INFLUENCES OF PETROLEUM TECHNOLOGY UPON COMPOSITE INTEREST IN OIL

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SUMMARY OUTLINE

Introduction ........................................ 771
Diversified groups comprising public interest in oil ........................................ 771
Public attitude toward petroleum industry before present era ........................................ 774
Rapid growth of industry to supply demand for illuminants ........................................ 774
Centralized management of refining and transportation facilities ........................................ 775
Competitive expansion to meet increasing gasoline requirements ........................................ 776
World-War period ........................................ 777
Indications of impending shortage of oil reserves ........................................ 777
Competitive development of new fields leading to proration ........................................ 777
Specific examples of growing public interest ........................................ 778
Oil on public lands ........................................ 778
Federal Oil Conservation Board ........................................ 779
Stabilization Forum ........................................ 780
Petroleum Code and reports of fact-finding committees after code adoption ........................................ 781
National Resources Board ........................................ 782
Technical considerations of stabilization ........................................ 783
Allocation of production ........................................ 784
Comparisons of controlled and uncontrolled production ........................................ 787
Production control in Kettleman Hills field ........................................ 789
"Rule of capture" and ownership in place ........................................ 792
Relation of technology to future economic conditions ........................................ 793

Complex forces having interrelated technical, economic, political, and judicial significance are tending to change the thought of the whole social order in this country. This condition is strikingly evident as it pertains to the petroleum industry. Almost from the beginning of this industry various ideas and concepts have been in conflict regarding property rights to oil and gas, production without waste, extent of reserves, productive life of fields, maximum ultimate recovery, output in accord with demand, relations of price to availability of supply, and many other related subjects. Out of these divergent views has grown a certain unanimity of thought by virtually all elements or units of the social economy having a direct interest in oil, with the result that there is now a generally expressed desire to bring conditions to a state where sudden and disrupting change will not be imminent and to make possible the conduct of an orderly program of development and industry. Despite this common urge there has been a continuing, wide-spread difference of opinion as to how this desirable objective, generally referred to as "stabilization", can be brought about most effectively.

The following pages analyze what appear to be important effects of outstanding technologic developments upon existing thought regarding oil and their influence upon the public interest in oil. This analysis indicates that ordinarily the limitations or possibilities of any given program are measured in the long run by the feasibility of its technical procedure.

DIVERSIFIED GROUPS COMPRISING PUBLIC INTEREST IN OIL

The public interest in oil is a complex state or condition. Standing in the way of a full understanding of this subject is the frequently expressed and widely believed opinion that the consumer interest is
the "public interest." This interpretation is restrictive, as the consumer interest represents only one of several diversified groups comprising the public interest, which actually is the composite of all integral parts of the social order, a few of which are discussed in the following paragraphs.¹

First, there is that part of the public interest represented by the thought and actions of the business group of managing ownership. Because of the diversified components of industrial activity the part played by this group cannot be described in a brief summary statement. Like all other industries comprising subdivisions serving different purposes the objective of the petroleum industry as a whole, as represented by management, is to perpetuate itself through making available to consuming markets fuels, lubricants, and other manufactured products needed in the course of a civilized existence. The actuating force behind industry is expectancy of monetary gain in return for goods delivered and service rendered. The prominent position of the petroleum industry is indicated by the 12 billion dollars reported as its capital investment; to this may be added that of its companion, the natural-gas industry, which has a total invested capital reported as 2 billion dollars and upward. Further, the average annual value of petroleum, natural gas, and natural gasoline produced in the United States during the last decade has been well over 1 billion dollars, representing approximately one-third of the average annual value of all mineral products; this in turn is nearly one-half the value of agricultural products for the same period.

Closely allied with managing ownership on account of financial considerations is the group comprising investors looking for places to put their capital to work, with fair assurance of its security and a return commensurate with the risk. Investment in the petroleum industry has received frequent unfavorable comment because of the unhappy outcome of unscrupulous dealings and questionable ventures. However, this is not representative of some 2 million investors, many of them people with only moderate incomes who, in good faith, have invested their savings in oil-company stocks or other securities or in oil royalties.

Labor and management are on the same footing in that the primary interest of each group is the welfare of the petroleum industry, which depends upon the uninterrupted production of oil and the ultimate sale of products at a profit. Therefore the viewpoint of the worker in the oil fields, at the refinery, or at the service station is as essential in developing a composite picture of the public interest in oil as that of the company executive who represents business management, the consumer, or any of the other component groups.

According to reliable estimates 1,197,000 workers were employed directly by the petroleum industry in March 1934. Of this number, 114,300 were in the producing branch, 22,000 were in pipe-line operations, 113,800 at refineries, 147,900 in wholesale distribution, and 799,000 at service stations. The total did not include rig builders or the employees of drilling contractors. The present enrollment of petroleum-industry employees is reported to be approximately the

¹ The writers believe that some term such as "common interest" is more inclusive and conveys a better over-all picture than the term "public interest." However, the use of "common interest" does not seem to be well established in writings on this subject; and to obviate possible misinterpretation, as implying complete unity of thought and action to obtain an orderly and stabilized program, the term "public interest" is used generally in the following text as the combined, although at times divergent, thought of the social and industrial groups of the country.
same as when the given figures were compiled, with over 200,000 persons reabsorbed and put to work during the last 2 years. The annual pay roll is more than 1½ billion dollars. To this labor group should be added all those persons who receive employment indirectly because of petroleum activity, from prospecting for likely deposits throughout the whole course of oil's progress to its ultimate consumer. The number comprising the last subdivision can only be conjectured.

The attitude of the labor group toward management, as expressed by the workmen's satisfaction or dissatisfaction with prevailing wages, hours of employment, and provisions for health and safety, usually reflects the general economic conditions within an industry. Wages paid by the petroleum industry to its workers always have been at a high level compared with many industries, for a large percentage of the employees must be skilled in the various trades, have knowledge of special technique (as in the drilling of wells and the refining of oil), or be trained as salesmen in the marketing branch. Evidences of disputes between labor and management in the petroleum industry because of unsatisfactory wages or working conditions have been relatively few and mostly in local areas. Accident-prevention programs have been conducted actively for more than a decade with marked reduction in the frequency and severity of injuries to workmen.

The misapplied use of the term "consumer interest" has been mentioned. Primarily, the consumer's interest has been concerned with having assurance of a long-continued supply of the products he uses for his necessity, convenience, comfort, and enjoyment at a personal cost to himself as low as can be obtained. Every person is a potential consumer of petroleum products and of natural gas. From the standpoint of utility and ready availability from no other source the chief products are motor fuel and lubricants. However, sight should not be lost of the great quantities of fuel oil required for domestic and commercial consumption and for transportation on land and water, as well as the volume of crude oil marketed in the form of kerosene, paraffin wax, and the almost untold variety of products that go to fill human needs.

Many discussions of the problems of the oil industry fail to recognize sufficiently the landowner's place and influence, despite his somewhat peculiar position. As an outgrowth of our laws regarding property rights, a heritage from the English common law, the owner of the surface initially is also the owner of the mineral rights beneath his property. He may sell, lease, or convey these several rights in a wide variety of ways prescribed by definite legal procedure, but in effect the landowner is the "land lord" to those who produce oil and gas from his property. Some oil and gas producers own their land in fee because of special conditions or by reason of railroad land grants, as in California, but the outright purchase of holdings usually requires prohibitively large initial investments, and the leasing of acreage prevails in most of the oil and gas fields in the United States.

Frequently the landowner is an agriculturist trained to expect the recurrence of crops and the cyclic reproduction of livestock. For that reason, in his position of "land lord" he is likely to be overanxious to have harvested what he considers the "crop of oil" so that he may collect his share. Time and again operators have been forced to fulfill lease provisions immediately to the letter, causing them to drill new wells and produce excess oil in the face of uneconomic
circumstances. On the other hand, the prevailing leasing system has been an important factor in the unprecedented growth of the oil industry, and although the landowner group is relatively small in numbers, its influence upon the prevailing thought regarding oil is a strong one. Whether they as individuals and the country as a whole might have benefited more under some other system is not a point of discussion here.

Other industries supplying materials needed to produce, transport, refine, and market petroleum and its products—for example, steel, lumber, and cement—and the automotive industry, because oil is the source material for the fuel and lubricants of the motors it designs and builds, are groups to be included in a composite picture of what comprises the public interest in oil. Finally, there is the question of oil for national defense, and the complex position of the Federal Government and that of the States and their subdivisions, involving legislation, regulation, and a multiplicity of other factors including taxation.

Other groups might be named, such as competing-fuel groups, but those that have been mentioned will suffice to show why the widespread interest in oil is forcing a national oil policy upon the attention of this country. For many years attempts have been made to define the oil policy of the United States, but compared with the British viewpoint or, more extremely, the operation of the oil industries of some other foreign countries, it can hardly be said that the United States has so far developed a well-articulated policy pertaining to oil.

Leith has pointed out that the many political, economic, and social considerations included in a national oil policy must be surveyed not only from the local and national viewpoints but from the world position as well. In a representative government such as that of the United States a national policy pertaining to a natural resource must be predicated upon the several interests involved, which collectively have been mentioned in the preceding paragraphs as the public or common interest.

PUBLIC ATTITUDE TOWARD PETROLEUM INDUSTRY BEFORE PRESENT ERA

Turning from discussion of some of the major groups that comprise the public interest in oil and now are thinking along widely different lines yet desire stability within the petroleum industry, attention should be given to the general public attitude toward the petroleum industry during the several outstanding periods of its history in the United States. Although there is no definite dividing line between the several eras a brief review of important sequences of events helps to show the stabilizing influence of technical developments upon present conditions. No attempt has been made to follow an entirely chronological continuity or to treat other than major events, although the writers are aware of the influence of many circumstances not cited in this paper.

1 This thought was suggested by and given more detailed treatment in a Memorandum Regarding the Natural-Gas Industry, a joint report by G. R. Hopkins, H. S. Kennedy, and H. C. Fowler, prepared by the Bureau of Mines at the request of the Chairman, Committee on Interstate and Foreign Commerce, House of Representatives, Dec. 20, 1934. Published in House, Report 327, pt. 4, 73d Cong., 2d sess., pp. III-XXXIV.

2 Although the important influence of taxation upon the public interest in oil is recognized, that subject is outside the scope of this writing.

Rapida growth of industry to supply demand for illuminants.—From 1859 to about 1870 and particularly following the Civil War the influence of oil had become felt throughout the country to a pronounced degree. During that period there were rapidly fluctuating increases in production throughout the Appalachian region which not infrequently demoralized the price structure of the oil markets. By the end of the period several hundred refineries were supplying kerosene to a growing population that had become conscious of a better means of illumination than had ever been known before. It had been fairly well established that the source of supply was not temporary and that part of the public interest represented by the consumers of kerosene was highly personal. Equally personal was the attitude of those engaged in finding new fields and in supplying the rapidly increasing consumer demand. The urge was to get the oil to calling markets as quickly as possible. Government interest was predominantly local; certainly it was not nationalistic. During that period, although some basic engineering principles were recognized and put to work—for example, the gas lift—in the main petroleum was produced and refined through methods based upon trial and error. Outstanding as a predominating feature was a set of pioneer conditions that made unnecessary a knowledge of production control, as the accepted meaning of the word is employed today.

Centralized management of refining and transportation facilities.—The individualistic and highly competitive practices in the production of oil of the first period merged gradually into those of the succeeding one, 1870 to 1911. In fact, the frequently cited Pennsylvania court decision, which likened the fugacious and migratory nature of oil and gas to that of birds and wild animals and has influenced the whole course of the petroleum industry, was not rendered until 1875. Because the courts lacked knowledge of the working of physical laws within natural reservoir systems, that and subsequent legal decisions of the earlier part of the second period shaped the jurisprudence concerning oil and gas property laws so definitely that the so-called “law of capture”, or the legal property requirement to reduce these minerals to possession, confronts and confuses the present social order despite the inaccurate postulates upon which it is founded.

Logan and others have pointed out that the economic life of the petroleum industry during this second major period is recorded in the history of the Standard Oil Co. By 1906 that organization, with its affiliates, controlled 86.6 percent of the total output of refined products. However, the production of crude oil continued on an individualistic and highly competitive basis, with capital from diversified sources forthcoming readily to cover the highly speculative risks of unscientific exploration and drilling. That condition did not result in an excessive output of crude oil, except for one or two occurrences during the earlier part of the period. The Federal Trade Commission has pointed out that because of the Standard Oil Co.’s ownership of

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virtually all important pipe lines this small corporate group "had nearly as complete control of the output of crude as it would have had through ownership of the producing areas."

That evolutionary period of the country's industrial expansion stands out as one characterized by a complete lack of thought regarding a national oil policy. Instead, it was one of centralized private control by a small group of men with keen ability that served well the vigorous requirements of the time.\(^{10}\) The effective price control of crude-oil production as exercised by the Standard Oil Co., during that era went a long way toward checking the tendency of individual operators to drill wells and produce oil far in excess of the available consuming markets. The concern of the Federal Government in the expanding control of the Standard Oil Co. was prompted by the expressions of alarm from the agricultural West over the rising industrialism of the East. The marketing of oil was outstanding, and the antitrust laws were invoked to check the expansion. The orderly production of petroleum was not an issue, for that condition was well-controlled.

**Competitive expansion to meet increasing gasoline requirements.**—Changed conditions emerged out of the gradual separation of the Standard Oil Co. into 33 separate companies, following the final dissolution by order of the United States Supreme Court in 1911. The character of the change was due partly to the separation; but concurrently new fields were discovered, new capital was brought together to form companies that not only produced oil but also transported, refined, and marketed their products, and the automobile was beginning to create a market for gasoline, making that product, rather than kerosene, first in importance.

After 1911 expansion was rapid and frequently wasteful. Competition between realigned integrated companies as well as nonintegrated companies became more evident, and there were general periods of flush production caused by the discovery of prolific fields, interspersed with periods of shortage and attendant high prices. The principle of laissez faire was uppermost. On the technical side there was a general failure to recognize the significant part of natural gas in bringing oil from the reservoir to the surface. Many oil producers looked upon natural gas accompanying their oil as a necessary evil, and more than one field was prevented from producing its extractable quota because, through lack of correct engineering knowledge or the tendency of current practice to "follow-the-leader", vast quantities of gas were blown to the air in an effort to get the oil to "come in."

This practice of wasting the value of natural gas, both as an energy factor in the reservoir system and as a fuel after it had reached the surface, did not go on without efforts to call the attention of the industry to the fallacy of such unscientific operating methods. Engineering thought was being crystallized within the Bureau of Mines, whose engineers were beginning their studies (1910–14) of the nature of oil and gas in underground structures and were performing initial work in formulating a philosophy of technical study with the view of showing that if man would develop oil and gas resources to his greatest benefit he must harmonize his actions with definite natural laws,

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because opposition brings its penalties of increased cost and diminished return.11

World-War period.—With the eyes of the world turned upon the conflict in Europe and particularly with the entrance of the United States into the World War in 1917 oil became a matter of deep concern; and every effort was bent by the industry, working closely with the Government through the United States Fuel Administration, to produce a maximum quantity of oil in a limited time. The results of applying technical knowledge that had been evolving gradually began to show in increased production and in the efficient manufacture of desired fuel products. The driving public became aware of the wartime need for petroleum through the "gasolineless" Sundays instituted and in general was willing to cooperate in conserving fuel. Never before had the attention of the whole country been brought as directly to the question of oil as an essential commodity, but this was an artificial condition, stimulated by temporary lack of supply and consequent high price, that would not have existed in times of peace.

Indications of impending shortage of oil reserves.—After the war period the mineral industries of the country were confronted with many difficulties attending the readjustments to lower levels of output, following the strain of meeting demands never before placed upon them. One very important fact that the demands of war forced upon the attention of the petroleum industry was the definitely limited supplies of its crude material. The suggestion of an oil shortage had been made repeatedly by various writers, but hitherto no large part of the industry had taken definite cognizance of the impending diminishing supply. For a year or two the scarcity of oil, with attending high prices, made it appear likely that overproduction never again would be an economic factor in the United States. Some companies even took steps to accumulate large stocks in storage above ground. The urge was to explore all favorable areas, resulting in extensive geological work and the increased drilling of "wildcat" wells. Some companies turned to fields abroad and their foreign explorations were looked upon with general favor. The total number of oil and gas wells drilled in the United States alone, which in 1920 reached an all-time peak of 33,911, is indicative of this search for more oil.

Competitive development of new fields leading to proration.—In rapid succession came discoveries of prolific horizons in southern California. The sites of these new fields were thickly populated and under diverse ownership. The town-lot drilling campaigns conducted in those fields are among the worst examples of highly competitive and frequently ruthless exploitation in accordance with the prevailing concept of the so-called "law of capture." These conditions led to overproduction. Shortly afterward new productive zones were discovered in the Mid-Continent area, and with the rapid development of the Seminole (Oklahoma) field, where large quantities of oil were brought to the surface by means of the gas lift, predominating thought turned to ways of restricting output through prorating the quantity of produced oil.

The historical sequence of events pertaining to proration is far too long and complicated to be rehearsed in this paper.\textsuperscript{12} It should be noted, however, that proration of oil production is not new. An effort was made to meet overproduction in Pennsylvania as early as 1869 and again in 1873 when a glutted market threatened the existing price level. There were other attempts from time to time in various parts of the country to control the production of petroleum, as in the Hewitt (Okla.) field in 1921. For this paper it suffices to state that the period of production control extending to the present followed appointment by the operators of a field umpire in November 1926 to cope with the situation developing out of the excessive production in the Seminole (Okla.) area.\textsuperscript{13} With a present ability to produce more oil than markets can absorb the principal features of this latest era of the petroleum industry are expressed in the many efforts that have been made to hold oil in the natural reservoirs for use as needed, instead of permitting uncontrolled flow to the surface, with its disturbing effect upon the markets and prices.

**SPECIFIC EXAMPLES OF GROWING PUBLIC INTEREST**

The brief decade comprising the present era of production control, with its problems of attempting to keep supply within the bounds of market demand, did not in itself change prevailing ideas with reference to oil, for the newer concepts, opposed to unrestrained competition, actually have been a development of a growing public concern in oil extending over the previous 50 or more years. Specific action of various groups and of government, during the several transitory periods that have been discussed in the broader view, have affected the future of the oil industry. The following examples are illustrative.

*Oil on public lands.*—The Placer Act of 1870,\textsuperscript{14} modified from time to time into various forms, had been the basis for acquiring oil and gas lands on the public domain. During the administration of President Taft a bill was passed\textsuperscript{15} providing for the withdrawal from public entry of large tracts of possible oil and gas bearing lands. Later (in 1912 and 1915) two areas in California and one in Wyoming were specifically designated as naval oil reserves. By January 1916 more than 5½ million acres, mostly in the Western States, had been withdrawn from public entry, although many of these tracts were subject to restoration to the former holders. The disputes and litigation which grew out of the public-land withdrawals and the difficulties attending supervision of oil and gas operations on these lands under the then existing laws were an ever-increasing source of difficulty for the General Land Office. After long and protracted debate the Mineral Leasing Act of February 25, 1920, became law, and the supervision of operations under oil and gas leases on public lands became part of the duties of the Bureau of Mines until July 1, 1925, when the Bureau was transferred to the Department of Com-


\textsuperscript{14} 16 Stat. 217.

\textsuperscript{15} 36 Stat. 847.
merce, and all of its regulatory activities were assigned to the Geological Survey.

It is unlikely that the Leasing Act had any great effect upon the discovery of new fields, but its economic influence in the public-land States has been evident. Further, it established a definitely stated operating policy of the Government on these lands, as contained in the regulations governing the production of oil and gas. These regulations were prepared by the Bureau of Mines to prevent damage to the producing horizons and waste from them through specified methods which embodied the results of engineering studies of the Bureau and the best practices of the industry. Provision was made that has relieved many Government permittees from drilling all except wells currently necessary at times when operators holding private leases were being forced to drill many wells and produce the extractable oil from them in the face of overproduction and low prices.

Full discussion of the Government's interest in oil, as evidenced by its more than academic participation in activities on public and Indian lands, would require much space. The following instances indicate and exemplify this active Federal interest in oil lands: Development of oil and gas on the tribal lands of the Osage Nation, Oklahoma, and on other Indian lands; the Red River operations while the Texas-Oklahoma boundary was in dispute; the naval oil reserves; the initiation of a unit plan of operation on nearly 9,000 acres of public lands in the North dome of the Kettleman Hills field, Calif., under KENDA (Kettleman North Dome Association) management; and the acts of July 3, 1930, and March 4, 1931, amending sections of the Mineral Leasing Act of February 25, 1920, and providing that all Government permittees sign an agreement in reference to the future unitization of their holdings.

*Federal Oil Conservation Board.*—The letter of President Coolidge authorizing the Federal Oil Conservation Board on December 19, 1924, marks the beginning of another phase of the crystallization of governmental interest in oil and the recognition of the influence exerted by engineering thought on petroleum subjects that had been coming steadily to the foreground. This definite pronouncement of the Chief Executive in which he (1) stressed the responsibilities of Government and appointed four members of his Cabinet to study the subject of oil conservation with the enlisted full cooperation of representatives of the oil industry, (2) directed attention to the Government's large interest in oil lands on the public domain, and (3) called upon technical advisers of the Board in the Government bureaus to contribute to the full discussion of ways and means of safeguarding the national security through the conservation of oil, probably did more than any other single act before that time to focus the attention of all concerned groups upon the subject of oil conservation as it affects the economic structure of the Nation.

The printed record of public hearings on February 10 and 11, 1926, and the five following reports were issued during the life of the Board reflect only part of the lasting influence of its activity upon the succeeding oil history of the country.

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16 Logan, Leonard M., Jr., work cited (see footnote 7), p. 66.
17 48 Stat. 1923.
This Board was confronted with a difficult set of conditions, for its status was entirely advisory. It could recommend only along broad lines that the industry apply the knowledge made available through the studies of better ways of conserving oil and gas than those currently practiced. If any part of the industry chose to ignore the studied advice of the Board, it had no delegated authority with which to enforce its findings. There were bitter differences of opinion within the industry which added to the difficult task of accomplishing definite ends in conserving the oil supply of the country.

The Federal Oil Conservation Board was a psychological rather than an immediately effective force; it educated the industry and to some extent the public as to the principal problems of oil conservation requiring cohesive group action. For the first time in the history of the industry Government representatives, oil-company executives, engineers, economists, jurists, and others had the broad picture of oil laid before them. The net result was that people began to realize the great variety of elements comprising the public interest in oil and to recognize some of the complicated relations of one factor to another.

Despite the many limitations placed upon it, subsequent events have proved the efficacy of its constructive work, for time and again in the present efforts to obtain an economic balance between supply and demand and to correct current practices that stand in the way of wise use of the country’s oil and gas resources, the premises have been based upon factual data and fundamental concepts developed from 1924 to 1932 in connection with the work of the Federal Oil Conservation Board.

Stabilization Forum.—Another organized activity (not governmental) that has helped to shape thought on oil is that of the Stabilization Committee of the Petroleum Division, American Institute of Mining and Metallurgical Engineers. Earl Oliver, chairman of the Petroleum Division in 1932, in outlining his plan for the year’s work, gave as his opinion that production control was the great problem ahead of the world for some time and said in part:

We believe the prerequisite of any satisfactory solution of the oil industry’s ills is an educational campaign establishing a better public understanding of the needs and merits of production control, by which we mean the maximum yield at the minimum cost coordinated to society’s current needs.

As a part of that committee’s efforts to arouse a common interest in stabilization, a series of 13 articles was published in the Oil and Gas Journal under the title, “A. I. M. E. Stabilization Forum,” between May 1 and September 21, 1933. The four essentials for bringing about stabilization in the petroleum industry as developed in that forum were: (1) Balancing supply and demand, (2) greatest recovery at lowest cost, (3) standard of ownership rights, and (4) preserving ownership control. In reference thereto, part of a previously unpublished statement by H. C. Fowler on October 10, 1933 is quoted; this was a reply to a direct request for comment on the “Stabilization Forum” series:

Even as such fields as Seminole, Oklahoma City, and East Texas in turn, have been proving grounds for engineering facts, it now appears that many of the economic, political, and legal concepts of the industry are being or will be subjected to the “acid test.” Therefore it is likely that as the course of the petroleum industry is plotted under a Code of Fair Competition for the Petroleum

Industry, pursuant to the National Recovery Act approved June 16, 1933, new or modified viewpoints will come to the foreground, and it is not unreasonable to believe that fast-moving developments will bring forth suggestions to augment the four essential needs of a stabilization program heretofore established by the forum.

_Petroleum Code and reports of fact-finding committees after code adoption._—An attempt to evaluate the final effect of the Petroleum Code upon the public interest in oil would be premature, for the experiment is too much a part of current social life for the complete picture to be seen. Moreover, the recent decision of the Supreme Court declaring certain provisions of the National Industrial Recovery Act unconstitutional increases the uncertainty regarding the future course of oil under Government regulation. However, present-day conditions seem to bear witness to the truth of the quoted statement above made in 1933 that new developments growing out of the period of operation of the Petroleum Code will add further considerations to the four essential needs of a stabilization program as indicated by the forum. The crux of what now appears as a definite fifth item is the trend toward the formulation of a national oil policy. Earlier this paper stated that a United States oil policy must be predicated upon the thought of the several groups making up the public interest in oil. Assuredly, since adoption of the Code of Fair Competition for the Petroleum Industry, approved by the President August 19, 1933, there has been more public interest than ever before in the stabilization problems of the oil industry, not only by the industry and Government but also by the consumer, investor, and all other groups referred to in the first part of this paper. This interest in itself does not imply that a national oil policy will be formulated, but it gives a basis upon which to judge the existence of a definite trend in that direction.

The sequence of events from the initiation of the Petroleum Code to the appointment of a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, to make petroleum investigations in compliance with House Resolution 441, passed at the close of the Seventy-third Congress, second session (June 1934), cannot be recorded here. The comprehensive scope of the subjects into which the subcommittee was directed to inquire indicates in some measure how many new factors developed under the code to add to those of long standing which influence current thought pertaining to oil. It also points to the fact that the Government is actively considering the broad aspects of the petroleum problem.

This attempt to determine the essential facts of the industry and the public interest in oil between the adjournment of the Seventy-third Congress and the opening of the Seventy-fourth was a stupendous undertaking. The extent and thoroughness of the subcommittee's investigations are indicated by the four large volumes of testimony, special technical reports, and other pertaining material indexed in part 5 of the hearings; but even with this great quantity of current material before it, the subcommittee did not find it advisable to embody in its report a draft of any bill setting forth what its members believed should become legislation pertaining to the petroleum industry, and the subcommittee gave reasons for that position in its report.29

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It may be concluded that the subcommittee found a continuing divergence from a bond of common understanding as to what legislative action should be taken to bring about stabilization. In other words, the subcommittee found many of the same self-interested views expressed in the testimony that have predominated throughout the years of the industry. The weight of facts, however, called the subcommittee's particular attention to and impressed it with two conditions of first importance:

1. An excessive supply of petroleum and its products to meet current demand undoubtedly exists.
2. Based upon conservative estimates of known reserves, an excessive supply of petroleum to meet future demand does not exist.

After the subcommittee made its report to the House of Representatives another statement originated in a careful, independent survey of conditions with special reference to the effects of the Petroleum Code on small enterprises in the industry. People in all parts of the country who are concerned with oil problems have given serious consideration to this report, of which the opening paragraph states:

This Committee has become convinced that no permanent benefits of material value to either small or large enterprises of the petroleum industry can be obtained under the Code without a permanent, assured, and effective balance of crude-oil supply and demand, nor can stability of the industry and conservation of the oil resources of the Nation be achieved without such balance.

The findings of both these investigating committees are not new in principle, but their restatement by official bodies representing large sectors of prevailing thought on petroleum matters call the attention of the country forcibly to the conditions or forces acting to change current thought in reference to oil matters.

National Resources Board.—The National Resources Board, an agency recently taking group action through the expression of its views, also has influenced the public thought in reference to oil matters. The President appointed the Planning Committee for Mineral Policy on April 7, 1934, and under the active direction of its vice chairman, C. K. Leith, this committee made a report early in 1935 to the National Resources Board as "a preliminary statement of the major elements of policy, with recommendations for action on a few of them." In the letter of transmittal accompanying the preliminary report the Planning Committee for Mineral Policy stated its expectation of preparing a more complete report to be submitted to the President.

The main consideration of this group has been to see whether conditions with respect to all minerals call for "better coordination of national policy in the public interest."

Dealing with the subject of petroleum this committee pointed out that the limited reserves of oil and gas have been withdrawn to such an extent that prompt adoption of a national policy to insure a wiser and more efficient use of the remaining resources is imperative. The committee stated among other conclusions that such a policy should have the influence "that will enable the operators of petroleum prop-

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erties (through technical and scientific knowledge) to use energy associated with the oil for moving it to the well and through the well to the surface, leaving a maximum of energy in the system available to do such work in the future, thus minimizing the quantity of oil to be left underground beyond recovery by ordinary means. 23 A complete reading of the Report of the Planning Committee on Mineral Policy and particular study of the section on petroleum suggest that the committee recognized the need for scientific analysis and the application of proved engineering methods if the public interest is to be served by a wise national oil policy.

TECHNICAL CONSIDERATIONS OF STABILIZATION

The public interest in oil at present is confronted with various concepts that have been evolved out of group and Government action during more or less definite periods in the history of the petroleum industry. The immediate task is to evaluate the limits and potentialities of technology in reference to the general objective of stabilization—the developing of deposits and production of oil and gas from them in an orderly sequence to meet current needs, using methods that will assure equitable distribution of production allotments and maintain the integrity of property rights. In doing this the other requisite of conservation must be met, as pointed out in the report of the Planning Committee on Mineral Policy.

Petroleum engineers have proved their ability to win more oil from the sands. At times they have been accused of doing their work too well, thus contributing to overproduction. Where only technical problems are presented by the physical conditions of the reservoir they have been able to devise means of bringing the oil to the surface in orderly sequence. The complexities of the social order make the problems of orderly development difficult and have called for a more encompassing role than engineering requirements alone demand of those engaged in technical pursuits. Today, petroleum engineering not only has a definite place in virtually every company's operations in its oil-field development, but the tenets of engineering principles are showing themselves ever more forcibly in economic considerations, in decisions of the courts, in statutes and regulatory orders, and in the general current thought pertaining to oil.

Many economic and legal considerations have become hopelessly involved over the problem of ownership of oil as it is produced from the underground strata. As an aid to better understanding of this subject, representative engineers and geologists throughout the country were asked in 1931 to state their views as to whether they believed it possible by engineering methods to determine with fair accuracy the relative contents of adjacent tracts in a common pool. 24 In other words, can each landowner be assured of receiving his share of the total recoverable reservoir content in proportion to the extractable fluid content within his holdings? The consensus of opinion at that time was that, given an opportunity to obtain the necessary engineering data, the computations could be made with assurance of equity to all. Several replies suggested the need for knowing more about the relation of factors, such as the solubility of the gas and the

permeability of the producing strata, to the quantity of oil recoverable from the individual tracts, and reference was made to "the capacity of wells to produce." Stephenson, for example, pointed out the desirability of allocating production either on the basis of the energy utilized in producing the oil or upon a proper balance between the factors of acreage of the individual tracts and the producing capacities of the wells.

Much progress has been made since that time when engineers were feeling their way toward more scientific methods of allocating production in an effort to meet the justified objections to open-flow potentials; and today, as never before, they recognize the truth of the poignant statement:

A knowledge of reservoir conditions is the starting point for attacking all problems of development, production, and the allocation of production. If the engineering phases of the problem can be solved and tangible evidence obtained of reservoir conditions in all parts of the pool, then recourse to uneconomical practices would soon become a thing of the past.

**ALLOCATION OF PRODUCTION**

The success or failure of any current program of production control depends upon the engineering methods used in allocating well quotas. These technologic requirements contrast with earlier restrictions on output which were the result of the business judgment of individuals and corporate groups as to how much oil should be taken from a field or area to supply a given market at a price satisfactory to them. The problems arising from present curtailed production are many but in general fall into two major categories which are definitely related, yet are influenced by different factors. Under the petroleum code State quotas were specified and comparative allocations between fields were made later to give each field what was determined to be its fair share of the limited market demand of the State. The mechanism developed for handling that type of allocation has been described by Miller and Lindsly. The engineering factors of a pool were requisite in determining the percentage of a State quota allowed to any pool during a given period, but the determined rate of withdrawal from the pool as a whole frequently has been the result of balancing factors of economic expediency against what the field could produce on account of its physical characteristics. There is reason to believe that some fields have been produced under prorated conditions at a rate lower than that dictated by the best engineering principles. However, in those fields where the pressure in the reservoir has been maintained and the energy conserved the main general effect of restricted production on a pool is retardation of the time of maturity in recovering the ultimate extractable oil. In the opinion of many engineers the ultimate recovery will be greater if the pool is produced under scientific control than if operated at capacity throughout its economic life.

The allocation of production from the field quota to individual wells or properties, in an attempt to assure "ratable taking" to each

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26 Stephenson, E. J., Professor of Petroleum Engineering, Missouri School of Mines, Rolla, Mo. (see footnote 24).
28 Miller, H. C., and Lindsly, Ben E., work cited, pp. 1296-1302.
well in a common pool, differs substantially from the foregoing conditions pertaining to State and field allocations. There is immediate concern by the property owners and leaseholders, not only because the present worth of the oil is influenced by the rate of extraction but the actual quantity that may be taken from the wells of individual properties may be affected in large measure by the comparative rates of production on the several adjacent tracts. The following discussion is confined to those phases of the allocation problem pertaining to the “ratable taking” of oil from wells in the same field to which a quota has been assigned without attempting to expand upon or to explain the many factors in addition to those of engineering significance that have been considered in determining State and field “allowables.”

The completely personal interest of an operator is centered primarily in (1) the quantity of oil and gas his well or wells are capable of producing under a set of conditions during a specified period of time and (2) the ratio between this quantity and the quantity he will be permitted to produce in accordance with the proration plan applying to his properties. This set of conditions led to the practice of taking well “potentials” in an effort to reach a basis for estimating the quantity of allowed production for individual wells throughout a given period.

Of all restrictive terms the word “potential” probably has been used more loosely and with more detrimental effect than any of the others. The mere statement that a well, tract, or field has a “potential” of a given number of barrels means little or nothing in relation to the capacity to produce—and the continuance of that established rate of production. “Potential” has been defined as “the rate at which a well will produce oil under any standard test conditions” and “open-flow potential” as “the rate at which a well will produce oil with atmospheric pressure at the well head”29; but the full implications of these definitions must be realized. Reservoir conditions change rapidly when and after wells are flowed to make capacity-production tests; the status of adjacent wells or tracts influences the the results of potential tests; and the mechanical conditions of wells appreciably affect the results. The potential method has been used extensively, but many erroneous figures have been established. In consequence, not only has production in a field been allocated inequitably, but field potentials have been raised to fictitious and impossible quantities; many oil royalties have been sold on this false basis, despite the fact that only meager knowledge of the fluid and energy relations in reservoirs is required to show the fallacy of buying oil properties on the basis of scheduled potentials.

Fortunately, the realization is growing that inflated potentials result in the uneconomic practices named as well as many others that cause unnecessarily rapid depletion of oil reserves and financial loss. Commendable progress has been made in working out scientific principles for allocating production—not on the basis of what a well can be made to flow in a specified number of hours with its adjacent wells closed, but rather by determining the comparative abilities of wells to produce efficiently with an optimum use of reservoir energy, through applying knowledge of reservoir and well performance.

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The term "productivity index" is now being used extensively by engineers to indicate the measure of a well's capacity to produce. The Topical Committee on Allocation of Production of the Central Committee on Drilling and Production Practice, American Petroleum Institute, has defined productivity index as "the number of barrels of oil produced per pound differential in pressure between static and flowing bottom-hole pressure". Although the committee states that there is much to be learned about this allocation factor the scientific thought upon which it is based indicates its applicability and practicability in many fields to supplant the "potential" method of allocation production with its evident objectionable features.

The use of an allocation formula which includes a productivity index or measure of the capacity of a well to produce oil and gas from the reservoir is a special application of the principles which have evolved from studies dealing with the control and operation of gas wells conducted by the Bureau of Mines in cooperation with the Natural-Gas Department of the American Gas Association. The efficacy and practicability of the so-called "back-pressure method" of gaging the capacities of gas wells to produce gas, supplanting the outmoded open-flow tests, have been proved, and it has been pointed out that the same fundamental relations in the reservoir and flow columns of gas wells, given in two Bureau of Mines reports published in 1929, in a more complete report on the subject in preparation, are applicable to reservoirs containing oil and gas mixtures if suitable modifications are made to the basic equations pertaining to the flow of natural gas.

The initial work of the American Petroleum Institute Topical Committee on Allocation of Production was cited by Cattell and Fowler in outlining the application of fluid-energy relations of petroleum and natural gas needed to arrive at equitable allocations of production. That committee's revised progress report (November 1934) merits careful study by every person connected in any way with allocation problems, not only for its technical data but also for the value of relevant information. The committee has stated aptly in the aims of its study that all of this knowledge may "possibly lead to the ultimate adoption and application of such basic principles and factors as will promote the conservation of a valuable and irreplaceable natural resource, insure maximum economic recovery, and maintain equity between productive tracts in any pool."

Even after essential facts permitting the establishment of a proper productivity index for the wells in a given pool are determined there is still the vexing consideration of what the courts may hold as belonging to the individual interests in a pool, especially one that is not unitized. In this connection Bingham, in his recent review of past,
present, and future proration methods, points out that in addition to assuring equity and true conservation a satisfactory method of pro-
ration must be practicable and of a type that will be sanctioned by
the courts. Any program of restricted production is almost sure to
involve complicated legal considerations of property rights, but it
cannot be claimed that these differences of viewpoint of landowners
or leaseholders result from any change in the working out of funda-
mental physical laws of fluid and energy in reservoirs. Man's knowl-
dge of them has increased, and fortunately the inadequacy of con-
cepts that previously prevailed concerning oil and gas and their
movement are being forced upon the attention of the courts. The
legality of action is based upon the rulings of the courts, but a very
important problem of stabilization during this period of production
control is whether allocation formulas are to be shaped to conform
with existing legal opinions or whether our laws, especially their
interpretation, may be made to conform more nearly with known
physical conditions in the reservoirs.

COMPARISONS OF CONTROLLED AND UNCONTROLLED
PRODUCTION

Many criticisms have been levied at the whole scheme of prora-
tion. One of the reasons given is that inequities have been experi-
enced under some types of allocation. Another cause for criticism
is that under certain proration plans more wells have been drilled
than necessary to obtain larger quotas for individual tracts. The
assertion also has been made that no economic benefits can result
from a production program that causes competitors to cooperate in
what has been termed an "unnatural relationship." Comparisons
of fields operated under highly competitive, "antidrainage" programs
with those under reasonable production control always are open to
additional criticism on the grounds that no two fields are identical,
and proper weight may not have been given to some influencing
condition in one that did not obtain in the other. However, if the
existing facts of similarity and dissimilarity of fields are recognized,
comparisons of results obtained from controlled and uncontrolled
fields are helpful in analyzing the validity of the claims and in chart-
ing future courses.

The Yates pool in west Texas affords a concrete example of what
has been accomplished in working out a program of orderly develop-
ment in a major field during the proration period. For 8 years this
field has been under restricted production based upon voluntary
agreement of the operators. According to Mills, 37 who has reported
the conditions of the field in some detail, after nearly 200,000,000
barrels of oil were flowed with a pressure drop of less than 0.35 pound
per square inch for each million barrels of oil produced, there is an
expectancy that the wells will continue flowing at least 10 years
more (or until the pressure has declined to 350 pounds per square
inch) and that 80 percent of the recoverable oil from the field will be
obtained by natural flowing methods.

The Hendricks pool, also in the Permian Basin of west Texas, exemplifies many operating practices that Yates does not. Both fields were discovered about the same time and are of the same general type of structure, although Yates is larger in area. Competitive development in Hendricks resulted in rapid fingerling of water into the producing formation. Reith\textsuperscript{33} reported the field in a period of decadence at the end of 1933. Approximately 97 percent of the fluid produced at that time was water. By the end of 1934 the total cumulative oil production was approximately 179.5 million barrels. What Hendricks might have done is of course conjectural, but its high rate of extraction of 57.7 and 50 million barrels in 1928 and 1929, respectively, followed by a rapid decrease with an ever-increasing water production, has led engineers to believe that the competitive methods used in the earlier life of the field mitigated against the more efficient use of the energy in the reservoir system and that if there had been better conservation of the gas energy the early and rapid encroachment of water would have been delayed.\textsuperscript{39}

Floyd and Raider\textsuperscript{40} have made another valuable comparison between results obtained from a community lease in the Keokuk Falls pool, Seminole County, Okla., and from the Maud pool, Pottawatomie County, Okla. The Community 28 block comprising the Keokuk Falls pool is described as the first and only pool in Oklahoma (February 1935) where through voluntary restriction reservoir pressures are being maintained in balance with the rate of encroaching edge water. After showing that the two fields are comparable, Floyd and Raider state:

Approximately 40 percent of the ultimate recovery from the Maud pool was produced by natural flow during 10 percent of the life of the pool, whereas at Community 28 it is expected that at least 75 percent of the ultimate recovery will be produced by natural flow, and if the water drive is effective, it is quite likely that it will be produced almost to depletion by natural flow. In the Maud pool 149 producing wells were completed as compared with a probable total of 25 or 30 in the Keokuk pool. Yet the recovery at Maud is estimated at approximately 74,000 bbl. per well as compared with an estimated recovery of 300,000 bbl. per well at Keokuk, Community 28.

They point out further that in the Maud pool operators and royalty owners whose properties were developed in the later life of the field were kept from their fair share of the wealth of oil, gas, and energy in the underground structure. Placed on a monetary basis, Floyd and Raider give the following figures: The total cost of developing the Maud pool was $11,973,000, with an average cost per barrel of oil of $1.09, whereas similar figures for the Keokuk pool were $2,150,000 total cost, and $0.29 per barrel.

Unit operation of oil and gas pools has been called the antithesis of competitive practices, and it is well recognized that prorating production among the wells of a pool operated under a unit plan usually is much simpler than in one where there is diversity of ownership and company-operating policies. However, the two subjects are closely related in their common objective of stabilization, because an allocation program based upon good engineering is an attempt to


\textsuperscript{39} Mills, Brad, Hendricks Remains Profitable Field Despite a Large Water Production: Oil Weekly, Apr. 8, 1935, p. 24.

\textsuperscript{40} Floyd, F. W., and Raider, M. L., Substantial Results Are Derived from Unit Plan Used at Keokuk Falls: Oil and Gas Jour., Feb. 14, 1935, p. 10.
accomplish, between different landowners through setting up certain specifications, what the management of a unit-controlled pool would do in the interest of the most efficient operation of the joint holdings. Their differences in approach to the problem of stabilization—a subject brought squarely before the industry in the pronouncements of Henry L. Doherty in 1924 in which he crystallized a definite plan of unit operation—opens such a wide field of thought that it cannot be discussed in detail in this paper. Miller and Lindsly have reviewed carefully current unitized production control versus competitive methods. Avery and Miller have considered the subject from the geological viewpoint, and the legal aspects of unit operation have been treated recently by Hines.

However, the facts presented in the two foregoing comparisons, to which many more could be added, seem ample proof that where controlled production has been based upon good engineering practices the operators have been more than compensated in financial return for any restraints placed upon them, and the public interest has been served better through increased production than in fields developed under highly competitive practices.

PRODUCTION CONTROL IN KETTLEMAN HILLS FIELD

In the North Dome of the Kettleman Hills (Calif.) field problems of allocating production to wells have presented many difficulties. The machinery devised for handling the Federal allocations to the several oil-producing States under the Petroleum Code and the method of allocation to wells in the North Dome, originating with the Kettleman Hills Advisory Board, have been described. Following hearings of an appeal of the Superior Oil Co. and Amerada Petroleum Corporation, Calif. (not participants in the Kettleman North Dome Association) with reference to the allocation plan, the Oil Administrator issued an order on March 25, 1935, establishing a new procedure in allocating production in the Kettleman Hills North Dome field. This order, effective April 1, 1935, based upon the recommendations of the Petroleum Administrative Board and its Technical Advisory Committee, is significant as several new departures were presented that pertain to methods of allocating production and related matters.

In analyzing the trend of the course of oil it is advantageous to look carefully at the major points of the conclusions of the Petroleum Administrative Board report, which were the substance of the Oil Administrator's order.

The Petroleum Administrative Board found the former allocation method neither unreasonable nor inequitable but considered it was not in the direction of recovering maximum ultimate production, stating further that the objective is to conserve oil and prevent waste by means of a method—based upon subsurface pressure data—giving a productivity index which will reflect the relative capacities of the wells.

44 Miller, H. C., and Lindsly, Ben E., work cited, pp. 1349-1373.
47 Miller, H. C., and Lindsly, Ben E., work cited, pp. 1396-1397 and 1392-1394.
48 A memorandum for the press containing the report and recommendations of the Petroleum Administrative Board and the Secretary's order was released by the Department of the Interior on March 28, 1935.
to produce oil. The point was made that well allotments should “provide for the establishment of more uniform pressure gradients throughout the field.”

The Petroleum Administrative Board stated its opinion that “under conditions presently existing, the use of acreage as such is not now essential in the Kettleman Hills North Dome field to the proper intrafield allocation of the field quota,” with the view that no operator would have an advantage because he might hold more acreage than his neighbor. However, the phrase, “acreage as such,” in the foregoing statement should be noted, for actually an acreage factor was provided to regulate volumetric withdrawals. To this end the field was divided into unit areas “which shall be twice the average area of a well space as per the present established well-spacing program.” Provision also was made for a change in the allocation formula if the present well-spacing density was changed. Further study shows that the method is not substantially different, except in some details, from the findings of the American Petroleum Institute Topical Committee as to ways of minimizing drainage across property lines and of discouraging unnecessary drilling by determining a unit area for each pool, to which the productivity index may be applied. However, the Petroleum Administrative Board report, in dealing with this phase of its allocation plan, emphasized the definite quantity of oil recoverable from the reservoir beneath a property. This is in contrast with some allocation programs where the acreage holdings play an important part and are permitted to participate in the recovery from the pool in proportion to those holdings, irrespective of the number of wells drilled on the unit areas. The emphasis of the Petroleum Administrative Board report in this regard is based on engineering fact, for it is well established that the same conditions seldom exist throughout the extent of a pool, regardless of the apparent uniformity of the underground structure.

The formula of the Petroleum Administrative Board for allocating production includes recognition of the following factors—which for purposes of exact determination are expressed in mathematical terms but are discussed here only in their general aspects:

A minimum allotment is specified to each well to assure recovery of actual lifting cost and referred to as “the wages of a well based upon and limited by its performance.” The productivity of each zone is recognized, and provision is made to apply the allocation formula to each of the several producing zones separately. Volumetric withdrawal of oil and gas per tract in the “gas-cap” and “black-oil” areas is provided for on the present basis (as determined by the Kettleman Hills Advisory Board) of a conversion factor of 1,000 cubic feet of gas at atmospheric pressure equivalent in volume to 1 barrel of oil in terms of reservoir space, with provision made for determining a conversion factor on the basis of subsurface conditions prevailing in each tract.

First taking account of the specified minimum well allotments and special allotments because of exceptional water conditions, the remaining field allotment is made by use of the stipulated allocation formula to ascertain “the comparative ability of a well to withdraw oil from
the producing formations without causing excessive pressure gradients or other conditions conducive to waste." The productivity index is virtually the same as that defined by the American Petroleum Institute Committee.

With the expressed intent of evaluating the ability of a producing zone to yield oil to the well, independent of the manner of its completion and the method of its production, transfer of allotment from one well to another was looked upon with disfavor in the Petroleum Administrative Board report because of the disturbing effect upon the adjustment and maintenance of reasonable pressure gradients. The transfer of allowable oil production from one well to another has been permitted under specified conditions in some fields—for example, the Oklahoma City pool—in an effort to conserve gas. The two fields cannot be compared directly in this regard, but to prevent unwarranted pressure drops between wells it is fundamental to consider whether the gas volume and the oil volume in a pool are directly connected or whether each should be treated as existing in a separate structure.

Some other specifications were made in reference to putting into effect the newer allocation program for the Kettleman Hills North Dome Field and the making of adjustments from time to time as occasion demanded based upon subsurface data to be obtained. The Oil Administrator's order expressly directed the office of the Oil Umpire of the Central Committee of California Oil Producers, the appointed agency to make the allocations to and in the several fields in California under the Petroleum Code, "to examine promptly the other fields in California where conditions conducive to waste and unfair production practices may be similar to those encountered in the Kettleman Hills North Dome Field" and to take steps to allocate production in those fields in accordance with the principles outlined for Kettleman Hills.

This order of the Oil Administrator contained a definitely stated method of allocation for the largest field in California in which the Government has a special royalty interest. Under the Petroleum Code this order had the effect of law, and certain suggestions for coping with the complicated technical and legal problems of property rights as they pertain to the "fugacious minerals", oil and gas, were incorporated in it. The ultimate effect of the application of specifications of this type upon the production of both oil and gas can be determined only after the results of their operation can be recorded for study. Nevertheless, the import of the provisions included in the order seems of more than passing significance in considering the trend of the interest in oil and its associated hydrocarbon, natural gas.

The technical evidence of the report set up a mechanism for withdrawing oil and gas in an orderly and equitable manner from the reservoir by control of pressure gradients permitting each property owner to take from within his boundaries in the reservoir his proportionate share of oil and gas in accordance with the ability of his property (within the reservoir) to produce these fluid minerals through the wells on his tract.

"RULE OF CAPTURE" AND OWNERSHIP IN PLACE

At first thought the objective of preventing drainage from one property to another through the maintenance of proper pressure gradients and the other devised means of the order may seem at variance with some of the statements in the body of the Petroleum Administrative Board report in reference to "the rule of capture", where it was stated in part:

* * * we find the only general rule of law or legal principle by which we may be guided is that of reasonably preserving for each operator taking from a common underground source of supply the total amount of oil and gas which he would have been able to capture in the absence of curtailment.

The argument substantiating this conclusion is too detailed to be quoted here, but the theory was that the rule of capture is essentially a rule of ratable taking and that restricted production must be on that basis. Such a line of reasoning differs from general current thought in respect to the rule of capture. In support of this theory the legal concept was stated that vested property rights do not privilege a man to drain his neighbor's property. Instead, the Petroleum Administrative Board report stated:

* * * The courts have presumed, in the absence of any restrictions upon production, that ratable taking from a common reservoir of oil and gas may be achieved by permitting each operator to protect himself from drainage by drilling and operating his wells as he sees fit. The ability of one to capture has been limited by the ability of all others to capture. It seems clear that the courts have sought to establish a self-operating principle which, in the absence of legislative control of production, would accord each operator his fair share of oil in a pool.

This suggestion that the rule of capture and the rule of ownership in place are neither necessarily discordant nor inconsistent with each other has been expressed by others. Wood, speaking as chairman of the Topical Committee on the Allocation of Production, American Petroleum Institute, suggested that the principles and factors of allocation developed by that committee probably would permit the same degree of participation in a restricted pool "as would have resulted by prudent and diligent operation under unrestricted flow—with probably greater protection from drainage and damage from neighboring leases." More specifically, Hardwicke has given in simple language his studied view of the terms "law of capture" and "law of oil in place." The following has been briefed from and is the essence of his more detailed statement:

The so-called "rule of capture", which is recognition of title to oil produced from a well, exists in every State. Until the State exercises its police power, an owner of land may drill in any way he may elect, and the only recourse of an adjoining landowner is to protect his property by offset wells. In theory, at least, the offset wells virtually confine the oil of each man to his own property. As long as a man is free to do as he chooses, he can in a measure protect himself. When government restricts his freedom to act to protect his property, the rule of capture becomes inoperative, except to the extent that a man uses what comes out of his well. The law of capture is not necessarily inconsistent with that of ownership in place, and a constitutional amendment is not needed to establish better rules for protection of property. Adjacent operators have certain quantities of oil and gas underlying their respective properties. An equitable proration or allocation

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order is in effect a plan of operating procedure to prevent undue drainage without
the necessity of the neighboring landowners engaging in an offset drilling campaign.

Wyckoff 48 expressed a somewhat similar thought when he said:

Thus, under such regulatory statutes (restricting the right of operators to
protect their own property from drainage) the State must assume the obligation
of maintaining the privileges which were formerly enjoyed under the law. This
can be done easily by proper application of the several component factors of a
reasonable allocation plan.

Few persons will contend that the rule of capture as applied in the
past history of the industry has resulted in other than uneconomic
conditions. Although in theory protective drilling may tend to re-
strict to each property owner the oil and gas within the confines of his
subsurface holdings, actually the possibility of movement across
property lines is well-recognized. Not infrequently the abuses of
offset drilling, sometimes resulting in ruthless tactics to encourage
cross-property drainage, have caused premature exhaustion of the
reservoir energy and depletion of the oil and gas reserves and have led
to costly lawsuits. Even when offset drilling has been done with
more or less tacit accord an unnecessary density of wells on both sides
of the property line has raised the production costs for each operator
to totals out of all line with development requirements.

Despite the evident disorder that has resulted from this rule that
grew out of a condition where scientific knowledge was lacking it is
worth while to observe what may result by interpreting and applying
the rule in the light of present knowledge. It is possible that such
a course of action may lead to a desirable state of stabilization and
permit the taking of oil and gas from a pool in an orderly manner.
The desirable objective is to accomplish this with minimum cost of
wells drilled to the producing horizons through a program of optimum
well spacing and with reduced operating costs through full utilization
of energy in the reservoir system, thereby prolonging the flowing life
of the field.

Engineering knowledge has established the fact that the mainte-
nance of correct pressure gradients between wells prevents cross-
drainage, premature water encroachment, shifting of the gas cap, and
other changes detrimental to proper pressure conditions within the
reservoir. In effect, this suggested concept of the reconciliability of
the rule of capture and the rule of ownership in place, combined with
an allocation formula based upon sound engineering principles, may be
the means of operating an entire pool for the optimum benefit of all
concerned regardless of diversified ownership and not as separate
parcels with no apparent relation to one another. In this way many
of the same objectives would be accomplished as if the pool were
under one management in some form of unit operation.

RELATION OF TECHNOLOGY TO FUTURE ECONOMIC CONDITIONS

The allocation order of March 25, 1935, applied to the North Dome
of the Kettleman Hills field, is a recent development that exemplifies
how economic, legal, and Government policies are affected by tech-
nology. Although the evident interest of drivers of motor vehicles
and many others still is centered in the price they have to pay for
gasoline and lubricants, nevertheless, the effect upon them of the

48 Wyckoff, R. D., work cited. (See footnote 48.)
outcome of these newer allocation methods, such as that applied to the Kettleman Hills field, may be far greater than they realize. Surely the interests of land owners, royalty owners, and other groups having direct relation with oil-producing properties will be affected as definitely (even if to a smaller degree) as the interests of the operators themselves.

It has been stated repeatedly that many major problems of the petroleum industry can be traced to the inequitable, wasteful, and antisocial results of the rule of capture as it has been applied. Assuming this premise to be substantially correct it is reasonable to suppose that a definite step toward stabilization and the formulation of a wise national policy of oil conservation can be made if the principles of ownership in place and ratable taking can be applied and remain consistent with the revised interpretation of the property law of capture. Moore 69 has shown aptly that proper understanding of property rights is requisite to developing and enforcing equitable allocation plans, and the courts eventually will have to rule on various points of issue. However, courts of today have access to knowledge of characteristics of oil and gas and their behavior in reservoirs that was not available to the judiciary bodies that initiated the concept of reduction to possession. As allocation of production on a recognized engineering basis does no violence to the legal concepts of property it seems reasonable that these newer interpretations of ownership in place, which are in accord with this new view of the rule of capture, will receive support of the courts and of all other component groups that comprise the public interest in oil.

At some future time, now indeterminable on the basis of present knowledge, there will come a period in which there will be a dearth of oil. The present requirements of restricted production will change, but the industry and the Nation will require efficient withdrawal and use of the remaining reserves. The lessons learned now in applying scientific knowledge of fluid and energy relations to obtain ratable taking of the greatest ultimate recovery of oil and gas should be of inestimable value in meeting the conditions of that new era.

69 Moore, T. V., work cited (see footnote 28).