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Manual for Discounting Oil and Gas Income

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(a) The Comptroller of Public Accounts adopts a Manual for Discounting Oil and Gas Income, with text as follows.

(b) Basis of the Manual for Discounting Oil and Gas Income.

(1) Tax Code Section 23.175, enacted by the 73rd Legislature, 1993, requires the comptroller's office to develop and distribute to each appraisal district an appraisal manual that specifies the methods and procedures to calculate the present value of oil and gas properties using discounted future income. The 82nd Legislature, 2011, amended Tax Code Section 23.175 to require the comptroller's office to specify the formula to be used in computing the limit on the price for an interest used in the second through the sixth year of an appraisal, beginning with the 2012 tax year. The formula is specified in subsection (p) of this section (Appendix 5).

(2) Section 23.175 also directs each appraisal district to use the specified methods and procedures.

(c) Introduction.

(1) This manual explains the concept of discounting, the discounted cash flow (DCF) equation, DCF appraisal, and three acceptable techniques for estimating a discount rate in the DCF method. The numbers used in the calculations are for illustrative purposes only.

(2) The three acceptable techniques for estimating discount rates are:

(A) market surveys;

(B) oil and gas sales analysis; and

(C) weighted average cost of capital (WACC), also called band of investment.

(3) Together, these techniques provide a range of discount rates. The appraiser must estimate the risk for each oil or gas property to assign a discount rate from the discount rate range.

(4) Subsections (l) – (o) of this section (Appendices 1-4) provide examples to illustrate DCF appraisal, the WACC estimating technique, a standard deviation analysis, and a description of property specific risk factors.

(d) Discounting.

(1) Because investors prefer immediate cash returns over future cash returns, investors pay less for future cash flows--they "discount" them. The amount investors discount the future cash flows depends on the length of time until the cash is due, the amount of risk that the cash will not be tendered when due, and the rate of return available from other comparably risky investments. This discounting procedure converts future income to present value, usually using annual discount factors. The discount factor for each successive year declines to reflect the reduced value of revenue received in the future. The appraiser calculates the present worth of the forecast revenue stream by multiplying the projected net income (cash flow) for each year by the calculated discount factor for that year. These discount factors are derived from the discount rate (also known as the yield rate), and the process is known as DCF analysis.

(2) The International Association of Assessing Officers in *Property Appraisal and Assessment Administration* (1990) defines discount rate as: "The rate of return on investment; the rate an investor requires to discount future income to its present worth. It is made up of an interest rate and an equity yield rate. Theoretical factors considered in setting a discount rate are the safe rate earned from a completely riskless investment (this rate may reflect anticipated loss of purchasing power due to inflation) and compensation for risk, lack of liquidity, and investment management expenses. The discount rate is most often estimated by band-of-investment analysis or a sales comparison analysis that estimates typical internal rates of return."

(3) The discount rate is a key variable in DCF analysis, making correct rate selection crucial. The market's expectations are critical when choosing a discount rate. According to the *Appraisal of Real Estate* by the Appraisal Institute (1992): "The selection of the yield discount rate is critical to DCF analysis. To select an appropriate rate an appraiser must verify and interpret the attitudes and expectations of market participants, including buyers, sellers, advisers, and brokers. Although the actual yield on an investment cannot be calculated until the investment is sold, an investor may set a target yield for the investment before or during ownership. Historical yield rates derived from comparable sales may be relevant, but they reflect past, not future, benefits in the mind of the investor and may not be reliable indicators of current yield. Therefore, the selection of yield rates for discounting cash flows should focus on the prospective or forecast yield rates anticipated by typical buyers and sellers of comparable investments. An appraiser can verify investor assumptions directly by interviewing the parties to comparable sales transactions or indirectly by estimating the income expectancy and likely reversion for a comparable property and deriving a prospective yield rate."

(e) Discounted cash flow appraisal.

(1) The DCF method is versatile and widely used to appraise income producing property. An appraiser using DCF first projects an anticipated net income for each year of the property's remaining economic life. Each annual cash flow is discounted to present value, and then all the present values are added to obtain the total market value of the real property interest being appraised.

(2) The DCF equation is expressed as follows.

$$PV = CF1 \times (PWF1) + CF2 \times (PWF2) + \ldots CFn \times (PWFn)$$

where:

PV=present value $;

CF=the cash flow or income for the period specified $;

PWF= the end of period present worth factor, equals $1/((1+i)^n)$;

i =discount rate (the period compound interest rate);

n =the period for the present worth factor being calculated.

(3) To estimate the present value (PV), an estimate of the income (cash flow) to be received in each period is necessary. The number of periods, n (usually years), used in the analysis is determined by the number of years that the mineral property is expected to produce a positive net income.

(4) There are many variations on the DCF formula. The formulas vary based on the time the money is received, i.e., continuously, beginning of period, middle of period or end of period. The period may be continuous, daily, monthly, quarterly, biannual or annual. Many oil properties are evaluated using an annual mid-period discounting variation of the DCF formula. The appropriate present-worth factor for mid-year DCF analysis is:

$$PWFMY = 1/((1 + i)^{(n - .5)})$$

where: PWFMY = mid-year present worth factor.

(5) Subsection (l) of this section (Appendix 1) illustrates how a DCF is calculated, using a midyear factor, for a mineral property.

(f) Discount rate components.

(1) Components. The discount rate used in DCF analysis has several components. These include:

(A) inflation rate;

(B) risk-free component;

(C) general risk premium; and

(D) property-specific risk premium.

(2) The inflation rate. The annual rate of price change for a basket of consumer goods. Inflation is normally measured by the Consumer Price Index for All Urban Consumers (CPI-U), calculated by the United States Bureau of Labor Statistics. The inflation rate is the most basic component of a discount rate. An investor's rate of return must equal the rate of inflation just to break even in real dollar terms.

(3) The risk-free component. A return to compensate the investor for a loss of liquidity. This component can also be defined as the risk-free rate minus the inflation rate. The risk-free rate is made up of the inflation rate plus a return to reimburse the investor for a loss of liquidity and is measured by the yield to maturity on federal government securities with a maturity period comparable to the investment under consideration (oil or gas reserves in this case). The market perceives these securities as risk-free for all practical purposes since they are issued by the United States government.

(4) General risk premium.

(A) A return to compensate the investor for assuming diversified company-wide risk. The WACC minus the risk-free rate is the general risk premium. The WACC is measured by weighting the typical oil company debt and equity costs by the typical oil company debt and equity capital structure percentages, and then adding the weighted costs. If one were appraising companies, the WACC would be the discount rate, since it reflects the market's expected yields from the stock and debt of a company. Calculation of a WACC will be explained in more detail later in this manual.

(B) For property tax purposes, appraisers estimate the value of individual mineral reserves, not the value of oil companies. Buyers of mineral reserves usually perceive these individual reserves as riskier than the stock and debt of an entire company. Companies can spread their risk over many individual mineral reserves and often over several kinds of assets (some of which are unrelated to the oil or gas business). This asset diversification reduces the company's risk and, as a result, the WACC derived from company financial data is usually lower than an individual producing property's discount rate. However, the WACC is always higher than the risk-free rate. This increase in the rate is a general risk premium to reward investors for assuming the diversified company-wide risk.

(5) Property-specific risk premium. A return that compensates the investor for assuming the unique risks associated with a particular mineral producing property. The discount rate minus the WACC is the property-specific risk premium. Investors demand a premium above the WACC to compensate them for this individual property risk. For certain high-risk properties, this premium can be quite high. See subsection (o) of this section (Appendix 4) for a list of property-specific risk factors.

(6) Component summary. These discount rate components can be summarized:

INFLATION RATE
+ RISK FREE COMPONENT
+ GENERAL RISK PREMIUM
+ PROPERTY SPECIFIC RISK PREMIUM
= DISCOUNT RATE.

(A) There are other ways to "build up" a discount rate. This method's advantage is that the first three components are quantifiable from public data. The property-specific risk premium may be derived from available data in some cases, but in general, the appraiser must estimate it.

(B) Refer to subsection (o) of this section (Appendix 4) for mineral-property conditions that should be considered when estimating the property-specific risk premium.

(g) Using the three techniques.

(1) Components contained in the three techniques.

(A) Market surveys and sales analysis result in rates that include all of the discount rate components. However, in these two techniques, the rate included for the property-specific risk premium is the typical rate for the properties included in the survey or sales analysis. The appraiser must estimate the property-specific risk premium (unless the sales sample is directly comparable to the property being appraised) and adjust for atypically high or low risk. This means that the appraiser must reduce the risk premium for properties with less than the typical risk and increase the risk premium for properties with more than the typical risk.

(B) The third technique, WACC, produces a rate that does not contain a component for property-specific risk. Because it lacks this component, the typical WACC of potential purchasers sets a minimum value for a discount rate and the appraiser must calculate the typical WACC of potential purchasers to know this lower limit. On a case-by-case basis, the appraiser should exclude oil companies from the WACC calculation if they cannot participate in the market for the property he or she is currently appraising. For instance, small companies may not be able to bid on certain very valuable oil and gas properties because of insufficient capital. A typical WACC for larger oil companies would establish an appropriate minimum discount rate for appraising these properties.

(C) An investor should not buy a property at a lower discount rate than his or her WACC, otherwise the investor's net worth will decrease. The appraiser must add the property-specific risk premium to the typical WACC of potential purchasers to develop a discount rate. See subsection (o) of this section (Appendix 4) for a list of property-specific risk factors.

(2) Developing a range.

(A) Ideally, the appraiser should use these three techniques simultaneously to develop a range of discount rates. The typical WACC sets the lower limit, while surveys and direct sales analysis provide a set of discount rates that the appraiser can use as a database that will help to estimate a midrange discount rate and an upper limit to the discount rate. Examples of these techniques can be found in subsections (l) – (p) of this section (the appendices).

(B) Some mineral properties may appear to sell at or below the purchaser's WACC. There are several reasons that a mineral property may appear to change hands at a discount rate equal to or less than the WACC. When a buyer (or appraiser) reduces the cash flows to account for reserve recovery risk the discount rate will not reflect the risk, but the purchase price will. To calculate a discount rate that is comparable to discount rates from other sales, the appraiser must quantify the risk adjustment and add it back to the cash flows. This discount rate will be higher than the non-risk-inclusive rate.

(C) Atypical income tax deductions, or abnormally high or low overhead can also create an artificially high or low discount rate. When faced with market evidence that would indicate a discount rate at less than a company's cost of capital, the appraiser should review all other appraisal parameters to determine why an abnormally low discount rate is indicated. An understated income stream is the most obvious reason. The appraiser may be able to adjust the cash flows and derive a market discount rate or may delete the sale from consideration.

(h) Market surveys.

(1) An appraiser may use market surveys as an indicator of the discount rate. Many studies and surveys are published to help the appraiser estimate an appropriate discount rate or range of rates for appraising oil and gas properties. The Society of Petroleum Evaluation Engineers' (SPEE) Annual Survey and the Western States Petroleum Association's (WSPA) Analysis of Oil and Gas Property Transfers and Sales and Derivation of a Band of Investment are good examples.

(2) The SPEE survey asks producers', consultants', and bankers' opinions on future prices, cost escalation and economic indices (including the discount rate) used in petroleum property evaluation.

(3) The WSPA study, conducted by Richard J. Miller and Associates, consists of two parts: an analysis of oil and gas property transactions and sales occurring in California from 1984 through the current year and an analysis of the WACC or Band of Investment of a representative group of companies for the same years. The WACC analysis is based on public data.

(i) Developing a discount rate from sales.

(1) Basic steps. To develop a discount rate from sales requires three basic steps:

(A) obtain recent sales prices from a variety of oil and gas producing properties;

(B) develop cash flow projections for each property; and

(C) calculate the internal rate of return (IRR) for each sale. This is also known as the DCF return on investment (DCFROI).

(2) Sales sources. Information about sales can be obtained from a variety of sources, but the best source is the buyer or seller. Other sources that list sales of oil and gas property include the Texas Railroad Commission, Oil and Gas Journal 300, Strevig and Associates, private firms and oil and gas companies. It is important to remember that the sale of an oil or gas property must be a market transaction when developing a discount rate from sales.

(3) Cash flow projections. After obtaining verified sales prices, the appraiser develops cash flow projections for each property. To the extent possible, the appraiser must talk with the parties to each sale to determine their expectations of the property and take those into account when making projections. The validity of the derived discount rate is a direct function of the amount of information obtained from the buyer and seller about their cash flow projections. The appraiser must incorporate this information into his or her projections. If the appraiser's projections differ from the buyer's and seller's expectations, the discount rate derived from the sale will be invalid.

(4) Calculating the IRR.

(A) The third step in developing a discount rate from sales is to calculate the internal rate of return (IRR) for each sale. The IRR is the yield (discount) rate at which the present value of a cash income stream equals the present value of the cash expenditures (the sales price in our analysis) necessary to produce that income stream. This discount rate is prospective; it does not depend on the historical performance of the property, but on the market participants' expectations of future performance. The discount rate at which the present value of the cash flows equals the sales price can be determined by trial and error. However, there are several calculators and personal computer software packages that can solve for the discount rate (IRR).

(B) Although computational procedures may vary slightly, this measure is also referred to as the profitability-index and investor's method. The IRR recognizes that funds received now are more valuable than those received at some future time. The investment outlay can be regarded as borrowed funds and the pre-tax cash flow as the payment of principle plus compound interest on the investment.

(j) Weighted average cost of capital.

(1) Definition. A widely used method for deriving a pre-tax base discount rate for valuation purposes is the band of investment, or WACC technique. The basis for this analysis is the financial data from a broad sample of oil companies that derive a majority of their operating revenues from oil and gas production. Since petroleum property valuation typically involves discounting cash flows over a long period of time, a long-term cost of capital is most appropriate for developing an oil or gas property discount rate. Thus, the appraiser should incorporate a broad time series of data to approximate a long-term cost of capital.

(2) Required calculations. Four sets of calculations are required to determine the WACC.

(A) The typical capital structure is derived and expressed as a proportion of debt and equity.

(B) The typical cost of outstanding debt is calculated based on bond yields.

(C) The typical cost of equity is computed using the Capital Asset Pricing Model (CAPM) or another method such as the DCF Model.

(D) Debt and equity costs are weighted according to the typical capital structure percentages and added to derive a typical cost of capital.

(3) Capital structure.

(A) Capital structure describes in percentage terms the sources of funds (capital) used to purchase the assets necessary to operate a company. The capital structure of any company consists of debt and equity. The debt portion consists of long-term debt (represented by outstanding bonds) and preferred stock, while the equity portion consists of outstanding common stock. If the company is funded by debt and equity of equal value, the capital structure is 50 percent debt and 50 percent equity.

(B) To estimate a discount rate for mass-appraisal purposes, the appraiser should use the typical market capital structure for a representative group of major and independent oil companies that derive a majority of their operating revenues from oil and gas production.

(4) Cost of debt. The yield-to-maturity is the best approximation of the cost of debt capital. This yield is observable in the marketplace and can be found by referring to Standard and Poor's Corporation Bond Guide, Moody's Bond Report or a comparable publication.

(5) Cost of equity.

(A) The CAPM is the preferred approximation of equity cost since it considers both historical market yields and current expectations, plus a market-derived equity risk factor. The CAPM method measures the cost of equity by considering that an investor's required rate of return on common stock is comprised of a risk-free return plus a risk-adjustment factor related to the specific stock. This is represented by the following equation:

$$K = Rfc + B(Rm - Rfh)$$

where:

K = cost of equity (after tax), percent/year;

Rfc = current risk-free rate, percent/year;

Rm = historic market return on equities, percent/year;

Rfh = historic market return on long-term government bonds, percent/year;

B = BETA coefficient.

(B) The current risk-free rate (Rfc) is typically based on current long-term government securities, i.e., the yield-to-maturity observed on an annual basis on a default-free treasury bond, note, or bill of the relevant time period. For oil and gas property appraisal, the yield on a long-term bond is an appropriate measure of the risk-free rate.

(C) The historical market return on equities (Rm) on common stocks and the historical arithmetic mean on long-term government bond income returns (Rfh) can be obtained from Ibbotson Associates' Stock, Bonds, Bills and Inflation. The beta coefficient (B) measures market risk by regressing the stock's total return against the market's total return. A more detailed description of the beta calculation can be found in the Ibbotson Associates report. The beta coefficient value can be obtained from Value Line Publishing, Incorporated's The Value Line Investment Survey, Standard and Poor's Corporation's S&P Stock Reports and similar investment services.

(D) The difference between the historical risk-free (Rfh) and market (Rm) rates of return is a measure of the non-systematic or non-market related risk caused by changes specific to the companies comprising the stock rate of return sample and is, in effect, an equity risk premium. Note that two different risk-free rates of return are used in the CAPM. The current risk-free rate (Rfc) is used to acknowledge the expectational function of the model. The historical risk-free rate (Rfh) is used in conjunction with the historical market return for the same time period when calculating the equity risk premium.

(E) The cost of equity resulting from this model is a nominal (current dollar) after tax rate. Conversion to a nominal, pre-tax rate requires dividing the equity cost (K) by one minus the federal statutory income tax rate for petroleum companies. The income tax rate is presently 35 percent. This is represented by the following equation:

$$K(\text{pre-tax}) = K/(1 - .35).$$

If the appraiser calculates a typical effective income tax rate from a representative sample of petroleum companies that could participate in the market for the property that he or she is appraising, the appraiser may substitute that typical effective income tax rate for the statutory rate.

(6) Weighting debt and equity costs.

(A) Once capital structure, debt, and equity costs are determined, the final step in deriving the WACC is to weight the cost of debt and equity by the proportional share each has in the overall capital structure. This is represented by the following equations.

Wtd Avg. Cost of Equity = (Cost of equity percentage) × (Equity fraction)

Wtd Avg. Cost of Debt = (Cost of debt percentage) × (Debt fraction)

WACC = Wtd Avg. Cost of Equity + Wtd Avg. Cost of Debt

The WACC can also be described as follows:

INFLATION RATE
+ RISK FREE COMPONENT
= RISK FREE RATE

RISK FREE RATE
+ GENERAL RISK PREMIUM
= WACC

(B) The WACC estimating technique is illustrated in subsection (m) of this section (Appendix 2).

(7) Final discount rate selection.

(A) As discussed earlier, the typical WACC of potential purchasers sets the lower end of the discount rate range. To help establish the upper end of the discount rate range, the appraiser can calculate a standard deviation of all the discount rates indicated by the sales in the sales sample and the survey. One standard deviation above and below the mean contains 68 percent of all the observations in a normally distributed set of data. Two standard deviations above and below the mean contains over 99 percent of all the observations in a normally distributed set of data. The data may not be normally distributed. Even so, this kind of analysis may help the appraiser to establish the upper end of the discount rate range.

(B) Very high-risk properties (for example, a one-well lease with high water production near the end of its economic life) may be discounted by the market at two standard deviations above the mean. Properties with lesser risk will have correspondingly lower discount rates. One standard deviation above the mean may establish an upper limit for properties in a typical risk-range. The mean or median of the discount rates from the sales analysis and the survey indicates the mid-range discount rate.

(C) For a standard deviation analysis to have meaning in selecting an upper limit to the discount rate range, the survey or sales data set must contain properties with broadly varying risk. A high-end discount rate selected by this method will not apply to very risky properties (it will be too low) unless these risky properties are represented in the sales data set used in the analysis.

(D) To select a discount rate for an individual property, the appraiser must assess the property-specific risk inherent in the property. Subsection (o) of this section (Appendix 4) lists risk factors that should be taken into account.

(k) Summary.

(1) This manual describes methods and procedures used to calculate the present value of oil and gas properties using discounted future income. The DCF method is the most widely used method to appraise mineral properties.

(2) Within the DCF equation, there are three generally accepted techniques for estimating a discount rate: market surveys, oil and gas sales analysis and WACC. Ideally, the appraiser should use these three techniques simultaneously to develop a range of discount rates.

(3) The evaluation of oil and gas properties demonstrates the importance of viewing a discount rate in the context of the entire appraisal, including the production decline rate, price, and cost parameters. The discount rate should not be considered an isolated variable, for it is only one component of a complex interaction of variables that collectively determine an estimate of value.

(l) Appendix 1: Discount Cash Flow Method (Working Interest Portion Only)

Year	(1) Net Oil Production (bbls)	(2) Oil Price ($/bbls)	(3) Gross Income ($)	(4) Op Exp+ SevTaxes ($)	(5) Net Income ($)	(6) Discount Factor @16.7%	(7) Discounted Cash Flow ($)
1	31,938	$ 19.75	$ 630,776	$ 159,015	$ 471,761	.925688	$ 436,703
2	25,550	20.54	524,797	159,341	365,456	.793220	289,887
3	20,440	21.36	436,598	160,692	275,906	.679709	187,536
4	16,352	22.22	363,341	162,946	200,395	.582441	116,718
5	13,081	23.10	302,171	165,982	136,189	.499093	67,971
6	10,465	24.03	251,474	169,733	81,741	.427671	34,958
7	8,372	24.99	209,216	174,115	35,101	.366471	12,863
						Subtotal	$ 1,146,636
				Salvage	$ 10,000	.339238*	3,392
						Total	$ 1,150,028

* End of year seven factor=$1/(1+.167)^7$

Calculation Procedures:

(1) Net Oil Production is Gross Oil Production times Net Revenue Interest (NRI). NRI equals 87.5 percent.

(2) Starting Oil Price, $19.75/bbl with an escalation rate of 4 percent/year.

(3) Gross Income equals Net Oil Production multiplied by Oil Price

(4) Op. Exp. + Sev. Taxes: Operating Expenses escalated at a rate of 4 percent/year; severance tax on oil is 4.6 percent/year

(5) Net Income equals Gross Income less Op. Exp. and Sev. Taxes

(6) Discount Factor (mid-year) @16.7 percent equals:

Year 1 $1/((1+.167)^{(1-.5)}) = .925688$

Year 2 $1/((1+.167)^{(2-.5)}) = .793220$

Year 3 $1/((1+.167)^{(3-.5)}) = .679709$

Year 4 $1/((1+.167)^{(4-.5)}) = .582441$

Year 5 $1/((1+.167)^{(5-.5)}) = .499093$

Year 6 $1/((1+.167)^{(6-.5)}) = .427671$

Year 7 $1/((1+.167)^{(7-.5)}) = .366471$

NOTE: The discount factor of 16.7 percent includes 1.7 percent for property taxes. Some appraisers handle property taxes as a deduction from gross income.

(7) DCF equals Net Income multiplied by the Discount Factor

Other factors that should be considered in the DCF method include capital expenditures, environmental remediation costs, and the present worth of the salvage value of equipment less well plugging costs.

(m) Appendix 2: Estimation of WACC

1. Derive the typical capital structure of a broad sample of potential purchasers as a proportion of debt and equity.

Data can be found in the 12/31/20xx issue of The Value Line Investment Survey under the headings "Petroleum (Integrated) Industry" and "Petroleum (Producing) Industry."

Outstanding Common Stock (Oil Company)

= 157,627,284 shares @ 12/31/20xx

Closing Common Stock Price

= $106.75/share

Common Stock Equity

= (157,627,284 shares) x ($106.75/share)

= $16,827,000,000 @ 12/31/20xx

Total Debt

= $6,791,000,000 @ 12/31/20xx

Total Capital

= Debt + Equity

= $6,791,000,000 + $16,827,000,000

= $23,618,000,000

Debt

= $6,791,000,000/$23,618,000,000

= .288 or 28.8 percent

Equity

= $16,827,000,000/$23,618,000,000

= .712 or 71.2 percent

The capital structure is 28.8 percent debt and 71.2 percent equity.

Repeat this procedure for each company in the sample.

2. Calculate the cost of outstanding debt

Data can be found using Standard & Poor's Bond Guide (12/20xx issue)

YTM = Yield-to-Maturity @ 12/31/20xx

Debt Instrument	Debt (MM$)	YTM (%/yr)	Debt x YTM
Debt A	$ 27	6.29	$ 170
Debt B	586	8.42	4,934
Debt C	132	7.52	993
Debt D	600	7.84	4,704
Debt E	265	4.95	1,312
Debt F	100	8.65	865
Debt G	300	7.87	2,361
Debt H	450	8.28	3,726
Debt I	123	8.70	1,070
Debt J	224	8.78	1,967
Debt K	300	8.29	2,487
Debt L	500	8.38	4,190
	$ 3,607		**$ 28,779**

Sum of Debt

= Debt (MM$) x YTM

= $28,779 MM

Cost of Debt

= Sum of Debt (MM$) / Debt (MM$)

= ($28,779 MM) / ($3,607 MM)

= 7.98 percent/year

Repeat this procedure for each company in the sample.

3. Calculate the cost of equity

Use the Capital Asset Pricing Model (CAPM) equation:

$$K = Rfc + B(Rm - Rfh)$$

where:

K = cost of equity (after tax), percent/year

Rfc = current risk-free rate, percent/year, can be found in the Federal Reserve Statistical Release (January of current year)

Rfh = historic market return on long-term government bonds, percent/year, can be found in Ibbotson & Associates: Stocks, Bonds, Bills and Inflation

Rm = historic market return on equities, percent/year, can be found in Ibbotson & Associates: Stocks, Bonds, Bills and Inflation

B = beta coefficient, can be found in The Value Line Investment Survey, 4th Qtr, 20xx

Given:

Rfc = 5.1 percent/year

Rfh = 5.5 percent/year

Rm = 12.4 percent/year

B = .80

$$K = Rfc + B(Rm - Rfh)$$
$$= 5.1 + .8(12.4\text{-}5.5)$$
$$= 10.6 \text{ percent/year}$$
$$K \text{ (pre-tax)} = 10.6/(1 - .34)$$
$$\text{Cost of equity} = 16.1 \text{ percent/year}$$

Repeat this procedure for each company in the sample.

4. Calculate a typical WACC by plugging the mean (or other measure of central tendency) cost of debt, cost of equity and capital structure from the sample companies into the following formula:

WACC = ((cost of debt) x (percent debt)) +
((cost of equity) x (percent equity))
= (7.98 x .288) + (16.1 x .712)
= 13.8 percent/year

(n) Appendix 3: Standard Deviation

The standard deviation is the square root of the average squared difference between the individual observations and the average value. The first step in the calculation of the standard deviation is to average the data arithmetically. The arithmetic average or mean value is denoted as z. An equation to calculate the mean value, z, of a data set is as follows:

$$z = 1/n(x1 + x2 + x3 + ... + xn)$$

where:

z = mean value of a data set of n values
x1 = unique value in data set
n = total number of values in data set

The standard deviation, usually denoted by the symbol, S, would be calculated using the following equation:

$$S = (((x1 - z)^2 + ... + (xn - z)^2)/(n-1))^{.5}$$

where:

S = standard deviation of a data set with n values
x1 = unique value in data set
xn = nth value in data set
n = total number in data set

Example: Procedure for calculating the standard deviation of a data set that has 10 sales with various internal rates of return (IRR).

Sales No.		IRR (%)	(x - z)	(x - z) ^2
1	x1	11.0	-4.7	22.09
2	x2	25.0	9.3	86.49
3	x3	6.0	-9.7	94.09
4	x4	16.0	0.3	0.09
5	x5	16.0	0.3	0.09
6	x6	22.0	6.3	39.69
7	x7	9.0	-6.7	44.89
8	x8	14.0	-1.7	2.89
9	x9	13.0	-2.7	7.29
10	x10	25.0	9.3	86.49
		157.0		**384.10**

Calculate the arithmetic average, z:

z = 157.0/10 = 15.7 IRR percent

Calculate the standard deviation, S:

$S = (384.1/(10-1))^{.5} = 6.5$ IRR percent

Range of 1 standard deviation

$= 15.7 \pm 6.5 = 9.2 < 15.7 < 22.2$

Range of 2 standard deviations

$= 15.7 \pm 6.5(2) = 2.7 < 15.7 < 28.7$

28.7 percent/year could be used as an upper limit to the discount rate range for high-risk properties.

(o) Appendix 4: Property Specific Risk Factors

A. One well lease

B. Oil lease with high water production

C. Lease near the end of its economic life

D. Gas well reservoir under partial or active water drive (recovery uncertain)

E. Curtailed gas well

F. Rapidly declining lease

G. Lease with less than six (6) months production history

H. Secondary Recovery Project in early stages before fill-up

I. Offshore oil or gas lease

J. Unusually high operating expenses (ex: paraffin problems, sour gas, etc.)

K. The appraiser should add to the base discount rate (WACC) for any other property specific factors that increase the investor's risk.

(p) Appendix 5: Formula for the Escalation or De-Escalation of Crude Oil and Natural Gas Prices

The formula to determine the maximum average annual escalation or de-escalation percentage for years two through six of an appraisal is:

$$((X/100)^{(1/Y)} - 1) \times 100 = \text{Percentage}$$

Where:

X = Most recent year annual average (not seasonally adjusted) Producer Price Index (PPI) for crude petroleum (domestic production) [Commodity Code 0561, Series ID# WPU0561] or natural gas [Commodity Code 0531] obtained from the Bureau of Labor Statistics during the month of January, which may contain preliminary statistics.

Y = Number of years from base year 1982 through the most recent year (most recent year minus base year).

The 100 denominator in the formula is the PPI annual average for domestically produced petroleum and natural gas in base year 1982.

Example Computation:

Most recent year = 2010

X = 218.6 for Crude Petroleum Domestic Production (Commodity Code 0561) [Series ID# WPU0561]

185.8 for Natural Gas (Commodity Code 0531)

Y = 2010 - 1982 = 28 years

1/Y = 1/28 = 0.035714286

Crude Petroleum (Domestic Production):

$((218.6/100)^{0.035714286} - 1) \times 100 = 2.832$ percent

Natural Gas:

$((185.8/100)^{0.035714286} - 1) \times 100 = 2.237$ percent

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