United States
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Agency

Office of Water
Enforcement and Permits
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Guidance Manual for POTWS to Calculate the Economic Benefit of Noncompliance

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

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OFFICE OF WATER

To: Regional and State Pretreatment Coordinators

Enclosed is the final version of the Guidance Manual for POTWs to Calculate the Economic Benefit of Noncompliance (P-BEN). The document describes the step-by-step procedure that Control Authorities may use to manually calculate the economic benefit an industrial user is expected to have realized by delaying installation or proper operation of pretreatment equipment. The manual calculation described in this document is based on the theory and methodology used in EPA's BEN computer model (as revised, July, 1990).

In order to make P-BEN as "user-friendly" as possible, this guidance document avoids use of economic jargon. This should not undermine the economic integrity of the method. Similarly, in order to facilitate a manual economic benefit calculation, certain simplifications of the BEN calculation methodology were necessary. In some circumstances these simplifications may result in an economic benefit calculation which differs slightly from that of the BEN computer program.

EPA has revised the BEN computer model and will make that software available to POTWs, upon request, on floppy disks in early 1991. POTWs using software to calculate economic benefit will then be using precisely the same software program as EPA. POTWs which choose to calculate economic benefit manually should use the process identified in the manual enclosed here.

If you have questions about the P-BEN methodology or need assistance in explaining P-BEN to your constituent POTWs, please call Greg Marshall of the Policy Development Branch at (FTS) 382-7745.

Sincerely,

James R. Elder, Director
Office of Water Enforcement
and Permits

Enclosure

GUIDANCE MANUAL FOR POTWS TO CALCULATE THE ECONOMIC BENEFIT OF NONCOMPLIANCE

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DISCLAIMER

This Pretreatment Economic Benefits (P-BEN) guidance document was developed by the Office of Water Enforcement and Permits, U.S. Environmental Protection Agency, reviewed by the EPA Office of Enforcement, and approved for distribution.

This document provides a means of manually calculating the economic benefit an industrial user accrued by not complying with pretreatment standards and requirements on time. The P-BEN method closely approximates the U.S. Environmental Protection Agency's BEN computer program (as revised in July, 1990) for those cases in which pretreatment violations began in 1987 or later. The economic benefit value derived from the manual P-BEN method may differ slightly from that of the BEN computer program because of the simplified nature of the P-BEN calculation. The P-BEN method of calculating economic benefit should be used if the BEN computer program is unavailable. For those cases in which pretreatment violations occurred prior to 1987 (when new tax laws became effective) the BEN program must be used since the differences between the P-BEN results and the BEN program are likely to be more pronounced.

This guidance document is intended for the use of POTW enforcement personnel in estimating the economic benefit of noncompliance with pretreatment standards and requirements for purposes of calculating a settlement penalty. This guidance document creates no rights, is not binding on U.S. EPA, and EPA may change this guidance without notice. The mention of any trade names or commercial products constitutes neither an Agency endorsement nor recommendation for use.

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1. INTRODUCTION

1.1 PURPOSE OF THIS MANUAL

This manual provides guidance to municipalities in determining the amount of "economic benefit" a firm is expected to have gained by delaying compliance with pretreatment requirements. The methodology presented here for calculating economic benefit is a simplified, step-by-step manual version of U.S. Environmental Protection Agency's (EPA) BEN computer program.[1]

This guidance is consistent with EPA's Clean Water Act Penalty Policy for Civil Settlement Negotiations (February, 1986) and tracks closely the methodology for calculating economic benefit using the BEN computer program. EPA strives to obtain settlement penalties for Clean Water Act violations that remove, at a minimum, the economic benefit to an industrial user by it's noncompliance. An additional monetary amount reflecting the seriousness or gravity of the violations is also sought. Consistent national application of this policy will ensure that all members of the regulated community have a strong economic incentive to comply in a timely manner with environmental laws. Thus, U.S. EPA urges all municipalities, especially those with an approved pretreatment program, to calculate an industrial user's economic benefit of noncompliance with pretreatment standards and requirements and to use this amount, plus an additional amount which reflects the gravity of the violations, as the lowest acceptable settlement penalty.

1.2 ORGANIZATION OF THIS MANUAL

Chapter 1 of this guidance manual describes the economic benefit of noncompliance and discusses the importance of assessing penalties for pretreatment violations. Chapter 2 outlines the procedure to calculate economic benefit. Chapter 3 discusses other factors that the POTW may consider in determining an appropriate penalty amount. A glossary of terms and four appendices follow the main body of the text. Appendix A describes in some detail the technical method and financial principles used to calculate economic benefit. Appendix B contains a blank worksheet for the POTW to copy and use in calculating economic benefit. Appendix C contains annual inflation rates and discount rates, and Appendix D presents tables of discounting and/or adjustment factors to be used with the worksheet to calculate economic benefit.

1.3 WHAT IS ECONOMIC BENEFIT?

A firm must usually spend money to comply with pretreatment standards and requirements. The firm makes initial capital expenditures for pretreatment equipment or process changes and incurs subsequent operation, maintenance, and repair costs annually. By delaying or avoiding

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[1] See BEN: A Model to Calculate the Economic Benefit of Noncompliance, User's Manual, U.S. Environmental Protection Agency, Office of Enforcement, Revised July 1990. A copy of the BEN manual may be obtained from the National Technical Information Service (NTIS) by calling (703) 487-4650. A copy of the BEN software program on a floppy disk, for use in an IBM compatible personal computer, should be available in 1991.

these costs, the firm realizes an economic advantage or benefit over a competitor which complied with pretreatment requirements on time. Thus, the "economic benefit" of noncompliance is defined as the difference between the costs of on-time compliance and delayed compliance. Economic benefits realized by the firm which fails to comply by a required deadline can be measured by:

- The money that the firm would expect to earn by delaying the purchase of pretreatment equipment and investing the money in more profitable projects.
- The annual costs that the firm avoids, and the expected return on avoided costs during the period of noncompliance.
- Any competitive advantage the firm may gain, such as increased market share over competitors already in compliance, because of cost advantages attributed to delayed compliance.

In this guidance manual, the economic benefit calculation is focused on the first two benefits. The calculation does not attempt to address the third benefit, which is generally of a market-specific nature and not conducive to individual firm modelling.[2]

1.4 PURPOSE OF PENALTIES IN PRETREATMENT ENFORCEMENT

Municipalities need to assess penalties against industrial violators for several purposes, including:

- To remove the economic benefit a firm gains over others by not complying.
- To deter future noncompliance by providing an incentive for users to remain in compliance (that is, to avoid costly financial sanctions).
- To provide fair and equitable treatment to all members of the regulated community.
- To promote swift and consistent resolution of environmental problems
- To maintain compliance, and

[2] For many violators, removing the economic benefit realized from delaying compliance will negate any competitive advantage that the firm gained from its noncompliance. However, in some cases, the violator may have gained additional advantage during the period of noncompliance by improving its market share of goods and services as a result of cost savings. This "benefit from competitive advantage" is not actually a cost savings of noncompliance; rather, it is additional revenue gained through noncompliance. No attempt is made here to describe the calculation of the benefit from competitive advantage. Such a calculation requires estimating profits from transactions that may not have occurred had the firm complied. Such an estimate must be based on a detailed economic evaluation of the firm and its competitors, rather than on a generic formula.

To recover for damages to public facilities and/or natural resources.

Each of these purposes is discussed briefly in the following subsections.

1.4.1 To Remove Economic Benefits of Noncompliance

A firm which fails to comply with pretreatment requirements in a timely manner may accrue a significant economic benefit. A penalty assessed against the violator should at least "take away" this economic benefit and make it unprofitable for the firm to ignore or violate pretreatment requirements. These requirements include installation of pretreatment equipment, one-time expenditures (e.g. land) and operation and maintenance (O&M) or other annual costs. The economic benefit calculation described in this guidance manual can be applied to any or all types of pollution control costs. For example, the economic benefit calculation for a firm which failed to install pretreatment equipment altogether will be based on capital and annual costs. On the other hand, if a firm installed pretreatment equipment but failed to adequately operate and maintain such equipment, the economic benefit would be based on the annual cost elements of the calculation.

1.4.2 To Deter Future Noncompliance

The intent of penalties is to deter noncompliance so that pollutant discharges by industry do not have significant negative impacts on sewage treatment plants, collection systems or receiving waters. If the POTW assesses a penalty that is too small (that is, less than the economic benefit from noncomplying), the violating firm and other firms may determine that noncompliance is less expensive than compliance. Therefore, to be effective in deterring future noncompliance, penalties must make noncompliance more costly than compliance.

1.4.3 To Provide Fair and Equitable Treatment

Treating all users fairly and equitably requires that the POTW assess penalties using a consistent methodology. Allowing one firm to realize an economic benefit from noncompliance potentially enables it to gain an economic advantage over complying firms. By assessing a penalty based on economic benefit, the POTW strives to eliminate or remove any financial advantage the violator gains.

By exercising a consistent penalty methodology, the POTW ensures that all violators are treated equitably. While the amount of the penalty will vary from case to case, the method used to develop the penalty should be consistent. As each POTW implements a uniform penalty policy, including removal of economic benefit, nationwide consistency will increase. Such consistency will reduce the possibility that firms can evade pretreatment costs by relocating to areas where pretreatment requirements might otherwise have been more lax. EPA is working to ensure that the Clean Water Act Penalty Policy is consistently applied by municipalities throughout the country to provide fair and equitable treatment of industry.

1.4.4 To Promote Swift and Consistent Resolution of Environmental Problems

A consistent and logical basis for establishing civil penalties helps to promote swift resolution of environmental problems. When the regulated community understands the penalty policy and is capable of estimating potential penalties itself, the imposition of civil penalties appears predictable and challenges claiming the penalty to be arbitrary are reduced.

1.4.5 To Maintain Compliance

After a firm installs the appropriate pollution control equipment to comply with applicable pretreatment regulations, maintaining compliance requires continuing O&M and other annual expenditures. For industrial users which fail to comply with pretreatment requirements, the POTW should design its penalties to remove, at a minimum, the economic benefit from avoided annual costs during its period of violation. Assessing a penalty which, at a minimum, eliminates the economic benefit of noncompliance (or makes noncompliance more expensive than compliance) encourages firms to remain in compliance.

1.4.6 To Recover for Damages to Public Facilities and/or Natural Resources

Failure to comply with pretreatment requirements may cause damage to the collection system and POTW serving the violating firm. Damage may also be caused to the natural environment. Therefore, an additional purpose of penalties in pretreatment enforcement might be to recover for such damages. Specifically, the POTW might conclude that a violating firm should pay for reparations to any damages caused to the collection system by improper disposal of pollutants. Such a firm might pay for replacement of equipment, facilities and/or other damaged processes at the POTW caused by pollutant interference. Pollutants which pass through or interfered with POTW processes, may cause damage to natural systems in receiving waters. In addition to assessing penalties to recover for such damages, the POTW may consider requiring mitigation and remediation programs.

2. PROCEDURE TO CALCULATE ECONOMIC BENEFIT

This chapter presents step-by-step instructions to calculate the economic benefit a firm may have obtained by its failure to comply with pretreatment requirements in a timely manner. This procedure involves the following six steps:

- Step A - Provide general information on violator
- Step B - Compile appropriate financial factors
- Step C - Obtain engineering cost estimates
- Step D - Calculate the cost of on-time compliance as of the base-year
- Step E - Calculate the cost of delayed compliance as of the base-year
- Step F - Calculate the net economic benefit.

For the POTW's convenience, an Economic Benefit Worksheet with these six steps has been developed on which the economic benefit component of a civil settlement penalty can be calculated. (Appendix B contains a blank copy of the Economic Benefit Worksheet which can be copied for POTW use.) Each section of the Worksheet builds on the information in sections preceding it. For example, in Steps A, B, and C, factors are developed that will be used in estimating the economic benefits of noncompliance as described in Steps D through F. Each line on the Worksheet is labeled in the right-hand column (e.g. "A1" refers to the first line of Step A). These labels are used as cross-references on subsequent sections of the Worksheet so that the POTW staff member can quickly find the data needed to complete the Worksheet.

This chapter explains the procedures used to perform each step of the analysis. To illustrate the procedure more fully, the steps are explained using an example case of XYZ Manufacturers, Inc., a violating firm discharging into the POTW in Anytown, USA. Figure 2-1 is the Economic Benefit Worksheet completed for the hypothetical situation of XYZ Manufacturers, Inc (see page 2-11). For a more detailed explanation of the economic benefit methodology, refer to Appendix A. Note that each step builds on previous steps. For example, Step C converts all pollution control expenditures to base-year (year of noncompliance, see Section 2.3.1) dollars which are then used throughout the rest of the calculation. To arrive at a net economic benefit figure at the penalty payment date, Step F serves to convert the net economic benefit as of the noncompliance date to the appropriate amount as of the penalty payment date.

2.1 STEP A - PROVIDE GENERAL INFORMATION

The economic benefit calculation begins with Step A of the Worksheet (General Information) wherein the violator is identified and the time period during which the violator received an economic benefit is established. The key dates in this section are used later in the calculation.

- *Case name* - **On Line A01, the industrial violator's name or another appropriate identifier is entered.** In Figure 2-1, the case name is our example violator, XYZ Manufacturers, Inc.

- *Date when noncompliance began* - **On Line A02, the month and year when the violator first failed to comply with pretreatment requirements are entered.** This date (the base-year) is used later for calculations in Step C of the Worksheet. In our example, XYZ Manufacturers, Inc. began noncompliance in August 1987.

- *Date of compliance* - **On Line A03, the month and year that the violator achieved compliance are entered.** This is the date on which the violator's pretreatment equipment is operating and achieving compliance. In our example, XYZ Manufacturers, Inc. achieved compliance in October 1989.

- *Penalty payment date* - **On Line A04, the month and year that the industry is expected to pay its penalty are entered.** The penalty payment date is used in Step F in calculating the net economic benefit component of the civil penalty to be paid. In our example, XYZ Manufacturers, Inc. is scheduled to pay its penalty in January 1990.

- *Number of months of noncompliance* - **On Line A05, the number of months that the violator was out of compliance (its period of noncompliance) is entered.** This number is obtained by counting the number of months between the date when noncompliance began (Line A02) and the date when compliance was achieved (Line A03). It is used in Step E to take into account the delay in compliance by the violator. For example, XYZ Manufacturers, Inc. was out of compliance for 2 years and 2 months or 26 months.

- *Number of months between noncompliance and payment* - **On Line A06, the number of months between the noncompliance date and the scheduled payment date is entered.** This number is obtained by again subtracting Line A02 (date when noncompliance began) from the scheduled payment date (Line A04). The number is used in Step F when the actual net economic benefit amount is calculated. For XYZ Manufacturers, Inc., this value is 2 years and 5 months or 29 months.

2.2 STEP B - COMPILE FINANCIAL FACTORS

In Step B, three financial values -- the marginal tax rate, the annual inflation rate, and the discount rate -- are determined. These values, which are defined below, are used in Steps C, D and E to calculate the economic benefit derived from noncompliance.

2.2.1 Marginal Tax Rate

The marginal tax rate reflects the amount of money a firm must pay to Federal, State, and local tax authorities on the last dollar of its income.[1] Costs incurred as a result of installing and operating pretreatment equipment are deducted from, and therefore lower, a firm's taxable income. Thus, the actual "out of pocket" expenditures for pretreatment are reduced by this tax savings. Based on current tax laws, the average marginal corporate tax rate, including typical marginal state taxes, is 38.4 percent.[2] For not-for-profit organizations, the tax rate is zero.

On Line B01, the tax rate for the violator is entered. For XYZ Manufacturers, Inc., the marginal tax rate of 38.4 percent is used. This value should generally be used for calculating the economic benefit to industrial facilities. The marginal tax rate is used later in Step D.

2.2.2 Annual Inflation Rate

The annual inflation rate is a measure of the increase in the price of goods and services over time. Because inflation reduces the purchasing power of money (that is, the same amount of money buys fewer goods and services) over time, the annual inflation rate is used to adjust and compare costs occurring in different years. Numerous indices are available to quantify inflation rates. Cost indices appropriate for estimating the inflation rate for pretreatment equipment are:

- Plant Cost Index, published in Chemical Engineering magazine
- Construction Cost Index, published in Engineering News Record magazine
- POTW cost indices, published by EPA's Office of Municipal Pollution Control.

While the Consumer Price Index (CPI) is frequently used in measuring inflation, it covers a broad range of consumer products (such as food and housing) and therefore is not appropriate for estimating specific changes in the price of a homogeneous product such as pretreatment equipment.

The annual average inflation rate during the past five years is recorded on Line B02. This value is derived by averaging the annual inflation rates for the past five years. To simplify further calculations, the average annual inflation is rounded off to the nearest one-half or full percent. For the example, the annual inflation rates for the years 1985 through 1989 (from Appendix C-1) are added and divided by five, resulting in the average annual inflation rate of two percent. Annual inflation rates for 1980 through 1989 based on Chemical Engineering's annual Plant Cost Index can be found in Appendix C-1. The annual average inflation rate is used in Steps C, D, and E.

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[1] Note that this is different than the "average" tax rate that a firm pays, which measures total taxes paid relative to total taxable income.

[2] The federal marginal rate is 34% and the average state marginal tax rate is 4.4%. Summing these two numbers yields the average marginal corporate tax rate of 38.4%.

2.2.3 Discount Rate

Money has a "time value" associated with it. This time value of money means that a dollar today is generally worth more than a dollar a year from now because today's dollar can be invested to earn a return over the coming year. For example, if the firm delays a $100 purchase of pretreatment equipment and invests that $100 available today in a variety of investments, with an expected average annual return of 15 percent, one year from today the firm will have $115. Therefore, equal dollar expenditures occurring in different years do not have equal financial value impacts on the violator. Simply stated, $100 spent today, the "present value", is not equivalent to an expenditure of $100 a year from now. (In this example, $100 today is equivalent to $115 a year from now.) When comparing dollar amounts or expenditures from two different years, a common standard must be employed, namely expressing the dollar amounts in the same "year dollars." The technique of converting dollar values to a common year is called discounting.

For this economic benefit calculation, the discount rate is based on the average return that a corporation expects to earn and deliver to its investors. In Lines B03 through B05, the discount rate is determined in a two-step process. **On Line B03, the annual rate of return (i.e., the yields) on a 30-year Treasury Bond for each of the past 5 years is entered and the average (the sum of the values divided by 5) is calculated.** Annual average rates of return on 30-year Treasury bonds purchased between 1980 and 1989 are found in Appendix C-2. For XYZ Manufacturers, Inc., the annual average rate of return from 1985 to 1989 (from Appendix C-2) are entered, added, and divided by 5 to yield an annual average rate of 8.9 percent.

A risk premium rate is entered on Line B04. The risk premium rate attempts to reflect the intrinsic level of risk associated with investing in a given industry group. Since a higher rate of return is expected from an investment in private business compared to a risk-free investment (such as a bank certificate of deposit), the investor needs to be compensated for the investment's uncertainty. This extra compensation is called the risk premium rate. For the pretreatment economic benefit calculation, the long-term (1926-1989) average equity risk premium rate of 7.5 percent is used.[3]

The discount rate in Line B05 is derived by adding Line B03 (the annual average rate of return on 30-year Treasury bonds) and Line B04 (the risk premium rate). This number, expressed as a percentage, is entered on Line B05. As with the annual average inflation rate, the discount rate should be rounded to the nearest one-half or full percent. This rate is used later in Steps D, E, and F. The discount rate is rounded off to 16.5 percent for XYZ Manufacturers, Inc.

2.3 STEP C - OBTAIN ENGINEERING COST ESTIMATES

In Step C, the POTW obtains engineering cost estimates, such as initial capital investment costs, other "one-time" capital expenditures, and annual costs. These estimates are then converted to base-year dollars as described in Section 2.3.1 below. Relevant terms for this Step are briefly defined below.

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[3] Stocks, Bonds, Bills and Inflation: 1990 Yearbook, Ibbotson Associates (Chicago, 1990), p. 121.

- ***Initial capital investment costs*** - Up-front expenditures for all depreciable assets. Depreciable assets are those which, through time or normal wear and tear, will require replacement or renewal. These will include costs associated with architectural and engineering design, site preparation, construction, and machinery and equipment. Costs of installing equipment are included here, as are all sales taxes paid on the equipment.

- ***One-time expenditures*** - Nondepreciable costs incurred upon implementation of pretreatment but not again thereafter. Such expenditures might include land purchases or setting up a record keeping system. These costs will not be incurred again when capital equipment is replaced.

- ***Annual costs*** - Costs incurred every year to operate and maintain the pretreatment system when the company comes into compliance, including the costs of labor, utilities, chemicals, materials, and repairs. Annual costs could also include costs of leasing equipment or user fees.

Dollar estimates for these costs can be obtained from various sources, including actual bids received by the firm, price quotes from equipment manufacturers, and EPA publications (such as the development documents for effluent guidelines available from the Industrial Technology Division). **The estimated costs of the initial capital investments in pretreatment equipment, one-time expenditures, and annual costs are entered in Lines C01, C06, and C11, respectively.** In this example, POTW personnel estimate that pretreatment equipment needed by XYZ Manufacturers, Inc. will cost $110,000 in 1988 dollars (Line C01), that one-time expenditures will cost $30,000 in 1989 dollars (Line C06), and the annual costs will run $25,000 annually in 1988 dollars (Line C11).

2.3.1 Adjusting for Inflation

In the simplest of situations, the total engineering cost estimate equals the sum of initial capital investment cost plus other one-time expenditures plus annual costs (Lines C01 + C06 + C11). However, in those cases where the cost estimates for the various engineering cost components are expressed in different "year-dollars", adjustments to the cost estimates in Lines C01, C06, and C11 are necessary to account for the effect of inflation. **In order to make this adjustment, the appropriate year-dollars for these three cost components are first entered on Lines C02, C07, and C12.** For example, in collecting cost estimates necessary to develop an economic benefit calculation for XYZ Manufacturers, Inc.'s period of noncompliance, the POTW obtained initial capital investment costs and annual costs in 1988 year-dollars and one time expenditures in 1989 year-dollars. In this example, 1988 is entered on Lines C02 and C12, and 1989 is entered in Line C07.

The goal of this exercise is to "normalize", as of the noncompliance year, 1987, the various year-dollar costs (in this case, 1988 and 1989) by taking into account the impacts of inflation on the purchasing power of money. This is accomplished by converting all year dollar estimates into base-year dollars. **The base-year selected should be the year in which noncompliance began as recorded in Line A02.** In this example, XYZ Manufacturers, Inc. became noncompliant in 1987. Therefore, the capital investment costs and annual costs must be converted from 1988 year-dollars to 1987 base-year dollars, and the one-time capital expenditures must be converted

from 1989 year-dollars to 1987 dollars. This conversion to base-year dollars is accomplished by dividing the estimated costs by what is known as the "inflation adjustment factor".

The correct inflation adjustment factor is found using two easily derived numbers. The first number is the difference between the year-dollars and the appropriate base-year. The resulting difference is known as the "adjustment period." **The adjustment periods for initial capital investments, one-time expenditures, and annual costs are entered into Lines C03, C08, and C13, respectively.** For example, in our XYZ Manufacturers, Inc. case, the difference between 1989, the year-dollars in which one-time capital expenditures were expressed, and 1987, the base-year, is two years (1989 minus 1987 equals 2).

The second number needed to identify the appropriate inflation adjustment factor is the average annual inflation rate. Step B discussed how to obtain the average annual inflation rate which is recorded on Line B02. Using the calculated average annual inflation rate and the adjustment factor, the inflation adjustment factor can be found in Appendix D-1. **These factors for the initial capital investment cost, one-time expenditures, and annual costs are entered into Lines C04, C09, and C14 of the Economic Benefit Worksheet, respectively.** Using Appendix D-1 for our one-time expenditures example, a 2-year period and 2 percent inflation rate yields an inflation adjustment factor of 1.040 percent. This value is entered on Line C09.

The costs recorded in Lines C01, C06, and C11 can now be readily converted into base-year dollars by dividing them by the relevant inflation adjustment factors recorded in Lines C04, C09, and C14. The costs in **base-year dollars are entered in Lines C05, C10, and C15.** Using the inflation adjustment factors in the case example, the initial capital investment in base-year dollars is $107,843; the one-time expenditures in base-year dollars is $28,846; and annual costs in base-year dollars are $24,510.

2.3.2 Useful Life of Equipment

The last information entered in Step C is the useful life of the pretreatment equipment. This is the number of years that the equipment is expected to stay in operation before it must be replaced. EPA generally estimates the average useful life of pollution control equipment to be 15 years; however, for specific cases, this estimate may be higher or lower. For example, pumps and other mechanical equipment may need to be replaced every 5 years, while buried pipes often last for 40 years or more. **The average useful life of all equipment required for compliance is entered on Line C16.** In the example, EPA's standard value of 15 years is used.

2.4 STEP D - CALCULATE ESTIMATED COST OF ON-TIME COMPLIANCE

Step D calculates the cost of "on-time" compliance. This is the cost that the violating firm would have incurred had it complied with all applicable pretreatment requirements within the prescribed time frame. In order to calculate the cost of on-time compliance, the POTW needs to know or estimate the violator's initial investment costs for the pretreatment equipment, other one-time expenditures, annual costs, and costs to replace the equipment when it wears out or breaks down. Thus, the engineering cost estimates from Step C are important inputs to the calculations performed in this step.

One new factor is introduced in Step D -- depreciation tax savings. These tax savings accrue to the firm over the depreciable life of the pretreatment equipment to reflect its wear and tear.[4] In order to appropriately add or subtract the costs developed in this step, all costs are adjusted to base-year dollars. The following discussion of Step D is organized into five subsections corresponding to the five substeps in Step D:

- Initial investment
- Depreciation tax savings
- Annual costs
- Cost of all subsequent equipment replacements
- Total cost of on-time compliance.

Procedures for performing each substep are detailed below.

2.4.1 Initial Investment

Determining the "first cycle" initial investment in pretreatment equipment requires taking the initial capital investment (expressed in base-year dollars) from Line C05 and the one-time expenditures (also expressed in base-year dollars) from Line C10 and entering them in Lines D01 and D02, respectively. In the example, the amount of $107,843 is recorded in Line D01 and the amount of $28,846 is recorded in Line D02. If the one-time expenditures are tax-deductible, an adjustment is necessary to take into account the after-tax cost of these expenditures.[5] To calculate the tax savings from making one-time expenditures (that is, the reduction in income tax due to a decrease in taxable income that results from the deductible expense), multiply Line D02 by the marginal tax rate (0.384, which is the same as 38.4%), which appears in Line B01. The result, a tax savings, is entered in Line D03. In our example case, the total tax savings amounts to $11,077. Subtracting the tax savings (recorded in Line D03) from the one-time expenditure in base-year dollars (recorded in Line D02) yields after-tax one-time expenditures of $17,769. The total cost of investment, as of the base-year, is then found by adding together the initial capital investment and after tax one-time expenditures (adding Lines D01 and D04 to yield Line D05). For XYZ Manufacturer, Inc., the total base-year (1987) cost of initial pretreatment equipment is $125,612.

2.4.2 Depreciation Tax Savings

In the second part of Step D, tax savings from annual depreciation (that is, the yearly decrease in the value of the pretreatment equipment due to wear, deterioration, or obsolescence)

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[4] Depreciation is how companies can deduct the costs of equipment or other long-lived assets against their taxable income. The tax code does not permit a company to deduct the full cost of equipment or other assets in a single year.

[5] Almost all one-time expenditures will be tax-deductible. The primary exception is the purchase of land which is a non-depreciable asset.

are calculated. This is a savings that accrues to the company in the form of reduced taxes as it deducts the depreciation of capital investments from its taxable income.

The pretreatment economic benefit model (P-BEN) uses what is termed a "straight line" depreciation method to keep deductions for annual depreciation constant. (This is consistent with tax code requirements for 1987 and later; Appendix A explains this assumption in detail.) The equipment is fully depreciated over a seven-year period although its useful life may be much longer. **The standard depreciation period of seven years is recorded in Line D06. The annual depreciation is calculated on Line D07 and is the initial capital investment (Line D01) divided by the depreciation period (Line D06).** In this example, $107,843 divided by 7 yields $15,406. **The annual tax savings is then derived on Line D08 as the product of the annual depreciation (Line D07) and the marginal tax rate (0.384; Line B01).** In our example, the result is $5,916.

Lines D09 through D11 calculate the projected annual tax savings accrued to the facility over a 7-year depreciation period. **The depreciation tax savings discount rate is equal to the discount rate recorded in Line B05. The value in Line B05 is entered in Line D09.** In our example, 16.5 percent (Line B05) is entered on Line D09.

In Line D10, the discounting factor is found using Appendix D-2. Finding the appropriate discounting factor in Appendix D-2 requires two numbers: the number of years in the depreciation period and the depreciation tax savings discount rate. These are recorded in Lines D06 and D09, respectively. **The discounting factor, taken from Appendix D-2, is entered in Line D10.** In our example, the depreciation period of 7 years is used with the discount rate of 16.5 to obtain the discounting factor of 3.980.

In Line D11, the base-year value of tax savings is found by multiplying the annual tax savings (Line D08) by the discounting factor (Line D10). In this example, the tax savings as of the base-year is $23,546.

2.4.3 Annual Costs

Lines D12 through D17 calculate the after-tax costs of annual expenditures as of the base-year. **In Line D12, the before-tax annual cost (in base-year dollars) from Line C15 is entered. In order to calculate the after-tax annual costs (Line D13), Line D12 is multiplied by 0.616 (which is one minus the marginal tax rate of 0.384).** In our example, the result is entered in Line D13 as $15,098 ($24,510 multiplied by 0.616).

Line D14 is the useful life of pretreatment equipment expressed in years. This was previously recorded in Line C16.

Line D15 adjusts the discount rate to remove the effect of inflation.[6] **Line D15 is calculated by subtracting the annual inflation rate (Line B02) from the discount rate (Line B05).** In this example, 16.5 percent minus 2 percent equals 14.5 percent, which is entered on Line D15. **The next item (Line D16) is derived from the table of calculated values in Appendix D-2. Two numbers are needed, (1) the expected life of the pretreatment**

[6] The associated calculations are performed in "real-dollars".

equipment (from Line D14) and (2) the inflation adjusted discount rate (Line D15). In this case, the estimated life of 15 years and the inflation adjusted discount rate of 14.5 percent result in a discounting factor of 5.992. In Line D17, the discounting factor found in Line D16 is multiplied by the after-tax annual costs (Line D13) to yield the after-tax annual costs as of the base-year. In the example, the amount is $90,467 ($15,098 multiplied by 5.992).

2.4.4 Cost of All Subsequent Equipment Replacements

The fourth part of Step D is used to calculate the costs to replace required pretreatment equipment after its useful life is over. The costs of this "second cycle" of equipment are generally similar to initial investment costs, except that the initial one-time expenditures are not incurred. Consequently, most of the information to be recorded in this part is taken from earlier parts of the Worksheet.

Lines D18 through D20 (capital investment, depreciation tax savings, and annual costs) are drawn directly from Lines D01, D11, and D17. Line D21 is calculated by adding Lines D18 and D20 and subtracting Line D19. In our example, these lines total $174,764.

Line D22, the inflation adjusted discount rate, and D23, life of equipment, are drawn from Lines D15 and C16, respectively. The discounting factor is taken from Appendix D-3 using the data provided in Lines D22 and D23. The resulting discounting factor is recorded in Line D24. In this example, the inflation adjusted discount rate of 14.5 and the equipment life of 15 years yield a discounting factor of 0.151. The discounting factor recorded in Line D24 is then multiplied by the value recorded in D21 to obtain the cost of all subsequent equipment replacements as of the base-year. This value appears in Line D25. In the example of XYZ Manufacturers, Inc., the cost of all subsequent equipment replacements is $26,389.

2.4.5 Total Cost of On-Time Compliance

To complete Step D, the total cost of on-time compliance as of the base-year is calculated by adding together all discounted compliance costs not incurred and subtracting tax savings not realized. This value is obtained by subtracting the value of tax savings (Line D11) from the total investment costs (Line D05), and then adding the after-tax annual costs (Line D17), and all subsequent equipment replacement costs (Line D25). The result is presented in Line D26. For XYZ Manufacturers, the total cost of on-time compliance as of the base-year is $218,922.

2.5 STEP E - CALCULATE COST OF DELAYED COMPLIANCE

Step E calculates the cost that the firm incurs upon installing pretreatment equipment after delaying compliance. This cost, expressed as a base-year value, is lower than the cost of on-time compliance because, by not complying on time, the violator gains two economic benefits. First, during the period of noncompliance, the money required for purchasing the necessary pretreatment equipment can be invested by the violator to earn a rate of return (that is, interest). Second, the firm avoids annual costs during the delay and these funds can also be invested by the violator to

earn a rate of return. These financial gains are accounted for in the simple procedures explained below.

- ***Number of months of noncompliance*** - This value, previously determined in Step A, is found on Line A05. **The value from Line A05 is entered on Line E01.** The number of months of noncompliance for XYZ Manufacturers, Inc. is 26 months.

- ***Inflation adjusted discount rate*** - This value was previously calculated from two previous values in Step B, namely the annual average inflation rate on Line B02 and the discount rate on Line B05. **The result of that calculation appears in Line D15.** This value entered on Line E02. The inflation adjusted discount rate for XYZ Manufacturers, Inc. is 14.5 percent.

- ***Discount factor (for delayed compliance)*** - **The discount factor for delayed compliance, entered on Line E03, is obtained from Appendix D-4 using the values in Lines E01 and E02.** For XYZ Manufacturers, Inc., the discount factor for the 26-month delay (August 1987 to October 1989) at a 14.5 percent discount rate is 0.746.

- ***Cost of delayed compliance as of the base-year*** - **The cost of delayed compliance as of the base-year is determined by multiplying the total cost of on-time compliance (Line D26) by the discount factor on Line E03. This cost of delayed compliance, expressed as a base-year value, is entered on Line E04.** For XYZ Manufacturers, Inc., the cost of delayed compliance is $163,316.

2.6 STEP F - CALCULATE NET ECONOMIC BENEFIT

Step F of the procedure is organized into two parts. The first part (Lines F01 to F03) calculates the economic benefit of noncompliance, as of the base-year, to the violator. The second part (Lines F04 to F07) calculates the net economic benefit as of the penalty payment date. This value is larger than the economic benefit as of the base-year because the violator has had an opportunity to invest the benefit since the base-year.

As defined earlier, the economic benefit of noncompliance is the difference between the costs of on-time and delayed compliance. To determine the economic benefit to the violating firm from its noncompliance, the POTW uses the following three values:

- ***Cost of on-time compliance*** - This value, calculated previously in Step D, is found on Line D26. **It is entered on Line F01.** For XYZ Manufacturers, Inc., the base-year cost of on-time compliance is $218,922.

- ***Cost of delayed compliance*** - This value was also calculated previously, in Step E (Line E04). **The number from Line E04 is entered on Line F02.** The base-year cost of delayed compliance to our example violator, XYZ, Manufacturers, Inc., is $163,316.

- ***Economic benefit*** as of noncompliance date - **This value is obtained by subtracting Line F02 from Line F01. The difference is entered on Line F03.** In the example, this value is $55,606.

Since the civil penalty amount will probably not be paid in the same year that noncompliance began, the economic benefit expressed as a base-year value on Line E03 must be adjusted to account for inflation and the return the violator earned on the economic benefit. This adjustment allows the economic benefit amount to be expressed in the appropriate year dollars (that is, if the penalty is to be paid in 1990, the economic benefit must be adjusted to 1990 dollars). Lines F04 through F07 perform this calculation.

- ***Number of months of noncompliance before payment*** - This value was calculated in Line A06 of Step A. **The value is entered on Line F04.** For our hypothetical case, XYZ Manufacturers, Inc. will be in noncompliance 29 months before the firm pays its penalty.

- ***Discount rate*** - This value was calculated in Step B, Line B05. **The value is entered on Line F05.** In our example, the discount rate used is 16.5 percent.

- ***Adjustment factor*** - **The adjustment factor, entered on Line F06, is obtained from Appendix D-4 using the values in Lines F04 and F05.** In the example, this value is 0.691.

- ***Economic benefit amount at payment date*** - **The penalty amount entered on Line F07 is obtained by dividing the economic benefit (expressed as a base-year value) on Line F03 by the adjustment factor on Line F06.** For XYZ Manufacturers, Inc., the economic benefit value from the date of noncompliance in 1987 (the base-year) must be adjusted to its value on the date that the penalty is expected to be paid in 1990. Accounting for inflation and the return the violator has earned, the economic benefit of $55,606 as of 1987 becomes $80,472 in 1990. This figure represents that portion of the civil penalty that the Anytown POTW will assess against XYZ Manufacturers, Inc. to remove the economic benefit that this firm would have realized during its period of noncompliance from August 1987 to October 1989.

Figure 2-1

Economic Benefit Worksheet

A. General Information

1. Case name: XYZ MANUFACTURERS, INC.		A01
2. Date when noncompliance began (base-year)	8 / 87 month/year	A02
3. Date of compliance	10 / 89 month/year	A03
4. Penalty payment date	1 / 90 month/year	A04
5. Number of months of noncompliance (A03 - A02)	26	A05
6. Number of months of noncompliance before payment (A04 - A02)	29	A06

B. Financial Factors

1. Marginal tax rate	38.4%	B01

2. Annual inflation rate

Enter inflation rates for last five years (see App. C-1)

19 85	0.8 %
19 86	-2.1 %
19 87	1.7 %
19 88	5.8 %
19 89	3.8 %

Average annual inflation (sum of above values divided by 5)	2.0 %	B02

3. Discount rate

Enter average yields for last five years from App. C-2

19 85	10.8 %
19 86	7.8 %
19 87	8.6 %
19 88	9.0 %
19 89	8.5 %

a. Annual average yield (sum of above values divided by 5)	8.9 %	B03
b. Risk premium rate (standard value = 7.5%)	7.5%	B04
c. Discount rate (B03 + B04)	16.5 %	B05

KEY:

"-" = minus (e.g. "A03 - A02" means "A03 minus A02"); "+" = plus

"/" = divided by (e.g. "C01 / C04" means "C01 divided by C04"); "x" = multiplied by

C. Engineering Cost Estimates

1.	Initial capital investment in pretreatment equipment		
	a. Estimated costs	$ 110,000	C01
	b. Year-dollars for cost	1988	C02
	c. Adjustment period (A02 - C02)	1	C03
	d. Inflation adjustment factor (App. D-1 using B02 and C03)	1.02	C04
	e. Initial capital investment in base-year dollars (C01 / C04)	$ 107,843	C05
2.	One-time expenditures		
	a. Estimated costs	$ 30,000	C06
	b. Year-dollars for cost	1989	C07
	c. Adjustment period (A02 - C07)	2	C08
	d. Inflation adjustment factor (App. D-1 using B02 and C08)	1.04	C09
	e. One-time expenditures in base-year dollars (C06 / C09)	$ 28,846	C10
3.	Annual costs		
	a. Estimated costs	$ 25,000	C11
	b. Year-dollars for cost (calendar year)	1988	C12
	c. Adjustment period (A02 - C12)	1	C13
	d. Inflation adjustment factor (App. D-1 using B02 and C13)	1.02	C14
	e. Annual costs in base-year dollars (C11 / C14)	$ 24,510	C15
4.	Useful life of pretreatment equipment (number of years)	15	C16

D. Cost of On-Time Compliance

1.	Initial investment		
	a. Initial capital investment (C05)	$ 107,843	D01
	b. One-time expenditures (C10)	$ 28,846	D02
	c. Tax savings (D02 x B01)	$ 11,077	D03
	d. After-tax one-time expenditures (D02 - D03)	$ 17,769	D04
	e. Base-year value of total investment (D01 + D04)	$ 125,612	D05
2.	Depreciation tax savings		
	a. Depreciation period (years; standard value = 7 years)	7	D06
	b. Annual depreciation (D01 / D06)	$ 15,406	D07
	c. Annual tax savings (D07 x B01)	$ 5,516	D08
	d. Marginal tax rate (B05)	16.5 %	D09
	e. Discounting factor (App. D-2 using D06 and D09)	3.98	D10
	f. Base-year value of depreciation tax savings (D08 x D10)	$ 23,546	D11
3.	Annual costs		
	a. Before-tax annual costs (C15)	$ 24,510	D12
	b. After-tax annual costs (D12 x [1 - B01])	$ 15,098	D13
	c. Useful life of pretreatment equipment (C16)	15	D14
	d. Inflation adjusted discount rate (B05 - B02)	14.5 %	D15
	e. Discounting factor (App. D-2 using D14 and D15)	5.992	D16
	f. After-tax base-year value of annual costs (D13 x D16)	$ 90,467	D17

4. Base-year value of pretreatment replacement costs			
a. Initial capital investment (D01)	$ 107,843	D18
b. Value of depreciation tax savings (D11)	$ 23,546	D19
c. After tax value of annual costs (D17)	$ 90,467	D20
d. Value of second cycle costs (D18 - D19 + D20)	$ 174,764	D21
e. Inflation adjusted discount rate (D15)	14.5 %	D22
f. Useful life of pretreatment equipment (C16)	15	D23
g. Discounting factor (App. D-3 using D22 and D23)	0.151	D24
h. Base-year value of all pretreatment replacement costs (D21 x D24)	$ 26,922	D25
5. Total cost of on-time compliance (D05 - D11+D17+D25)	$ 218,922	D26

E. Cost of Delayed Compliance

1. Discount factor (for delayed compliance)		
a. Number of months of noncompliance (A05)	26	E01
b. Inflation adjusted discount rate (B15)	14.5 %	E02
c. Discount factor (App. D-4 using E01 and E02)	0.746	E03
2. Cost of delayed compliance as of base-year (D26 x E03)	$ 163,316	E04

F. Net Economic Benefit

1. Economic benefit as of base-year		
a. Cost of on-time compliance in base-year values (D26)	$ 218,922	F01
b. Cost of delayed compliance in base-year values (E04)	$ 163,316	F02
c. Net economic benefit as of base-year (F01 - F02)	$ 55,606	F03
2. Economic benefit as of penalty payment date		
a. Number of months of noncompliance before payment (A06)	29	F04
b. Discount rate (B05)	16.5 %	F05
c. Adjustment factor (App. D-4 using F04 and F05)	0.691	F06
d. Economic benefit at penalty payment date (F03 / F06)	$ 80,472	F07

3. OTHER CONSIDERATIONS IN DEVELOPING A SETTLEMENT PENALTY

The preceding chapter explained how to calculate economic benefit to determine the minimum penalty that must be recovered to offset the costs saved by the violator for noncompliance. The POTW should consider the following four additional factors to determine the total penalty that should be collected in any settlement:

- Gravity of the violation
- Adjustment factors (including compliance history and ability to pay)
- Amounts previously paid
- Benefit from competitive advantage.

These factors are discretionary and usually determined on a case-by-case basis. While each of these factors is discussed below, specific information is not provided in this manual on how they should be included in the penalty calculation. For futher guidance on this topic refer to EPA's Pretreatment Compliance Monitoring and Enforcement Guidance (September 1987) and its Guidance for Developing Control Authority Enforcement Response Plans (September 1989).

3.1 GRAVITY OF THE VIOLATION

Consideration of the gravity of a violation is important when determining the penalty amount. Removing the economic benefit of noncompliance only places the violating industry in the position it would have been had it complied on time. Both deterrence and fundamental fairness require that the penalty include an additional amount to ensure that noncompliance is more costly than compliance. In order to achieve these objectives of deterrence and fairness, the EPA uses the following five factors in determining the gravity or seriousness of violations: 1) the significance of the violation; 2) potential or actual health and environmental harm caused by the violation; 3) the number of violations; 4) the duration of noncompliance; and 5) the significance of non-effluent violations. Each of these is discussed below. The POTW should consider using similar criteria in developing an appropriate gravity component of the settlement penalty. For more information on developing the gravity component of a settlement penalty refer to U.S. EPA's Clean Water Act (Penalty) Policy for civil settlement negotiations.

3.1.1 Significance of the Violation

EPA recently defined "significant noncompliance" in its revisions to the General Pretreatment Regulations (see 55 Federal Register 30082) as violations which meet one or more of the following criteria:

- Violations of wastewater discharge limit
  - Chronic violations are those in which sixty-six percent or more of all of the measurements (of monitored parameters) taken during a six-month period exceed (by

any magnitude) the daily maximum limit or the average limit for the same pollutant parameter.

- Technical Review Criteria (TRC) violations are those in which thirty-three percent or more of all the measurements for each pollutant parameter taken during a six-month period equal or exceed the product of the daily average maximum limit or the average limit times the applicable TRC (TRC = 1.4 for BOD, TSS, fats, oil, and grease, and 1.2 for all other pollutants except pH).

- Any other violation of a pretreatment effluent limit (daily maximum or longer-term average) that the POTW determines has caused, alone or in combination with other discharges, interference (e.g., slug loads) or pass-through (including endangering the health of POTW personnel or the general public).

- Any discharge of a pollutant that has caused imminent endangerment to human health, welfare or to the environment or has resulted in the POTW's exercise of its emergency authority to halt or prevent such a discharge.

- Violations of compliance schedule milestones contained in a local control mechanism or enforcement order for starting construction, completing construction, and attaining final compliance by 90 days or more after the scheduled date.

- Failure to provide reports for compliance schedules, self-monitoring data, or categorical standards [Baseline Monitoring Reports (BMRs), 90-day compliance reports, and periodic reports] within 30 days of the due date.

- Failure to accurately report noncompliance

- Any other violation or group of violations that the POTW determines will adversely affect the operation or implementation of the local pretreatment program.

In addition to assessing appropriate penalties commensurate with the factors listed above the POTW should consider assessing larger penalties in cases of repeat violations, including all violations of permit effluent limitations, monitoring and reporting requirements, and other standard and special discharge conditions. This consideration provides flexibility in assessing penalties for multiple violations.

3.1.2 Potential or Actual Health and Environmental Harm

The POTW should consider assessing higher penalties for violations resulting in actual or potential harm to the environment. Such potential environmental harm occurs whenever an industrial user discharges a pollutant into the sewer system that:

- Passes through the POTW inadequately treated and causes a violation of the POTW's National Pollutant Discharge Elimination System (NPDES) permit (including water quality standards).

- Has a potentially toxic effect on the receiving waters (for example, a fish kill).

Some violations may have negative impacts on the POTW itself. For example, such violations may result in significant increases in treatment costs, interfere or harm POTW personnel, equipment, processes, or operations, or cause sludge contamination, resulting in increased disposal costs. When a user's noncompliance harms the treatment plant, the POTW should assess a larger penalty.

3.1.3 Number of Violations

It is important to account for each violation in assessing the significance of industrial user noncompliance. Violations of average effluent limitations should be considered a violation for each day of the averaging period. Therefore, a monthly average violation should be counted as 30 days of violation, a weekly average violation as seven days of violation and a four day average (as used in Section 413 for Electroplating) should be counted as four violations. Violations of different parameters at the same outfall are counted separately, and violations at different outfalls or indirect discharge locations are counted separately. In short, the gravity penalty should increase as the number of violations increases.

3.1.4 Duration of Noncompliance

The POTW should consider increasing penalty amounts for continuing, long-term violations. Generally, a "long-term" violation is one that continues for three or more consecutive months. In turn, penalties should be higher for violations that have continued for three years than for violations that have only occurred for six months.

3.1.5 Significance of Non-effluent Limit Violations

This factor is used to address the most significant non-effluent violations in each month. Violations included in this category include failure to report, late reporting, schedule violations, failure to implement an approved pretreatment program, laboratory analysis deficiencies, unauthorized discharges, operation and maintenance deficiencies and sludge handling violations.

3.2 ADJUSTMENT FACTORS

Two "adjustment" factors should be considered by the POTW as it determines the appropriate settlement penalty for a violating firm. These factors are:

- Any history of recalcitrance by the firm
- The firm's ability to pay.

3.2.1 History of Recalcitrance by the Firm

The POTW should consider increasing the penalty amount when the violating firm appears to be acting in "bad faith" (that is, by not cooperating with the POTW in effecting a timely

correction of the violation); when the firm experiences unjustified delays in preventing, correcting, or mitigating violations; when the firm has already violated prior administrative orders, compliance agreements or consent decrees; or when the firm fails to provide timely and full information. This recalcitrance factor also may be increased during negotiations if the firm continues to resist efforts to settle.

3.2.2 Firm's Ability to Pay

When a firm demonstrates that it is unable to pay a settlement penalty, the POTW should independently evaluate the firm's ability to pay. Although the POTW typically should seek to settle for as high an amount as the firm can afford, when it is determined that the firm cannot afford to pay the penalty or that payment of all or part of the penalty will preclude the violator from achieving compliance, the POTW should consider other options. For example, the POTW may consider an installment payment plan with the firm paying interest. Only as a last recourse should the POTW consider reducing the penalty amount. If the firm's behavior has been exceptionally culpable, recalcitrant, or threatening to human health and the environment, inability to pay should be disregarded.

3.4 AMOUNTS PREVIOUSLY PAID

EPA can take an enforcement action against firms violating the Clean Water Act, including Federal pretreatment standards and regulations. Citizens or citizen groups can also bring civil suits against individual firms for violating environmental regulations. If the violating firm has been sued by EPA, a State regulatory agency, or citizens, and penalties were imposed upon it from these civil actions, the POTW may consider reducing the penalty by an amount equal to that which the firm already paid for the same violation.

GLOSSARY

TERM	DEFINITION
Annual Inflation	Annual rate at which the costs for goods and services increase over time.
Base-Year Dollars	Costs converted to the year of noncompliance to remove the effect of inflation on the purchasing power of money. See definition of "year-dollars" below.
Base-Year Value	Costs converted to the year of noncompliance to take into account the effect of inflation and return that the violator is expected to earn on its investments.
Cash Flows	Money flowing into and out of a firm over a period of years, including expenditures for pretreatment equipment, annual depreciation tax savings, and annual costs.
Capital Investment	Cost to purchase items, such as machinery and other equipment, that have a useful life of several years (3 to 40 years). Construction, engineering, design, and delivery costs are also included in capital investment costs. Capital investments are "depreciated" over a period of time to recover their costs. The cost of land is not included in this category because land is not depreciable.
Depreciation	Gradual decrease in the value of a capital investment through wear, deterioration, or obsolescence. The tax code permits firms to deduct depreciation from taxable income. The code establishes rigid formulae which spread the depreciation over a period of years and prescribe the amount to be deducted each year. The depreciation period for tax purposes is usually far less than the capital investment's "useful life" (see below).
Discount Rate	Rate used to convert subsequent (or "future" in economic vernacular) costs to earlier, constant year dollars.
Marginal Tax Rate	Maximum tax rate that an industry must pay on its taxable income. Since the cost of pretreatment equipment is a tax deductible expense and therefore reduces a firm's taxable income, the effect of taxes is to reduce the firm's net out-of-pocket costs for pollution control.

Present Value	Method for expressing cost and benefits occurring at different periods in time in equivalently valued dollars.
Risk Premium Rate	Incremental rate of return beyond riskless investments, such as U.S. government securities, expected by the investor to compensate for the additional risk associated with the investment. The investor expects the riskier investment to yield a higher rate of return.
Useful Life	The number of years a piece of equipment or structure is expected to operate and be functional before it must be replaced.
Year-dollars	Year in which a cost is estimated or expressed. For example, the cost of a piece of equipment to be installed in 1990 may have been estimated using a manufacturer's price list from 1987. This cost estimate is said to be expressed in 1987 dollars. Because inflation reduces the purchasing power of money over time, this 1987 cost cannot be directly compared or combined with another cost that is expressed in 1988 (or any other year) dollars. To compare or combine the costs, the costs must be converted to common year or base-year dollars.

APPENDIX A

METHOD FOR CALCULATING ECONOMIC BENEFIT

APPENDIX A

METHOD FOR CALCULATING ECONOMIC BENEFIT

1. INTRODUCTION

This technical appendix provides additional detail about the method used to calculate the economic benefit to an industry from delaying compliance with pretreatment requirements. The method is based on a computer model developed by EPA and successfully used by enforcement authorities in obtaining settlement penalties for violations of environmental regulations.[1] The economic benefit of noncompliance described in this manual is based on two components: (1) the earnings a violator can gain by postponing capital investments and one-time expenditures; and (2) the avoidance of annual costs and earnings on the avoided costs during the period of noncompliance. The formulas used to calculate economic benefit are derived and described. In an effort to be more precise for the technical reader, this appendix uses the appropriate economic terms more liberally than does the main body of this guidance manual.

2. REVIEW OF ECONOMIC CONCEPTS

The calculation of economic benefit is based on the concept of the "time value of money." This means that a dollar today is worth more than a dollar a year from now because today's dollar can be invested to earn a return over the coming year. If a firm complies with pretreatment requirements by the imposed deadline, it loses potential investment income from the money it must spend on pretreatment equipment. By delaying compliance, a violator earns a return on its money as long as it continues to delay necessary compliance expenditures. Similarly, the violator benefits by not paying annual costs during the period of noncompliance and by earning a return on those monies invested elsewhere.

Because of the time lag between when the violator began its noncompliance and when it achieved compliance, inflation usually has an impact on the costs. Since costs are incurred at different times, and dollars in the future are likely to be worth less than current dollars due to the time value of money, a method must be used to express the economic benefits to the violator in constant terms. This is accomplished by discounting all estimated costs to a "present value" (as of the base-year) equivalent. The "present value" is a method for expressing costs and benefits occurring at different points in time, in equivalently valued dollars. This conversion to equivalent dollars removes the differences in the value of money between the money saved by the violator while it was out-of-compliance and money spent by a firm which complied by the required deadline. This allows an appropriate comparison of the benefits and costs of on-time and delayed compliance since they are both expressed in equivalent terms.

The concept of the present value calculation may best be explained by the following example. If a firm were to invest $100 in production equipment today and receive a 15 percent rate of return, its investment will be worth $115 one year from today. Therefore, the present value of receiving $115 one year from now (given an expected annual rate of return of 15

[1] BEN User's Manual, U.S. Environmental Protection Agency, Office of Enforcement, revised July, 1990.

percent) is $100. The difference between the present value of costs for on-time compliance and the present value of costs for delayed compliance represents the industry's economic benefit from delaying the purchase of the pretreatment equipment.

The following sections further explain key factors used to simplify the calculation of present values and describe the resulting formulas.

3. SELECTION OF DISCOUNT RATE

An appropriate estimate for the discount rate is the rate of return that an investor normally expects from an investment. The expected rate of return is defined here as the expected return on a risk-free investment plus a risk premium factor to compensate for the degree of risk or uncertainty associated with an investment in a typical business operation.

A generally accepted risk-free investment is long-term U.S. Government securities, such as the 30-year Treasury bond. An investment in U.S. Government securities is considered risk-free because the return on the investment (the interest rate) is known at the time of investment. There is little chance that the investor will lose his investment, since Government securities are backed by full faith and credit from the U.S. Government. Appendix C-2 presents the annual rates of return on 30-year Treasury bonds for 1980 through 1989.

Investors demand a higher rate of return from an investment in private business relative to a risk-free investment. This extra expected return, or risk premium factor, is needed to compensate the investor for the uncertainty of the investment's profitability. The P-BEN calculation conforms to that of the revised BEN method in assuming a risk-premium of 7.5% for an average or typical business.[2] Therefore, assuming the return on a 30-year Treasury bond is 9 percent, an individual investing in a company of average risk would expect a return of 16.5% (9% risk-free plus 7.5% risk-premium).

4. CONSTANT ANNUAL CASH FLOWS ASSUMPTION

The general formula for the present value of annual costs is:

$$PV = \sum_{n=1}^{t} \frac{A_n}{(1+r)^n} \qquad (1)$$

where: PV = total present value of all annual costs
A_n = annual costs in year n
r = annual discount rate
t = total number of years

[2]Stocks, Bonds, Bills and Inflation: 1990 Yearbook, Ibbotson Associates, (Chicago, 1990), p. 121.

If the annual costs (A_n) remain constant, Equation 1 can be transformed to:

$$PV = A \times \frac{1-(1+r)^{-n}}{r} \qquad (2)$$

This occurs for constant costs such as depreciation tax savings which are assumed to be constant over a seven-year period.

A similar approach is used to calculate the present value of annual costs. First, the annual costs are adjusted to reflect the tax effects. Then, assuming annual costs grow at a constant inflation rate i (calculated by the average of inflation over the previous five years), the after-tax annual costs can be expressed by the following formula:

$$OM_n = OM \times (1+i)^n \qquad (3)$$

where:
OM_n = annual after-tax costs in year n
OM = annual after-tax costs as of the base-year
i = average annual inflation rate.

The total present value of all annual costs is thus equal to:

$$PV_{OM} = \sum_{n=1}^{t} \frac{OM \times (1+i)^n}{(1+r)^n} \qquad (4)$$

where:
t = useful life of pretreatment equipment

Equation 4 can be simplified as follows:

$$PV_{OM} = \sum_{n=1}^{t} \frac{OM}{(1+r')^n} \qquad (5)$$

or $$PV_{OM} = OM \times \frac{1-(1+r')^{-n}}{r'} \quad (6)$$

where: $$r' = r - i \quad (7)^3$$

The rate " r' " is called the inflation adjusted discount rate in this manual and is used to calculate the values of costs expressed in constant dollars (i.e., not inflated to reflect the change in purchasing power of the dollar over time). It is used in steps D and E to calculate the present values of annual costs that increase annually due to inflation.

5. DEPRECIATION ASSUMPTIONS

To simplify the pretreatment economic benefit calculations, this manual uses a seven-year straight line depreciation method with constant annual depreciation rather than a seven-year declining balance method. This is applied to all calculations, regardless of when the pollution control equipment is installed.[4]

6. PRESENT VALUE OF FUTURE REPLACEMENT COSTS

As described in Chapter 2 of this guidance manual, the economic benefit of noncompliance includes the present value of all replacement costs following initial investments. These are called future replacement costs. To determine this value, the present value of first replacement costs must be calculated. This is done by using the same formulas used to calculate the present value of the initial investment, assuming current applicable tax law and no additional one-time expenditures. All future replacement costs, expressed in base-year dollars, are similar to the first replacement costs, and their present values are expressed by the following formula:

---

[3] (r' = r - i) is derived as follows:

$$1+r' = \frac{1+r}{1+i}$$

Solving this for r':

$$r' = r - i - (i \times r')$$

Since i and r' are small numbers, (i x r') is a very small number and the equation can be simplified to: r'= r - i.

[4] For capital investments made before 1987, annual depreciation is based on a five-year straight line depreciation method to approximate the tax law provisions applicable at that time. For pollution control investments made after 1987, the revised tax law specifies a double-declining balance depreciation method or straight-line calculation over a seven-year depreciation life.

$$PV_{REP_n} = \frac{PV_{REP1}}{(1+r')^{nL}} \quad (8)$$

where: PV_{REP_n} = present value of nth replacement costs
PV_{REP1} = present value of first replacement costs
L = expected life of pretreatment equipment
r' = inflation adjusted discount rate.

The present value of all future replacement costs (PV_{REP}) is calculated by the following formula:

$$PV_{REP} = PV_{REP1} + \frac{PV_{REP1}}{(1+r')^{L}} + \frac{PV_{REP1}}{(1+r')^{2L}} + \ldots \quad (9)$$

or $$PV_{REP} = PV_{REP1} \times \left(1 + \frac{1}{1+R} + \frac{1}{(1+R)^2} + \ldots + \frac{1}{(1+R)^n}\right) \quad (10)$$

where: $$1+R = (1+r')^{L} \quad (11)$$

Equation 10 can be transformed to:

$$\frac{PV_{REP}}{(1+R)} = PV_{REP1} \times \left(\frac{1}{1+R} + \frac{1}{(1+R)^2} + \ldots + \frac{1}{(1+R)^n} + \frac{1}{(1+R)^{n+1}}\right) \quad (12)$$

and $$PV_{REP} - \frac{PV_{REP}}{1+R} = PV_{REP1} \times \left(1 - \frac{1}{(1+R)^{n+1}}\right) \quad (13)$$

As n increases, $1/(1+R)^{n+1}$ will approach zero and Equation 15 can be approximated to:

$$PV_{REP} \times \left(1 - \frac{1}{1+R}\right) = PV_{REP1} \qquad (14)$$

or

$$PV_{REP} = PV_{REP1} \times \frac{1}{1 - (1/(1+R))} \qquad (15)$$

or

$$PV_{REP} = PV_{REP1} \times \frac{1}{(1-(1/(1+r')^{L})} \qquad (16)$$

The value PV_{REP} is the present value at the beginning of the first replacement cost period (or the end of the initial investment). To convert this value to the present value as of the beginning of the initial investment period (BPV_{REP}), the following calculation is made:

$$BPV_{REP} = \frac{PV_{REP}}{(1+r')^{L}} \qquad (17)$$

Appendix D-3 lists the calculated values for the above formula for various expected lives of pretreatment equipment at selected discount rates.

APPENDIX B

ECONOMIC BENEFIT WORKSHEET

Figure 2-1

Economic Benefit Worksheet

A. General Information

1. Case name:		A01
2. Date when noncompliance began (base-year)	/ month/year	A02
3. Date of compliance	/ month/year	A03
4. Penalty payment date	/ month/year	A04
5. Number of months of noncompliance (A03 - A02)		A05
6. Number of months of noncompliance before payment (A04 - A02)		A06

B. Financial Factors

1. Marginal tax rate	38.4%	B01

2. Annual inflation rate

Enter inflation rates for last five years (see App. C-1)

19		%
19		%
19		%
19		%
19		%

Average annual inflation (sum of above values divided by 5)	%	B02

3. Discount rate

Enter average yields for last five years from App. C-2

19		%
19		%
19		%
19		%
19		%

a. Annual average yield (sum of above values divided by 5)	%	B03
b. Risk premium rate (standard value = 7.5%)	7.5%	B04
c. Discount rate (B03 + B04)	%	B05

KEY:

"-" = minus (e.g. "A03 - A02" means "A03 minus A02"); "+" = plus

"/" = divided by (e.g. "C01 / C04" means "C01 divided by C04"); "x" = multiplied by

C. Engineering Cost Estimates

1.	Initial capital investment in pretreatment equipment		
	a. Estimated costs	$	C01
	b. Year-dollars for cost		C02
	c. Adjustment period (A02 - C02)		C03
	d. Inflation adjustment factor (App. D-1 using B02 and C03)		C04
	e. Initial capital investment in base-year dollars (C01 / C04)	$	C05
2.	One-time expenditures		
	a. Estimated costs	$	C06
	b. Year-dollars for cost		C07
	c. Adjustment period (A02 - C07)		C08
	d. Inflation adjustment factor (App. D-1 using B02 and C08)		C09
	e. One-time expenditures in base-year dollars (C06 / C09)	$	C10
3.	Annual costs		
	a. Estimated costs	$	C11
	b. Year-dollars for cost (calendar year)		C12
	c. Adjustment period (A02 - C12)		C13
	d. Inflation adjustment factor (App. D-1 using B02 and C13)		C14
	e. Annual costs in base-year dollars (C11 / C14)	$	C15
4.	Useful life of pretreatment equipment (number of years)		C16

D. Cost of On-Time Compliance

1.	Initial investment		
	a. Initial capital investment (C05)	$	D01
	b. One-time expenditures (C10)	$	D02
	c. Tax savings (D02 x B01)	$	D03
	d. After-tax one-time expenditures (D02 - D03)	$	D04
	e. Base-year value of total investment (D01 + D04)	$	D05
2.	Depreciation tax savings		
	a. Depreciation period (years; standard value = 7 years)		D06
	b. Annual depreciation (D01 / D06)	$	D07
	c. Annual tax savings (D07 x B01)	$	D08
	d. Marginal tax rate (B05)	%	D09
	e. Discounting factor (App. D-2 using D06 and D09)		D10
	f. Base-year value of depreciation tax savings (D08 x D10)	$	D11
3.	Annual costs		
	a. Before-tax annual costs (C15)	$	D12
	b. After-tax annual costs (D12 x [1 - B01])	$	D13
	c. Useful life of pretreatment equipment (C16)		D14
	d. Inflation adjusted discount rate (B05 - B02)	%	D15
	e. Discounting factor (App. D-2 using D14 and D15)		D16
	f. After-tax base-year value of annual costs (D13 x D16)	$	D17

4. Base-year value of pretreatment replacement costs			
a. Initial capital investment (D01)	$		D18
b. Value of depreciation tax savings (D11)	$		D19
c. After tax value of annual costs (D17)	$		D20
d. Value of second cycle costs (D18 - D19 + D20)	$		D21
e. Inflation adjusted discount rate (D15)		%	D22
f. Useful life of pretreatment equipment (C16)			D23
g. Discounting factor (App. D-3 using D22 and D23)			D24
h. Base-year value of all pretreatment replacement costs (D21 x D24)	$		D25
5. Total cost of on-time compliance (D05 - D11+D17+D25)	$		D26

E. Cost of Delayed Compliance

1. Discount factor (for delayed compliance)			
a. Number of months of noncompliance (A05)			E01
b. Inflation adjusted discount rate (B15)		%	E02
c. Discount factor (App. D-4 using E01 and E02)			E03
2. Cost of delayed compliance as of base-year (D26 x E03)	$		E04

F. Net Economic Benefit

1. Economic benefit as of base-year			
a. Cost of on-time compliance in base-year values (D26)	$		F01
b. Cost of delayed compliance in base-year values (E04)	$		F02
c. Net economic benefit as of base-year (F01 - F02)	$		F03
2. Economic benefit as of penalty payment date			
a. Number of months of noncompliance before payment (A06)			F04
b. Discount rate (B05)		%	F05
c. Adjustment factor (App. D-4 using F04 and F05)			F06
d. Economic benefit at penalty payment date (F03 / F06)	$		F07

APPENDIX C

SAMPLE TABLES

APPENDIX C-1

CHEMICAL ENGINEERING PLANT COST INDEX
(Inflation Rate)

Year	Index	Percent Change (Inflation)
1980	261.2	
1981	297.0	13.7
1982	314.0	5.7
1983	316.9	0.9
1984	322.7	1.8
1985	325.3	0.8
1986	318.4	-2.1
1987	323.8	1.7
1988	342.5	5.8
1989	355.4	4.0
1990		
1991		
1992		
1993		
1994		
1995		
1996		
1997		
1999		
2000		

SOURCE: Chemical Engineering, McGraw Hill, Inc., biweekly issues, 1985-1990.

APPENDIX C-2

ANNUAL AVERAGE YIELDS ON 30-YEAR TREASURY BONDS
(To Calculate Discount Rate)

Year	Average Yield (%)
1981	13.5
1982	12.8
1983	11.2
1984	12.4
1985	10.8
1986	7.8
1987	8.6
1988	9.0
1989	8.5
1990 (1st half)	8.5
1991	
1992	
1993	
1994	
1995	
1996	
1997	
1998	
1999	
2000	

SOURCE: Federal Reserve Bulletin, "Table 1.35 - Interest Rates: Money and Capital Markets," 1980-1990.

APPENDIX D

PRESENT VALUE TABLES

APPENDIX D-1

INFLATION ADJUSTMENT FACTORS

FORMULA: (1+R)^n

No. of Years	0.5%	1.0%	1.5%	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%	5.0%	5.5%	6.0%	6.5%	7.0%	7.5%	8.0%	8.5%	9.0%	9.5%	10.0%
1	1.005	1.01	1.015	1.02	1.025	1.03	1.035	1.04	1.045	1.05	1.055	1.06	1.065	1.07	1.075	1.08	1.085	1.09	1.095	1.1
2	1.01	1.02	1.03	1.04	1.051	1.061	1.071	1.082	1.092	1.103	1.113	1.124	1.134	1.145	1.156	1.166	1.177	1.188	1.199	1.21
3	1.015	1.03	1.046	1.061	1.077	1.093	1.109	1.125	1.141	1.158	1.174	1.191	1.208	1.225	1.242	1.26	1.277	1.295	1.313	1.331
4	1.02	1.041	1.061	1.082	1.104	1.126	1.148	1.17	1.193	1.216	1.239	1.262	1.286	1.311	1.335	1.36	1.386	1.412	1.438	1.464
5	1.025	1.051	1.077	1.104	1.131	1.159	1.188	1.217	1.246	1.276	1.307	1.338	1.37	1.403	1.436	1.469	1.504	1.539	1.574	1.611
6	1.03	1.062	1.093	1.126	1.16	1.194	1.229	1.265	1.302	1.34	1.379	1.419	1.459	1.501	1.543	1.587	1.631	1.677	1.724	1.772
7	1.036	1.072	1.11	1.149	1.189	1.23	1.272	1.316	1.361	1.407	1.455	1.504	1.554	1.606	1.659	1.714	1.77	1.828	1.888	1.949
8	1.041	1.083	1.126	1.172	1.218	1.267	1.317	1.369	1.422	1.477	1.535	1.594	1.655	1.718	1.783	1.851	1.921	1.993	2.067	2.144
9	1.046	1.094	1.143	1.195	1.249	1.305	1.363	1.423	1.486	1.551	1.619	1.689	1.763	1.838	1.917	1.999	2.084	2.172	2.263	2.358
10	1.051	1.105	1.161	1.219	1.28	1.344	1.411	1.48	1.553	1.629	1.708	1.791	1.877	1.967	2.061	2.159	2.261	2.367	2.478	2.594
11	1.056	1.116	1.178	1.243	1.312	1.384	1.46	1.539	1.623	1.71	1.802	1.898	1.999	2.105	2.216	2.332	2.453	2.58	2.714	2.853
12	1.062	1.127	1.196	1.268	1.345	1.426	1.511	1.601	1.696	1.796	1.901	2.012	2.129	2.252	2.382	2.518	2.662	2.813	2.971	3.138
13	1.067	1.138	1.214	1.294	1.379	1.469	1.564	1.665	1.772	1.886	2.006	2.133	2.267	2.41	2.56	2.72	2.888	3.066	3.254	3.452
14	1.072	1.149	1.232	1.319	1.413	1.513	1.619	1.732	1.852	1.98	2.116	2.261	2.415	2.579	2.752	2.937	3.133	3.342	3.563	3.797
15	1.078	1.161	1.25	1.346	1.448	1.558	1.675	1.801	1.935	2.079	2.232	2.397	2.572	2.759	2.959	3.172	3.4	3.642	3.901	4.177
16	1.083	1.173	1.269	1.373	1.485	1.605	1.734	1.873	2.022	2.183	2.355	2.54	2.739	2.952	3.181	3.426	3.689	3.97	4.272	4.595
17	1.088	1.184	1.288	1.4	1.522	1.653	1.795	1.948	2.113	2.292	2.485	2.693	2.917	3.159	3.419	3.7	4.002	4.328	4.678	5.054
18	1.094	1.196	1.307	1.428	1.56	1.702	1.857	2.026	2.208	2.407	2.621	2.854	3.107	3.38	3.676	3.996	4.342	4.717	5.122	5.56
19	1.099	1.208	1.327	1.457	1.599	1.754	1.923	2.107	2.308	2.527	2.766	3.026	3.309	3.617	3.951	4.316	4.712	5.142	5.609	6.116
20	1.105	1.22	1.347	1.486	1.639	1.806	1.99	2.191	2.412	2.653	2.918	3.207	3.524	3.87	4.248	4.661	5.112	5.604	6.142	6.727
21	1.11	1.232	1.367	1.516	1.68	1.86	2.059	2.279	2.52	2.786	3.078	3.4	3.753	4.141	4.566	5.034	5.547	6.109	6.725	7.4
22	1.116	1.245	1.388	1.546	1.722	1.916	2.132	2.37	2.634	2.925	3.248	3.604	3.997	4.43	4.909	5.437	6.018	6.659	7.364	8.14
23	1.122	1.257	1.408	1.577	1.765	1.974	2.206	2.465	2.752	3.072	3.426	3.82	4.256	4.741	5.277	5.871	6.53	7.258	8.064	8.954
24	1.127	1.27	1.43	1.608	1.809	2.033	2.283	2.563	2.876	3.225	3.615	4.049	4.533	5.072	5.673	6.341	7.085	7.911	8.83	9.85
25	1.133	1.282	1.451	1.641	1.854	2.094	2.363	2.666	3.005	3.386	3.813	4.292	4.828	5.427	6.098	6.848	7.687	8.623	9.668	10.835

APPENDIX D-1 (cont.)

No. of Years	10.0%	10.5%	11.0%	11.5%	12.0%	12.5%	13.0%	13.5%	14.0%	14.5%	15.0%	15.5%	16.0%	16.5%	17.0%	17.5%	18.0%	18.5%	19.0%	19.5%	20.0%
1	1.1	1.105	1.11	1.115	1.12	1.125	1.13	1.135	1.14	1.145	1.15	1.155	1.16	1.165	1.17	1.175	1.18	1.185	1.19	1.195	1.2
2	1.21	1.221	1.232	1.243	1.254	1.266	1.277	1.288	1.3	1.311	1.323	1.334	1.346	1.357	1.369	1.381	1.392	1.404	1.416	1.428	1.44
3	1.331	1.349	1.368	1.386	1.405	1.424	1.443	1.462	1.482	1.501	1.521	1.541	1.561	1.581	1.602	1.622	1.643	1.664	1.685	1.706	1.728
4	1.464	1.491	1.518	1.546	1.574	1.602	1.63	1.66	1.689	1.719	1.749	1.78	1.811	1.842	1.874	1.906	1.939	1.972	2.005	2.039	2.074
5	1.611	1.647	1.685	1.723	1.762	1.802	1.842	1.884	1.925	1.968	2.011	2.055	2.1	2.146	2.192	2.24	2.288	2.337	2.386	2.437	2.488
6	1.772	1.82	1.87	1.922	1.974	2.027	2.082	2.138	2.195	2.253	2.313	2.374	2.436	2.5	2.565	2.632	2.7	2.769	2.84	2.912	2.986
7	1.949	2.012	2.076	2.143	2.211	2.281	2.353	2.426	2.502	2.58	2.66	2.742	2.826	2.913	3.001	3.092	3.185	3.281	3.379	3.48	3.583
8	2.144	2.223	2.305	2.389	2.476	2.566	2.658	2.754	2.853	2.954	3.059	3.167	3.278	3.393	3.511	3.633	3.759	3.888	4.021	4.159	4.3
9	2.358	2.456	2.558	2.664	2.773	2.887	3.004	3.126	3.252	3.383	3.518	3.658	3.803	3.953	4.108	4.269	4.435	4.607	4.785	4.969	5.16
10	2.594	2.714	2.839	2.97	3.106	3.247	3.395	3.548	3.707	3.873	4.046	4.225	4.411	4.605	4.807	5.016	5.234	5.46	5.695	5.939	6.192
11	2.853	2.999	3.152	3.311	3.479	3.653	3.836	4.027	4.226	4.435	4.652	4.88	5.117	5.365	5.624	5.894	6.176	6.47	6.777	7.097	7.43
12	3.138	3.314	3.498	3.692	3.896	4.11	4.335	4.57	4.818	5.078	5.35	5.636	5.936	6.25	6.58	6.926	7.288	7.667	8.064	8.48	8.916
13	3.452	3.662	3.883	4.117	4.363	4.624	4.898	5.187	5.492	5.814	6.153	6.51	6.886	7.282	7.699	8.138	8.599	9.085	9.596	10.134	10.699
14	3.797	4.046	4.31	4.59	4.887	5.202	5.535	5.888	6.261	6.657	7.076	7.519	7.988	8.483	9.007	9.562	10.147	10.766	11.42	12.11	12.839
15	4.177	4.471	4.785	5.118	5.474	5.852	6.254	6.682	7.138	7.622	8.137	8.684	9.266	9.883	10.539	11.235	11.974	12.758	13.59	14.472	15.407
16	4.595	4.941	5.311	5.707	6.13	6.583	7.067	7.585	8.137	8.727	9.358	10.03	10.748	11.514	12.33	13.201	14.129	15.118	16.172	17.294	18.488
17	5.054	5.46	5.895	6.363	6.866	7.406	7.986	8.609	9.276	9.993	10.761	11.585	12.468	13.413	14.426	15.511	16.672	17.915	19.244	20.666	22.186
18	5.56	6.033	6.544	7.095	7.69	8.332	9.024	9.771	10.575	11.442	12.375	13.381	14.463	15.627	16.879	18.226	19.673	21.229	22.901	24.696	26.623
19	6.116	6.666	7.263	7.911	8.613	9.373	10.197	11.09	12.056	13.101	14.232	15.455	16.777	18.205	19.748	21.415	23.214	25.156	27.252	29.511	31.948
20	6.727	7.366	8.062	8.821	9.646	10.545	11.523	12.587	13.743	15.001	16.367	17.85	19.461	21.209	23.106	25.163	27.393	29.81	32.429	35.266	38.338
21	7.4	8.14	8.949	9.835	10.804	11.863	13.021	14.286	15.668	17.176	18.822	20.617	22.574	24.708	27.034	29.566	32.324	35.325	38.591	42.143	46.005
22	8.14	8.994	9.934	10.966	12.1	13.346	14.714	16.215	17.861	19.666	21.645	23.812	26.186	28.785	31.629	34.74	38.142	41.86	45.923	50.361	55.206
23	8.954	9.939	11.026	12.227	13.552	15.014	16.627	18.404	20.362	22.518	24.891	27.503	30.376	33.535	37.006	40.82	45.008	49.605	54.649	60.181	66.247
24	9.85	10.982	12.239	13.633	15.179	16.891	18.788	20.888	23.212	25.783	28.625	31.766	35.236	39.068	43.297	47.963	53.109	58.781	65.032	71.917	79.497
25	10.835	12.135	13.585	15.201	17	19.003	21.231	23.708	26.462	29.521	32.919	36.69	40.874	45.514	50.658	56.357	62.669	69.656	77.388	85.94	95.396

NOTE: " ^ " = raised to the power of...
R = percentage expressed as decimal

APPENDIX D-2

DEPRECIATION TAX SAVINGS DISCOUNTING FACTOR
(Base-year value of $1 received per year over n years)

FORMULA: 1-(1/(1+R)^n)/R

No. of Years	10.0%	10.5%	11.0%	11.5%	12.0%	12.5%	13.0%	13.5%	14.0%	14.5%	15.0%	15.5%	16.0%	16.5%	17.0%	17.5%	18.0%	18.5%	19.0%	19.5%	20.0%
1	0.909	0.905	0.901	0.897	0.893	0.889	0.885	0.881	0.877	0.873	0.87	0.866	0.862	0.858	0.855	0.851	0.847	0.844	0.84	0.837	0.833
2	1.736	1.724	1.713	1.701	1.69	1.679	1.668	1.657	1.647	1.636	1.626	1.615	1.605	1.595	1.585	1.575	1.566	1.556	1.547	1.537	1.528
3	2.487	2.465	2.444	2.423	2.402	2.381	2.361	2.341	2.322	2.302	2.283	2.264	2.246	2.228	2.21	2.192	2.174	2.157	2.14	2.123	2.106
4	3.17	3.136	3.102	3.07	3.037	3.006	2.974	2.944	2.914	2.884	2.855	2.826	2.798	2.77	2.743	2.716	2.69	2.664	2.639	2.613	2.589
5	3.791	3.743	3.696	3.65	3.605	3.561	3.517	3.475	3.433	3.392	3.352	3.313	3.274	3.236	3.199	3.163	3.127	3.092	3.058	3.024	2.991
6	4.355	4.292	4.231	4.17	4.111	4.054	3.998	3.943	3.889	3.836	3.784	3.734	3.685	3.636	3.589	3.543	3.498	3.453	3.41	3.367	3.326
7	4.868	4.789	4.712	4.637	4.564	4.492	4.423	4.355	4.288	4.224	4.16	4.099	4.039	3.98	3.922	3.866	3.812	3.758	3.706	3.655	3.605
8	5.335	5.239	5.146	5.056	4.968	4.882	4.799	4.718	4.639	4.562	4.487	4.415	4.344	4.274	4.207	4.142	4.078	4.015	3.954	3.895	3.837
9	5.759	5.646	5.537	5.431	5.328	5.228	5.132	5.038	4.946	4.858	4.772	4.688	4.607	4.527	4.451	4.376	4.303	4.232	4.163	4.096	4.031
10	6.145	6.015	5.889	5.768	5.65	5.536	5.426	5.32	5.216	5.116	5.019	4.925	4.833	4.745	4.659	4.575	4.494	4.415	4.339	4.265	4.192
11	6.495	6.348	6.207	6.07	5.938	5.81	5.687	5.568	5.453	5.341	5.234	5.13	5.029	4.931	4.836	4.745	4.656	4.57	4.486	4.406	4.327
12	6.814	6.65	6.492	6.341	6.194	6.053	5.918	5.787	5.66	5.538	5.421	5.307	5.197	5.091	4.988	4.889	4.793	4.7	4.611	4.523	4.439
13	7.103	6.923	6.75	6.583	6.424	6.27	6.122	5.979	5.842	5.71	5.583	5.461	5.342	5.228	5.118	5.012	4.91	4.81	4.715	4.622	4.533
14	7.367	7.17	6.982	6.801	6.628	6.462	6.302	6.149	6.002	5.861	5.724	5.594	5.468	5.346	5.229	5.117	5.008	4.903	4.802	4.705	4.611
15	7.606	7.394	7.191	6.997	6.811	6.633	6.462	6.299	6.142	5.992	5.847	5.709	5.575	5.447	5.324	5.206	5.092	4.982	4.876	4.774	4.675
16	7.824	7.596	7.379	7.172	6.974	6.785	6.604	6.431	6.265	6.106	5.954	5.808	5.668	5.534	5.405	5.281	5.162	5.048	4.938	4.832	4.73
17	8.022	7.779	7.549	7.329	7.12	6.92	6.729	6.547	6.373	6.206	6.047	5.895	5.749	5.609	5.475	5.346	5.222	5.104	4.99	4.88	4.775
18	8.201	7.945	7.702	7.47	7.25	7.04	6.84	6.649	6.467	6.294	6.128	5.969	5.818	5.673	5.534	5.401	5.273	5.151	5.033	4.921	4.812
19	8.365	8.095	7.839	7.596	7.366	7.147	6.938	6.739	6.55	6.37	6.198	6.034	5.877	5.728	5.584	5.447	5.316	5.191	5.07	4.954	4.843
20	8.514	8.231	7.963	7.71	7.469	7.241	7.025	6.819	6.623	6.437	6.259	6.09	5.929	5.775	5.628	5.487	5.353	5.224	5.101	4.983	4.87
21	8.649	8.354	8.075	7.811	7.562	7.326	7.102	6.889	6.687	6.495	6.312	6.139	5.973	5.815	5.665	5.521	5.384	5.252	5.127	5.007	4.891
22	8.772	8.465	8.176	7.903	7.645	7.401	7.17	6.951	6.743	6.546	6.359	6.181	6.011	5.85	5.696	5.55	5.41	5.276	5.149	5.026	4.909
23	8.883	8.566	8.266	7.984	7.718	7.467	7.23	7.005	6.792	6.59	6.399	6.217	6.044	5.88	5.723	5.574	5.432	5.296	5.167	5.043	4.925
24	8.985	8.657	8.348	8.058	7.784	7.526	7.283	7.053	6.835	6.629	6.434	6.249	6.073	5.905	5.746	5.595	5.451	5.313	5.182	5.057	4.937
25	9.077	8.739	8.422	8.124	7.843	7.579	7.33	7.095	6.873	6.663	6.464	6.276	6.097	5.927	5.766	5.613	5.467	5.328	5.195	5.069	4.948

NOTE: " ^ " = raised to the power of...

APPENDIX D-3

DISCOUNTING FACTOR FOR REPLACEMENT COSTS

FORMULA: 1/(1-1/(1+R)^n)*(1/(1+R)^n)

No. of Years	10.0%	10.5%	11.0%	11.5%	12.0%	12.5%	13.0%	13.5%	14.0%	14.5%	15.0%	15.5%	16.0%	16.5%	17.0%	17.5%	18.0%	18.5%	19.0%	19.5%	20.0%
1	10	9.524	9.091	8.696	8.333	8	7.692	7.407	7.143	6.897	6.667	6.452	6.25	6.061	5.882	5.714	5.556	5.405	5.263	5.128	5
2	4.762	4.524	4.308	4.111	3.931	3.765	3.611	3.47	3.338	3.215	3.101	2.994	2.894	2.799	2.711	2.627	2.548	2.474	2.403	2.336	2.273
3	3.021	2.863	2.72	2.589	2.47	2.359	2.258	2.164	2.077	1.996	1.92	1.849	1.783	1.721	1.662	1.607	1.555	1.506	1.46	1.415	1.374
4	2.155	2.037	1.93	1.833	1.744	1.662	1.586	1.516	1.451	1.391	1.335	1.283	1.234	1.188	1.144	1.104	1.065	1.029	0.995	0.962	0.931
5	1.638	1.545	1.46	1.382	1.312	1.247	1.187	1.132	1.081	1.033	0.989	0.947	0.909	0.873	0.839	0.807	0.777	0.748	0.721	0.696	0.672
6	1.296	1.219	1.149	1.085	1.027	0.973	0.924	0.879	0.837	0.798	0.762	0.728	0.696	0.667	0.639	0.613	0.588	0.565	0.544	0.523	0.504
7	1.054	0.989	0.929	0.875	0.826	0.781	0.739	0.701	0.666	0.633	0.602	0.574	0.548	0.523	0.5	0.478	0.458	0.438	0.42	0.403	0.387
8	0.874	0.818	0.767	0.72	0.678	0.639	0.603	0.57	0.54	0.512	0.486	0.461	0.439	0.418	0.398	0.38	0.362	0.346	0.331	0.317	0.303
9	0.736	0.687	0.642	0.601	0.564	0.53	0.499	0.47	0.444	0.42	0.397	0.376	0.357	0.339	0.322	0.306	0.291	0.277	0.264	0.252	0.24
10	0.627	0.583	0.544	0.508	0.475	0.445	0.418	0.392	0.369	0.348	0.328	0.31	0.293	0.277	0.263	0.249	0.236	0.224	0.213	0.202	0.193
11	0.54	0.5	0.465	0.433	0.403	0.377	0.353	0.33	0.31	0.291	0.274	0.258	0.243	0.229	0.216	0.204	0.193	0.183	0.173	0.164	0.156
12	0.468	0.432	0.4	0.371	0.345	0.322	0.3	0.28	0.262	0.245	0.23	0.216	0.203	0.19	0.179	0.169	0.159	0.15	0.142	0.134	0.126
13	0.408	0.376	0.347	0.321	0.297	0.276	0.257	0.239	0.223	0.208	0.194	0.181	0.17	0.159	0.149	0.14	0.132	0.124	0.116	0.109	0.103
14	0.357	0.328	0.302	0.279	0.257	0.238	0.221	0.205	0.19	0.177	0.165	0.153	0.143	0.134	0.125	0.117	0.109	0.102	0.096	0.09	0.084
15	0.315	0.288	0.264	0.243	0.224	0.206	0.19	0.176	0.163	0.151	0.14	0.13	0.121	0.113	0.105	0.098	0.091	0.085	0.079	0.074	0.069
16	0.278	0.254	0.232	0.212	0.195	0.179	0.165	0.152	0.14	0.129	0.12	0.111	0.103	0.095	0.088	0.082	0.076	0.071	0.066	0.064	0.057
17	0.247	0.224	0.204	0.186	0.17	0.156	0.143	0.131	0.121	0.111	0.102	0.094	0.087	0.081	0.074	0.069	0.064	0.059	0.055	0.051	0.047
18	0.219	0.199	0.18	0.164	0.149	0.136	0.125	0.114	0.104	0.096	0.088	0.081	0.074	0.068	0.063	0.058	0.054	0.049	0.046	0.042	0.039
19	0.195	0.176	0.16	0.145	0.131	0.119	0.109	0.099	0.09	0.083	0.076	0.069	0.063	0.058	0.053	0.049	0.045	0.041	0.038	0.035	0.032
20	0.175	0.157	0.142	0.128	0.116	0.105	0.095	0.086	0.078	0.071	0.065	0.059	0.054	0.049	0.045	0.041	0.038	0.035	0.032	0.029	0.027
21	0.156	0.14	0.126	0.113	0.102	0.092	0.083	0.075	0.068	0.062	0.056	0.051	0.046	0.042	0.038	0.035	0.032	0.029	0.027	0.024	0.022
22	0.14	0.125	0.112	0.1	0.09	0.081	0.073	0.066	0.059	0.054	0.048	0.044	0.04	0.036	0.033	0.03	0.027	0.024	0.022	0.02	0.018
23	0.126	0.112	0.1	0.089	0.08	0.071	0.064	0.057	0.052	0.046	0.042	0.038	0.034	0.031	0.028	0.025	0.023	0.021	0.019	0.017	0.015
24	0.113	0.1	0.089	0.079	0.071	0.063	0.056	0.05	0.045	0.04	0.036	0.033	0.029	0.026	0.024	0.021	0.019	0.017	0.016	0.014	0.013
25	0.102	0.09	0.079	0.07	0.062	0.056	0.049	0.044	0.039	0.035	0.031	0.028	0.025	0.022	0.02	0.018	0.016	0.015	0.013	0.012	0.011

NOTE: " ^ " = raised to the power of...

APPENDIX D-4

NET ECONOMIC BENEFIT ADJUSTMENT FACTOR
(Present value of $1 to be received in nth month.)

FORMULA: 1/(1+R)^(n/12)

No. of Months	10.0%	10.5%	11.0%	11.5%	12.0%	12.5%	13.0%	13.5%	14.0%	14.5%	15.0%	15.5%	16.0%	16.5%	17.0%	17.5%	18.0%	18.5%	19.0%	19.5%	20.0
1	0.992	0.992	0.991	0.991	0.991	0.99	0.99	0.99	0.989	0.989	0.988	0.988	0.988	0.987	0.987	0.987	0.986	0.986	0.986	0.985	0.985
2	0.984	0.983	0.983	0.982	0.981	0.981	0.98	0.979	0.978	0.978	0.977	0.976	0.976	0.975	0.974	0.973	0.973	0.972	0.971	0.971	0.97
3	0.976	0.975	0.974	0.973	0.972	0.971	0.97	0.969	0.968	0.967	0.966	0.965	0.964	0.963	0.962	0.96	0.959	0.958	0.957	0.956	0.955
4	0.969	0.967	0.966	0.964	0.963	0.961	0.96	0.959	0.957	0.956	0.954	0.953	0.952	0.95	0.949	0.948	0.946	0.945	0.944	0.942	0.941
5	0.961	0.959	0.957	0.956	0.954	0.952	0.95	0.949	0.947	0.945	0.943	0.942	0.94	0.938	0.937	0.935	0.933	0.932	0.93	0.928	0.927
6	0.953	0.951	0.949	0.947	0.945	0.943	0.941	0.939	0.937	0.935	0.933	0.93	0.928	0.926	0.925	0.923	0.921	0.919	0.917	0.915	0.913
7	0.946	0.943	0.941	0.938	0.936	0.934	0.931	0.929	0.926	0.924	0.922	0.919	0.917	0.915	0.912	0.91	0.908	0.906	0.904	0.901	0.899
8	0.938	0.936	0.933	0.93	0.927	0.924	0.922	0.919	0.916	0.914	0.911	0.908	0.906	0.903	0.901	0.898	0.896	0.893	0.891	0.888	0.886
9	0.931	0.928	0.925	0.922	0.919	0.915	0.912	0.909	0.906	0.903	0.9	0.898	0.895	0.892	0.889	0.886	0.883	0.88	0.878	0.875	0.872
10	0.924	0.92	0.917	0.913	0.91	0.907	0.903	0.9	0.897	0.893	0.89	0.887	0.884	0.88	0.877	0.874	0.871	0.868	0.865	0.862	0.859
11	0.916	0.913	0.909	0.905	0.901	0.898	0.894	0.89	0.887	0.883	0.88	0.876	0.873	0.869	0.866	0.863	0.859	0.856	0.853	0.849	0.846
12	0.909	0.905	0.901	0.897	0.893	0.889	0.885	0.881	0.877	0.873	0.87	0.866	0.862	0.858	0.855	0.851	0.847	0.844	0.84	0.837	0.833
13	0.902	0.897	0.893	0.889	0.884	0.88	0.876	0.872	0.868	0.864	0.859	0.855	0.851	0.848	0.844	0.84	0.836	0.832	0.828	0.824	0.821
14	0.895	0.89	0.885	0.881	0.876	0.872	0.867	0.863	0.858	0.854	0.85	0.845	0.841	0.837	0.833	0.828	0.824	0.82	0.816	0.812	0.808
15	0.888	0.883	0.878	0.873	0.868	0.863	0.858	0.854	0.849	0.844	0.84	0.835	0.831	0.826	0.822	0.817	0.813	0.809	0.805	0.8	0.796
16	0.881	0.875	0.87	0.865	0.86	0.855	0.85	0.845	0.84	0.835	0.83	0.825	0.82	0.816	0.811	0.807	0.802	0.797	0.793	0.789	0.784
17	0.874	0.868	0.863	0.857	0.852	0.846	0.841	0.836	0.831	0.825	0.82	0.815	0.81	0.805	0.801	0.796	0.791	0.786	0.782	0.777	0.772
18	0.867	0.861	0.855	0.849	0.844	0.838	0.832	0.827	0.822	0.816	0.811	0.806	0.8	0.795	0.79	0.785	0.78	0.775	0.77	0.766	0.761
19	0.86	0.854	0.848	0.842	0.836	0.83	0.824	0.818	0.813	0.807	0.801	0.796	0.791	0.785	0.78	0.775	0.769	0.764	0.759	0.754	0.749
20	0.853	0.847	0.84	0.834	0.828	0.822	0.816	0.81	0.804	0.798	0.792	0.786	0.781	0.775	0.77	0.764	0.759	0.754	0.748	0.743	0.738
21	0.846	0.84	0.833	0.827	0.82	0.814	0.807	0.801	0.795	0.789	0.783	0.777	0.771	0.765	0.76	0.754	0.749	0.743	0.738	0.732	0.727
22	0.84	0.833	0.826	0.819	0.812	0.806	0.799	0.793	0.786	0.78	0.774	0.768	0.762	0.756	0.75	0.744	0.738	0.733	0.727	0.721	0.716
23	0.833	0.826	0.819	0.812	0.805	0.798	0.791	0.784	0.778	0.771	0.765	0.759	0.752	0.746	0.74	0.734	0.728	0.722	0.716	0.711	0.705
24	0.826	0.819	0.812	0.804	0.797	0.79	0.783	0.776	0.769	0.763	0.756	0.75	0.743	0.737	0.731	0.724	0.718	0.712	0.706	0.7	0.694
25	0.82	0.812	0.805	0.797	0.79	0.782	0.775	0.768	0.761	0.754	0.747	0.741	0.734	0.727	0.721	0.715	0.708	0.702	0.696	0.69	0.684

APPENDIX D-4 (cont.)

No. of Months	10.0%	10.5%	11.0%	11.5%	12.0%	12.5%	13.0%	13.5%	14.0%	14.5%	15.0%	15.5%	16.0%	16.5%	17.0%	17.5%	18.0%	18.5%	19.0%	19.5%	20.0%
26	0.813	0.805	0.798	0.79	0.782	0.775	0.767	0.76	0.753	0.746	0.739	0.732	0.725	0.718	0.712	0.705	0.699	0.692	0.686	0.68	0.674
27	0.807	0.799	0.791	0.783	0.775	0.767	0.76	0.752	0.745	0.737	0.73	0.723	0.716	0.709	0.702	0.696	0.689	0.683	0.676	0.67	0.664
28	0.801	0.792	0.784	0.776	0.768	0.76	0.752	0.744	0.737	0.729	0.722	0.714	0.707	0.7	0.693	0.686	0.68	0.673	0.666	0.66	0.653
29	0.794	0.786	0.777	0.769	0.76	0.752	0.744	0.736	0.729	0.721	0.713	0.706	0.699	0.691	0.684	0.677	0.67	0.664	0.657	0.65	0.644
30	0.788	0.779	0.77	0.762	0.753	0.745	0.737	0.729	0.721	0.713	0.705	0.698	0.69	0.683	0.675	0.668	0.661	0.654	0.647	0.641	0.634
31	0.782	0.773	0.764	0.755	0.746	0.738	0.729	0.721	0.713	0.705	0.697	0.689	0.682	0.674	0.667	0.659	0.652	0.645	0.638	0.631	0.624
32	0.776	0.766	0.757	0.748	0.739	0.73	0.722	0.713	0.705	0.697	0.689	0.681	0.673	0.665	0.658	0.65	0.643	0.636	0.629	0.622	0.615
33	0.769	0.76	0.751	0.741	0.732	0.723	0.715	0.706	0.697	0.689	0.681	0.673	0.665	0.657	0.649	0.642	0.634	0.627	0.62	0.613	0.606
34	0.763	0.754	0.744	0.735	0.725	0.716	0.707	0.699	0.69	0.681	0.673	0.665	0.657	0.649	0.641	0.633	0.626	0.618	0.611	0.604	0.597
35	0.757	0.747	0.738	0.728	0.719	0.709	0.7	0.691	0.682	0.674	0.665	0.657	0.649	0.641	0.633	0.625	0.617	0.61	0.602	0.595	0.588
36	0.751	0.741	0.731	0.721	0.712	0.702	0.693	0.684	0.675	0.666	0.658	0.649	0.641	0.632	0.624	0.616	0.609	0.601	0.593	0.586	0.579
37	0.745	0.735	0.725	0.715	0.705	0.695	0.686	0.677	0.668	0.659	0.65	0.641	0.633	0.624	0.616	0.608	0.6	0.593	0.585	0.577	0.57
38	0.739	0.729	0.719	0.708	0.698	0.689	0.679	0.67	0.66	0.651	0.642	0.634	0.625	0.617	0.608	0.6	0.592	0.584	0.576	0.569	0.561
39	0.734	0.723	0.712	0.702	0.692	0.682	0.672	0.663	0.653	0.644	0.635	0.626	0.617	0.609	0.6	0.592	0.584	0.576	0.568	0.56	0.553
40	0.728	0.717	0.706	0.696	0.685	0.675	0.665	0.656	0.646	0.637	0.628	0.619	0.61	0.601	0.593	0.584	0.576	0.568	0.56	0.552	0.545
41	0.722	0.711	0.7	0.689	0.679	0.669	0.659	0.649	0.639	0.63	0.62	0.611	0.602	0.593	0.585	0.576	0.568	0.56	0.552	0.544	0.536
42	0.716	0.705	0.694	0.683	0.673	0.662	0.652	0.642	0.632	0.623	0.613	0.604	0.595	0.586	0.577	0.569	0.56	0.552	0.544	0.536	0.528
43	0.711	0.699	0.688	0.677	0.666	0.656	0.645	0.635	0.625	0.616	0.606	0.597	0.588	0.579	0.57	0.561	0.553	0.544	0.536	0.528	0.52
44	0.705	0.693	0.682	0.671	0.66	0.649	0.639	0.629	0.619	0.609	0.599	0.59	0.58	0.571	0.562	0.554	0.545	0.537	0.528	0.52	0.512
45	0.699	0.688	0.676	0.665	0.654	0.643	0.632	0.622	0.612	0.602	0.592	0.583	0.573	0.564	0.555	0.546	0.538	0.529	0.521	0.513	0.505
46	0.694	0.682	0.67	0.659	0.648	0.637	0.626	0.615	0.605	0.595	0.585	0.576	0.566	0.557	0.548	0.539	0.53	0.522	0.513	0.505	0.497
47	0.688	0.676	0.664	0.653	0.642	0.63	0.62	0.609	0.599	0.588	0.578	0.569	0.559	0.55	0.541	0.532	0.523	0.514	0.506	0.498	0.49
48	0.683	0.671	0.659	0.647	0.636	0.624	0.613	0.603	0.592	0.582	0.572	0.562	0.552	0.543	0.534	0.525	0.516	0.507	0.499	0.49	0.482
49	0.678	0.665	0.653	0.641	0.63	0.618	0.607	0.596	0.586	0.575	0.565	0.555	0.546	0.536	0.527	0.518	0.509	0.5	0.491	0.483	0.475
50	0.672	0.66	0.647	0.635	0.624	0.612	0.601	0.59	0.579	0.569	0.559	0.549	0.539	0.529	0.52	0.511	0.502	0.493	0.484	0.476	0.468

NOTE: " ^ " = raised to the power of...