________________________________

LOOKING AHEAD 3 TO 5 YEARS, WHAT DO YOU EXPECT WILL BE THE ONE OR TWO PRINCIPAL
PROBLEMS THAT YOUR ORGANIZATION WILL BE FACING? __________________________

ON WHAT OTHER TOPICS WOULD YOU LIKE TO SEE US DEVELOP CONFERENCES? ________________________________

ADDITIONAL COMMENTS:_____________________________________________________

We will, of course, continue to keep you informed of our future conferences. If
there is someone else who might be interested in receiving information about our
programs, PLEASE LIST THE FULL NAME AND ADDRESS:

NAME __________________ TITe __________________
ORGANIZATION ____________________________________________
ADDRESS __________________________________________________
CITY __________________ STATE ______________ ZIP __________

NAME __________________ TITe __________________
ORGANIZATION ____________________________________________
ADDRESS __________________________________________________
CITY __________________ STATE ______________ ZIP __________

Thank you for your cooperation. We hope that you will see the answers to some of
your needs reflected in our future conferences.
CRUDE OIL & REFINING
THE ECONOMICS
THE POLITICS

SPONSORED BY
PLATT'S OILGRAM NEWS AND
THE PETROLEUM INDUSTRY RESEARCH
FOUNDATION, INC.

FEBRUARY 23–24, 1981
WALDORF ASTORIA HOTEL
NEW YORK CITY

Delegate's Roster
Delegates' Roster
"Crude Oil & Refining: The Economics, The Politics"

Waldorf-Astoria - New York, N.Y.

Abdalla Abulaiha  
Marketing  
Brega Petroleum Marketing  
Tripoli, Libya

Ian R. Adamson  
Manager, Energy Resources  
Polysar Limited  
Sarnia, Ontario

M.H. Ajaj  
Managing Director  
Jeddah Oil Refinery  
Jeddah, Saudi Arabia

Indraman Akman  
Pertamina Head Office  
Jakarta, Indonesia

Zeb D. Alford  
Director of Fuel Supply  
New England Power Service  
Westborough, MA.

Sheikh Ahmed Alkhereiji  
Managing Director  
Petromin Lubricating Oil Refining Co.  
Jeddah, Saudi Arabia

Bader Khaleefah Al-Jassem  
Sales Assistant  
Kuwait National Petroleum Co.  
Safat, Kuwait

Douglas E. Allen  
Project Manager, Energy  
Royal Bank of Canada  
Calgary, Alberta

S.M. Allen  
Caltex Petroleum Corporation  
New York, New York

Faisal A. Al-Mudhaf  
Crude Oil Sales Representative  
Kuwait Petroleum Corporation  
Safat, Kuwait

Ebrahim Al Mutawa  
Qatar General Petroleum Corporation  
Doha - Qatar

Abdulla Hamad Al-Roumi  
Executive Assistant Managing Dir.  
Kuwait Petroleum Corporation  
Safat, Kuwait

Hussain Al-Shamma  
Crude and Special Products Mgr.  
Kuwait Petroleum Corporation  
Safat, Kuwait

Lennart Andersson  
Executive Vice President  
Oljekonsumenternas forbund  
Stockholm, Sweden

Kathleen Argiropoulos  
Asst. V.P. Law and Secretary  
Air Transport Ass'n. of America  
Washington, D.C.

William F. Ariano  
V.P., Crude Trade Relations  
Atlantic Richfield Company  
515 S. Flower St., #3155  
Los Angeles, CA.

Sanji Arisawa  
Manager Feedstock Purchasing Dept.  
Mitsubishi Petrochemical  
London, England

J.M. Armistead  
Gulf Oil Company-U.S.  
Houston, Texas

David J. Atton  
Mgr., Supply & Transportation Policy & Planning  
The Standard Oil Co. (Ohio)  
Cleveland, Ohio

Mr. Badeeb  
Petromin Lubricating Oil Refining Co.  
Jeddah, Saudi Arabia
Ernest A. Baetz
Senior Advisor
Exxon Corporation
New York, New York

Keith E. Bailey
President
Williams Pipe Line Company
Tulsa, Oklahoma

Giancarlo Baldassarri
Member of the Board
Sr. Executive Vice President
AGIP S.P.A.
San Donato Milanese, Italy

Robert W. Baldwin
President, Gulf Refining & Mktg. Co.
Gulf Refining & Marketing Co.
Houston, Texas

C.D. Bale
Senior Vice President
Gulf States Oil & Refining
Houston, Texas

J. Mike Bandy
Manager-Fuel Purchasing
Delta Air Lines, Inc.
Atlanta, Georgia

J. Luis Banos, Jr.
Ingram Corporation
New Orleans, Louisiana

Joseph F. Barbieri
Planning Advisor-Producing Dept.
Exxon Corporation
New York, New York

William G. Bares
Executive Vice President
The Lubrizol Corporation
Wickliffe, Ohio

Steve Barton
Barton Consultants
Geneva, Switzerland

Yousuf Basrawi
Manager-Petroleum Admin.
Saudi Arabian Airlines
Jeddah, Saudi Arabia

Edwin Bassler
Manager-Business Development
Stone & Webster Engineering Corp.
New York, New York

Raymond J. Batla, Jr.
Attorney
Hogan & Hartson
Washington, D.C.

Ludwig Bauer
General Manager
OMV-Aktiengesellschaft
Vienna, Austria

Jake Belin
Vice President-Supply
Kern County Refinery, Inc.
Houston, Texas

Sanni Bello
General Mgr., Kaduna Refinery,
Kaduna
Nigerian National Petroleum Corp.
Kaduna, Kaduna

Paul Bendel
Dorchester Gas Corporation
Dallas, Texas

Curt Benefield
Manager, Energy Planning
Valero Energy Corporation
San Antonio, Texas

Fred A. Bennett
Gulf Oil Exploration and Product Co., International
Houston, Texas

Jean-Baptiste Bergevin
Managing Director-Industrial and Commercial Division
SOQUIP
Ste-Foy, Quebec
Paul E. Bergevin
Vice President-Energy Dept.
Seattle-First National Bank
Seattle, Washington

Gary R. Bishop
Economist
Marathon Oil Company
Findlay, Ohio

E. Newbold Black, IV
Director of Marketing
The Badger Company, Inc.
Cambridge, Massachusetts

Carlos A. Blanco
International Marketing
Dept. Manager
Lagoven, S.A.
Caracas, Venezuela

Edward H. Blum
Executive Director
Merrill Lynch White Weld
Capital Markets Group
New York, New York

Pierre M. Boisvieux
Elf Aquitaine
Paris, France

Dr. John Boles
Ashland Oil, Inc.
Ashland, Kentucky

G.A. Bornemann
Dow Chemical, U.S.A.
Freeport, Texas

William H. Bosler
Principal
Booz, Allen & Hamilton
Houston, Texas

Andrew Botterill
General Mgr. Cargo Trading Div.
Mabanaft GmbH
Hamburg, Germany

M.L. Bowles
Managers
Champlin Petroleum Company
Tulsa, Oklahoma

James K. Bowman
General Manager
Mellon Service Company
Houston, Texas

R. Wallace Bowman
Sr. Vice President
Tosco Corporation
Los Angeles, California

Andrea Bressani
Agip Petroleum Co., Inc.
New York, New York

John Brewster
Guam Oil & Refining Co., Inc.
Dallas, Texas

Barry Brokaw
President
Petraco (USA) Inc.
Houston, Texas

Laura Brown
Research Assistant
Tosco Corporation
Washington, D.C.

Thomas P. Brown
President
Synthetic Crude Development Co.
Los Angeles, California

Neville Browne
Mktg. Representative
Trinidad & Tobago Oil Co., Ltd.
Port-of-Spain, Trinidad, W.I.

David H. Bruce
V.P.-International Sls.&Trading
Gulf Trading & Transportation Co.
Houston, Texas

Neil B. Bunis
Dir., Industry Studies
Conoco, Inc.
Stamford, Connecticut
Kenneth Butler  
President  
Vanguard Oil & Service Co., Inc.  
Brooklyn, New York

Robert F.J. Butler  
Director-Energy Affairs  
Reynolds Metals Company  
Richmond, Virginia 23218

Geoff H. Bye  
General Manager Sales  
Scallop Petroleum Company  
New York, New York 10020

Van Cammack  
Dir., Environmental Analysis  
ARCO Oil and Gas Company  
Dallas, Texas

J. Douglas Campbell, Jr.  
Manager-Mktg. & Refg. Plng. & Analysis and Regulatory Affairs  
The Standard Oil Co. (Ohio)  
Cleveland, Ohio

Edmundo Cardenas  
Scallop Corporation  
Maraven, Caracas

Dennis J. Carey, Jr.  
President  
Peerless Petrochemicals, Inc.  
Roslyn, New York

Lee R. Carlson  
Manager, Crude Oil Supply  
Oklahoma Refining Company  
Oklahoma City, Oklahoma

Angelo Carpentieri  
Petromin  
Riyadh, Saudi Arabia

Enrique Carrero  
Manager Foreign Trading  
CIBRO Sales Corp.  
New York, New York

Richard Carroll  
Director of Operations  
The Grimes Oil Co., Inc.  
Boston, Massachusetts

Robert Carroll  
Project Manager  
Sun Company  
Radnor, Pennsylvania

J. Carson  
Director of Fuels  
Florida Power & Light Company  
Miami, Florida

Margaret Carson  
Dir., Government Crude and Product Acquisitions  
Gulf Trading & Transportation Co.  
Houston, Texas

Orain N. Carter  
V.P., Petroleum Special Projects  
Farmland Industries, Inc.  
Kansas City, Missouri

Gonzalo Castillo  
Lagoven Co. S.A.  
Caracas, Venezuela

Margaret Chase  
Chase Manhattan Bank  
New York, New York

Y.S. Chen  
V.P. and Representative in U.S.A.  
Chinese Petroleum Corporation  
New York, New York

M. Ruben Chirinos  
Corpoven  
Caracas, Venezuela

Nicholas Cirillo  
Vice President  
Cibro Sales Corporation  
New York, New York

William V. Cirillo  
Vice President  
Cibro Sales Corporation  
New York, New York

Jim Clark  
Vice President  
DeWitt & Company  
Houston, Texas

Paula Clayton  
Attorney  
Standard Oil Company (Indiana)  
Chicago, Illinois
Fred Cochran  
Guam Oil & Refining Co., Inc.  
Dallas, Texas

Joseph E. Cochran, II  
Vice President  
Provident Energy Company, Inc.  
Phoenix, Arizona

Barry Cochrane  
V.P., Corp. Plnng.  
Norcen Energy Resources Limited  
Toronto, Ontario, Canada

I. Matt Coffman  
Price Projection Administrator  
Phillips Petroleum Company  
Bartlesville, Oklahoma

Patrick Coggins  
President  
Sun International, Inc.  
Wayne, Pennsylvania

John Coleman  
Treasurer  
Isthmus Energy Corporation  
Houston, Texas

Paul Collier  
Vice President-Plnng. & Admin.  
Amoco Oil Company  
Chicago, Illinois

Richard E. Conser  
Assistant Director  
UOP Process Division  
Des Plaines, Illinois

William W. Coogler, Jr.  
Union Carbide Corporation  
Danbury, Connecticut

Kathleen A. Cosgrove  
Administrative Assistant  
Ingram Corporation  
Washington, D.C.

Ramon Curiel  
Sub-Coordinator  
Petroleos De Venezuela, S.A.  
Caracas, Venezuela

Richard Cushner  
Synthetic Fuel Specialist  
Power Industry Personnel  
Groton, Connecticut

Ahmed A. Dadi  
President  
Total Development Corp.  
Farmington, Connecticut

Robert Daigle  
President  
Tipco Trading Company  
New Orleans, Louisiana

W. Robert Dalton  
Dir., Corp. Plnng. Group  
Gulf Oil Corporation  
Pittsburgh, Pennsylvania

Thomas Davis  
Mgr. of Plnng. Division, Planning & Analysis Dept.  
Exxon International, Inc.  
New York, New York

Terry W. Day  
Sr. Staff Plnng. Analyst  
Exxon Company, U.S.A.  
Houston, Texas

S. J. DeBruyn  
Caltex Petroleum Corporation  
New York, New York

Antonio De Cardenas  
V.P. Refining and Petrochemicals  
Hideca Petroleum Corporation  
Houston, Texas

David M. Delahay  
Income Tax Specialist  
Phillips Petroleum Company  
Bartlesville, Oklahoma

D.C. Delbridge  
Managers  
Champlin Petroleum Company  
Tulsa, Oklahoma
Delegates' Roster - page 6

Larry Delpit
President
Kern County Refinery, Inc.
Long Beach, California

Hishem Khattech Depuy
General Manager
Tunisian National Oil Co.
Tunis, Tunisia

John W. Dewes
V.P. and General Manager,
Cargo Transactions
Chevron International Oil Co.
San Francisco, California

Francois Didier
Director Strategic and Corporate
Planning
Elf Aquitaine
Paris, France

John L. Disney
Manager, Business Analysis Dept.
Arabian American Oil Company
Washington, D.C.

Terry Dobbins
Charter Oil
Jacksonville, Florida

Fred Dominey
Manager-Industry Economics
Cities Service Company
Tulsa, Oklahoma

R.E. Dougherty
General Manager
Caltex Petroleum Corporation
New York, New York

Richard Downey
Sr. Vice President
Tesoro Alaska Petroleum Company
Anchorage, Alaska

Fred W. Drogula
Attorney
Ginsburg, Feldman, Weil and Bress
Washington, D.C.

Charles Duke
Coordinator of External Affairs
and Operations Analysis
Champlin Petroleum Company
Fort Worth, Texas

Charles Dunlap
Vice President
Clark Oil & Refining Corporation
Dallas, Texas

J. Doug Dunn
Vice President - Purchasing
Delta Air Lines, Inc.
Atlanta, Georgia

R.S. Dunwald
Senior Advisor-Technical and
Economic Studies
Alberta Petroleum Marketing
Commission
Calgary, Alberta, Canada

James Easterlin
Mgr., Crude Oil Economics
Charter Oil Company
P.O. Box 4726
Jacksonville, Florida

George Edes
Vice President, Corporate Studies
Energy Cooperative, Inc.
Rosemont, Illinois

Donald B. Edmondo
General Mgr., Corp. Supply
and Distribution
Standard Oil Company (California)
San Francisco, California

Hisham El-Sid El-Fil
Planning Director
General Petroleum Corporation
Khartoum

Dr. Galal Fakhr El Din
Vice President
Petroleum Development Svs. Corp.
Guiza, Egypt

Nathan J. Emory
President
Corsican Corporation
Denver, Colorado

Bertil Ericson
Svenska Petroleum
Stockholm, Sweden

Donald Evans
Vice President
New Energy Corp. of Indiana
Washington, D.C.
Thomas L. Eveland  
V.P. of Government Affairs  
Kern County Refinery, Inc.  
Bakersfield, California

H. Philip Farnham  
Vice President  
GAF Corporation  
Wayne, New Jersey

Oladiran Fawibe  
Head, Crude Oil Mktg. Dept.  
Nigerian National Petroleum Corp.  
Lagos, Nigeria

Perrin Fay  
Vice President  
Standard Oil Company (California)  
San Francisco, California

R. Krug Fenz  
Associate  
Booz, Allen & Hamilton  
Houston, Texas

J.E. Fisher  
President  
Petrol Armada, S.A.  
Geneva, Switzerland

W.T. Flis  
CED Department Head  
Exxon Company, U.S.A.  
Baytown, Texas

Roy Foley  
Mgr., Planning Operations  
Gulf Oil Corporation  
Pittsburgh, Pennsylvania

Rolland G. Frakes  
Group Vice President  
Polysar Limited  
Sarnia, Ontario

Wm. C. Franklin  
Director Market Planning  
Saber Petroleum Corporation  
Houston, Texas

Bodo Fries  
Dir. Governmental & Industrial Affairs  
Mabanaft GmbH  
Hamburg, Germany

R.E. Funk  
Manager Planning  
Cities Service Company  
Tulsa, Oklahoma

Madison Galbraith  
Products Manager  
Petromer America, Ltd.  
New York, New York

Edwin Gambrell  
Mgr., North America Crude Sup.  
Dow Chemical U.S.A.  
Houston, Texas

P. Gilbert  
Caltex Petroleum Corporation  
New York, New York

Theodore H. Gilbert  
Mgr. Economic & Energy Analyst  
Scallop Corporation  
New York, New York

William Gillespie  
Director of Regulatory Economics  
Tosco Corporation  
Los Angeles, California

Terry Glasgow  
Sales  
Occidental Crude Sales  
Houston, Texas

Ray Glasscock  
Sr. V.P., Manufacturing  
Charter International Oil Co.  
Houston, Texas

Harry Glidden  
Specialist  
E.I. du Pont de Nemours, Central Research and Development  
Wilmington, Delaware

John Goff  
Mgr. Negotiations & Land Acquisitions  
Mobil Oil Corporation  
New York, New York

Juan Carlos Gomez  
Commercial Planning Coordinator  
Lagoven, S.A.  
Caracas, Venezuela
Max Gonzales
Vice President
Vedette Oil Refining, Inc.
Houston, Texas

Paul Grady
Corp. Purchasing Manager
General Electric Co.
Bridgeport, Connecticut

William C. Grant
Mgr. of Supply
Seaview Petroleum Company
Blue Bell, Pennsylvania

Patrick Grattan
Mgr., Business Planning
The Standard Oil Co. (Ohio)
Cleveland, Ohio

Pinky Green
President
Marc Rich & Co. Int'l., Ltd.
New York, New York

William Guazzo, Jr.
Special Projects Coordinator
Central Bank for Cooperatives
Denver, Colorado

Ing. Jorge F. Haiek
B.A. Capital Corporation
New York, New York

Brereton Hall
Business Analyst
Moore & Munger, Inc.
Fairfield, Connecticut

J.G. Hall
Vice President
Energy Cooperative, Inc.
Dallas, Texas

Jeffrey Harder
Attorney
Standard Oil Company (Indiana)
Chicago, Illinois

John E. Harris, Jr.
Vice President
Phillips Petroleum Company
Bartlesville, Oklahoma

Harry M. Hartzband
of Petroleum Products Dept.
Exxon Corporation
New York, New York

Brian Haskell-Thomas
Head, Crude Oil and Freight Trading
Shell U.K. Oil
London, England

C.D. Head
Cities Service Company
Tulsa, Oklahoma

Richard Headley
Sales Manager
Burmah Oil Tankers Limited
New York, New York

James L. Helm
Mgr. Lubes Plnng. and Economics
Sun Petroleum Products Co.
Wayne, Pennsylvania

Harold Henriquez
Minister Plenipotentiary for
Netherlands Antilles Affairs
Royal Netherlands Embassy
Washington, D.C.

Gunther E. Hering
Mgr., Strategic Planning
Fluor Corporation
Irvine, California

Luis Hernandez
Mgr. Information and Studies
Petroleos De Venezuela Corp.(USA)
New York, New York

Paul H. Hertel
Mgr., Strategic Assessment
Sun Petroleum Products Co.
Philadelphia, Pennsylvania

Lynn M. Hillman
General Mgr. - Crude Oil Sales
Gulf Trading & Transportation
Houston, Texas

William J. Hindson
Vice President
Gulf Canada Products Company
Toronto, Ontario, Canada
David A. Hinnawi  
Conoco, Inc.  
Houston, Texas  

Jeffrey W. Hobbing  
Executive Vice President  
Charter Oil Company  
Jacksonville, Florida  

James A. Holding  
Mgr.-Crude, NGL & Sulphur Supply  
Gulf Canada Products Company  
Toronto, Ontario, Canada  

C.Y. Hong  
Director, Plnng. Inform.&Coord.  
Ssangyong Oil Refining Co.  
Seoul, Korea  

David L. Hooper  
President  
Texota Oil Co.  
Abilene, Texas  

Robert I. Hooper  
Fluor Corporation  
Irvine, California  

W.H. Hopper  
Chairman and Chief Executive Officer  
Petro-Canada  
Calgary, Alberta  

Stig Host  
President  
International Energy Corporation  
Stamford, Connecticut  

W. N. Hsu  
Deputy Dir. of Mktg. & Transportation  
Department, Head Office  
Chinese Petroleum Corporation  
Taipei, Taiwan, China  

C. Edward Hudgins  
Mgr. Financial Services  
Sun Petroleum Products Company  
Wayne, Pennsylvania  

James Hudick  
Burmah Oil Tankers Limited  
New York, New York  

John Humphreville  
Vice President  
Blyth Eastman Paine Weber  
New York, New York  

Elmer L. Jacobs  
President  
Conti Carriers & Terminals, Inc.  
Des Plaines, Illinois  

Mohammed Jamil  
Market Research Department  
Petromin  
Riyadh, Saudi Arabia  

Robert L. January  
Poten & Partners, Inc.  
New York, New York  

James T. Jensen  
President  
Jensen Associates, Inc.  
Boston, Massachusetts  

Stanley H. Johansen  
Sr. Plnng. Analyst  
Champlin Petroleum Co.  
Fort Worth, Texas  

Dr. T.M. John  
Refinery Manager  
Nigerian National Petroleum Corp.  
Lagos, Nigeria  

Axel R. Johnson  
V.P.-Business Development  
Stone & Webster Engineering Corp.  
New York, New York  

Earl L. Johnson  
General Mgr.-Producing Eastern Hemisphere  
Texaco, Inc.  
White Plains, New York  

John G. Johnson, Jr.  
Mgr.-Fuels & Chemicals Plnng.  
Atlantic Richfield Co.  
Los Angeles, California  

Robert L. Johnson  
Mgr. Environmental Analysis  
Mobil Oil Corporation  
New York, New York
Guy Joly
LPG Division Manager
INTSEL Corporation
New York, New York

Mary S. Jones
Union Pacific Corporation
New York, New York

Victor P. Jucker
AGIP - U.S.A., Inc.
New York, New York

Fred Kalian
Sr. Vice President
Charter Crude Oil Company
Houston, Texas

John H. Kalmbach
Assistant to the President
Pauley Petroleum, Inc.
Los Angeles, California 90067

Franz Kalwach
Director
OMV-Aktiengesellschaft
Vienna, Austria

Hiromi Kanagawa
Executive Vice President
Maruzen Oil of U.S.A., Inc.
New York, New York

John A. Kaneb
Chairman
Northeast Petroleum Industries
Chelsea, Massachusetts

E.M. Keely
Energy Compliance & Reporting Mgr.
Cities Service Company
Tulsa, Oklahoma

William F. Kenny, III
President
Meenan Oil Company, Inc.
Syosset, New York

Ahmed Al Khereiji
Petromin
Riyadh, Saudi Arabia

Sheikh Bakar Khoja
Petromin Lubricating Oil Refining Co.
Jeddah, Saudi Arabia

R.R. Kiehle
Mgr., Analysis/Support-Plans
& Analysis-Oil
Shell Oil Company
Houston, Texas

Michael J. Kies
Vice President, Government Rels.
Clark Oil & Refining Corporation
Milwaukee, Wisconsin

John Kildea
Mgr., Advanced Technology Coordination
Gulf Refining & Marketing Co.
Houston, Texas

Bob Kimmel
Executive Vice President
Questor Petroleum Corporation
Houston, Texas

Edith Kinloch
Director, Industry Analysis
Atlantic Richfield Co.
Los Angeles, California

Gordon D. Kirk
President
Sun Petroleum Products Co.
Philadelphia, Pennsylvania

Bill Klesse
Mgr., Unit Plng.
Oil and Gas Unit, Diamond Shamrock Corporation
Amarillo, Texas

Magnus Konow
2nd Vice President
Continental Bank
Chicago, Illinois

Michael Kratochwill
V.P., Business Development
Badger America, Inc.
Cambridge, Massachusetts

Kunjiro Kusuyama
General Mgr., Petroleum Dept.
Japan Line, Ltd.
Chiyoda-Ku, Tokyo
Delegates' Roster - page 11

Thomas Laity
Economic Support Manager
Shell Oil Company
Houston, Texas

Richard Lakier
Planning Coordinator
Northern Petrochemical Co.
Omaha, Nebraska

Edward M. Lakusta
Vice President
Gulf Oil Company-U.S.
Houston, Texas

M.G. Langhorne
V.P., Mktg., Refining and Transportation
Hunt Oil Company
Dallas, Texas

Kenneth A. Le Mesurier
Government of Canada
Ottawa, Ontario, Canada

Angelo Lemma
Kuwait National Petroleum Co.
Western Hemisphere (K.S.C.)
Safat, Kuwait

John Liberatore
Mgr., Economics & Plnng.
Sun Oil Trading Co.
Wayne, Pennsylvania

Peter Lilley
Oil Analyst
W. Greenwell & Co.
London, England

Charles G. Lindberg
Atlantic Richfield Company
Los Angeles, California

Richard Lindsay
General Mgr., Plng. & Stgic. Studies
Gulf Trading & Transportation
Houston, Texas

K. Liu
Caltex Petroleum Corporation
New York, New York

Thomas C. Lockhart
Petraco (USA) Inc.
Houston, Texas

Curtis W. Loftin
Sr. Vice President-Corp. Plnng. & Development
The Charter Company
Jacksonville, Florida

Harry A. Logan, Jr.
President & C.E.O.
United Refining Co.
Warren, Pennsylvania

Eugene S. Lubarsky
Vice President
A. Johnson & Co., Inc.
New York, New York

Robert Luckner
Planning Advisor
Exxon Company, U.S.A.
Houston, Texas

Peter Luitweiler
Vice President-Crude Oil Dept.
Gulf Oil Company - U.S.
Houston, Texas

Cheri Lundin
Legal Assistant
Standard Oil Company (Indiana)
Chicago, Illinois

Richard F. Lynch
Director, Planning & Analysis
Tosco Corporation
Los Angeles, California

Hugh Macnaughton-Jones
Manager
New York, New York

Raymond E. McDonald
Manager, Crude Oil Supply & Dist.
Sun Petroleum Products Company
Philadelphia, Pennsylvania

Leighton McGregor
Manager
Trintoc Services Ltd.
New York, New York
Kenneth R. Masters  
Director - Refining Planning  
Farmland Industries  
Kansas City, Missouri

Jeffrey Matthews  
Industry Analyst  
Merrill Lynch, Inc.  
New York, New York

Gunter Meyer  
General Manager  
Klockner & Co., Oil and Oil Products  
Duisburg, West Germany

Joseph Miller  
Manager, International Marketing  
Union Texas Petroleum Corporation  
Houston, Texas

Donald P. Mitchell  
Vice President  
The Louisiana Land and Exploration Company  
New Orleans, Louisiana

Paul MLotok  
Energy Analyst  
Cyrus J. Lawrence Incorporated  
New York, New York

Paul McKim  
Vice President  
Texas Eastern Corporation  
Houston, Texas

Stephen Maresca  
Energy Analyst  
Argus Research Corporation  
New York, New York

L. W. Marshall  
Senior Vice President  
Tenneco Oil Company  
Houston, Texas

Tim Martin  
Staff Engineer  
Coastal States Petroleum Company  
Houston, Texas

Mayo Martinez  
Petroleum Products Superintendent  
Petroleos Mexicanos  
Mexico, Distrito Federal

Luis Mora  
Corporate Planning Director  
CEPSA  
Madrid, Spain

H. P. Morgan  
Fuel Engineer  
Florida Power Corporation  
St. Petersburg, Florida

Jose Mulet  
Supply Manager  
Petroleos del Mediterraneo, S.A.  
Madrid, Spain

D. R. Muller  
Assistant Manager  
Caltex Petroleum Corporation  
New York, New York

Edward Murphy  
Director, Statistics Dept.  
American Petroleum Institute  
Washington, D.C.

Julia Nanay  
Assistant  
Northeast Petroleum Industries, Inc.  
Boston, Massachusetts

Takashi Nemoto  
Manager  
Y. S. Line (U.S.A.) Corporation  
New York, New York

Mark G. Newgard  
Vice President Supply and Trading  
Oasis Petroleum Corporation  
Culver City, California

Hugh Newman  
Saber Refining  
New York, New York

David Norr  
Lieber & Co.  
Harrison, New York

Musallam A. Nuwailati  
General Manager  
General Petroleum & Mineral Services  
Houston, Texas
Delegates' Roster - page 13

Peter O'Callaghan
Operations Manager
Irish National Petroleum Corp.
Dublin, Ireland

Y. Okamura
General Manager and V.P.
Idemitsu Apollo Corp.
Tokyo, Japan

James A. O'Neill, Jr.
President
Ingram Corporation
New Orleans, Louisiana

Roberto Osegueda
Foreign Commerce Asst. Mgr.
Petroleos Mexicanos
Mexico

Mario Pacheco, Jr.
President - Director
Mapa and Mapa Caribe Oil and Trade Company, S.A.
Rio De Janeiro, Brasil

George Pappas
Dir. Supply & Transportation
Ec. & Planning
Charter Oil Company
Jacksonville, Florida

John Parziale
Mgr., Crude Oil Purchases and Sales
Marathon Oil Company
New York, New York

Dr. Giorgio Paulucci
President
AGIP Petroleum Co., Inc.
New York, New York

Barry R. Pearl
Mgr.-Plnng. & Economics
Champlin Petroleum Company
Fort Worth, Texas

Dr. Luigi Perini
Montedison U.S.A., Inc.
New York, New York

Richard C. Perry
Director, Hydrocarbons Supply Planning
Union Carbide Corporation
Danbury, Connecticut

John R. Petrie
Manager, Mktg. Operations
Petrosar Limited
Sarnia, Ontario, Canada

A.J. Phipps
Mgr., Plnng. & Eval.
Tenneco Oil Processing & Mktg.
Houston, Texas

Anthony C. Pichnarcik
Vice President
Provident Energy Co., Inc.
Phoenix, Arizona

Frederick Pickering
Vice President
Citibank, N.A.
New York, New York

Victor E. Pierce
M.W. Kellogg
Houston, Texas

John F. Pittas
President
UOP Process Division, UOP, Inc.
Des Plaines, Illinois

Elsa S. Polatajko-Lobos
Business Plnng. & Development
Analyst-Chemicals Division
Polysar Limited
Sarnia, Ontario, Canada

R.M. Ponder
Managers
Champlin Petroleum Company
Tulsa, Oklahoma

Giuseppe Poropat
Executive V.P. Mktg. & Dev.
AGIP Petroleum Co., Inc.
New York, New York
Delegates' Roster - page 14

Eraldo Porto  
Petrobra's  
Rio De Janeiro, Brasil

Jose Prats  
Scallop Corporation  
Maraven, Caracas

Sharyn Preddy  
President  
Carlson & Associates, Inc.  
Houston, Texas

Charles R. Puckett  
V.P. Finance and Administration  
An-Son Transportation Co.  
Oklahoma City, Oklahoma

Jacques Puech  
If Aquitaine  
Paris, France

Juan Pulgar  
Lagoven Co. S.A.  
Caracas, Venezuela

Pondrung Rajagopal  
Manager-Crude Oil  
Earth Resources Co.  
Dallas, Texas

Marvin L. Ralston  
President  
Geoman  
Houston, Texas

Robert Reasor  
President  
Copano Refining Company  
San Antonio, Texas

David Rees  
Supply and Marketing Mgr.  
Volvo Energy Corporation  
Gothenburg, Sweden

March Rich  
Chairman of the Board  
New York, New York

Donald A. Rickett  
V.P., Economics & Plnnng.  
Charter Crude Oil Co.  
Houston, Texas

R.J. Riddell  
Gulf Oil Company, U.S.  
Houston, Texas

Vince Risi  
Operations  
PVM Oil Associates, Inc.  
New York, New York

R.F. Roberts  
Vice President, Economics  
Charter International Oil Co.  
Houston, Texas

John Robertson  
V.P., Corp. Development  
Ultramar Canada, Inc.  
Don Mills, Ontario, Canada

J.J. Rodrigueq  
President  
Vedette Oil Refining, Inc.  
Houston, Texas

Michael L. Rose  
Vice President  
Peerless Petrochemicals, Inc.  
Roslyn, New York

John Rossiter  
President-Union 76 Division  
and Sr. V.P.  
Union Oil Co. of California  
Los Angeles, California

Thomas Roth  
V.P. Crude Oil Supply  
Tosco Corporation  
Los Angeles, California

Heather Rowland  
Planning Coordinator  
BP North America Trading, Inc.  
New York, New York

Charles Roxburgh  
Exxon Co., U.S.A.  
Houston, Texas

Juan J. Ruegar  
Lagoven, S.A.  
Caracas, Venezuela

William Rusher  
V.P., General Manager  
Ethyl Overseas Development Corp.  
Baton Rouge, Louisiana
Delegates' Roster - page 15

John W. Ruth
Senior Technical Advisor Light Oils
Sun Petroleum Products Co.
Philadelphia, Pennsylvania

Javier Santamaria
Secretary General
Petroleos del Mediterraneo, S.A.
(PETROMED)
Madrid, Spain

Cornelius Santos
Executive President
Petrosur Enterprises Inc. and
Richard Santos Int'l., Inc.
Malibu, California

Kazuo Sawada
Assistant Secretary
Nippon Oil (Delaware) Ltd.
New York, New York

M. O. Sayes
General Manager - Marine
Jeddah Oil Refinery
Jeddah, Saudi Arabia

John Scansaroli
Director - New Business Development
Engelhard Minerals & Chemicals
Corporation
Edison, New Jersey

Fred W. Schaffert
Manager Business Development
Huffco Energy Systems
Houston, Texas

Dieter Schroer
Chief Liaison Officer
The Lurgi Companies
New York, New York

Leonard Schuman
President
Petromer America, Ltd.
New York, New York

D. J. Schwiderski
Crude Oil Representative
Conoco
Houston, Texas

Charles Searle
Chief Petroleum Planner
NYS Energy Office
Albany, New York

A. J. Seaton
General Manager
Petromin Lubricating Oil Refining
Company
Jeddah, Saudi Arabia

Warren R. Sedlacek
Vice President, Marketing
UOP Process Division, UOP Inc.
Des Plaines, Illinois

William Swuren
Manager - Liquids Marketing
The Louisiana Land and Exploration
Company
New Orleans, Louisiana

Paul Sheedy
Vice President Crude Oil & Refining
Huffco Energy Systems
Houston, Texas

R. M. Shillington
Senior Advisor
Alberta Petroleum Marketing
Commission
Calgary, Alberta, Canada

Kenneth C. Shovlar
Manager - Supply & Industry Analysis
Shell International Petroleum
Company Limited
London, England

John W. Sibal
Director of Government Affairs
Ingram Corporation
Washington, D.C.

W. P. Siderius
President
Energy Cooperative, Inc.
Rosemont, Illinois

Dileep N. Sirur
Manager, Crude Strategic Planning
AtlanticRichfield Co.
Los Angeles, California

Norton Smirlock
Manager, Energy Regulatory Coord.
Atlantic Richfield Company
Los Angeles, California

Albin W. Smith
Senior Vice President
The Coastal Corporation
Houston, Texas
Delegates' Roster - page 16

Albin W. Smith
Sr. Vice President
The Coastal Corporation
Houston, Texas

Monte G. Smith
Sr. Vice President
Bonner & Moore
Houston, Texas

Walter F. Smith
Vice President
Creole Crude Company
Tulsa, Oklahoma

Warren A. Smith
Mgr., Crude Oil Coordinator
Gulf Oil Exploration &
Production Company, Int'l.
Houston, Texas

Edward T. Smolarski
Sr. Vice President
Tosco Corporation
Los Angeles, California

S.A. Soeramoelina
Research Dept.
Pertamina
Los Angeles, California

Milos Soudek
Vice President
Coastal States Petroleum Company
Houston, Texas

Frank R. Spadine
Assistant Manager
Caltex Petroleum Corp.
New York, New York

Robert Speir
Dir. Div. of Validation Research
Dept. of Energy-Energy
Information Admin.
Washington, D.C.

Gary Sproule
Economic Analyst
Union Oil Company of California
Los Angeles, California

Branko Srenger
President
Petraco Group of Companies
3 Princes Street
London, England

Ernie W. Stamper
Vice President
Ashland Petroleum Co.
Ashland, Kentucky

Charles A. Steen
Administration Manager
Southwestern Refining Co., Inc.
Corpus Christi, Texas

O.A. Stephen
Process Engineer
Nigerian National Petroleum Corp.
Kaduna, Nigeria

Leonard P. Steuart
President
Steuart Petroleum Co.
Washington, D.C.

Cam Stiernberg
Energy Banking Officer
First City National Bank of
Houston
Houston, Texas

Jack R. Stitt
Sr. Vice President-Sales
and Marketing
The Lubrizol Corporation
Wickliffe, Ohio

Gilbert W. Stockwell
Mgr., Manufacturing & Oil
Supply Dept.
Aramco Services Co.
Houston, Texas

Dirk J. Stronck
President
Sidco Oil Co., Inc.
Houston, Texas

F.X. Stuart
Mgr., Project Development
Gulf Trading and Transportation
Houston, Texas
William Sudhaus
Vice President
Coral Petroleum, Inc.
Houston, Texas

M.S. Sulaiman
Qatar General Petroleum Corp.
Doha-Qatar, Arabian Gulf

Henry W. Sullivan
Shell Oil Company
Houston, Texas

Mahmoud Abdullah Sultan
Chairman & Managing Dir.
Petromin Lubricating Oil Co.
Jeddah, Saudi Arabia

Jachja Sumitramidhardja
Pertamina Head Office
Jakarta, Indonesia

H. Jay Surrena
Mgr., Strategic Plnng.
Sun Petroleum Products Co.
Philadelphia, Pennsylvania

Thomas G. Swanson
Mgr.-Purchasing, Chemical Div.
Georgia-Pacific Corp.
Houston, Texas

Robert G. Szabo
Attorney
Van Ness, Feldman & Sutcliffe
Washington, D.C.

C.F. Tebo
V.P.-RMT Plnng. & Correlation
Cities Service Co.
Tulsa, Oklahoma

D.J. Thomson
V.P., Supply and Transportation
Gulf Trading and Transportation Co.
Houston, Texas

Gough W. Thompson, Jr.
President
East-West Group, Ltd.
Princeton, New Jersey

R.H. Thrash
Superior Oil
Houston, Texas

Richard J. Thumser
Asst. Mgr.-Trading & Acquisitions
Mobil Sls and Supply Corp.
New York, New York

John T. Tippit
General Mgr. Latin Amer./West Africa-Refining
Texaco, Inc.
Coral Gables, Florida

Fred Tracy
General Mgr.-Supply
Northville Industries Corp.
Melville, New York

Joaquin Tredenick
Lagoven, S.A.
Caracas, Venezuela

Walter A. Trost, Jr.
Mgr., Refining & Product Supply Planning
Mobil Oil Corporation
New York, New York

A. Tsuboi
Manager of Cargo Trading
Idemitsu Apollo Corporation
New York, New York

Toru Tsuneki
Nippon Oil
New York, New York

Anthony Turano
Vice President Corp. Plnng.
Commonwealth Oil Refining Co.,Inc.
San Antonio, Texas

Michael D. Tusiani
Poten & Partners, Inc.
New York, New York

Herbert F. Uhlig
Manager
Stone & Webster Engineering Corp.
New York, New York
Robert G. Wallace
Executive Vice President
Phillips Petroleum Co.
Bartlesville, Oklahoma

Michael D. Ware
President
Fuel & Energy Consultants, Inc.
New York, New York

Thomas W. Warren
Group Vice President
Pennzoil Company
Houston, Texas

Bill Waycaster
Business Mgr.
Dow Chemical U.S.A.
Houston, Texas

Erich R. Westfield
Product Supply & Distribution Planning Manager
Getty Refining & Mktg. Co.
Tulsa, Oklahoma

Christian Weyer
F.E.V.P.
BPPB (Suisse) S.A.
Geneva, Switzerland

J.W. White
Caltex Petroleum Corporation
New York, New York

Ray M. Whitmire, Jr.
President
Texas Oil Traders, Inc.
Houston, Texas

D.D. Williams
Sr. Fuel Engineer
Florida Power Corporation
St. Petersburg, Florida

Robert G. Williams
Mgr. Mktg. Development
Bonaire Petroleum Corp., NV
New York, New York

Professor Bayly Winder
East-West Group, Ltd.
Princeton, New Jersey
Wesley M. Witten  
Vice President-Crude Supply  
Atlantic Richfield Co.  
Los Angeles, California

Luis Wolff  
Hideca Petroleum Corp.  
Houston, Texas

Arnold Wolgast  
Plnng. & Analysis Dept. Mgr.  
Exxon International Co.  
New York, New York

Graham Worton  
Vice President  
Asphalt International, Inc.  
Fort Lauderdale, Florida

Shunzo Yamada  
Dir. Foreign Rels.  
Nippon Oil Co., Ltd.  
Tokyo, Japan

Robert Yancey  
President  
Ashland Oil, Inc.  
Ashland, Kentucky

Louis H. Yardumian  
Sr. Vice President  
Tosco Corporation  
Los Angeles, California

Peter Young  
Liaison Manager  
ICI Americas, Inc.  
Wilmington, Delaware

Claude Lee Young  
Manager  
Trinidad and Tobago Oil Co., Ltd.  
Port-of-Spain, Trinidad, W.I.

Mohamed Yousef  
Mktg.  
Brega Petroleum Mktg. Co.  
Tripoli, Libya

Abdul Aziz Zamzami  
Asst. Deputy Governor  
Petromin Riyadh  
Riyadh, Saudi Arabia

Oliver Zandona  
Sr. Vice President  
Ashland Petroleum Co.  
Division of Ashland Oil, Inc.  
Ashland, Kentucky

Guido Zerbino  
V.P. of Business Development  
AGIP Petroleum  
New York, New York