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EVALUATION ENGINEERS

1969-1970

VOLUME II
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"A Proposed Industry Inventory of Our Fuel Resources"
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by Charles F. McCoy

"Government Influence on Industry Operations"
by Granville Dutton

"Preparation of Engineering Appraisal Reports"
by Tom G. Calhoun II

"Rulison-Nuclear Stimulation"
by C.W. Leisk
HISTORY

There has long been a need for a Society which would bring together for their mutual benefit the specialists in petroleum evaluation engineering. Realizing this need, Harold Vance, William Hurst and H. F. Poyner, Jr. secured a charter from the State of Texas for such a Society which is known as "The Society of Petroleum Evaluation Engineers." The number of the charter setting up such a corporation is No. 187252 and was issued by the Secretary of the State of Texas on September 24, 1962.

This corporation was chartered under the Texas Non-Profit Corporation Act and its period of duration is perpetual. The corporation was organized exclusively for educational purposes and to promote the profession of petroleum evaluation engineering, to foster the spirit of scientific research among its members, and to disseminate facts pertaining to petroleum evaluation engineering among its members and the public.

The various, technical associations, such as the American Institute of Mining, Metallurgical, and Petroleum Engineers, the American Association of Petroleum Geologists, and even the requirements of our engineering laws, provide no measure of the experience and ability of an individual in petroleum evaluation. Therefore, a need for this specialized Society is self-evident.
MEMBER QUALIFICATIONS

Any person with a bachelor's or advanced degree in engineering or geology, duly licensed by his state as a professional engineer or geologist and ten years' experience in the evaluation of oil and gas properties may qualify to become a member. In the event his state has no professional engineering or geological license laws, the person shall be able to meet the requirements for a license in either of these categories in another state having such laws. Also, a person may substitute five years' responsible petroleum engineering experience or teaching of the subject in a college or university of recognized standing for five years' experience in the evaluation of oil and gas properties.
THE PRESIDENT’S PAGE

The Society of Petroleum Evaluation Engineers was founded in 1962 to bring together for their mutual benefit the specialists in petroleum evaluation engineering. During the past seven and one-half years about one hundred engineers have met the qualifications and been accepted as members of our Society. Undoubtedly the membership will continue to grow even though no concerted efforts have been made to enlarge the membership purely for the sake of numbers. Qualified applicants are certainly welcome and I believe we should make an effort to invite those who are qualified but not now members to apply for membership.

Mutual benefits have already accrued to the members who have attended and participated in the annual and bi-monthly luncheon meetings. Through the exchange of ideas and the presentation of papers covering petroleum evaluation each participant has broadened his scope. Your officers and directors hope to have included in the 1970 annual meeting the discussion of subjects which will prove very informative to those engaged in petroleum evaluation. In order to be of maximum benefit, the participation must include a large percentage of our members.

Even though the Society members are fully qualified to perform petroleum evaluations, neither they nor the public receive the maximum benefits unless the latter are aware of the services offered. Of course a wider acceptance will benefit the petroleum evaluation engineer financially and provide an identity, both individually and collectively, which we have not previously enjoyed. The executive committee is trying to gain more recognition for the Society and its members among the financial community, governmental agency members and oil and gas producers who would be better served with proper petroleum evaluations. We solicit your help in this endeavor.

The 1969 annual meeting had a “nuclear” theme and included a trip to the nuclear test site near Las Vegas, Nevada. Several with the Atomic Energy Commission deserve our thanks for making our meeting and field trip so successful. We especially want to thank Messrs. Dean Thornbrough and Leo Woodruff with the AEC for their active participation in our program.
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A PROPOSED INDUSTRY INVENTORY OF OUR FUEL RESOURCES

by David M. Evans, Director, Potential Gas Agency

Mineral Resources Institute, Colorado School of Mines, Golden, Colorado

By permission of A.I.M.E.

The paper was previously presented before the Council of Economics

At the Annual A.I.M.E. Meeting

February, 1969

"The human proclivity for capturing an ever larger fraction of the total flux of the energy of the earth, and eventually for tapping the large supplies of stored energy, has had the effect of continuously upsetting the ecological equilibrium in the direction of an increase in the human population."—M. King Hubbert in "Energy Resources," A Report to the National Academy of Sciences—National Research Council.1

INTRODUCTION

The worldwide population and energy explosions are like the hen and the egg. However, today, the question "Which came first?" is academic. Experts tell us that by the year 2000 United States population will be up 40 percent (to about 280 million people), and our energy needs will be up 40 percent per person (to about 315 million Btu).2

Recently, the population and energy explosions have been joined by another—worldwide pollution of our environment. A start has been made on pollution but much more must be done, as we shall see.

Industry can, and will, supply the needed energy, but the problem is complex and will require careful planning. Periodic inventories of all energy available at current prices and operating conditions must be made.

In order to keep up with the fast-changing energy industry of the future we must learn to think in terms of the energy available from each fuel—Btus instead of tons, cubic feet or barrels. Such terms as "reserves" must have the same meaning throughout the industry or costly miscalculations can result. Here are three examples of what is already happening.

First, the Atomic Energy Commission (AEC) has announced that by 1980 nuclear power plants will be generating about 25 percent of the nation's electric power—yet the total U.S. reserves of uranium ore available at today's prices and technology are about one-fourth the requirements of the planned reactors.

Second, a large gas company recently said in its annual report, "Mincable reserves of coal in the United States have been estimated at 830 billion tons. If used solely for gasification, this volume of coal would be sufficient to produce gas for 700 years at the present rate of gas consumption."

How much of the coal mentioned in the annual report is commercial—comparable to the proven reserves of oil and natural gas reported by the petroleum industry? Twenty (20) billion tons, or about 21/2 percent of the 830 billion tons mentioned in the report.

Third, United States oil shale policy was recently determined, in part, by reports that oil reserves in federally-owned oil shale lands "... contains 2 trillion barrels of shale oil, which conservatively is estimated to be worth $2.5 trillion—or enough for $40,000 for each American household. Its market value may be twice that ..."

How much of the oil can be recovered from oil shale and sold at a profit? Not one drop. As one wit in the Colorado oil shale country commented, "Talking about the trillions of dollars worth of oil in shale is like talking about the billions of dollars worth of granite tombstones in Pikes Peak awaiting development. The trick is to sell them at a profit."

We need a periodic inventory of the amount of energy available from each fuel. This inventory must report the fuel reserves available at current prices and technology. Further, these estimates must be available to everyone. Would a public utility company go ahead with plans to build an $80-million nuclear generating plant if it knew that the fuel for the plant had not yet been found?

Would the gas company management feel as confident about manufacturing gas from coal if it knew the "minable reserves" it was counting on includes coal seams 14 inches thick at a depth of 3,000 feet—and that economics were not a factor in estimating the reserves? I doubt it.

It is not enough to know that a certain tonnage of fuel is waiting to be dug out of the ground. What is important is to know how much energy can be produced at a profit under existing operating conditions. M. A. Adelman,3 Professor of Economics at Massachusetts Institute of Technology, recently said, "Whether fossil fuels (and also uranium) will be found within our borders in sufficient amounts is no more meaningful than whether there is enough gold dissolved in sea water to expand gold liquidity and cure balance-of-payments problems. There is many times as much gold as we could possibly use, but the cost is prohibitive."

KNOWN RECOVERABLE VS. COMMERCIAL RESERVES

Are any estimates made of the energy available from fuels under current economics and operating conditions? Yes. Such estimates are made periodically for
crude oil, natural gas, and natural-gas liquids. They are not made for the other fuels—coal, oil shale, or nuclear fuels. However, rough estimates can be made using the data published in the authoritative study, "Energy R&D and National Progress," prepared by the Energy Study Group under the direction of Ali Bulent Cambel.4

Column 1 in table 1 lists "Known recoverable reserves" of fossil fuels and "Known deposits of U₃O₈ at $5-$10/lb". (Reproduced from tables 3-1 and 3-8, pages 91 and 106 of the R&D Study.) Column 2 is a tabulation showing estimated reserves recoverable under existing economic and operating conditions. The evidence for the estimates in column 2 is given in the following discussion for each fuel. In addition to reporting the conventional units of each fuel, the energy equivalent is given in Q (quintillion Btu = 10¹⁸ Btu).

The total energy available from "known recoverable fossil fuel reserves" plus "known deposits" of uranium at $5 to $10 per pound of U₃O₈ is reported by the R&D Study Group (R&D) as 27.5 Q. The amount of this energy available at current prices and technology is about 1.21 Q. (Figs. 1 & 2.)

CRUDE OIL, NATURAL GAS AND NATURAL-GAS LIQUIDS

Petroleum is defined as "... gas, liquid, semi-solid, or solid, or in more than one of these states at a single place. Chemically any petroleum is an extremely complex mixture of hydrocarbon compounds, with minor amounts of nitrogen, oxygen, and sulphur as impurities".5

Petroleum reserves, called "proved reserves", are defined as "... the estimated quantities of crude oil, natural gas, and natural-gas liquids which geological and engineering data demonstrate with reasonable certainty to be recoverable from known reservoirs under existing economic and operating conditions." These estimates are a compilation of estimates by several hundred industry engineers and geologists organized into committees under the direction of the industry associations—the American Gas Association (A.G.A.) and the American Petroleum Institute (API).

The proved reserves shown in column 2, table 1, for crude oil, natural gas, and natural-gas liquids, are the latest estimates available (31 December 1967). The crude oil reserves in columns 1 and 2 include in addition 16 billion barrels of oil considered "... economically recoverable by established secondary-recovery methods as estimated by the Interstate Oil Compact Commission (IOCC) as of 1 January 1962." (R&D, p. 97).

In addition to the estimates reported here, A.G.A., API and Independent Natural Gas Association of America (INGAA) also support an industry study that periodically estimates the undiscovered quantities (potential supply) of natural gas. This study is conducted by industry and government geologists and sponsored by the Colorado School of Mines.

The "proved reserves" estimates are the best energy estimates available. However, they should be augmented by regular estimates of the oil recoverable by secondary-recovery methods as was done in 1962 by the IOCC. In addition, the industry should follow the example of the natural gas industry in making regular estimates of the potential supply of crude oil and natural-gas liquids.

TABLE 1. Estimates of fossil and uranium fuel reserves of the United States

<table>
<thead>
<tr>
<th>Fuel</th>
<th>(1) Known Recoverable Reserves</th>
<th>(2) Reserves Recoverable Under Existing Economic and Operating Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fossil:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Petroleum (crude oil)</td>
<td>48 x 10⁶</td>
<td>47 x 10⁶</td>
</tr>
<tr>
<td></td>
<td>(0.278 Q)</td>
<td>(0.276 Q)</td>
</tr>
<tr>
<td>Natural gas</td>
<td>268 x 10¹²</td>
<td>293 x 10¹²</td>
</tr>
<tr>
<td></td>
<td>(0.279 Q)</td>
<td>(0.290 Q)</td>
</tr>
<tr>
<td>Natural-gas liquids</td>
<td>7 x 10⁹</td>
<td>9 x 10⁹</td>
</tr>
<tr>
<td></td>
<td>(0.032 Q)</td>
<td>(0.034 Q)</td>
</tr>
<tr>
<td>Coal</td>
<td>220 x 10⁹</td>
<td>20 x 10⁹</td>
</tr>
<tr>
<td></td>
<td>(1.45 Q)</td>
<td>(0.42 Q)</td>
</tr>
<tr>
<td>Oil in bituminous rocks</td>
<td>1.3 x 10¹⁰</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(0.006 Q)</td>
<td>0</td>
</tr>
<tr>
<td>Shale oil (from oil shale)</td>
<td>50 x 10⁹</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(0.39 Q)</td>
<td>0</td>
</tr>
<tr>
<td>Total energy in fossil fuels</td>
<td></td>
<td>1.032 Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uranium:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U₃O₈ (at $5-$10/lb)</td>
<td>382,000⁺</td>
<td>148,000</td>
</tr>
<tr>
<td></td>
<td>(22 Q)</td>
<td>(17 Q)</td>
</tr>
<tr>
<td>Total fossil and uranium fuel</td>
<td>(27.3 Q)</td>
<td>(1.202 Q)</td>
</tr>
</tbody>
</table>

1 Prepared by D.C. Duncan and V.E. McKelvey of the U.S. Geol. Survey.
2 As defined here known recoverable reserves include measured, indicated, and inferred reserves. The estimates shown are proved (measured) reserves and therefore not wholly comparable to the estimates shown for the other commodities.
3 These estimates are based upon information from Energy R&D and National Progress, 1964, and revised to reflect the latest estimates available.
4 The numbers in parentheses represent the energy equivalent in Q (quintillion Btu) and the total energies are rounded values.
5 See Energy R&D. Other estimates of the size of these reserves vary widely.
6 Reported as 225,000 tons uranium metal in R&D, which is here converted to the equivalent tonnage of U₃O₈ to conform to other estimates.
7 The numbers in parentheses represent the energy equivalent in U/235 as well as U/238. With light-water reactors, using current technology, only 1 or 2 percent of this energy is recoverable. With advanced technology, most of this energy is expected to be recoverable.

COAL

The R&D Study Group defined known recoverable reserves of coal (col. 1) as "those in thick coalbeds lying at depths of less than 1,000 feet; 50-percent recovery of the coal in place is assumed. The minimum thickness of beds of bituminous and higher rank coal included in the estimate is 3.5 feet, and that of subbituminous and lower rank coal is 10 feet." (R&D, p. 92.) Notice that there is no mention of economics or technology in this definition.

What portion of the known recoverable reserves are recoverable under present economic conditions? The Energy Study Group reported that this was the chief uncertainty. It reported that an effort was made to acquire an estimate of the coal "... analogous to the oil controlled by producers and comprising the amount reported by the American Petroleum Institute (API) as proved reserves. A poll of independent coal producers yielded incomplete results but indicated that 20 billion tons are available at 1960 prices and 35 billion tons would be available at a price 23 cents higher." (R&D, p. 95.)
The Study Group also reported, however, that the 20 billion ton estimates "... did not take account of large deposits, both on public domain and privately held, that are not yet controlled by operating companies, but nevertheless could be mined under present conditions." The Study Group went on to say that in their opinion, "... the 220 billion tons of reserves can be mined at present costs, but it is likely that much of it can be mined or delivered at lower costs than those prevailing now."

In other words, the 200 billion tons of coal not included in column 2, table 1, are comparable to potential supply of crude oil, natural gas, and natural-gas liquids that is as yet undrilled in known fields, or is undiscovered.

The purpose of this discussion is not to prove that we are about to run out of coal—but to point out the need for accurate estimates of the coal reserves available at current prices in each coal-producing area.

For example, the coal deposits of Pennsylvania and West Virginia have been mentioned as possible sources for coal to be used in manufacturing pipeline gas for eastern markets. How much low-cost coal is available at present prices and operating conditions?

We don't know, but concerning the strip-coal production in this area, Averitt said in 1968, "The fact that strip-coal production in Pennsylvania and West Virginia is falling behind the national trend suggests that much of the readily accessible, low-cost strip coal has been mined out."

Averitt also said, "The future of the strip-mining industry is obviously strongly dependent on an effective nation-wide program of reclamation of stripped-over lands." The additional cost of reclaiming spoil-banks will add to the future cost of strip-mining coal in this area and elsewhere, and must be taken into account in calculating commercial reserves.

**URANIUM**

The R&D Study Group's provisional estimate of "known deposits" of uranium metal available at $5 to $10 per pound of U₃O₈ is 323,000 tons. This is equivalent to 382,000 tons of U₃O₈. The "theoretical maximum energy value" for this amount of fuel is given as 22 Q (R&D, p. 106).

How much energy is available from 382,000 tons of U₃O₈ using present technology? R&D said, "The numbers in the parentheses represent the total energy contained in U-235 as well as U-238. With light-water reactors, using current technology, only 1 or 2 percent of this energy is recoverable." Two (2) percent of 22 Q is .44 Q—the energy available using present technology.

What are the most recent estimates of uranium reserves? Butler, in 1967, estimated that U₃O₈ mined and in reserves at the end of 1970 would be 243,000 tons. He arrived at this figure by projecting the 1962-66 discovery rate and adding 40,000 tons assuming that the price would be raised to $10 per pound from the present $8.

In October 1968, AEC Chairman Glenn T. Seaborg said that at the current official price of $8 a pound for U₃O₈, economically recoverable uranium reserves total only 148,000 tons. He said that if the price was raised to $10 a pound the total economic reserves would only total about 200,000 tons.

Using the most recent estimate, the present U.S. uranium reserves available at present prices and technology are 148,000 tons with an energy value of .17 Q.

**OIL IN SHALE AND BITUMINOUS ROCKS**

The Study Group says there are 50 billion barrels of "known recoverable reserves" of oil in shale. This includes oil recoverable by destructive distillation of the organic matter from higher grade oil shale in Colorado and Utah, in beds 25 feet or more thick, yielding about 30 gallons of oil per ton of rock, and lying at depths less than 1,000 feet below the surface. The assumed recovery in mining is 50 percent of the shale. (R&D, p. 102.)

Where have the stories of "trillions of barrels of oil from oil shale" come from? R&D describes "known marginal resources" of oil shale of 2 trillion barrels (1,000 to 10,000-foot depth and minimum yield of 10 gallons of oil per ton of rock) and 4 trillion barrels of "undiscovered marginal and submarginal resources" (a speculative estimate of equivalent oil content of selected shale deposits, yielding 10 gallons or more of oil per ton of rock, to depths as great as 20,000 feet). (R&D, p. 103.)

How much of the known recoverable reserves of oil shale are commercial at today's prices and technology?

The Study Group said in 1962, "... it appears that commercial operation will be feasible in the near future. The known recoverable reserves listed very likely can be produced at or near present prices." Today, 7 years later, no commercial production of shale oil has been achieved. Until this happens, oil shale must be classed as noncommercial.

Concerning oil in bituminous rocks or tar sands, the Study Group said, "None of the tar-sand deposits in this country or Canada are being mined commercially now and hence it is perhaps premature to class them as reserves minable under present economic and technological conditions."

At present, there is one large-scale operation attempting commercial production in Canada. There are no commercial operations in the United States and no reports of any being attempted in the near future. Therefore, the minable reserves of oil in bituminous rocks are considered noncommercial under present economic and technological conditions.

**SUMMARY—FUEL RESERVES**

The striking contrast between "known recoverable reserves" and "recoverable energy under existing economic and operating conditions" is shown in figures 1 and 2.

In order to report the energy reserves of the United States in equivalent units one final correction is necessary. "Coal," which includes anthracite, bituminous,
subbituminous, and lignite coals, should be compared
with "Petroleum", which includes crude oil, natural
gas, and natural-gas liquids. When this is done (fig. 3),
it is interesting to see that under existing economic
and operating conditions there is .612 Q of recoverable
energy in petroleum, .42 Q of energy in coal, and .17 Q
of energy in uranium.

In 1965, T. A. Hendricks10 of the U.S. Geological
Survey said, "Because man cannot see oil and gas
resources, it is not surprising that he has been ultra-
conservative in estimating yet-undiscovered quantities.
Repeatedly, expert estimates of total undiscovered
quantities have been exceeded within a decade or so
by quantities actually discovered."

Conversely, because man can see coal and oil shale
—can measure it, and estimate the tonnage available—
it is not surprising that he has been over-optimistic in
estimating the value of these reserves.

In the past, a few government experts have made
the published estimates of coal reserves. Perhaps in the
future they will be joined by industry experts in each
producing area and together they will make periodic
estimates of the commercial quantities of coal available
for market.

In the uranium industry, past estimates have been
made by government experts, and there appears to
have been confusion over the reserves available for
industry. As with the coal and petroleum industries,
uranium reserves should be estimated by teams of
industry and government experts working together, and
the estimates published so that industry can make long-
range plans based upon realistic price and reserves
estimates.

FOSSIL FUEL AND THE ATMOSPHERE

What does our use of fossil fuel have to do with the
oxygen, carbon dioxide, and pollution in our environ-
ment?

All play a part in nature's great carbon dioxide-
oxygen cycle. Fossil fuel and the "excess" oxygen in
our atmosphere were both created from sunlight, carbon
dioxide and water by photosynthesis—the process by
which plants create the starches and sugars, of which
they are made, and release oxygen to the atmosphere.1
Plants may be eaten by animals, but eventually, when
plants or animals die and decompose, or are burned,
the remains recombine with oxygen to form the origin-
al carbon dioxide and water. When plant and animal
remains are buried, or sink to the ocean bottom where
there is no oxygen, they become fossil fuel—and some
oxygen remains in the atmosphere.

Throughout geologic time somewhere between 50
and 90 percent of the world's oxygen has originated in
the oceans from microscopic organisms called phyto-
plankton.11,12 The carbon dioxide and pollution in the
atmosphere and the oceans have a bearing on how
much oxygen the phytoplankton are able to produce.

The fact that most of the world's oxygen was formed
in the oceans has a bearing on where fossil fuel is to
be found. And, the survival of mankind depends on
the phytoplankton's continuing ability to generate
oxygen.

Oxygen, Carbon Dioxide and the Atmosphere

The burning of fuel is shown by the schematic
equation:

\[
\text{Fuel} + O_2 = \text{CO}_2 + \text{H}_2\text{O} + \text{Heat}
\]

It takes about 21⁄4 pounds of oxygen to burn 1 pound
of coal—and the results of this chemical reaction are
about 3 pounds of carbon dioxide, varying amounts
of water, and about 13,000 Btu of heat.

The U.N. publication, "World Energy Supplies,"13
reported that in 1966 the world consumption of fossil
fuel was equivalent to 6.2 billion tons of coal. This
means that the world also consumed more than 14
billion tons of oxygen from the atmosphere—and
dumped about 19 billion tons of carbon dioxide and
8 billion tons of water vapor into the atmosphere.

Apparently, so much of the world's fossil fuel is
scattered through the rocks in noncommercial amounts
that we can burn all of the commercial deposits of
fossil fuel without burning too much oxygen. Francis
S. Johnson,14 of the Southwest Center for Advanced
Studies, has calculated that if "... the total reservoir
of fossil carbon in forms suitable for exploitation ..." (was) ... fully expended, the oxygen consumption
associated with it would not be enough to seriously
deplete the atmospheric oxygen reservoir."

What about the carbon dioxide we are dumping in
the atmosphere? There is cause for concern about the
effect of carbon dioxide on our climate—but evidence,
too, that this may be offset by atmospheric pollution.

Writing in the Government publication "Restoring
the Quality of our Environment", Roger Revelle, et al14
reported evidence that the carbon dioxide in the earth's
atmosphere had increased 10 percent since the begin-
ing of this century, and that by the year 2000 it
could be 25 percent above the level of the 19th cen-
tury. The effect of this carbon dioxide would be to
trap and hold more of the sun's heat and warm the
earth's atmosphere (called the "greenhouse effect") to
the point where the Antarctic icecap could be melted
in from 400 to 1,000 years. This would raise the sea
level somewhere between 4 and 10 feet every 10 years
—enough to have a disastrous effect upon the seaside
cities in which 80 percent of the world's population
live. Melting the whole Antarctic icecap would raise
the sea level 400 feet.

Pollution of the Atmosphere and the Oceans

However, Reid A. Bryson and Wayne M. Wendland15
have recently reported that the pollution in the earth's
atmosphere is having a cooling effect on the earth.
They said, "Since 1940 the effect of the rapid rise of
atmospheric turbidity (dustiness) appears to have ex-
ceeded the effect of rising carbon dioxide, resulting in
a rapid downward trend of temperature."

If most of the world's oxygen is produced in the
oceans by phytoplankton, what is the effect of atmos-
pheric pollution on these organisms? There is some
evidence that they may be in trouble.

Francis Johnson\textsuperscript{13} says, "The growing spread of pollution has already shown up indirectly in midocean areas. DDT dust has been observed far out at sea." He mentions evidence that some sea-birds are harmfully affected by chlorinated hydrocarbons (insecticides) that got into the birds food chain "... from fish, whose food source in turn goes back ultimately to the phytoplankton, which presumably gathered the insecticide from dust settling into the ocean."

Lawrence R. Cory,\textsuperscript{14} a biologist at California's St. Mary's College, cites a laboratory study,\textsuperscript{15} so far unconfirmed, that only a few parts of DDT per billion in water interferes with the capacity of phytoplankton to absorb carbon dioxide and produce oxygen. The oceans already contain the chemical in this concentration.

Most of the oxygen produced by plants is recombined with carbon to form carbon dioxide when the plant dies. It is only when plant or animal remains are kept from oxygen in a few areas of the world that oxygen is added to the oxygen reservoir of the atmosphere. Francis Johnson says, "... the net oxygen production —photosynthesis exceeding respiration and decay—is very small compared to the total production. A few ocean areas with anoxic (no oxygen) bottom conditions and a few marshy areas in which peat is forming are presumably the key areas for maintaining our oxygen replenishment on a long-term basis. These limited areas are at least as susceptible to poisoning as are the open oceans. It is a matter of importance to man's future to recognize and preserve these areas."

Fossil Fuel Beneath the Sea

How much fossil fuel is associated with the present ocean basins? If there is a direct connection between oxygen in the atmosphere and buried organic material (fossil fuel), it might be interesting to speculate on how much fossil fuel is to be found beneath the ocean basins—based upon oxygen production from the ocean basins.

Frederick J. Vine\textsuperscript{18} has estimated the ocean basins' age at 200 million years. Discounting oxygen production during the first 75 million years of their growth, and assuming that for the past 125 million years that they have produced an average of 25 percent of the world's oxygen, then 25 percent of the world's fossil fuel should be beneath the present oceans. This seems a conservative estimate since over 50 percent of the world's oxygen is being produced in the ocean basins today.

The R&D Study Group estimated the world's recoverable reserves of coal at 18 Q and of petroleum (oil, natural gas, and natural-gas liquids) at 3.8 Q. Averitt\textsuperscript{19} estimates that substantially all coal reserves have been formed since the beginning of Carboniferous time (350 million years ago). Based upon Levorsen's\textsuperscript{5} estimates it is assumed that 90 percent of the R&D petroleum estimate was formed during the same period of time. In other words, a total of 21.4 Q of recoverable reserves of fossil fuel were formed during the past 350 million years. Assuming an average rate of fossil fuel deposition, 9 Q of energy would have been deposited during the past 125 million years.

The R&D estimates are largely based upon the fossil fuel deposited upon the present continents—representing 75 percent of the world's oxygen supply and fossil fuel. The R&D estimates do not take into account the fossil fuel that resulted from the 25 percent of the world's oxygen and plant life formed in the ocean basins.

Therefore, the total recoverable reserves of fossil energy should be 12 Q for the world—9 Q on the continents and 3 Q in the ocean basins. Since practically no coal is to be found on the margins of the present oceans, probably this fossil fuel will be petroleum.

If an additional 3 Q of energy (doubling the R&D estimates of recoverable petroleum reserves) are waiting to be found beneath the present ocean basins, where will it be found? Probably between the continental margins and the abyssal plain. This is where the phytoplankton are to be found that produce the oxygen.

NUCLEAR ENERGY PROBLEMS

As was said earlier, using present technology, only 1 or 2 percent of the energy is recoverable from uranium ore. This is because current reactors must rely upon the only isotope capable of fissioning naturally—uranium-235. U-235 comprises 0.7 percent of whole uranium. The rest of natural uranium is the isotope U-238.

With U-235 as a starter, it is possible to create fissionable isotopes from uranium-238 and also thorium-232 by a process that is known as "breeding".

When the breeding process is developed commercially, not only will it be possible to use U-238 (140 times more abundant than the present fuel, U-235) and thorium (3 times as abundant as U-238), but the development of nearly complete breeding will change the cost of the operation in such a manner as to make it economical to utilize rocks with low uranium or thorium contents. The fuel added in this manner is millions of times greater than that available when only U-235 can be used.\textsuperscript{1}

Since the breeder reactor is an impossibility without U-235, it would seem prudent to stockpile enough of this fuel to start the breeding process when the breeder reactors are developed. Indeed, present U.S. policy seems bent upon consuming more than all known U.S. reserves available at present prices. Figure 4 illustrates the present supply and demand for nuclear fuel.

The U\textsubscript{3}O\textsubscript{8} needed to supply the lifetime needs of reactors in use, ordered or planned as of June 1968 is 323,000 tons. Another 352,000 tons of U\textsubscript{3}O\textsubscript{8} will be needed for reactors that will be in use by 1980. United States reserves available at current prices are 148,000 tons of U\textsubscript{3}O\textsubscript{8}.

With a sufficient supply of U-235 on hand when the breeder reactor is developed we have the possi-
bility of limitless energy. Without U-235 we face nuclear bankruptcy.

Safety

Apparently, there is some question among experts about the safety of the present generation of nuclear reactors. In September, 1968, Edward Teller deplored the proliferation of surface nuclear reactors and urged that they be buried “deep underground”. Teller said, “A nuclear reactor 700 feet under Manhattan is safer than a nuclear reactor 70 miles from Manhattan.” The nuclear scientist added that only “great care and a little luck” have prevented a major nuclear power station accident.

Radioactive Waste

Concerning nuclear wastes, Dr. Clyde L. Cowan, nuclear physicist at Catholic University of America, said (September, 1968) that one of the biggest problems facing the world today is the way man is increasing the amount of nuclear power he is generating without knowing the world’s storage capacity for the deadly waste.

Thermal Pollution

Nuclear plants will be releasing 40 to 80 percent of the heat generated as waste. Wilfrid E. Johnson, Commissioner, U.S. Atomic Energy Commission, said (January, 1968) that it has been estimated that by 1990 more than half of all river runoff in the U.S. would be required for cooling purposes if the heat were rejected to the rivers. Phillip N. Ross, Westinghouse Electric Corporation engineer, told the President’s Water Pollution Control Advisory Board, December 1968, that generating plants in the United States would have enough waste heat by the year 2000 to raise the temperature of the entire Mississippi River by 100 degrees.

Nuclear Theft

One other unique problem with nuclear power is the possibility that criminals or terrorists might steal the materials for making an atomic bomb. Theodore Taylor, who headed the Defense Department’s atomic bomb design and testing program for 7 years, was recently quoted by the Wall Street Journal as saying the once-secret information needed to build nuclear bombs became available in unclassified literature several years ago. He especially recommends the World Book for its explanation of how a bomb works.

The Wall Street Journal quoted scientists as saying that it takes only 13 pounds of plutonium to make an atomic bomb as powerful as the one that devastated Nagasaki. This is less than one-tenth of 1 percent of the plutonium that the world’s nuclear reactors will soon be producing yearly as one of the by-products of their chain reactions. This plutonium is shipped to reprocessing plants, and experts say the shipments will soon be so numerous it will be extremely difficult to guard all of them adequately. Rep. Chet Holifield of California, vice chairman of the Joint Congressional Committee on Atomic Energy, quoted experts as saying that security measures at the reprocessing point are minimal, and that plutonium is “easily accessible to diversion” during reprocessing.

Export of Nuclear Fuel

In November 1967, the AEC reported that to date it had shipped abroad approximately 20 thousand kg of U-235 representing a value of about $200 million, and that it expected to ship abroad nuclear fuel at the rate of 10 to 15 thousand kg U-235 per year over the next several years, primarily for power reactors. In October 1968, the chairman of the AEC said that American and some foreign nuclear power plants could be producing enough by-product plutonium by 1980 “to make potentially dozens of nuclear weapons per day.” Dr. Glenn T. Seaborg said the prospect “should emphasize the importance of the nuclear non-proliferation treaty and the application of international safeguards through the International Atomic Agency.”

Since the United States has only about one-fourth of its projected needs of U-235 it seems fair to ask why we are exporting nuclear fuel at all.

In 1957, Schubert and Lapp said, “One cannot escape the conclusion that we are proceeding toward a full-scale nuclear power economy on the basis of high optimism that somehow or other the future problems will be solved.” Today, 12 years later, it appears that we are still roaming into production of nuclear power with inadequate fuel supply, and only early pilot-plant knowledge of reactor technology and radioactive waste disposal.

A LOOK INTO THE FUTURE

Looking into the future, it appears that we have plenty of energy available for United States, and world, needs. The problems facing the energy industry, and government, concern the orderly development of the fuels available, and the proper handling of pollution problems.

Industry, in the name of “enlightened self-interest”, should team up with government to make periodic inventories of all U.S. energy resources. When this is done, mineral economists and other future-planners will be able to draw up realistic blueprints for the world of tomorrow.

The survival of mankind depends upon the oxygen he breathes. Pollution of the atmosphere and the oceans appears to have a direct bearing upon the rate at which most of the world’s oxygen is produced in the oceans. Since the burning of fossil fuel consumes great quantities of oxygen—and adds pollution (including carbon dioxide) to our environment, “enlightened self-interest” again dictates that the energy industry take the lead in research to preserve the world’s oxygen supply and prevent the pollution of the atmosphere and the oceans. The importance of these problems was underscored by Francis Johnson before the American Association for the Advancement of Science at its December 1968
meeting, when he said "Because of the importance of these problems to man's future we should be very confident of our full understanding of them . . . Catastrophic problems appear to be in prospect for mankind because of the population explosion and its associated pollution explosion."

The nuclear industry appears to be attempting full-scale production with inadequate fuel supply, and incomplete knowledge of technologic problems, including the disposal of radioactive wastes. In a report, entitled "U.S. Energy Policies, an Agenda for Research", Resources for the Future (RFF) 28 mentioned the possibility of a "bandwagon psychology" developing in some segments of the nuclear industry. RFF quoted an energy expert in the nuclear industry who said, "If I were asked whether I thought that all of the pro-nuclear power decisions have been based on thorough studies illuminated by enlightened self-interest, I could not say yes. I think there may even be something in the idea that one sometimes encounters these days that what we are seeing reflects the general adoption of a fashion . . ."

A unified industry-government approach can identify and solve our fuel problems. We have plenty of fossil fuel to last until nuclear problems are licked.

If we stockpile sufficient U-235 to fire up the breeder reactor program when it is developed commercially, we have the prospect of limitless power to serve mankind. The breeder reactors will be able to use U-238 and thorium. And, low-grade ores such as the Conway granite of New Hampshire (that crops out over a 300-square-mile area) can be used. This granite contains enough thorium per ton to equal the energy in 168 tons of coal.

King Hubbert 1 has pointed out that when limitless power is achieved it will be possible to use this power to synthesize chemical fuel from limestone and water. The chemical fuel will be just as useful for highway and air transport vehicles as our present petroleum products.

When mankind achieves the dream of limitless energy to do his work, will he have achieved Utopia—or limitless population? In 1962, Hubbert 1 said of the world's energy-triggered population explosion, "It represents, in fact, one of the greatest biological upheavals known in geological as well as in human history."

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FUNDED COMPANIES FOR OIL AND GAS EXPLORATION

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It is a pleasure to talk to you today about an increasingly important part of the oil and gas industry—the funded companies. It is my thesis that this approach to financing industry activities will grow to major significance and that its eventual size and importance may well depend on the ability of you petroleum evaluation engineers to create new concepts for evaluation of properties at all stages of their development.

Mr. Calhoun’s paper surveyed both technical and ethical considerations in evaluation in the form of guidelines. Mr. Evans has given us all something to think about with his projections of the nearly overwhelming problems of meeting energy demands from available and known resources. His chart on estimated needs for all forms of energy forcefully displayed much of what I had intended to say on that subject. However, I do want to discuss what this huge growth in demand may mean in terms of the capital requirements of the oil industry and the problems associated with attracting this needed capital.

The Chase Manhattan Bank estimates that demand for oil and gas in the United States is growing at a rate of 500,000 barrels per day per year and in the Free World at a rate in excess of 3 million barrels per day per year, rates that cast grave doubts on the industry’s ability to meet estimated demand by 19801.

The United States will require two-thirds more oil and 100 percent more natural gas in the 1965-1980 period than in the 15 years immediately preceding2. They estimate that at least an additional $2.8 billion must be added each year for the next 10 years to the $4.4 billion average expenditure on domestic exploration and development for the decade ending in 19673.

The whole Free World is the province of the oil industry and thus establishes the total capital requirement for the industry to meet the growth of the world’s consumption of petroleum4, with U. S. operations using $110 billion of that total. These estimates may well be too low. Adequate reserves do not necessarily mean adequate daily production.

Both the Bank and the United States Department of the Interior suggest that the Government and the public at large cannot just assume that the required capital will be available5. There are numerous alternative investments for the suppliers of capital.

How can the needed capital be supplied?

There are four traditional means of financing oil and gas operations: equity capital, long-term borrowing, internally-generated funds, and sharing an interest with a partner—including direct investors.

Common stock or convertibles are considered usual means of bringing capital into the major oil companies in “normal” times. However, times have not been normal for most oil companies in recent years. Analysts have been taught that all industries follow a bell curve and many believe the oil industry is over the top and on the way down. Thus, while still “safe”, major oil companies in general are considered by these people as less exciting than the high fliers. Right or wrong, this attitude adversely affects oil stock prices. As a result, except for short periods of time, all major oil companies have been undervalued in the market. Frequently the prices of their shares do not even reflect their liquidation value; they are worth more dead than alive. Those companies, the dominant companies of the industry, cannot issue more equity shares without near-certain dilution of their stockholders’ position. Can you recall the last offering of common stock by a major oil company? Yet, I believe you will see many common stock offerings in the next few years if capital is not otherwise available.

Debt ratios for many companies are well above 25 percent, a load which Kenneth E. Hill, senior partner in Eastman Dillon, Union Securities & Co., New York investment house, observes “is regarded by lenders as a high ratio for risk-taking business such as petroleum6.” While there is still considerable room for further borrowing, at a price, the interest rates of past months, high as they were, have become even higher.

The interest rate for independents, historically higher than majors, has risen to 11 percent to 12½ percent, rates that are effectively stifling activity, and today money is not available even at these rates for oil and gas drilling.

Profits, while somewhat improved, trail manufacturing generally7. In the absence of some very dramatic, unexpected increase in earnings their availability for reinvestment cannot materially improve in the future. In fact, concentration on Alaska and offshore by much of the industry will put further strains on profits over the near term because of the long delays between investment and start of revenue. Depletion and depreciation cannot be expected to contribute much more to the increased need; in fact, Congress seems determined to reduce depletion this session.

For over a century independents have sold interests in a well or wells to investors, many of whom later became successful oil men themselves. These direct investors, of course, are not stockholders of a corporation taxed on its earnings, who must then pay taxes again on their dividends. They are operators who receive their proportionate share of the profits and pay taxes once. As operators, their share of the incentives of intangible drilling cost expensing and the depletion allowance flows directly to them, not to the company where they may not be reflected in the price of its stock.

Until the early 1950’s no effort was made to reach more than a few very rich investors. In the 10 years before 1966 several companies offered direct investments more broadly to the investing public through offerings registered with the Securities and Exchange Commission,
selling unit participations in a given project or projects. Officers of the issuer did most of the selling, with the established salesman, the broker-dealer, seldom involved or even aware that such an investment opportunity existed.

The last three years have brought a great change in the formulation of means of investing, acceptance by the investment community and significance to both the oil and gas and securities industries of this method of financing oil and gas operations. Growth has been rapid. In 1968 the dollar amount of 90 filings with the S.E.C. was $694,065,000 of which approximately 70% was sold and has been invested. If the present rate of filings continues it is anticipated that over $1 billion will be filed with the S.E.C. in 1969. This is new capital not otherwise available to the oil and gas industry.

I would like to take a few minutes to discuss the significance, as I see it, of this growth. Then we will turn to the structure of modern funded activities and your role in their future.

We have seen that the majors are not generating sufficient capital internally and will be unable to obtain the necessary amounts of additional capital from usual sources to meet the requirements of the next decade. They are beginning to be aware of the modern funded companies who, for the first time, have sufficient capital to be of real assistance. Thus, they are beginning to offer to those companies groups of projects which cannot be done under their own tight budgets. The problem is acute for the majors; it is desperate for the independents. In fact, expenditures on exploration and production by the thousands of independent producers from 1956 to 1967 declined over 50 percent ($2.5 billion in 1956 to $1.2 billion in 1967); and over 3,000 independents have been forced to quit in the last dozen years.

Even if he can borrow significant amounts of money, the independent has to pay a substantially greater rate of interest than the major. Yet, because of his size he is all but foreclosed from entering into big projects and more profitable areas such as offshore, Alaska and foreign. How much should he borrow against his assets at these high interest rates to do new projects, however good they appear to be? If the projects are unsuccessful he may be nearly out of business with overhead continuing until the loans are paid down out of income and he can borrow again to do other projects. The risk of failure, sooner or later, is great because he does not have enough diversification to reduce risk.

Alert independent operators have become aware of what the modern funded company can do for them much sooner than the majors and are offering increasing numbers of projects to this new source of capital. For instance, Imperial-American Resources Fund, Inc., the company with which I am associated, has committed over $40 million for projects so far this year and has a large inventory of accepted projects for partnerships next year. New submittals are coming in every day.

The independent operator does not have to borrow this new capital, thus does not risk his present assets on new projects. He leaves investor relations to a company geared to handle them efficiently and can concentrate on what he is very good at—the development of drilling and other prospects. He can keep as much of the working interest in a prospect as he desires or he may choose to retain an override with or without a backin provision, in either case doing much more than his own capital would allow. Large projects with correspondingly greater economic potential such as offshore, Alaska and foreign ventures are now possible for him. The increased activity provides the diversification he needs to reduce risk and gives him the opportunity for an increased growth rate. As long as the projects he has to offer are good and meet the investment requirements of the funded company he may "run" as hard as he wishes to with increasing amounts of capital on a continuing basis. His projects will be carefully and quickly evaluated for quality and whether they meet investment objectives and he will be evaluated as to his expertise as an operator. If he is a good operator, operations will be left with him subject to monitoring his performance, since the modern funded company does not seek to duplicate any function that can be properly left to existing qualified operators. In return, he and his counterparts throughout the industry offer investors in the funded company local technical expertise that could not be assembled in any oil company. Each good local operator has proved that he can succeed in the province he has chosen as his specialty. In fact, local independents frequently know their area better than employees of major oil companies who are temporarily stationed there and who are often moved to a new area about the time they are beginning to get a grasp of the local history and of how to solve the problems peculiar to the area.

In short, the partnership of the many qualified independents and a modern funded company serves the needs of both the independent oil industry and of the modern sophisticated investor. In doing so a new source of capital is available to the oil and gas industry to help develop the increased production which is needed now and as we have seen will be needed so greatly in the future.

The decline in drilling since 1956 has forced a large number of drilling contractors out of business, has cut the number of active rotary drilling rigs in half and has caused the associated supply industry to retrench. Rigs have been cannibalized, stacked or converted to foreign or offshore use and competent crews are hard to keep because of sporadic work. The ability to stay busy in the early months of each year, traditionally a time of reduced activity, has often been the difference between success and failure. New capital producing more drilling—particularly new capital available in the first six months of the year—is what the industry needs. The modern funded company with four quarterly partnerships each year meets those needs. Already there is some indication of the positive effect of this additional capital in the oil fields. Rigs are being reactivated and crews assembled. The future health of this vital segment of the industry may well depend upon the future of the oil and gas funded companies.

Many of the important geological ideas and technical
innovations have come from the independent consultants. Tight budgets in the major and independent companies mean that experimentation will be reduced. However, the modern funded company is eager to support any new areas of promise and will encourage the consultant to take part in their testing. New ideas mean the potential of added profit to investors and creative consultants. We will hear about one of these pioneering projects this afternoon.

In the paragraphs above I have stressed the role of the modern funded company as it relates to some of the vital segments of the oil and gas industry. The emphasis was on the independent, not the major oil company because the former has felt the pinch first. However, as we have seen, the majors are only relatively better off. They have the projects and they need capital. Those that use the new capital available from the modern funded companies will grow faster than they otherwise could and they can maintain a better balance in their operations and greater diversification.

With this new capital the majors may not only continue their search for very large fields around the world but also increase their activity in older established areas in the United States and Canada. Existing staffs in those areas could move from a sort of low budget, stand-by status to active drilling and development of non-priority, static acreage. The importance of such a change upon the demand-supply problems of the industry and, thus, to the consumer in the years to come cannot be overstated. These established areas contain vast reserves and, what is equally important, they are reserves that are quickly useable. Pipelines and refineries are in; men, equipment and know-how are available.

Certainly the great discoveries, such as the Prudhoe Bay field, are exciting and necessary, but Mr. M. A. Wright, chairman of the board of Humble, has stated that it may be the late 1970’s before they will be delivering 2 million barrels per day. With demand growing at 500,000 barrels per day per year, we can see that this country cannot rely on major discoveries alone. Projects with large possible reserves are essential to a major oil company to assure its future. Projects with lesser potential reserves are excellent for investors in oil and gas funded companies, particularly investors in those companies that specialize in development drilling. Investors are interested in a financial result within a reasonably short time. Reserves that may be produced far in the future have a severely discounted present value. To a direct investor the financial result of continually drilling even “second-rate prospects” in established areas with established markets is better than all but the greatest discoveries.

What has been done to the direct investment vehicle that has caused greater acceptance by the public? The older forms of direct investment in oil and gas were not competitive with alternative investments because they were not formulated to fit what the sophisticated modern investor expects and were not sold through professional channels of distribution. In fact, the formulations were, and still are in many cases, for the convenience of the issuing company not the investor. The modern approach has considered the expectations of today’s investor and within the realities of the oil and gas industry tried to meet them. As a consequence, direct investment in oil and gas operations has become competitive with alternative investments and thus finally gained the attention of the investment community and of sophisticated investors in large numbers.

There are many more affluent investors today than even 10 years ago, and they have become very knowledgeable and sophisticated in determining where their dollars should be placed at work. For a few minutes I want to talk about the expectations of these investors and how the funded companies are attempting to be competitive with alternate investments while staying within the realities of our industry. I also want to point out that the areas where we have been least successful are those in which you are the experts.

(1) An investment must have a distinct objective and character, expressed and understandable to the investor.

Traditionally, direct investments have been sold in an exploratory well or wells which, if successful, could result in development drilling. In other words, the investment was structured like the oil industry operates. However, farmouts of development wells and development programs are continuously available in the industry. The economic and risk factors of a wildcat are completely different from the economic and risk factors of a development well. Thus, the development operator can take prospects with an entirely different range of return than the wildcat operator who must have many times that potential in the projects he undertakes.

Aside from their different economic bases, wildcating and development are recognized as two different “businesses” by many companies who assign oil-finder types of personality to exploration and more detail-oriented types of personality to exploitation. Viewed from the investor’s and broker-dealer’s point of view, wildcating appears to be nearly a rank gamble, but with large potential returns; on the other hand, development is more like a normal business with no greater risk and similar potential returns. Thus, to them, these are two different “products” which will have appeal to different investors.

The funded offering of interests in producing properties to be purchased rather than drilled is undergoing changes at this time and will become more important if ABC transactions are no longer possible. This area if properly structured should appeal to the investor seeking income and represents a growth area of importance to the industry as well.

(2) Good management by men with national reputations is demanded.

The modern funded company begins with experienced oil men, who have been successful in their own right, to handle operations for the investors through the existing facilities of the oil industry.

Investors are not just a “necessary nuisance” with projects evaluated on the basis of company objectives, rather than investors’ objectives. Long term reserves which will outlive investors are subordinated to financial results.

These managers act as an evaluation and control
group. No effort is made to set up a whole new structure. In this country there are talented independents and consultants and experienced operators wherever oil and gas are found. They do not have to be employees of the funded company; in fact, they prefer to develop their own projects and share in the success or failure of their ideas. Local operators frequently are lower-cost operators and additional operations may be at incremental costs as well. In dealings with majors, they frequently want to operate and, of course, are fully competent.

(3) The "product" must be readily available, flexible in purchase price and have the same sales incentive to the broker-dealer (his commission) as competing opportunities.

In our affluent society every broker-dealer of any size has customers who might be interested in and benefit from a direct investment in the oil and gas industry. The industry needs their participation. Thus, the modern approach is to offer participation through any broker-dealer who is a member of the National Association of Securities Dealers.

A good broker-dealer seeks out investment opportunities that meet his customers' desires and needs and sells them the ideas. He expects to receive a competitive commission. While the oil and gas industry used to try to get by on sub-standard commissions, that is no longer the practice. Commissions are ordinarily taken out of the investment capital, reducing the amount put to work for the investors' accounts. This is in line with the traditional practice that oil and gas promoters be fully "carried."

A few of these investment vehicles, including the one with which I am associated and which pioneered this feature, pay competitive commissions out of their own funds and must recover their investment along with the investor out of profitable operations. In addition to being a desirable feature to the investor, this method assures that management's objective is operations which are profitable to the investor in order that the company, which shares in those profits, may at the same time recover its investment and then also profit.

Obviously, a direct oil investment must be at least large enough to warrant handling and processing. With modern data processing capabilities this can be very small, indeed. However, the aggregate investment may be quite large, particularly when we consider the modern sophisticated investor's desire to be able to add to an investment he likes as often as possible.

A professional man may have very irregular income. He likes the idea of a small initial commitment and the ability to add small amounts some months of low receipts or larger amounts other months when income is high. Such flexibility conforms to his ability to invest, and it provides diversification.

Some of my friends in the industry contend that no oil investment, even in proven properties, should be offered in less than $5 thousand increments. They seem to say that an investor who wants to put up less than that is not "suitable" per se. I do not think an investor who can put up more than that is suitable per se. For instance, I am sure we would all agree a widow who has received $10 thousand should not invest half of it in a drilling program.

The only real control over the suitability of the investor to be offered such an investment is, first, the judgment of his broker-dealer and, ultimately, that of the investor, himself. No offering company wants its product sold to investors unsuited to this type of investment. Is it really a protection to the investor to force him to put 5 or 10 thousand dollars to try out a new type of investment? I think an investor benefits more from the ability to make frequent small investments than from minimums which attempt to define suitability.

(4) The investment must have certainty as to size.

Assessments are undesirable from the investor's point of view and are not essential to good operations. Certainly, it is easier for the operating company to be able to assess for the cost of additional wells and for unforeseen expenses. Some operators presently may not have the budgeting and other skills necessary to operate without assessing the investor. It would profit the operator to consider this feature carefully for assessments (and the penalties for failure to respond) are an anathema to both the investor and the broker-dealer. I believe the traditional assessment was one of the major stumbling blocks to investor and dealer interest in oil and gas investments.

(5) Risk must be reduced as much as possible.

The limited partnership form of organization is essential to the modern approach. The investor is protected from unlimited liability. As a limited partner his liability is limited to his capital investment and any undistributed profits. This form of organization is also essential to the operator where he is dealing with large numbers of investors. A limited partner does not have the right to make operating decisions or bind the partnership, these powers being retained for the general partner. It would be literally impossible to canvass the many thousands of investors before undertaking projects or performing remedial work on wells, etc.

New partnerships made up of investors who have invested by a given date might be formed at any time during the year; however, quarterly partnerships are about "right" for both sales and operations. Three months is a reasonable time between major investor accounting periods and when coupled with reinvestment provides a sufficient amount of reinvestment for partners of earlier partnerships in later partnerships. Perhaps more important is the continuous availability of funds to the operating company so that drilling operations may proceed throughout the entire year.

The modern oil and gas funded company is structured to attain large size. The fact that it is sold very widely through broker-dealers who are members of the National Association of Securities Dealers provides the magnitude of funds which will allow the operator to invest in many different projects both geologically and geographically. This diversification spreads the risk association with an investment in one well or in one field. Equally important, large size means greater potential economic return. As in any other business, there are many
operators who can drill a $40,000 or $50,000 well. There is tremendous competition with consequent limited potential economic return. But, as you get into $150,000 to $1,000,000 wells and into development programs costing millions of dollars, there are fewer and fewer operators who can undertake such obligations. Consequently, there is greater potential economic return per dollar invested.

(6) The investor wants to know what his properties are worth and he expects to be able to sell them at a fair price at any time. By worth, he means both what he can get for them now and ultimate total return if he holds them; "at any time" means in a few days.

Modern funded companies have not been able to meet these desires in a way that is truly competitive with many alternative investments.

There is the inevitable delay between investment in a partnership until the project is begun, tested, completed, connected, the paper-work of ownership accomplished and income produced. During this period some of the data necessary for preliminary evaluation has been obtained. However, unless the well is a look-alike to one with which you engineers have had experience and with which you feel "comfortable," you want to know more. Knowing more means more time—further delay. In a large program of wells (even development wells) there are always some on which you want and doubtless need further production history. The problem is more complex in cases of continuing projects such as secondary recovery operations or new approaches such as we shall hear about this afternoon.

Most of the industry continues to report success ratios, cumulative results of various types for past partnerships and frequently sends to investors lengthy reports on individual prospects or projects supported by land or geological maps and replete with technical terms that have no real meaning to them. If large modern programs were to report in detail on all wells or projects the preparation and handling costs would be prohibitive, and all to a questionable purpose.

The investor tolerates the delay, but has a difficult time accepting the fact that after months of production the absolute, ultimate value of the well is not reported. He is used to a market value of his stocks which at least is the temporary, ultimate value.

The modern investor demands liquidity, and yet this, as you know, is one of the most difficult things to provide in an oil and gas investment. A precise value for reserves, particularly in the early months or years of production, is, of course, impossible.

Most direct investments in oil and gas have no formal liquidity feature based upon the estimated value of an investor's assets. Some exchange interests for stock of the operator or negotiate on an individual basis with each investor who must sell out.

The company with which I am associated has approached this problem by setting forth in the limited partnership agreement the method by which future net cash receipts from oil and gas sales will be discounted to what is called a "cash surrender value." Briefly, it amounts to two-thirds of the future net revenue attributable to the investor's interest after being reduced to present value by applying an alternate use of funds percentage. Investors may file a written election any quarter and be paid the cash surrender value applicable as of the end of that quarter before the end of the succeeding quarter. I have detailed this provision merely to show one approach to bringing meaningful liquidity to the investor where he has not had it before, at least not as he is accustomed to it in the stock market. It is still far from a satisfactory solution to the problem for either the investor or the company. In the early months of operations of a partnership it can result in either a low value to the investor or else in the shifting of some of the risk to the operator, depending on how much of the work has been adequately tested and how conservatively the estimates have been made. Certainly, size gives both the company and investors considerable protection because highs and lows would tend to offset each other over many projects.

Reporting of results and liquidity are areas which must receive a great deal more attention before we are truly competitive with alternative investments. Perhaps these are areas where oil and gas investment can improve but never quite attain the seeming certainty and the liquidity provided by the market. However, as a plus feature we can justifiably point to the fact that the values of assets in oil and gas do not fluctuate like the market, and that an investor who must sell will not find himself selling as what may be a temporary low, nor will he be negotiating with the operator in a climate of emergency.

What I am saying to you is these are our greatest problems. You are all experts in the oil industry elements of these problems, but have you looked at them from the competitive view? When is the earliest time we could properly tell investors what you believe to be the ultimate value of their investments? Could you give them this opinion earlier if you added some qualifications that investors should be expected to understand? Could these qualifications be standardized and approved by the S.E.C. and others? Would averaging or a concept similar to actuarial tables in life insurance help both in the area of results and in the area of liquidity? Et cetera.

We need your ideas and your help if we are to become more competitive and thus attract the amount of dollars our industry needs.

What is the future of the funded company approach? We have seen that demand for oil and gas is growing at a tremendous rate. The need for new capital is nothing short of fantastic. Traditional means of financing oil and gas operations cannot alone meet this need. The modern funded company approach appeals to sophisticated investors in increasing numbers. By working with and through independent and major oil and gas companies good projects handled by expert operators are available to those investors. Thus, their interest, and therefore the capital they make available, will grow.

I predict that this fund-raising industry can grow in the coming year to more than $2 billion and that it can eventually furnish all the additional capital requirements of the oil and gas industry. At the same time, this approach will grow to major importance in the develop-
ment of all of our other natural resources. However, to do these things, the S.E.C. must handle this new industry properly and with full regard to the importance of its role in furthering the development of our natural resources in our national interest. Members of Congress must get down to the facts, eschew the temporary pleasure of attacking this popular whipping-boy and provide the incentives necessary to assure the infusion of the vast amounts of capital, from whatever source, that are required. Last, but not least, you evaluation engineers must give us better and more timely methods to report results and support the propriety of their use. You can make the difference.

References
6. For the debt ratios of a number of companies see Oil & Gas Journal (June 16, 1969) at 36.
7. First National City Bank of New York shows average rate of return on net book assets in 1968 was 13.0% compared with 13.4% for all mining and manufacturing.
8. 31 filings in 1964 for $78,157,000
   18 filings in 1965 for $61,385,000
   23 filings in 1966 for $95,343,000
   45 filings in 1967 for $230,745,000
GOVERNMENT INFLUENCE ON INDUSTRY OPERATIONS
Granville Dutton
Manager of Unitization and Joint Operations
Sun Oil Company, Dallas, Texas

Our forefathers did not intend it and our Constitutions
do not sanction it, but today nothing influences our lives
as much as government. In our business life, every aspect
of providing a product or a service is subject to govern-
ment oversight so pervasive that it, rather than efficiency,
determines whether the operation is profitable.

The magnitude of the influence exerted by the Federal
Government is well illustrated by the recent edict on
artificial sweeteners. Here, as so often where govern-
mental force is applied to legitimate business, it was in
the role of "protector." Now government should be a
protector—a protector against the use of force or fraud
to deprive a person of his life or property. Such protection
creates a climate of free enterprise in which each person
is able to profit according to his ability to fulfill the
needs and desires of others. In such an atmosphere, a
person can be of greatest help to others by maximizing
his own gain; in so doing, he will be providing the prod-
uct or service sought by others at the competitively-
ddictated lowest price.

Big Government

Today government falls far short... or perhaps far
overshadows... the goals set for it by those who sought
freedom with their lives, their fortunes and their sacred
honor. In 1964, twenty-six million Americans made a
desperate attempt to recapture liberty—liberty for the
individual, liberty for business, liberty from government.
The effort failed under a landslide of Pavlovian re-
actions; today government reigns supreme in the school,
in the factory, in the market and even... as the up-
coming census will demonstrate... in the home.

Government dominates business—is that bad? Both
are operated by people having basically the same in-
stincts. Certainly a man does not grow horns just be-
cause he accepts a Federal Position. But motivations
differ: in business, profit is the criterion of success; in
government, number of employees. Where freedom
reigns, profits are a function of how well a service or
product is supplied; the size of government bureaucracies
are determined by how much power they can obtain.
Government contributes nothing to the standard of liv-
ing; only gainfully employed private citizens and private
capital do this. Therefore, the laborer as well as the
investor must bear the burden of government spending.

Levels of Government Supervision

The first major governmental influence on the petro-
leum production industry was State regulation. The goal
was conservation and the rationale was protection of
the correlative rights of all owners of a common supply.
World War II brought Federal regulation, primarily in
the areas of materials, allocations and price controls.
After the war, Federal regulation subsided until the U.S.
Supreme Court rewrote the Natural Gas Act to bring
gas producers under price control of the Federal Power
Commission. As offshore production became more sig-
nificant in the late fifties, Federal regulation of offshore
activities by a host of agencies began to expand to the
point where drilling operations in Santa Barbara were
actually prohibited by the Federal government on leases
for which the industry had paid that same government
600 million dollars.

The late fifties also saw the mandatory imports con-
trol program instituted after a "voluntary" limitations
had failed to curb the increasing imports. In the early
sixties, Attorney-General Kennedy initiated the attack
on state conservation laws as price-fixing measures. Fed-
eral pressure has steadily mounted to the point where
the petroleum industry is held to be absolutely liable for
pollution whether or not negligence is involved; where
the Congress has voted to decrease depletion provisions
in effect for four decades; where the Administration has
requested elimination of intangible expenses; and where
a Cabinet-level Task Force has recommended changes in
the import program admittedly designed to lower the
price paid for domestic crude.

Local regulation of the industry for years involved
little more than drilling restrictions within incorporated
towns and cities. More recently, aesthetic regulations
calling for elaborate and expensive installations to dis-
guise drilling and production facilities have been en-
acted. In 1969, both county and city severance taxes
were levied on petroleum production. So today, govern-
ment controls influence industry operations on the Fed-
eral, State and local levels to an extent that merely
keeping abreast of the regulations involves substantial
expenditures of time and money; compliance with these
rules costs such staggering sums that only the most
ingenious technological advances have enabled petro-
leum to remain competitive.

Areas of Government Influence

Government influence is felt in three areas: direct
regulation, taxation and policy-making. The first two
of these are exerted by all three governmental levels
whereas in the policy field the Federal level is dominant.

This paper will discuss briefly the interrelations be-
tween Federal and State influence which seem to be
approaching State reaction to federal actions. Back-
ground trends and the current situation are discussed
in order to set the stage for a prediction as to what
effect upon State production and allowables would result
from replacing the import control program with a tariff
system.

BACKGROUND AND TRENDS

The past is prologue—yet it is our only guide to the
future. Trends based on past performance can, of course, be interrupted by a change in conditions such as the Arab-Israeli conflicts of 1957 and 1967. Both of these “little wars” disrupted supply from the Middle East and caused temporarily high demands on our domestic supply. In 1957, there was no problem in filling this market with our excess producing capacity; after ten years of depressed prices, natural gas price regulation and inflation, there still was no surface indication of a problem in meeting the 1967 crisis. However, a close study of the allowances developing out of the 1967 disruption indicates that today the domestic industry would be hard pressed to fill the additional demand resulting from a termination of our overseas imports. This reduction in producing capacity has come about through the inevitable effects on supply of government policies affecting petroleum demand, prices and costs. A brief examination of the recent history of these factors is useful in understanding the current situation.

Demand

The demand for liquid petroleum was up 60% during the period 1950-1963; during this same time gas demand more than doubled. All qualified analysts, including those in the Federal government, agree that by 1980 demand for liquid hydrocarbons and natural gas will increase at least 50%. With such unanimity of my predictions one would think the domestic industry would be proceeding full speed to develop the producing capacity to meet the predicted high demand. Under free market conditions such an effort would surely be forthcoming. However, several factors in the feed-back loop of the law of supply and demand have been short-circuited by government policies which prevent domestic petroleum prices from providing the incentive and investment capital necessary to develop the required supplies.

Supply

The general trend of domestic liquid reserves added annually has been downward since 1950. Not once since that year have discovered reserves equaled the liquid hydrocarbons produced. During the period 1950-1967 discovered reserves averaged only 40% of the liquids produced; worse still, during 1960-1967 the average was less than 20% and in 1967 reserves discovered were only 4% of production. The domestic oil industry has been surviving on upward revisions of known liquid reserves brought about primarily by advanced recovery technology.

Gas reserves added failed to equal production for the first time during 1968. Already signs of a deficiency are developing and the long-range outlook is that alternate fuel sources will have to be used.

New reserves are discovered only through drilling. Yet domestic exploratory drilling is barely holding a level of 9000 wells a year after reaching a peak of 16,000 in 1956. In view of a guaranteed increase in demand, why is domestic exploratory drilling lagging? The reason involves producing costs and petroleum prices.

Costs

One good measurement of costs is the investment required per dollar of lease revenue. In the latest ten-year period for which figures are available this value has increased from $1.31 to $2.30 per dollar of revenue. This increase of 75% is one and a half times the 50% increase in demand during the same period.

One big reason for the increased costs of producing hydrocarbons is inflation. Inflation, of course, and in spite of all the divisionary propaganda about wages and prices, is a direct result of the federal government’s policy of monetizing the debt. This process of printing money to make up the difference between government expenditures and income causes the increase in dollars to exceed the increase in goods and services. Since a sizable portion of the Federal budget is spent specifically to depress the output of goods (such as agricultural subsidies in lieu of production) and services (such as welfare payments rather than wages for productive labor), inflation has progressed at an alarming rate. Normally the price of petroleum products would also inflate at the same rate as the general economy; the fact that the investment per dollar of revenue has increased 75% indicates revenues have fallen far behind in their race with costs. Why? Government policies which have artificially restrained petroleum prices.

Prices

In 1927 a million BTU’s of heat could be generated from oil costing $36.00; in 1967 this amount of heat could be generated from $30.00 worth of petroleum—up only $1.00 from the low reached in 1947. Why did fuel increase only 3% in 20 years while automobiles tripled in price, housing and food doubled and clothing was up 75%.

Competition with gas has held down the price of oil. In terms of energy production, gas is now as important to this country as oil. Since 1954 the Federal Power Commission has been dictating the price of gas and, by controlling the price of its chief competition, has managed to put a ceiling on the price of oil. Two years ago the short-range economists advocating government “protection” of the consumer against the law of supply and demand were happily crowing about the great fuel savings brought about by forcing one man to sell his commodity to another at a price less than that determined by a free market. Today even the Federal Power Commission recognizes that a critical gas shortage is developing which can be alleviated only by abandoning the fraudulent fantasy that a few bureaucrats can establish a “just and reasonable” price different from that agreed upon by willing buyers and sellers in arms-length transactions. The current commissioners are now groaning about, with an increase here and a review there, in an effort to find a way out of the bureaucratic morass created by previous price-fixing. To their plaintive plea, “Where do we go from here?”, one answer is surely, “Don’t go protecting the consumer anymore. Another fifteen years of such protection and all will surely freeze to death.”
Just at the time the gas shortage has dented the ceiling which has prevented prices from rising to the level necessary to permit meeting the demand, the domestic producing industry is accosted with a tax increase which raises costs and a new tariff system designed to depress prices as well. The combination of rapidly increasing costs and artificially depressed prices raises this concern: Can the replacement costs of the petroleum reserves necessary to meet future demand be justified by the anticipated profit margin? The answer to this question will be more influenced by government than by purely economic considerations.

CURRENT SITUATION

Today the petroleum industry is being handicapped by government influence exerted at various levels and in various areas. On the municipal level, unfair and discriminatory taxes coupled with expensive requirements to abate even the most remote dangers of air, water and even noise pollution substantially increase costs and hinder efficient, reasonable operations. The pollution spectre also poses a real problem and expense on the state level. State budgets now rival the skyrocketing Federal budget in their insatiable demand for new and additional taxes. Yet the crucial influence, the influence which could cripple the industry and the nation, remains at the Federal level where the ultimate powers have migrated or . . . if you believe that the 9th and 10th Amendments to the U. S. Constitution remain valid . . . have been usurped.

All three branches of the Federal Government exercises their influence on the domestic petroleum industry. For purposes of examining these influences, the areas in which they operate can be classified as direct regulation, taxation and policy making.

Direct Regulation

Numerous federal agencies have issued orders directly regulating various aspects of the domestic producing industry. From the railroad freight rates of pipe and equipment to the navigational lights on offshore platforms there is a bureau and a regulation governing essentially every facet of drilling and producing. Federal proration of oil and gas remains a threat and legislative authority for such regulation has already been adopted.

Operating rules are becoming more and more stringent as well as detailed. Aesthetic and ecological regulations are becoming so prevalent that one observer has noted that only the combination of a landscape company and an animal trainer will be able to bid on the proposed Alaskan pipeline.

Air and water conservation are vital to this nation but the current rash of regulations based on emotional rather than factual considerations are wasting more money than they are conserving environment. Concerned and well-meaning people do not seem aware that an energy deficiency poses a far greater and more immediate threat to the American way of life than does the extinction of the Alaskan moose, smog or water pollution. With energy these problems can be solved; without it there is no way to protect our freedom to solve such problems.

In spite of the vast number of prolific agencies regulating the producing industry, two continue to exercise more influence than the combined effort of all others. These are the Federal Power Commission and the Department of Interior which administers the Mandatory Import Control Program. The Commission is now at least considering abandoning the policy of “cheap gas now” in favor of policies that will insure future supplies of gas at competitive and reasonable prices. Hopefully the relief will not be too little and too late so that reserves may yet be developed to avoid the serious shortage which looms on the immediate horizon. But whatever relief more enlightened Commission policies might provide could easily be overcome by an unwise change in the import program.

Taxation

The tax reform bill is now law and the 27½% depletion provision that was proper for over forty years is now 22%. This change will increase the industry’s tax bill nearly a half billion dollars a year—further reducing the capital needed to develop new reserves. Since the 27½% depletion has been in effect for decades, its influence on costs has been reflected in the current price structure. The reduction to 22% will inevitably increase costs and reduce the incentive to invest the capital necessary to insure the development of the new supplies needed.

The proponents of the reduction claim that the oil industry does not pay its fair share of taxes. Yet the facts are that the industry, in addition to collecting billions in gasoline taxes without charge, was paying 6% of its gross revenues as taxes . . . compared to the 5.8% average paid by all mining and manufacturing. Another claim is that the oil industry enjoys excessive profits. The facts? During the last fifteen years the industry has averaged 11.5% profit on net worth compared to nearly 13% for all manufacturing. Even in the good year of 1968 the industry realized a profit of only 12.9% on net assets as compared to 13.1% for all manufacturing.

Under these facts how did the reduction of the 27½% depletion become synonymous with tax reform? The unfortunate but true answer is that the oil industry has a poor reputation. Yet no industry has made a product available more conveniently or at a lesser price. There are over 220,000 gasoline outlets in this country and it is doubtful if the average buyer has ever found one out of gas. Since 1950 retail gasoline prices exclusive of taxes have been increased from only 20 to 23 cents, less than a third of the increase in general cost of living. But unless such facts are understood by the public and their elected officials the industry will continue to be a scapegoat. Here then is a challenge to all associated with the industry and to all fair-minded and knowledgable Americans; a challenge to communicate, to educate and to correct false impressions. Public opinion has hurt oil producers in the past; in the future it could destroy them.
Policies

Many governmental policies influence petroleum production. The inflationary effect on production costs of federal deficit financing through printing money has already been described. Leasing policies affect where and how money is spent and in this area some State policies exercise considerable influence. The nine hundred million dollar Alaska sale and the three offshore sales off Santa Barbara, Texas in 1968 and Louisiana in 1967 siphoned off nearly three billion dollars in industry funds that might otherwise have been used to explore for and develop new reserves. The current confusion as to federal policies relating to oil shale leases is delaying development plans for the domestic shale oil which will soon be needed to augment conventional domestic reserves if the United States is to maintain its capability to be self-sufficient.

Numerous other federal policies harass the industry in minor ways. Government subsidized nuclear power generators, government encouraged speculation on gasoline lead poisoning and government sponsored development of an electric car are examples of such policies whose constitutional authority is hazy to say the least.

But the policy currently at the center of the stage concerns imports. The federal Task Force on imports has apparently proposed a policy of increasing the nation's reliance on foreign oil through manipulation of the current import program into a tariff system. The usual press leak which constitutes the trial balloon for such policy changes emphasizes the desired results of a reduced price to the consumer and an increase in government income with a hint of possible individual tax reduction. As for the reduced consumer prices, it would seem that the long-range aspects of such a reduction should be evaluated in the light of the results of the Federal Power Commission's "cheap-gas-now" policy.

Another question about price reduction that should be asked is, if such reduction is desirable, why not start with something under direct government control, postal fees. In 1940, a penny-postcard could be sent from New York to San Francisco for one cent; today that same postcard may be sent for five cents, or 500% of the 1940 price. In 1940 a long-distance telephone call from New York to San Francisco cost $3.00; today that call may be made for 75¢, or 25% of the 1940 price. Yet the Federal government which raised postal rates 500% forced the company which had decreased telephone rates 75% to reduce their rates to prevent the company from making "excess profits."

Such examples indicate why the future of our general economy and particularly that of the oil industry will be more influenced by government actions than by purely economic developments. The government action currently under consideration which could have the greatest effect upon both the petroleum industry and the nation's defense capability is the proposed change in the import program.

INFLUENCE OF IMPORTS

For those committed to a free economy there is but one legitimate reason for import restrictions: National Security. It is also true that the Constitution authorizes tariffs to provide such protection and that the constitutional method should have been adopted instead of the Mandatory Import Control Program. However, today the reported tariff plan will not provide the necessary protection.

The principal reason tariffs will not do the job is associated with the unstable political climate under which the bulk of foreign operations are conducted. The dangers of expropriation and confiscatory contract renegotiations through legislation make it expedient for the producers to bring in foreign crude at the same price or an even lower price than domestic crude. The resulting lower demand for domestic crude coupled with the announced intention to set tariffs so as to lower prices will drastically reduce the incentive to explore for and develop the reserves needed to maintain the nation's petroleum self-sufficiency.

The effects of the mandatory import program, like those of the 27½% depletion provision, on costs have been reflected in the price structure during the decade the program has been in effect. A change to the tariff system will add costs which will reduce the anticipated profit margin of developing the needed reserves to a level which will not justify the commitment of the required capital. In addition, the tariff itself will consume a billion dollars annually of the industry's resources which could otherwise be used for developing additional reserves. Further reserve reductions in proved reserves will occur as a result of substantial volumes of currently marginal production being rendered uneconomical and abandoned.

Effects on Domestic Capacity

To examine the effects of the tariff plan on domestic production it is necessary to compare the resulting situation with that which would exist under the current program. Table 1 shows the predicted situations during the next six years for an increased crude demand of approximately 4% per year.

It is estimated that removal of import limitations would increase crude imports approximately 1.5 million barrels per day. This would involve displacing the entire 600,000 BPD of domestic crude currently being refined on the East Coast, 500,000 BPD of Gulf Coast crude and replacing 400,000 BPD of Midwest refinery runs with Canadian supplies.

These increased imports would necessarily lower domestic production. Under the current program it is estimated that the 1975 demand of 13.7 million BPD would be met by imports of 1.8 million; Texas production of 4.0 million; Louisiana, 3.3; California, 9; Alaska, 1.4; and the other states 2.3 million BPD. It is estimated that the additional imports would reduce Texas to 3.4 million BPD, Louisiana to 3.0 and Alaska to .8 million BPD.

Table II indicates that the Texas market demand factor would be essentially 100% in 1975 under a continuation of the current program. The significant indica-
tion is that the market demand factor would be 100% in 1975 under a tariff plan although Texas production would be 600,000 BPD less. This result would follow from the abandonment of marginal producing capacity and reduction in capacity occurring as a result of decreased investments. The actual capacity reduction as shown by scheduled allowables would be in excess of 800,000 BPD.

Table III shows a similar situation for Louisiana. Although Louisiana is not predicted to be producing at capacity in 1975 under either set of circumstances, the percent of depth bracket is estimated to be even higher for the lower production under the tariff plan. Again the reason is a reduction in producing capacity as indicated by the 100% allowable being 600,000 BPD less.

The total reduction in domestic producing capacity would be over 2.3 million BPD. Alaska is estimated to have a capacity reduction in excess of 600,000 BPD since there would be insufficient incentive to develop the additional capacity at the reduced price. Other states would suffer a smaller reduction of 300,000 BPD primarily as a result of abandoning marginal reserves which would no longer be economical at the lower price.

Dangers

The most serious danger resulting from the tariff plan would be insufficient producing capacity to meet a national emergency. By 1975 the United States would have an excess producing capacity of only 700,000 BPD while relying on foreign sources for 3,600,000 BPD of crude and 2,200,000 BPD of residual and products. Thus 36% of the total hydrocarbon demand would rely on foreign supplies of which 4,800,000 BPD would be from overseas. A disruption of such overseas supplies would leave the nation with a deficiency of four million BPD after putting all excess capacity on production.

The projected 1975 total demand for crude, residual fuel and imported products is 15.9 million BPD so such an emergency would cut available oil by 25%. Such a cut would exceed that which the nation can withstand without disrupting its industrial efficiency. Under the tariff system this situation would continue to become more serious until foreign nations raised the price of their crude to a point where the domestic industry could again compete. However, the finding, developing and transporting of new oil reserves is a lengthy process which would require three to five years to change the trend after a competitive price was established. It is doubtful that the Communists would give the United States sufficient time to restore its defense capability.

A second danger is the additional pressure against the nation’s fiscal stability occasioned by the increased deficit in its balance of payments. Today the expense of the current level of foreign imports is offset by sales of equipment and supplies. Yet during the first nine months of 1969, the overall trade balance deficit was 2.5 billion dollars. An additional billion dollars annually for increased purchases of foreign oil would be a critical addition to an already serious situation.

NATIONAL OIL POLICY

Concerned government officials, cognizant of the potential dangers of unsecured petroleum supplies, have initiated actions which will probably result in negotiations for continental and western hemisphere energy fuels policies. Yet the United States does not have a rational energy policy at this time.

The lack of a clear national policy is one of the principal reasons the depletion provision has been reduced and the changed import policy is under consideration. Basically, the long-range effects of such changes would be to reduce the producing capacity of the domestic petroleum industry, to lower the nation’s defense capability and to damage the country’s trade balance.

A policy which could avoid such pitfalls could be simply stated as follows: the United States Government will encourage the development of adequate, secure energy supplies which will be available at reasonable costs. The outlook of such a policy would emphasize the principle of the long term good of the nation rather than the expediency of short-lived savings accompanied by the expense of future shortages. Every knowledgeable citizen interested in preserving freedom should inform his elected officials including the President of the necessity of such a policy and the resulting rejection of the announced tariff plan. The adoption of such a policy would encourage government and industry to consolidate their efforts toward the joint goals of protecting the national security and satisfying the needs of consumers.
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<th>Calif.</th>
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**Predicted—Continuation of Current Import Program**

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<tr>
<td>1972</td>
<td>12,180</td>
<td>1,545</td>
<td>3,650</td>
<td>2,885</td>
<td>1,000</td>
<td>500</td>
<td>2,600</td>
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<tr>
<td>1973</td>
<td>12,670</td>
<td>1,625</td>
<td>3,800</td>
<td>3,045</td>
<td>1,000</td>
<td>700</td>
<td>2,500</td>
</tr>
<tr>
<td>1974</td>
<td>13,180</td>
<td>1,710</td>
<td>3,900</td>
<td>3,195</td>
<td>900</td>
<td>1,075</td>
<td>2,400</td>
</tr>
<tr>
<td>1975</td>
<td>13,710</td>
<td>1,795</td>
<td>4,000</td>
<td>3,295</td>
<td>900</td>
<td>1,420</td>
<td>2,300</td>
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</table>

2. Includes approximately 150 MBPD of condensate not carried as crude by Texas RRC.
3. Estimated on basis of partial year.

<table>
<thead>
<tr>
<th>Year</th>
<th>Prod.</th>
<th>Total</th>
<th>Exempt</th>
<th>Prorated</th>
<th>Sched.</th>
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<tbody>
<tr>
<td></td>
<td>MBPD</td>
<td>MBPD</td>
<td>%</td>
<td>MBPD</td>
<td>%</td>
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<tr>
<td>1965</td>
<td>2,556</td>
<td>2,929</td>
<td>43.1</td>
<td>1,666</td>
<td>56.9</td>
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<tr>
<td>1966</td>
<td>2,740</td>
<td>3,156</td>
<td>37.6</td>
<td>1,968</td>
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<td>1967</td>
<td>2,942</td>
<td>3,389</td>
<td>31.8</td>
<td>2,312</td>
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<tr>
<td>1968</td>
<td>2,973</td>
<td>3,405</td>
<td>28.4</td>
<td>2,438</td>
<td>71.6</td>
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<tr>
<td>1969</td>
<td>3,014</td>
<td>3,430</td>
<td>25.5</td>
<td>2,557</td>
<td>74.5</td>
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</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>3,150</td>
<td>3,500</td>
<td>780</td>
<td>2,720</td>
<td>4,500</td>
<td>60.5%</td>
<td></td>
</tr>
<tr>
<td>1971</td>
<td>3,300</td>
<td>3,667</td>
<td>700</td>
<td>2,967</td>
<td>4,350</td>
<td>68.2%</td>
<td></td>
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<tr>
<td>1972</td>
<td>3,450</td>
<td>3,833</td>
<td>640</td>
<td>3,193</td>
<td>4,210</td>
<td>75.8%</td>
<td></td>
</tr>
<tr>
<td>1973</td>
<td>3,600</td>
<td>4,000</td>
<td>600</td>
<td>3,400</td>
<td>4,050</td>
<td>84.0%</td>
<td></td>
</tr>
<tr>
<td>1974</td>
<td>3,700</td>
<td>4,111</td>
<td>580</td>
<td>3,531</td>
<td>3,920</td>
<td>90.1%</td>
<td></td>
</tr>
<tr>
<td>1975</td>
<td>3,800</td>
<td>4,222</td>
<td>580</td>
<td>3,642</td>
<td>3,820</td>
<td>95.3%</td>
<td></td>
</tr>
</tbody>
</table>

1. Scheduled allowables subject to market demand factor.
3. Prorated by market demand factor.
4. Scheduled allowables subject to market demand factor.
### Table III
LOUISIANA CRUDE PRODUCTION AND ALLOWABLE DATA
Yearly Averages

<table>
<thead>
<tr>
<th>Year</th>
<th>Prod. MBPD</th>
<th>Allow. MBPD</th>
<th>100% Allow. MBPD</th>
<th>% Depth Bracket</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>1,424</td>
<td>1,480</td>
<td>4,510</td>
<td>32.8</td>
</tr>
<tr>
<td>1966</td>
<td>1,602</td>
<td>1,662</td>
<td>4,710</td>
<td>35.3</td>
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<tr>
<td>1967</td>
<td>1,840</td>
<td>1,926</td>
<td>5,020</td>
<td>38.3</td>
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<tr>
<td>1968</td>
<td>1,940</td>
<td>2,032</td>
<td>4,865</td>
<td>41.6</td>
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<tr>
<td>1969</td>
<td>2,000</td>
<td>2,100</td>
<td>4,830</td>
<td>43.5</td>
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</tbody>
</table>

Predicted Production, Allowables and Depth Bracket Percentages
Continuation of Current Import Program

<table>
<thead>
<tr>
<th>Year</th>
<th>Prod. MBPD</th>
<th>Allow. MBPD</th>
<th>100% Allow. MBPD</th>
<th>% Depth Bracket</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>2,150</td>
<td>2,250</td>
<td>4,800</td>
<td>46.9</td>
</tr>
<tr>
<td>1971</td>
<td>2,450</td>
<td>2,570</td>
<td>4,700</td>
<td>34.7</td>
</tr>
<tr>
<td>1972</td>
<td>2,600</td>
<td>2,730</td>
<td>4,600</td>
<td>38.1</td>
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<tr>
<td>1973</td>
<td>2,750</td>
<td>2,880</td>
<td>4,500</td>
<td>64.0</td>
</tr>
<tr>
<td>1974</td>
<td>2,900</td>
<td>3,040</td>
<td>4,350</td>
<td>69.9</td>
</tr>
<tr>
<td>1975</td>
<td>3,000</td>
<td>3,150</td>
<td>4,100</td>
<td>76.8</td>
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</table>

Predicted—Imports Restricted Only By Tariff Plan

<table>
<thead>
<tr>
<th>Year</th>
<th>Prod. MBPD</th>
<th>Allow. MBPD</th>
<th>100% Allow. MBPD</th>
<th>% Depth Bracket</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>1,550</td>
<td>1,630</td>
<td>4,800</td>
<td>34.0</td>
</tr>
<tr>
<td>1971</td>
<td>1,850</td>
<td>1,950</td>
<td>4,700</td>
<td>41.5</td>
</tr>
<tr>
<td>1972</td>
<td>2,000</td>
<td>2,100</td>
<td>4,600</td>
<td>45.7</td>
</tr>
<tr>
<td>1973</td>
<td>2,150</td>
<td>2,260</td>
<td>4,400</td>
<td>51.4</td>
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<tr>
<td>1974</td>
<td>2,500</td>
<td>2,630</td>
<td>4,000</td>
<td>65.7</td>
</tr>
<tr>
<td>1975</td>
<td>2,650</td>
<td>2,780</td>
<td>3,500</td>
<td>79.4</td>
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</table>

1. Scheduled Allowable—% Depth Bracket/100
2. Intermediate Allowables established 1/1/67
3. Estimated on basis of Jan.-July Data
The purpose of this discussion is to set forth some broad, general guidelines concerning the preparation of petroleum engineering appraisal reports. First, let me state that I feel that no engineering society or group of engineering societies should dictate the style or format of an engineering report to either the engineer preparing the report or the client for whom the report is prepared. The engineering report may consist of anything from a verbal report on the telephone or a xerox copy of work notes to a formal report bound in red leather with gold engraving. The report should adequately cover the scope of engineering work and be in a form which is in accordance with the function of the engineering report. The form of this report should be based on an agreement between the client and the engineer concerning what the client requires for his purpose, the availability and cost of data and data preparation, the amount of information available and pertinent to the study, and the amount of money that the client is willing to pay for engineering work. If, in the preliminary discussions concerning the scope of work and the nature of the engineering assignment and subsequent report, the engineer feels that he cannot do an adequate appraisal with the information available or for the amount of money the client is willing to pay for the work, or for any other reason he feels that his professional conduct would be compromised in this assignment, he should turn the work down and make such recommendations as he feels advisable to the prospective client. It is obvious in the case of a number of extremely small interests of low value that extreme detail work is not justified either from an engineering standpoint or an economic standpoint.

The writer was privileged to serve on a committee under the Chairmanship of the late D. V. Carter under the auspices of the Society of Petroleum Engineers from late 1965 through early 1967. The assignment of the committee was “(1) To develop an evaluation format suitable for the bulk of evaluations, whether or not third parties are involved, for the purpose of: financing the purchase of oil and gas properties which are wholly or partially proved; financing installation of some method of improved recovery; borrowing money; or any other purpose such as Estate evaluations, trading of properties or merger purposes, as well as field-wide unit or reservoir unitization or relatively simple drilling unit evaluations with the objective of achieving acceptable equities to all interested parties concerned. (2) To write a code of ethics or a list of admonishments to guide the evaluation.” The report of this committee was published in the Society of Petroleum Engineers’ Journal of Petroleum Technology in February, 1967 on Page 193. Generally, the conclusions of this committee were (1) The committee could not standardize an accepted format for all engineering reports, (2) any statement or action by the committee could not have any material effect on the ethics of individual engineers. The writer was and is still in agreement with the conclusions drawn by Mr. Carter’s committee.

During World War II, the Armed Services had a policy concerning reports. This policy stated, “A report should not be written so that it may be understood; it should be written so that it is absolutely impossible for it to be misunderstood.” While everyone here would certainly agree that this is an excellent policy, I am sure everyone here would also agree that it is extremely difficult to carry out. However, this is a goal that we should all strive for in the preparation of engineering reports and the writer has a few suggestions for your consideration. It has been my experience that most misunderstandings are brought about by lack of proper definition of terms. Such simple things as working interest and net interest, future gross revenue, and present worth of future net revenue can be, and frequently are, misunderstood. For this reason it is frequently desirable to define these terms in the body of the report or to use such terms that cannot be misunderstood. For instance, the term “working interest” to some companies and individuals means the share of expenses paid by the company and to others it means the share of income received. For this reason, the writer has ceased using the term “working interest” and “net interest” and has started to use “expense interest” and “income interest.” These terms are more easily understood. “Future gross revenue” to some companies means revenue before production or severance taxes and in some cases, revenue before taxes and royalty, while to most companies “future gross revenue” means revenue derived from the sale of their interest in production after royalty and production or severance taxes. The term “present worth of future net revenue” means a great variety of things to various individuals. In any event, the meaning as the appraisal engineer understands it should be clearly defined in the engineering report. The discount rate together with the method of discounting should be stated. The writer has found some present worth projections discounted as if income were received in one lump sum at the end of the year, at the mid-point of the year, compounded monthly, quarterly, semi-annually, or annually and frequently the client confuses the term “present worth of future net revenue” with “fair market value.” For these reasons, it is highly desirable that a good understanding and a meeting of the minds should exist between the client and the engineer on definition of these terms.

Much committee work has been done on definition of categories of oil and gas reserves. The American Petroleum Institute and the Society of Petroleum Engineers have achieved some degree of agreement through work by a committee under the Chairmanship of John J. Arps on the definition of proved reserves for property evaluation. The report of this committee was
published in the July, 1965 issue of the Journal of Petroleum Technology. This definition includes proved developed reserves, proved developed nonproducing reserves and proved undeveloped reserves. We have all seen reports which have included, in addition to proved reserves, various categories such as probable reserves and possible reserves. The writer has seen engineering reports which included possible reserves which might be more reasonably carried under the category of “possible but highly unlikely” reserves. If categories other than proved reserves are used, the engineer should go to the trouble to adequately define what he considers to be probable and possible reserves and should be prepared to substantiate his reasons for their inclusion. It has been the writer’s experience that reserves in the probable and possible category are not valued so highly by lenders or prospective purchasers as they are by owners and usually should be omitted from most engineering appraisals. However, there are occasions where probable and possible reserves should be a part of the engineering report and here again, the treatment of these reserves should be left to the discretion of the appraising engineer.

The scope of work should be defined in general terms and in some cases, very specific terms. The source or sources of information used in the preparation of the report should be stated together with all qualifications deemed necessary by the engineer involved. For instance, the Carter Committee Report includes a statement “The valuation engineer does not fulfill his obligation and does not relieve himself of the responsibility for erroneous conclusions by the acceptance of data and the statement that all such data were accepted as provided by the client. He should attempt to obtain all available pertinent data, whether furnished to him by the client or not, by a diligent search of all sources of existing data known to him.” Here again, all of us would be in agreement that this is an excellent policy but one that is usually very difficult to follow. An engineer who must appraise several dozen leases in 20 or more fields with a very tight deadline, on non-operated leases, maintaining strict secrecy, cannot be expected to go into the amount of detail that might be justified in another situation. In this case, the engineer and the client should achieve absolute understanding on the scope of work, and if such is impossible or unacceptable to the engineer, he should refuse the assignment. During the course of the Carter Committee deliberations, a case in point was raised where an engineer made an erroneous evaluation due to a typographical error on the elevation of a well or wells. The typographical error was made by parties other than the engineer involved and the engineer in this case could hardly be expected to go to the field with a level and check all elevations involved. The engineer should be experienced and knowlegable to the extent that he will probably catch obvious errors of this nature. A few months ago, the writer was confronted with a structure map that did not make sense—it was possible, but highly unlikely. The wells were spotted according to the locations given on the logs and completion cards on the lease plat supplied to the Railroad Commission, but two wells created rather severe problems on the structure map. In this case, a simple telephone call to the pumper determined that these wells were west of a key well rather than to the east as shown on the logs. This simplified the structure and isopach maps and cost about 10 minutes of engineering time. Especially in the area of well tests, the engineer is frequently confronted with well test data that his experience tells him is erroneous. We have all seen absolute open flow tests which indicated deliverability far in excess of the true sustained capacity of the well or wells. The writer once heard a knowledgable engineer state that under a given set of conditions he could probably get an absolute open flow of one million feet a day from a butane lighter; this may be stretching a point but we have all seen situations which attest, to some extent, to its basic truthfulness. The engineer should use his best judgment in the use of all information available and relevant to the study, but he should not be expected to do any title work to check interests or carry the use or validation of information available to unwarranted and ridiculous extremes.

The advent of the high-speed computer has made possible a number of refinements in engineering calculations which have been uneconomic to perform by hand with a desk calculator. We can now discount by compounding monthly and do a great number of things which add to the basic accuracy of those things which we can control by mathematical processes. We can now handle a great array of data and simulate various conditions which affect the economics and market value of a property or a group of properties. These new tools should be used but not misused in the preparation of engineering appraisal reports. For instance, a model study might be justified in appraising extremely valuable properties in some cases, but it would not materially affect the fair market value of royalty under a one-well lease in the East Texas Field in the Castleberry survey of Gregg County. A great number of highly exotic engineering tools are available for our use but these tools should be used judiciously so that the form of the engineering study follows its function. If the individual engineer is not possessed of enough judgment to decide when and where these techniques are applicable, he should find another line of work.

Some engineering reports consist of a one-page letter and a one-page projection of reserves and revenue while others include maps, curves, cross-sections, and all manner of basic data. Here again, the form of the report should follow its function and be in keeping with the scope of investigation as determined by the engineer, the client and the ultimate user. Some statement may be made in the report giving an indication of the nature and quantity of the data available in the engineer’s files available for examination by interested parties with permission of the client. In all cases the engineer’s judgment on what should and should not be included in the report is the determining factor.

The writer has found the following outline to be helpful in the preparation of appraisal reports. He is
not, however, recommending its adoption, but only stating an outline that seems to be suitable for the purpose in a great many cases.

FOREWORD
Scope of Investigation
Authority
Source of Information
ESTIMATION OF RESERVES
PROJECTION OF FUTURE PRODUCTION AND REVENUE
SUMMARY AND CONCLUSIONS
TABLES AND/OR FIGURES (IF ANY)
In the case of letter reports a similar format can be used with each general heading being a new paragraph or group of paragraphs.

Finally, I would like to say that this paper, of necessity, has been of a very general nature. Engineering reports, in the final analysis, are like truth, beauty and contact lenses—in the eye of the beholder. The engineer should make every effort to define his terms so that the chance for possible misunderstanding should be minimized. He should, to the extent of his ability, be absolutely fair, honest and unbiased. He should make every effort to gather and examine all factual data which are available and relevant to the study within the scope of investigation agreed upon by the engineer and the client. The client has every right to expect competence and honesty from an appraisal engineer; by the same token, the engineer has every right to expect honesty and full disclosure from the client. We are all familiar with situations where these conditions have not been met. The client, or any other interested person using an engineering report, should understand that the appraisal represents the conclusion of the appraiser and the estimates contained therein are estimates based on his best judgment. The method, or combination of methods utilized in the study, should be tempered by experience in the area, state of development, quality and completeness of basic data, and production history. After all, an appraisal engineer can estimate fair market value but fair market value is determined in the market place. By definition, fair market value is the value determined by a willing buyer and a willing seller, both being equally knowledgeable of the facts involved and neither being under any compulsion to buy or sell. These conditions are rarely met. Appraisal of oil and gas properties is frequently an art rather than a science but is an extremely satisfying and fascinating profession. We deal with quantities that cannot be measured as the civil engineer measures the length of a highway and the span of a bridge. We only see little pieces of the reservoir cores and can only examine small quantities of the reservoir rock and fluids in the laboratory. At Texas A & M in 1950, Harold Vance told us that this business was similar to the problems of a carpenter who had to drive nails with a hammer having a handle a mile long. Sometimes the handle on the hammer is too flexible and we make mistakes. As long as these mistakes are honest mistakes, we will enhance the professional status of Petroleum Evaluation Engineers. This society, in a few years, has had an impact on the petroleum industry. Let us continue to work for those things which improve the society, the industry and ourselves.
Mr. President, ladies and gentlemen it is a privilege to have the honor of addressing you this afternoon.

It is always a pleasure to be in this great state and this most fascinating of all American cities. This is the only convention city in the country where they give you a chance to make expenses.

We recently detonated a nuclear device underground with the aid and cooperation of the Atomic Energy Commission as part of its Pivotal Share Program and I am happy to say that, as in all of more than 200 such shots to date, this one has been conducted without evidence of any hazard or possible harm to any living being.

Dr. Edward Teller has called Project Rulison the first thoroughly practical use of nuclear energy for peace. This sets this apart from all other underground nuclear detonations, but it does not mean that we could have accomplished such a use of nuclear energy without Project Gasbuggy and all of the preceding underground nuclear tests.

Our purpose, as was that of El Paso Natural Gas at Gasbuggy, was to attempt to stimulate the almost impermeable rocks of the Mesaverde formation containing vast stores of natural gas and totally resistant to now known conventional well stimulation techniques.

I believe it is unnecessary for me to explain how rapidly the demand for natural gas is mounting, and how desperately the gas industry and the government are facing the problem of meeting both present and future requirements for this perfect fuel. Gas is recognized as the cheapest, safest, cleanest, and most convenient energy in the history of human endeavor.

Despite the barriers thrown in the path of explorers by puzzling and emotional changes and interpretations of the law and incomprehensible decisions of the federal judiciary, including the Supreme Court, the search for gas in this country has never been greater. Nothing could inspire such a herculean effort to find new gas, except the knowledge that we are running out of supply.

This is not a sales pitch for a gas producer. But I would like to pass on these recent quotes:

"Evidence is mounting that the supply of natural gas is diminishing to critical levels in relation to demand. On the basis of current trends, only a few years remain before demand will outrun supply."—Staff report, Federal Power Commission, October 2, 1969.

And another:

"The latest estimates on total U.S. gas demand exceeded supply in 1968 and will continue to do so by an ever increasing margin up to the year 2000."—Henry R. Linden, Institute of Gas Technology.

And this one:

"... a major gas shortage is approaching unless there is a basic change in our underlying resource situation."—John F. O'Leary, director, U. S. Bureau of Mines.

These are facts, which most of us have known for at least a decade, and have preached from the house-tops. But it is satisfying to see warnings now being echoed by many who heretofore questioned our appeals.

It was with the realization of the existence of an impending shortage of natural gas that the Bureau of Mines boldly stated in a 1966 report: "If the technique of underground nuclear stimulation of gas rock reservoirs proves economically feasible, this method could develop an additional 317 trillion standard cubic feet of gas and more than double this nation's proved gas reserves."

These locked-in reserves are situated in thick sandstones of the Piceance, Uinta, Green River, Wind River, and San Juan Basins, all in the great Rocky Mountain region, which, it has been said, is the potential center of one of the most remarkable areas of industrial progress and prosperity of any region in the world.

In this awe-inspiring and most colorful region of our nation, all of these 317 trillion cubic feet of natural gas are found in tight sandstone reservoirs and if nuclear stimulation works, this gas can be produced.

If sustained high rates of flow of natural gas are obtained through nuclear stimulation, then, at a price of 20 cents per MCF, this 300+ trillion cubic feet of gas could be worth $60 billion dollars.

This is ten times the product value that oil explorers envision on the North Slope of Alaska and this product is here in the center of the United States.

Dr. Edward Teller has brought out the point that natural gas can be our greatest asset in solving the problem of pollution, thereby eliminating some of the greatest hazards to national health.

Today at Rulison we are on schedule. There have been no miscalculations that the Atomic Energy Commission or Austral can detect.

As of November 24, last Monday, a shut-in pressure of 2490 pounds per square inch was observed at the Rulison test well. This is precisely as expected. Shut-in pressure is not expected to exceed 2600 psi by the re-entry date in March.

So far, we are encouraged by the smooth predictable operation, and feel certain the stimulation effects of the detonation will be as predicted. We have no question in our minds about the success of Rulison, because there have been no indicators that would give us pause.

There is no question in our minds, or on the part of any of the other participants, that if sustained high rates of gas flow are obtained, scientists and technicians, and the incredible know-how of both that placed a man on the moon this year, will enable us to produce gas from nuclear stimulated wells, safe in its usage and marketable to industry and the ultimate consumer.
When we undertook this task, we had technological and scientific problems facing us, but we were totally confident we could master these. Today we are even more confident, since every predicted technological problem to date has been met with almost uncanny success and precision.

But I must admit that unforeseen problems have arisen which seem to be more serious, more vexing, and often more frustrating than problems of technology and science.

First, there are the legal problems, in which we are being forced into landmark decisions. So far, we have been successful, even to the Supreme Court. Still, we do not know what tomorrow holds in the court room.

Second, there is the emotional and public acceptance problem, which is understandable. In war, the atom bomb was a terrible weapon. Its devastation was beyond imagination. But that was in wartime. Since then, thousands of advanced scientists and technologists of the world, and especially in this country, have devoted their talents and skills, and billions of dollars, to the harnessing of this great power and to turning it toward peaceful uses that can serve mankind in a manner most of us still cannot comprehend. Concerned conservationists and other citizens are still not convinced that nuclear energy can be safely harnessed for peaceful use. I believe that closer and better communication is necessary to overcome this concern.

Solutions to these problems do not lie in the direction of confusion or polemics. Solutions lie in reason and in an appeal to the common sense and understanding of intelligent men.

It should be understood by everyone concerned that nuclear scientists and technologists, who are actually in charge of every step in Plowshare, would take no gamble that would endanger the health or life of a single American. Rulison might not produce gas, but it certainly will not produce a public hazard.

And I can assure you that no one is demanding more in the way of safety to man, animals, and vegetation than my company. We find these facts are difficult to communicate, but we are confident that those who will gain the most—the American people—and especially those of the Rocky Mountain Region—will understand in time.

We have a film portraying what has been accomplished to date at Project Rulison which my company had undertaken with the aid and cooperation of the Atomic Energy Commission as part of its Plowshare Program.