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REPORT OF THE
NATIONAL PETROLEUM COUNCIL COMMITTEE
ON PETROLEUM PRODUCTIVE CAPACITY

OCTOBER 3, 1957

CHAIRMAN OF THE COMMITTEE: L. F. McCOLLUM

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(1957)

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October 3, 1957

Mr. Walter S. Hallanan, Chairman
National Petroleum Council
1625 K Street, N. W.
Washington 6, D.C.

Dear Mr. Hallanan:

On March 1, 1957, Mr. H. A. Stewart, Director of the Office of Oil and Gas of the United States Department of the Interior, addressed a letter to the Chairman of the National Petroleum Council requesting the following information: (1) the productive capacity of the United States for crude oil and natural gas liquids as of January 1, 1957, (2) the length of time this petroleum productive capacity could be sustained without drilling, (3) the estimated rate of decline of productive capacity assuming no further drilling, (4) the number of wells that must be drilled to maintain this productive capacity, and (5) the effects of technological developments on the relationships between reserves and petroleum productive capacity. A copy of Mr. Stewart's letter is attached as Exhibit A.

Pursuant to this request, the Committee on Petroleum Productive Capacity (1957) was appointed. Separate subcommittees were appointed for the five producing districts in the United States. These subcommittees consisted principally of the engineers and geologists who worked on prior studies on productive capacity for the National Petroleum Council. They represented all segments of the producing industry from small operators to the largest companies. Because of

the magnitude of its task, the District 3 (Southwest) Subcommittee established additional subcommittees of its own. The district subcommittees called upon hundreds of specialists with particular knowledge about the reservoir conditions and productive capacity of the principal fields. Numerous meetings were held to discuss and review the findings on productive capacity. The estimates prepared by the subcommittees as of January 1957 are comparable with the previous availability studies prepared for the National Petroleum Council as of January 1951, January 1953 and July 1954, and are shown in the tabulation below. A comparison with previous estimates is set forth in Table 1.

	Productive Capacity, Thousand Barrels Daily		
District	Crude Oil	Natural Gas Liquids	All Oils
1. East Coast	37	14	51
2. Mid-Continent	1,591	135	1,726
3. Southwest	6,613	589	7,202
4. Rocky Mountain	615	16	631
5. West Coast	1,011	91	1,102
Total	9,867	845	10,712

As shown above, the productive capacity of petroleum liquids at wells and plants in January 1957 was 9,867,000 barrels daily of crude oil and 845,000 barrels daily of natural gas liquids. The Committee wishes to emphasize the fact that its estimates deal only with the quantities that could be produced at wells and plants regardless of whether sufficient transportation facilities exist to permit actual realization of such production. It is known from experience early in 1957 that transportation facilities in a number of fields, particularly in Texas, are not adequate to handle the full productive

capacity. Therefore, it must not be assumed that all of the oil producible in the United States can be made available to markets on short notice.

The current study indicates an increase in productive capacity since July 1954 of 1,536,000 barrels daily for crude oil and 80,000 barrels daily for natural gas liquids. The annual rate of increase in productive capacity for all petroleum liquids was 646,000 barrels daily in the past thirty months, compared with 625,000 barrels daily in eighteen months between January 1953 and July 1954. In other words, the growth in productive capacity since July 1954 has apparently continued at a rate approximately the same as that experienced in the period January 1953 to July 1954.

In January 1957, production was 7,480,000 barrels daily of crude oil and 826,000 barrels daily of natural gas liquids. The margin between productive capacity and production was 2,387,000 barrels daily of crude oil and 19,000 barrels daily of natural gas liquids, compared with respective margins in July 1954 of 2,089,000 barrels daily and 123,000 barrels daily. The amount of this margin is determined by fluctuations in production. The variation in production in recent years has been at least 250,000 barrels daily between the low and high months, and in 1957 there has already been a variation of about 800,000 barrels daily between the peak in March and the low point in August. Because the fluctuations in production bring about such changes in the margin between it and productive capacity, measurement of the reserve capacity for a single month is of limited significance.

The productive capacities stated above cannot be sustained under ordinary circumstances for more than a brief period without drilling. The depletion of reserves by production brings about a normal decline in productive capacity which varies with reservoir conditions in different fields. In some fields with water drive and pressure maintenance facilities, full productive capacity estimated as of January 1957 could be sustained for a considerable period of time. In other fields, the ability to produce will decline almost immediately. In case of an emergency, sufficiently grave to preclude the drilling of enough wells to maintain productive capacity, projects for additional water injection and other means of increasing productive capacity could be undertaken in some fields, thereby offsetting part of the decline that would be experienced in the remaining fields during the first year of such an emergency. A large proportion of these projects could be placed in operation with little delay.

It is difficult to estimate with reasonable accuracy the extent of the decline in productive capacity if there were no drilling, because the industry has had no experience with such a situation. Subject to this reservation, the Committee estimated that the decline in productive capacity in the first year might be in the order of 735,000 barrels daily, or about 7.5 percent, if production were at full maximum efficient rate.

The Committee assumes that a drastic curtailment, or a temporary complete discontinuance, of drilling activity would be caused solely by acute shortages of steel. Curtailment of drilling would have

serious immediate effects, and no less serious after effects, on the productive capacity because of the inevitable loss of trained drilling crews to other emergency activities. Therefore, in the event of an emergency, careful attention should be paid to the variations in the levels of productive capacity with the view of assuring to the petroleum industry adequate supplies of steel and other essential materials in order to: (1) carry on the necessary maintenance work on existing wells (such work calls for constant replacement of worn-out or damaged casing, tubing, rods and other well and lease equipment); (2) permit the full realization of existing capacity at wells and plants through installation of additional power and pumping equipment, flow lines and other transportation and storage facilities; (3) permit the carrying out of projects for additional water injection and other means of maintaining or stimulating production; and (4) permit maintenance of drilling activity at levels sufficient to offset the decline and provide adequate petroleum supplies for a prolonged emergency.

The district subcommittees have made estimates of the number of wells that would have to be drilled in 1957 to maintain the productive capacity estimated at the beginning of the year. These estimates are necessarily based on past experience and on the assumption that wells drilled in the future would achieve reasonably comparable results. It must be recognized, however, that changes in the proportion of productive wells to dry holes and in the quality of the successful wells can alter materially the amount of drilling required to maintain productive capacity. Therefore, the Committee believes

that its reply to this part of Mr. Stewart's inquiry is best expressed as a range. If the recent favorable experience in development of capacity should continue, the district subcommittees estimate that operations at capacity might be sustained by the drilling of about 41,000 wells. On the basis of experience during World War II, however, when the drilling of an average of 22,500 wells a year in the period 1942-1945 was just sufficient to offset the decline resulting from production of 4,300,000 barrels daily, it might take in excess of 50,000 wells to maintain a capacity of 9,867,000 barrels daily. It is the conclusion of the Committee that it would probably require 41,000 to 50,000 wells a year merely to maintain productive capacity.

As noted in Mr. Stewart's letter, changes have taken place in the relation between the nation's productive capacity, as estimated by the National Petroleum Council, and reserves of crude oil and natural gas liquids, as estimated by the American Petroleum Institute and the American Gas Association. The relation between productive capacity of natural gas liquids and reserves depends principally on the capacity of gas processing plants and on the production of gas. It has changed only slightly during recent years. The present estimated productive capacity would represent annual withdrawals equivalent to 5.2 per cent of proved reserves compared with 4.9 per cent in 1951. A more significant change in the relation of productive capacity to reserves has occurred in crude oil, which is set out in Table 2 and summarized as follows:

Date of NPC Study	Crude Oil Productive Capacity Thousand Barrels Daily	Crude Oil Reserves Million Barrels	Annualized Productive Capacity as Per Cent of Reserves
Jan. 1,1951	6,727	25,268	9.7
Jan. 1,1953	7,465	27,961	9.7
July 1,1954	8,331	29,253(1)	10.4
Jan. 1,1957	9,867	30,435	11.8

(1) Average of reserves at beginning and end of year 1954.

For the United States as a whole, productive capacity has increased more rapidly than proved reserves, with the result that annualized productive capacity has increased in the past four years from 9.7 per cent to 11.8 per cent of reserves; stated in other terms, the ratio of reserves to annualized productive capacity has declined from 10.3 to 8.5 years during the same period. It will be noted from Table 2 that there is a wide variation in the relation of productive capacity to reserves among the districts and even in the same district over a period of time. In Districts 1 and 5 the percentage relation has declined since 1951, whereas in Districts 3 and 4 the relation has increased but is still below the level for District 2 and below the demonstrated relation of production to reserves in District 2 during 1948. These variations reflect changing conditions as to the average age of fields, changing production practices and varying degrees of application of new technological developments.

It is impossible to determine quantitatively the contribution of any one or all of the several major technological developments on the nation's productive capacity. Some of these developments and the manner in which they affect the relation between productive capacity and reserves are discussed briefly in the following paragraphs.

Multiple completion of wells permits simultaneous production from two or more productive strata through a single well. Prior to this development, it was customary to defer production from one stratum until the other had been depleted. An increasing number of wells have been completed to produce from multiple zones in recent years.

Hydraulic fracturing of producing formations in new wells frequently increases the productive capacity by a significantly greater proportion than it increases economically recoverable reserves. Further, the successful application of fracturing treatments has led to the drilling of many new wells in and around old marginal producing areas. The quicker and more assured payout induces operators to invest the necessary capital for this type of development, which makes oil rapidly available that might otherwise never be produced.

Water floods, pressure maintenance projects and other recognized means of stimulating or maintaining production rates frequently add proportionately more to productive capacity than to economically recoverable reserves.

The cumulative effects of these technological developments on productive capacity are frequently immediate and obvious. These developments usually contribute in some measure to increases in economically recoverable reserves, but such contribution is not immediately reflected in the reserves estimates.

Improved technology and more intensive development of proved reserves now enable the domestic oil industry to produce its reserves at a higher rate than in World War II. This fact should prove of value in any emergency. It does not, however, permit any relaxation of the industry's efforts to find and develop enough new reserves to enable the industry both to keep pace with the steady growth in peacetime demand for petroleum and to maintain, at the same time, sufficient reserve capacity for any sudden emergency.

Respectfully submitted,

/S/ L. F. McCollum

L. F. McCollum, Chairman
NPC Committee on Petroleum
Productive Capacity (1957)

EXHIBIT A

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UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF OIL AND GAS
WASHINGTON 25, D. C.

March 1, 1957

Mr. Walter S. Hallanan
Chairman, National Petroleum Council
1625 K Street, N. W.
Washington, D. C.

Dear Mr. Hallanan:

Reports of the National Petroleum Council on the United States availability and production of petroleum have become recognized both in Government and industry as authoritative. The last report, dated May 5, 1955, submitted data as of July 1, 1954. These data have had great value not only to the Office of Oil and Gas and the Department of Defense but to other agencies of the Federal Government in the assessment of our petroleum capability for both peace and war.

In reviewing past studies of petroleum productive capacity and relating data, such as the joint annual petroleum reserves reports of the American Petroleum Institute and American Gas Association, there is noted what appears to be changes in the relationships between productive capacity and reserves.

Technological developments in the production of petroleum must of necessity affect these relationships. Among these developments are: (1) widespread development in the use of secondary recovery methods on seriously depleted fields, (2) wide application of pressure maintenance practices in early stages in the productive life of fields, (3) increased use of formation fracturing and (4) better understanding of reservoir mechanics and wider application of engineering principles in the conservation of reservoir energies.

The petroleum productive capacity study should be broadened to include information on the effects of these and other important technological developments on the relationships between reserves and petroleum productive capacity.

In order that the significance of the productive capacity can be properly understood, data should be included on: (1) length of time this petroleum productive capacity could be sustained without drilling, (2) the estimated rate of decline of productive capacity assuming no further drilling and (3) the number of wells that must be drilled to maintain this productive capacity.

For the use of Government in its security planning, information is needed on petroleum productive capacity by the principal producing areas of the United States.

It is requested that the National Petroleum Council make the study as outlined above of petroleum productive capacity of the United States for crude oil and natural gas liquids as of January 1, 1957, and report thereon together with such conclusions and recommendations as it may deem appropriate.

Sincerely yours,

/S/ H. A. Stewart

Director

TABLE 1

UNITED STATES PETROLEUM PRODUCTIVE CAPACITY
AT WELLS AND PLANTS (1)
(Thousand Barrels Daily)

Crude Oil District	Jan. 1951	Jan. 1953	July 1954	Jan. 1957	Annual Rate of Change 1951-53	1953-54	1954-57
1. East Coast	54	49	43	37	- 2	- 4	- 2
2. Mid-Continent	1,083	1,238	1,380	1,591	78	95	85
3. Southwest	4,161	4,686	5,224	6,613	262	359	555
4. Rocky Mountain	350	394	561	615	22	111	21
5. West Coast(2)	1,079	1,098	1,123	1,011	9	16	-45
Total Crude Oil	6,727	7,465	8,331	9,867	369	577	614
Natural Gas Liquids	573	694	765	845	61	48	32
All Oils	7,300	8,159	9,096	10,712	430	625	646

(1) As is stated in the text of the report, the Committee's estimates of productive capacity deal only with the quantities that could be produced at wells and plants regardless of whether sufficient transportation facilities exist to permit actual realization of such production.

(2) Including Elk Hills. The estimate for July 1954 included Elk Hills at 158,000 barrels daily, but the estimate for January 1957 included Elk Hills at 87,000 barrels daily because minor modifications to existing facilities would have been required in January 1957 to provide the full estimated capacity of 147,000 barrels daily.

TABLE 2

RELATION OF ESTIMATED CRUDE OIL RESERVES AND PRODUCTIVE CAPACITY, 1951-1957

District	Estimated Reserves (1) Million Barrels	Estimated Productive Capacity(2) Thousand Barrels Daily	Annualized Productive Capacity Per Cent of Reserves
January 1951			
1. East Coast	204	54	9.8
2. Mid-Continent	2,926	1,083	13.5
3. Southwest	17,091	4,161	8.9
4. Rocky Mountain	1,313	350	9.7
5. West Coast	3,734	1,079	10.6
United States	25,268	6,727	9.7(3)
January 1953			
1. East Coast	212	49	8.5
2. Mid-Continent	3,392	1,238	13.3
3. Southwest	18,934	4,686	9.0
4. Rocky Mountain	1,569	394	9.2
5. West Coast	3,854	1,098	10.4
United States	27,961	7,465	9.7(3)
July 1954			
1. East Coast	191	43	8.2
2. Mid-Continent	3,851	1,380	13.1
3. Southwest	19,414	5,224	9.8
4. Rocky Mountain	1,893	561	10.8
5. West Coast	3,904	1,123	10.5
Unites States	29,253	8,331	10.4(3)
January 1957			
1. East Coast	226	37	6.0
2. Mid-Continent	4,300	1,591	13.5
3. Southwest	20,017	6,613	12.1
4. Rocky Mountain	2,120	615	10.6
5. West Coast	3,772	1,011	9.8
United States	30,435	9,867	11.8(3)

(1) American Petroleum Institute figures as of the beginning of 1951, 1953 and 1957, and the average at the beginning and end of 1954.

(2) National Petroleum Council reports.

(3) The ratio of reserves to annualized productive capacity corresponding to these percentage figures was 10.3 years in 1951, 10.3 in 1953, 9.6 in 1954 and 8.5 in 1957.