Valuation of Natural Gas Property

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The appraisal of natural gas properties is a complex problem affected by many non-engineering factors. Attention will be brought here to the more important matters that influence value of such properties, such as the necessity of competent estimates of reserves, availability of the products and of market outlets, the expected rate of recovery, the anticipated prices of products and future costs, the effect of the graduated income tax on profits which lead to greater value of a property to one owner than to another, and other items. To a degree, in each appraisal the problems are unique in that the approach must be suited to the particular case.

During the past 30 years and more, many engineers and geologists have accumulated considerable experience in the problems of evaluating properties capable of producing oil and natural gas. An extensive literature has developed outlining the principles and methods that govern appraisals. Emphasis is placed herein on the importance of careful analysis of the various factors which should lead to a determination of value, and to point out the inadequacy of rather common engineering appraisals that frequently have little relation to what has been termed "fair market value." In a Delaware court some years ago an engineer admitted freely on cross-examination that his appraisal was "an engineering valuation — not a determination of the fair market value.' Such so-called "engineering appraisals" are perhaps interesting, and occasionally may be of some use, but must not be considered of fair value.

During the past few years the effect of the graduated income tax has become especially important in the appraisal of properties yielding income, and promises to continue to be so far a long time. This tax places some corporations in the 52 per cent bracket and subjects individuals to rates that may be as high as 85 to 90 per cent. To those institutions whose income is not taxed, a property can be worth two or three times as much as it may be to the individual in a high tax bracket. Hence it is necessary to consider and determine the fair value applicable to the tax situation of the prospective purchaser. Government regulation of the buying and selling price of gas also influences value. Examples are known where a single property is owned in part by a gas company whose earnings are regulated to, say, 6 per cent and the other co-owner is able to sell his gas even to his regulated partner at a price far above that permitted the latter for his own gas. The result is that one part of the property has a fair value in the market place of several times that of the regulated share. Appraisals are made for business purposes and although it would seem illogical to find at a given time substantially different values for a particular property, depending upon the business purpose, it is clear that these factors just mentioned have produced precisely that situation.

What an Appraisal Is

An appraisal is an estimate of the value of a property. It requires a study made by a person with knowledge of the type of property to be appraised. The elements which are important in evaluations of real property are: annual production, expected prices and costs, risks, physical deterioration and exhaustion of productivity. In the case of oil and natural gas property, their appraisal is a relatively recent development of the older art of appraising mining property. In both cases the fundamental requirement is an estimate of the ultimate production, the timing of this production, its costs and income. The determination of these elements is based upon geology and engineering.

Some Aspects of "Value"

An appraisal results in a dollar value of the property in question. What is this value? The appraised value may be above or below the value of the property to its owner, or to a particular prospective purchaser. It will probably differ from the value as indicated by a recent sale for similar property. The careful evaluator does not necessarily underwrite the judgment of the principals who make a transaction. Rather, the appraised value is an expression in dollars of the interplay of all the principal physical, economic and perhaps political forces that affect the property now and perhaps in the future.

An appraisal is a guide to business decisions, not their determinant. The buyer, the seller, the lender, the borrower, each views a property differently, because each one must consider it in relation to his particular tax position.

Property may have value for a number of reasons. "Use value" is a quality of consumer goods, such as houses and shoes. "Investment value" is based on earning power in the form of future annual incomes which the property is expected to produce. For example, the appraisal of a proved gas property yields an investment evaluation. "Speculative value" arises because of expected capital appreciation over present value. Acreage which is probable or prospective for mineral production has speculative value.

A fundamental economic difference is apparent between proved and unproved acreage. The appraiser's estimate of the investment value of proved acreage is a process that is reducible largely to measurable quantities. The steps in the process, other than judgment, are explicit, objective and can be substantially verified. The methods of valuing unproved acreage are quite different. Hence, a clear distinction must be drawn between what is proved and unproved, and the investment value ascribed to the proved acreage only.

This distinction is particularly important under current business conditions. Our economy operates under a burden of income taxes which extracts a toll from every significant segment of productive activity, and influences virtually every major business transaction. The relative tax position of different individuals and corporations may be the primary consideration that determines the desirability of an investment either in proved properties, or in unproved lands which may or may not yield a profitable return after expensive exploration costs have been incurred.

Unproved acreage has value because prospectors may test it with the drill and discover oil or gas. The valuation ought to depend largely on the degree of probability that the property contains hydrocarbons recoverable in commercial quantities. Thus the distinction between probable and prospective is a difference of degree rather than of kind.

The Classification of Acreage

The classification of unproved property is primarily a matter of informed geological discretion, and depends largely on the known facts in each particular case. If the area is favorable for the accumulation of hydrocarbons, the acreage may be classified as prospective. If the property in question is favorably situated on a known productive structure it may be classified as probable.

In 1909, Herbert Hoover published a classic treatise entitled *Principles of Mining*[1] which is still useful for analysis of some of the basic principles and problems of mineral valuation. Much of his discussion, modified to fit the specific case, can be profitably applied to present day appraisals of oil and gas property. This is particularly true of his classification of ore reserves. Because of his emphasis on the importance of carefully chosen words in order to avoid ambiguous definitions, his classifications of reserves may well be quoted here:

> "Proved Ore: Ore where there is practically no risk of failure of continuity.
>
> Probable Ore: Ore where there is some risk, yet warrantable justification for assumption of continuity.
>
> Prospective Ore: Ore which cannot be included in the above classes, nor definitely known or stated in any terms of tonnage."

Hoover said: "The old terms 'ore in sight' and 'profit in sight' have been of late years subject to much malediction on the part of engineers because these expressions have been so badly abused by the charlatans of mining in attempts to cover the flights of their imaginations. A large part of Volume X of the *Institution of Mining and Metallurgy* has been devoted to heaping infamy on these terms, yet not only have they preserved their place in professional nomenclature, but nothing has been found to supersede them."

One may wonder why reference is made to so old a treatise. written to discuss valuation of certain metallic minerals. It is because of a desire to emphasize the fact that some of the greatest difficulties met today in making dependable valuations of oil and gas properties are of the same kind that were common a half century ago in the valuation of metal mines. In oil and gas appraisal work, no sharply defined standards have been established for the common terms "proved," probable" and "prospective" reserves. Reliance must be placed on the prudence of the appraiser.

Valuation of Unproved Acreage

In valuing probable and prospective acreage, the appraiser must consider a number of factors. The weight to be given each factor is a matter of discretion. The price at which comparable acreage is selling is one possible guide. But market forces are frequently fickle. Enthusiasm sometimes triumphs over judgment, and probable acreage may be selling at prices unwarranted by the available information. At other times, the reverse may be true. The experienced evaluator is able to assess the reliability of "going prices" as a measure of value.

[1]References at end of paper.

Economics of future development and availability of markets are often important elements in the value of unproved acreage. For example, extensive areas of the Hugoton Field were highly probable in the early 1930's, but development costs were so great relative to the available gas markets that the value of this acreage was low.

Frequently the available geological information enables the geologist to estimate roughly the magnitude of the potential reserves. And this knowledge may guide his decision as to whether or not it will be feasible to develop a commercial property if gas is discovered.

The evaluator considers the geologic and economic data that suggest the order of magnitude of possible discoveries. He gives weight to the timing, the costs of development, and market prices, to arrive at the order of magnitude of the value of the unproved acreage. Finally it should be emphasized that in valuations of unproved lands, the appraiser must recognize that the risk element controls.

Within the past decade, income tax rates have created a new phenomenon known as "tax money." The value of unproved acreage may be influenced by the tax-dollar position of prospective purchasers and sellers. Hence the relationship between the risks of unproved properties and the tax position of those who commonly explore them, has become an important factor in the valuation of such acreage.

Appraisal of Proved Gas Properties

Natural gas reserves are frequently classified according to their physical position relative to petroleum, although many enormous gas accumulations have no association with oil. Gas also occurs associated with oil both as a gas cap above the oil and dissolved therein. In general, the gas in the reservoirs that do not contain oil consists of the lighter hydrocarbons, predominantly methane and ethane. Larger proportions of the heavier hydrocarbons are present in the gas associated with oil, and these are also important constituents of the deep, high pressure accumulations known as condensate reservoirs or fields. Gas found in solution with oil will be produced at rates dictated by the engineering and economics of oil production and ordinarily this will be true also of gas cap gas. Gas from a condensate type reservoir may, and probably will be returned to the reservoir, if economic conditions justify, after the liquids have been removed, in order to maintain the underground pressure, and thus prevent possible loss of liquids through retrograde condensation. Associated gas is ordinarily valued as a by-product of the production of oil or condensate. Gas not associated with oil or with substantial amounts of lighter liquids is generally produced in accordance with market requirements for the gas.

Choosing the Method

Before monetary value can be placed on a proved gas property, it is necessary to determine the quantity of gas in place, how much of it is likely to be recovered, and at what annual rates. Several methods may be used to calculate these quantities,[2-9] but the principal ones are the volumetric method and the production-pressure history method. It should be emphasized that not infrequently the judgment exercised in making a proper selection of method is far more important than any refinements of method that subsequently may be made.

Volumetric Estimates

The volumetric estimate is the result of a calculation of the size of the reservoir and of the known gas-containing space within it. The calculation follows this sequence:

(a) The gross volume of reservoir rock containing gas is computed areally, in acres, with thickness expressed in feet, and the size of the reservoir stated in units of acre feet, or cubic feet. Geological information as to the magnitude of the structure and the limits of gas accumulation within it is needed. Structural and isopachous maps of the reservoir must be prepared based upon geological logs of the formation penetrated, electrical logs and core analyses. The results of tests of the sand made to determine its productivity are also generally required. Some sections of the reservoir rock may be eliminated because porosity or permeability are too low, or because too large a percentage of interstitial water is present. The remaining reservoir rock is considered to be commercially producible, and is classified as the pay thickness, measured vertically in feet.

(b) The gross volume of the pay, measured horizontally in acres and vertically in feet, has varying degrees of porosity in its different parts. The average porosity of the pay is ascertained from labortary information. The acre feet of pay are converted to cubic feet and multiplied by the average porosity of the pay section to yield a product that represents the total volume or space containing reservoir fluids, expressed in cubic feet.

(c) Oil and gas reservoirs generally contain water, which adheres to the sedimentary grains in quantities primarily related to the physical and chemical character of the sediment. Based upon physical laws, it may be inferred that the interstitial water is less in gas than in oil reservoirs. Information regarding this point is meager. It is necessary to deduct the connate or interstitial water from the volume of total pore space before arriving at the net volume of gas-containing space. The total quantity of gas contained in this pore space or reservoir is directly related to the reservoir pressure. Corrections are made for temperature and deviation from the "ideal gas" behavior before arriving at the quantity which the reservoir contains.

The customary volumetric formula used in estimating gas in place may be expressed as follows:

$$V = 43{,}560 \times A \times S \times P \times (1-C) \times \frac{P_r}{P_{mb}} \times \frac{T_{mb}}{T_r} \times \frac{1}{Z}$$

Where:

V = the volume of gas in the reservoir, in cu ft, at pressure P_{mb} and temperature T_{mb}.

43,560 = the number of sq ft per acre.

A = the proven area, in acres.

S = the average net effective pay thickness, in ft.

P = the porosity of the pay usually expressed in per cent.

C = the connate water content of the pay usually expressed in per cent.

P_r = the reservoir pressure psia.

P_{mb} = the pressure measuring base in psia.

T_r = the reservoir temperature in degrees Rankine (Fahrenheit plus 460°).

T_{mb} = the temperature measuring base in degrees Rankine.

Z = the deviation of the gas from ideal gas behavior.

The foregoing discussion indicates the fundamental importance of geological knowledge in making estimates of gas in place by the volumetric method. Virtually every significant step taken in the calculation of the space within which gas is confined requires an act of judgment based on geological and engineering evidence. Errors in judgment, as well as in data, can result in grossly inaccurate estimates.

The role of the geologist in oil and gas discovery has been greatly enhanced by geophysical methods for the delineation of both subsurface structure and stratigraphy. Interpretation of the geophysical data requires a more intensive type of training and broad geological experience. At one time the geologist would not go far astray in the portrayal of a subsurface structure if he assumed approximate similarity to the attitude of the rocks observed at the surface. The increased depth of modern wells, the numerous unconformities, the multiplicity of sands, their lenticularity and the frequency of faults make it imperative more than ever that he visualize subsurface features in three dimensions. The structural complexity of many producing fields is comparable to the intricate system of mineral veins that distinguish many mining districts. But in mines the ramifications of underground workings reveal to the eye the intersection of one vein with another, as well as the several generations of faults and their chronological sequence. In the case of hydrocarbon reservoirs, nature's blankets of successive sedimentary rocks have reduced such visibility to zero, and reliance must be placed upon material obtained through the use of geological and geophysical tools. However, remarkable skills have been developed for translation into the essential engineering terms the information available from seismic studies, cores, electric logs, bottom hole samples and pressure bombs, as to position, extent, and peculiarity of the various strata, together with data relative to the physical properties of their fluid contents. Computation of recoverable reserves in these deep reservoirs depends upon these geological and engineering facts, and also demands familiarity with their effect upon the movement of the reservoir fluids.

(d) Only a portion of the gas contained in the reservoir will ultimately be produced. It is necessary to determine a recovery factor, or percentage of the gas which will likely be produced during the economic life of the property. In the final analysis, the recovery factor is estimated after consideration of the net interplay of physical, regulatory and economic forces, many of which may be known imperfectly.

A study of many depleted or nearly depleted fields[10] indicates that under average conditions about 85 per cent of the total gas in place will be recovered. The amount in any case is dependent upon an interplay of many factors, of which the permeability of the reservoir rock is a major one. The recovery may reasonably be estimated as low as 50 per cent to 60 per cent or higher than 95 per cent. In each case the suitable recovery factor must be determined.

Production Performance Estimates

Long experience with producing wells has demonstrated that there may be a considerable degree of uniformity in their life performance. In the case of volumetrically controlled reservoirs, curves can be constructed that describe the production history of wells; these can be extrapolated to forecast the future production. Even though fields or wells rarely produce at uniform rates, an experienced appraiser can evaluate the degree of dependabiilty of various estimates that are based on past production.

These estimates take several forms, but they rest on observed facts. Production per unit of time may decline with the age of the well. The annual rate of production may therefore be plotted against time, and the resulting curve extended to measure annual rates in future years. For ease in extrapolation, it may be desirable in certain instances to plot the production decline curve on some type of logarithmic paper. If the production rates of the wells fluctuate widely with market requirements or proration controls, past performance may be of little use as a guide to the future.

Estimates based on production performance are fundamentally dependent on Boyle's law (suitably modified for deviations therefrom), according to which the quantity of gas contained in a reservoir of fixed volume is directly related to the pressure, at constant temperature. As the gas reserve is produced, the pressure declines. The estimator needs to know the average shut-in wellhead pressure, or the bottom hole pressure, and the cumulative production as of various dates.

Average pressure plotted against cumulative production on cartesian coordinate paper will yield a reasonably straight line descending to the right. It is sometimes convenient to divide the pressures by Z, the deviation factor, and then use the corrected or modified pressures[7] as one of the variables which is plotted against cumulative production to give a straight line on cartesian coordinate paper. This line can be extended to some assumed abandonment pressure, in order to measure the total estimated ultimate production. The difference between the ultimate and the past production, is the estimate of the remaining reserves that will be recovered. It should be noted that this method does not indicate the annual rate at which the gas will be produced. Furthermore, since it assumes production from a reservoir of constant volume, it is not applicable to a gas field actuated by an active water-drive.

The matter of water-drive requires special comment. Sometimes in the early history of a field the data may indicate water-drive. The evaluator may not be certain that an estimate based on pressure decline is a wholly trustworthy guide to future production; it may need correction to allow for water encroachment in the reservoir. At other times, the relation between gas production and pressure decline may be considered a reliable guide, until new evidence indicates that pressures are abnormally maintained by water-drive. In the first instance, reserves could be under-estimated if no water-drive exists; in the second, over-estimated before discovery that the reservoir is contracting in volume. The curve is affected by the production rate, which is a function of the pressure differential. Reservoir performance may very between 100 per cent volumetric control and 100 per cent hydraulic control.

Production performance estimates are extensively used in valuing fields which meet particular conditions. Since they are based on history of production and the resulting cumulative data, they cannot be used in newly developed properties. Their accuracy increases with the age of the field or wells. Since such estimates are based on well and reservoir performance history, they are often limited in usefulness to the developed portions of a field or of a particular property.

Market Availability

Gas moves only in pipe lines. Accordingly the nation's gas reserves require their own individual transportation systems in order to reach their market. The owner of a gas property can realize no income from it unless his gas reserves are tied by pipe line to a consumer who may be located in the field itself or at a more distant market. His reserves must be sufficient to justify the cost of building, maintaining, operating and amortizing the transportation system, at least in part, if they are to earn an income.

Neither can natural gas be stored economically by most consumers. The gas consumer does not lay up a supply of the fuel, but takes it from the seller as his needs require, and uses it immediately upon receipt. At any point of time, the consumer is utterly dependent upon a particular supplier. In order to protect himself, he seeks contractual assurance of a continuous supply.

Gas Contracts

Gas contracts not only determine the prices to be paid; they also impose on the seller certain conditions as to quality and delivery which may in effect require that he develop the property according to a pattern implicit in the sales agreement. Accordingly in a valuation, all the provisions of the contract must be considered.

Availability of Gas

Availability is the capacity of a property to produce under certain operating conditions. It depends upon the physical character of the reservoir, well completion methods, the development in the field, and the method of operating the property involved and those adjacent to it. It is affected by physical laws governing the flow of gas through the reservoir rock to the well, through the tubing, the gathering lines, and so on into the purchaser's line.

These physical conditions of availability must be considered in the light of the gas sales contract. They dictate that enough wells be drilled initially to supply the daily volumes specified in the contract. As a property is produced, the reservoir pressure declines, and it becomes necessary either to drill additional wells or to install compressors or both. The contract determines what the property, under expected conditions, must do, while natural forces determine in part what it can do. In order to win the income, the operator must incur development costs appropriate to the conditions imposed by nature and the contract requirements. The evaluator must make estimates of the timing and the costs of a development program before he can estimate the expected future annual incomes.

Furthermore, the evaluator must consider the effects upon availability that stem from regulation of production by public authorities. The gas flow of many properties is restricted by proration orders imposed for conservation purposes, or for protection of the rights of all owners in a common pool. Occasional instances are known where state-imposed allowables have superseded contract volumes, and as a result, altered the development pattern, the annual production rate and the value of the property. While the evaluator may be unable to predict the imposition or continuation of proration, he must consider it either as a fact or as a possibility.

The Calculation of Income — Gross Revenues

After an estimate of the recoverable gas reserves, the by-products (if any), and the annual rates at which they will be produced, the appraiser calculates the owner's annual net working interest after royalty. This involves assumptions about future prices. Ordinarily it is safe to assume future prices that are in line with those currently offered in the same area. From the estimates of future production and prices, calculations of future annual gross incomes may be made. From these incomes, proper cost and expense deductions should be made to estimate the net annual taxable income and the net annual cash income.

Costs or Expenses

The pattern of development of a property is dictated largely by contract requirements, considered in relation to physical characteristics. With this in mind, the appraiser must prepare a reasonable development program. This involves estimates not only of the number of wells and the amount of compression, but the timing of development. It should be noted that, to a degree, compression is a substitute for additional wells.

Cost estimates depend upon assumptions about future prices of labor, materials and other items. If the present scale of gas prices is used in determining future revenues, it is generally reasonable to estimate future costs on the basis of current wages, materials, prices and taxes. Over the life of the property appraised, costs and revenues will probably fluctuate in the same direction, though perhaps not always at the same time.

Costs must be viewed in another way. Cash outlays reduce the actual dollars which accrue to the owner in each income period, but do not represent the total costs of production. Since income tax payments are cash outlays, it is necessary to compute the net annual taxable incomes in order to determine expected income tax costs. Thus two calculations must be made, one of net cash income subject to tax, another of net annual profits after all cash outlays. In order to determine the taxable income, the appraiser must act in accordance with the appropriate Federal regulations.

Depletion Allowance

An investment in a natural gas property is an investment in a wasting asset. When production ceases, the property has little or no salvage value. Accordingly, the investor expects the property to return to him his capital outlay as well as pay him a return on that investment. The rate at which the investor recoups his capital is dependent not only on the gross earning power of the property, but on the methods of depreciation and depletion permitted by the income tax laws. These provisions are found in the laws of both the United States and Canada, with but slight differences between the two.

In the income tax laws of this nation, depreciation charges are considered operating costs and hence are tax free. It has been the theory that productive enterprises should have some incentive to replace physical assets as they wear out, and thus maintain the productive capacity of the economy. With oil and gas, their replacement involves great uncertainty and risk. The real costs of replacement rise because progressive depletion makes it necessary to search deeper and in less accessible areas. Finally, the historical costs of finding productive properties furnish little guide to such costs in the future. The operator has no assurance that the expenditure on exploration of a sum equal to the cost of a past discovery will add an equivalent quantity of new reserves to the national total.

The percentage deduction for depletion is a recognition of these facts. This permits the owner to deduct 27.5 per cent of the gross value of production after royalty (or 50 per cent of the net, whichever is smaller) from his net revenues before arriving at his taxable income. By another provision, the owner is permitted to charge intangible drilling costs to expense for the year in which the costs are incurred. These two features of the income tax law recognize the owner's investment in a dwindling asset, and are a substitute for the depreciation charges permitted to other industries for recovery of investment in replaceable productive assets, like factories or machinery. They serve as a powerful inducement to the operator to earmark revenue from the sale of hydrocarbons for reinvestment in the hazardous business of further search for oil and gas. They are a type of public policy which contributes mightily to the increase in the national inventory of energy resources.

Net Income Before Tax

The net annual income subject to tax is a residual after all allowed "costs" incident to production have been met. It is not "profit" in any abstract economic sense, but a value which must be calculated in accordance with the law. From the estimated annual gross revenues, deductions are made for operating costs including property taxes and management, and for intangible drilling expenses, if any. This yields a schedule of expected annual taxable incomes, from which the income tax costs may be computed.

Net Cash Revenue

In the discussion of costs, distinction was made between items which involve actual cash outlays and those which are accounting charges in an income period. The "net cash revenue" is the dollars remaining to the owner after all out-of-pocket payments for the year have been met, and after income tax. By examination of the "net cash revenues" and not net income one discovers the cash to be retained by the owner after all outlays have been made. Since these annual sums are computed without reference to depreciation or depletion allowances, it is to them that the owner must look for the return of his principal.

Income Tax Problems in Appraisals

The fair value of a proven property is related ultimately to the cash it is expected to yield after income tax. Hence future income taxes must be deducted from net cash revenues to arrive at the annual dollars estimated to be available to pay out the investment plus a reasonable return.

The income tax is all-pervasive, and affects the earning power and hence the value of proved gas properties. The estimation of income taxes in appraisal work may be complicated because different rates apply to different persons, but this does not alter the fact that the market views the tax as a cost to be borne by the property. The seller has his tax problem. Each of several purchasers has his tax problems. The appraiser has these problems to consider.

The impact of the graduated income tax at high rates is so violent that it distorts market forces and relationships which formerly were considered normal. The common definition of fair value should be modified somewhat as follows: "The fair market value of a property is the price at which a willing and informed owner would sell to a willing and informed buyer, with full consideration given to their relative tax positions."

The Pay-Out Period

The value of a property is in part related to the pay-out time. The longer it takes for the owner to recover his investment, the lower the value, if other things are equal. A property which will return the owner his investment in five years will have a higher relative value than one which will be produced at rates equivalent to a ten year pay-out, even though the reserves are about the same in both cases. Furthermore, a prospective purchaser would wish not only the return of his capital, but substantial expected income after the "pay-out" period.

Some Types of Valuation

Before concluding this discussion, it is probably desirable to distinguish sharply the engineer's appraisal from some other types of valuation. In the case of regulated gas utilities, the valuation is for the purpose of establishing rates. The theory of public utility regulation is that the utility should be permitted to charge prices which are fair. Fair prices are conceived to cover all costs (including income tax) and permit if possible a reasonable return to the owners. Price determination therefore requires decisions as to what should be included in the rate base, and what constitutes a fair return thereon. The rate base is a valuation of the property based not on what the property will earn, since that is the matter to be determined, but on what it cost originally or what it would cost to reproduce currently. Several of the large interstate gas companies owned producing gas properties when Federal regulation was introduced into the gas business in 1938. For rate making purposes, these gas reserves are valued on the basis of depreciated original cost, not in terms of current field values for gas. As a result, some of the nation's choicest gas reserves are valued at ridiculously low figures.

Secondly, distinction should be made between the engineer's valuation and that placed on property by the securities markets. While the value of equity stock is related to the value of the property, part of the value of gas and oil properties lies in the chance of capital gain through new discoveries. The stock market may very well place a much higher (or much lower) value on the probable and prospective acreage of a company than would a prudent engineer.

It is not expected that the engineer's estimate of the fair value of proved or unproved properties would agree with, or

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even necessarily approximate valuations for rate purposes or values as indicated by the securities markets.

CONCLUSION

It is apparent that the appraiser makes many decisions in his analysis, based on his skill, his technical knowledge of geology and engineering, and his familiarity with the economic realities which affect the value of a natural gas property. He makes his studies and reaches his conclusions on the basis of the best information available. His final determination of the fair value is conditioned by all of the pertinent facts. If he is conscientious and informed, then the value reached will command respect, and will not be dependent upon "flights of the imagination" which Mr. Hoover deplored.

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REFERENCES

1. Hoover, Herbert C.: *Principles of Mining,* McGraw-Hill Book Co., Inc., (1909).
2. Shaw, Eugene W.: "Natural Gas Resources of Parts of North Texas-Gas in the Area of Fort Worth and Dallas," *U. S. Geol. Surv. Bull.,* (1916) 629.
3. Davis, Ralph E.: "Estimation of Natural Gas Reserves," *Oil and Gas Jour.,* (June 16, 1927) 125-126.
4. Versluys, J.: "An Investigation of the Problem of the Estimation of Gas Reserves," *Bull.* AAPG, (Nov. 1928) *12,* (11), 1095-1105.
5. Stephenson, Eugene A.: "Valuation of Natural Gas Properties," *Geology of Natural Gas,* (1935) AAPG 1021-1033.
6. Biddison, P. McDonald: "Estimation of Natural Gas Reserves," *Geology of Natural Gas,* (1935) AAPG, 1034-1052.
7. Stephenson, Eugene A., and Moore, John I.: "The Otis Gas and Oil Pool," *Kansas Geol. Surv., Bull.,* (1940) 38.
8. Spoor, H. C., Jr.: "Estimation of Gas Reserves," Composite Study Group Papers, Texas Gulf Coast; Houston Geol. Soc., (1946) 41-59.
9. Gruy, Henry J., and Crichton, Jack A.: "A Critical Review of Methods Used in Estimation of Natural Gas Reserves," *Trans.* AIME, (1949) *179,* 249-262.
10. Davis, Ralph E., and Meltzer, L. H.: "The Availability of Natural Gas," Presented at the Petroleum Branch AIME Fall Meeting, Houston, Tex., Oct. 1-3, 1952. ★ ★ ★