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# ***Methods of Estimating Reserves of Crude Oil, Natural Gas, and Natural Gas Liquids***

By

WALLACE F. LOVEJOY AND PAUL T. HOMAN

Baltimore: The Johns Hopkins Press for Resources for the Future, Inc. 1965.

Pp. xvi, 163, \$3.00 (soft cover)

Some books appear at just the right time. This is one of them. In the past several years there has been increasing dissatisfaction outside the petroleum industry—especially in the Federal Government—and to some extent within the industry, with the reserve data published by the industry. The terrain of petroleum reserve data is a terminological jungle. Hidden conceptual snares abound; in some places there is a thick undergrowth of ambiguities, in others there is only darkness and silence. Over all hangs a brooding sense of proprietary right—the explorer is viewed as a poacher.

At the same time there has been a growing involvement of the Government in policy matters directly concerned with the industry, in which the direction of policy is importantly affected by the prospects for future domestic petroleum supply. Since 1954, for example, the Federal Power Commission has had the authority to regulate the wellhead price of natural gas. Since 1959 the Interior Department has administered an oil import quota program designed to protect the domestic industry from the unrestrained influx of lower cost foreign oil. Within the past five years pressure has built up on the Interior Department to open up the Government-owned oil shale lands for commercial exploitation, a move that could not help but have an important impact on the petroleum industry. In the last decade an expanding portion of the industry's activity has been taking place on the outer continental shelf on Federal leases. In addition there is the perennial matter of percentage depletion, the special tax privilege afforded the industry.

We have, then, an industry whose health and very existence are dependent on a congeries of Government policies and that exhibits a highly unusual characteristic—the known stock of the depletable resource on which it is based is relatively small compared to that in many other mineral industries and must constantly be replenished through discovery. (“Reserves” of crude oil and natural gas are some 12 and 18 times current annual production, respectively.) In

this context the need of the Government for the fullest and most complete knowledge of the reserve position and future supply prospects of the industry is not only understandable, it is imperative.

Under these circumstances nothing could be more propitious than a guided tour through the concepts and definitions used in reserve estimation and measurement, together with a critical but wholly objective analysis of the problems involved and the results obtained. This is what Lovejoy and Homan provide.

Indeed, the title of their work is a bit misleading, for it fails to suggest the full scope and content. After discussing the concept of "reserves," the authors proceed through a detailed investigation of the basis of estimation, the methods employed, the personnel involved, and the crude oil reserve estimates themselves as published by various sources—the American Petroleum Institute, the National Petroleum Council, the Interstate Oil Compact Commission, and individual companies.

The study then turns to the larger perspective of what can be termed "future supply," that is, the quantities of crude oil, natural gas and natural gas liquids that can be or will be the "reserves" of the future. This section covers the various approaches using producing capacity (in U.S. Geological Survey publications), the "resource base" (in earlier Resources for the Future studies) and "ultimate reserves" (in publications by the National Academy of Sciences and the Office of Oil and Gas of the Interior Department). Again, each is critically evaluated.

Similar attention is given to the reserve estimates and future supply estimates for natural gas and natural gas liquids. The study concludes with a brief identification of specific needed improvements in the reserve data.

The fundamental problem is the crucial role of reserve data in competition within the industry and the consequent need for confidentiality. The reserve information must come from the industry, yet the reserves of individual fields and reservoirs are vital knowledge in (to name only a few activities) the acquisition of drilling rights, the planning of exploration and development programs, the borrowing of funds, and the purchase and sale of properties and leases. The industry has attempted to meet the problem of confidentiality by protecting it through an elaborate establishment and procedure in the collection of reserve data. As a result, only national, state and area totals are published, with none of the details

that would be of immense help in improving the interpretation of the totals.

A second major problem is the limited scope and perspective of the basic data on "proved reserves." The industry uses a highly restrictive definition of this term that limits the coverage to those quantities known to exist with the greatest degree of certainty, excluding other quantities known to exist with sufficient certainty to be bought and sold and to function as collateral for loans. From this problem stem several others involving the relation of reserve additions to the efforts expended to find them and, ultimately, the unit cost of crude oil, natural gas and natural gas liquids.

The authors identify, as the basic need for improvement in the data, the development of the ability "to project the *unfolding* pattern of supply. Evidence is needed which will throw light continuously on what is *emerging*. The most important evidence of this sort would appear to be statistical evidence which would show (1) trends in discovery relative to discovery effort and (2) trends in the rate of recovery from discovered oil and gas in place."<sup>1</sup> The authors believe that the fundamental shortcoming in the data published by the American Petroleum Institute is that it provides a "static or 'stock' concept of reserves." They propose that the API furnish data that will attribute each year's reserve additions to the year of discovery, as has been done for a few years in National Petroleum Council studies. This would eventually provide a basis for "refined statistical analysis" of the flow of reserves and hopefully supply the answers to many presently unanswered questions.

In the authors' opinion there is no point in attempting to standardize the present welter of concepts and definitions. Rather, they believe, it would be more useful if companies making their own reserve estimates were to furnish them to the government, together with the definitions and concepts used as supplemental information of value, despite the fact that such estimates could not be aggregated.

The authors also think that the recovery rate of crude oil is another area in which useful improvements can be obtained, despite the many obstacles. Noting that secular improvement in the recovery rate of crude oil is an important industry characteristic, they call for some sort of systematic compilation of the necessary data to measure over-all recovery with a greater precision than is now possi-

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1. P. 154.

ble. They do not specify what should be done but urge that industry and government solve the problem jointly.

Lovejoy and Homan support the current Government efforts, led by the Bureau of the Budget, to improve petroleum statistics but suggest that eventually the best results can be obtained through the creation of an agency specifically established for the purpose of collecting data from the industry and disseminating the information throughout the Government and to the general public.

One could, perhaps, find fault with the limited nature of these proposals,<sup>2</sup> but the book's value would be unaffected even if no proposals had been made. It fills an immense gap that has long been felt. The meticulousness of the analysis and the rigid objectivity maintained throughout will make it the standard reference on the subject until the hoped-for day when the jungle has been cleared and replaced with the productive vista of fields of cultivated (but not planted!) statistics.

The book is, incidentally, so well written that even for the reader who may be told more about petroleum reserves than he wishes to know, it should be a pleasure to read.

As always, there are points on which individual interpretations may differ. Thus, the authors refer to the language in the official American Gas Association definition of proved reserves of gas which states that they are "reserves estimated to be producible under present operating practices" and interpret this as meaning that the definition does not exclude reserves which may be uneconomic, in contrast to the definition of proved reserves of oil. "Included in this noneconomic category would be such things as gas in remote places such as Alaska, gas in small deposits for which a pipeline is not feasible, and associated gas in a depleted oil reservoir which may be at low pressures and in small quantities."<sup>3</sup> Although they admit they have no idea how much of the total gas reserves may consist of such "uneconomic" gas, they suggest it may be a significant fraction.

There is no denying the lack of consistency between the proved reserves definitions for oil and for gas, but it would appear that the authors' concern over the possible inclusion of "uneconomic" gas in the proved reserve data is unwarranted. The use of Alaska as an

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2. In addition, other proposals and comments on specific statistical series and activities are scattered throughout the book. It would be impossible to appraise each of these in this review.

3. P. 109.

example of remoteness is an unfortunate choice. Large gas finds there are currently the subject of negotiations for supplying Japan with liquefied natural gas via tanker. When did this gas cross the dividing line from uneconomic to economic? The real point here is that remoteness is not merely a matter of location but of location and size combined. It can be assumed that there are small gas occurrences in Alaska known to exist but which are not counted in the proved reserves figures, just as there are small gas occurrences in the contiguous 48 states that are known but considered "noncommercial," as the industry terms them.

Even here, however, there is no clear dividing line. A single small occurrence may be unquestionably uneconomic in the sense that it does not justify a pipeline connection, but the discovery of several small occurrences in the same area may justify a pipeline connection. Should the initial find be considered uneconomic until the pipeline connection materializes? The fact that, at a particular time, the gas cannot be marketed is really irrelevant, for the bulk of the proved reserves of gas cannot be immediately produced because of physical limitations, no matter how "marketable" it may be. There is, in the last analysis, no possibility of separating, by any definition, gas awaiting a market and gas in occurrences too remote from markets ever to be marketable (if such can be said categorically to exist). By the marketability test most of the offshore gas in the Gulf of Mexico should not be counted in proved reserves even when it meets the other established reserve criteria, for pipeline connections to shore have not yet been provided.

As for the associated gas in depleted oil reservoirs, the authors appear to be describing a situation in which gas dissolved in the crude oil has been allowed to escape to form a gas cap. Such a practice is now uncommon, since it is universally recognized as both wasteful and uneconomic.

The authors also wonder whether gas below the abandonment pressure may not be included in proved reserves. But they overlook the language in the definition which says that "proved *recoverable* reserves . . . are those reserves estimated to be producible under present operating practices. . . ." If there is one thing that is inseparable from the concept and measurement of recoverable gas, it is abandonment pressure. Proved reserves cannot include gas below the assumed abandonment pressure at the time of the estimate, and *some* pressure figure has to be assumed in making the estimate.

Moreover, the crucial element in the abandonment pressure is the price of the gas. Hence, it is not quite correct to say, as the authors do, that " 'proved' oil reserves have a stated, albeit rather fuzzy, economic parameter, while 'proved' gas reserves do not."<sup>4</sup> Gas reserves do have such an economic parameter; it is so fuzzy it is hard to detect.

But such differences in interpretation are not criticism. *Resources for the Future* is to be congratulated on providing those interested in the subject with such an excellent work.

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4. P. 129.

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