Chapter 10

Statutory Funding Requirements

For decades the Internal Revenue Code has placed requirements on pension plans receiving favorable tax treatment and has limited the maximum amount of tax deduction for employer contributions. In 1974 the Employee Retirement Income Security Act (ERISA) was enacted, representing a monumental piece of legislation designed primarily to secure the benefit rights of plan participants by mandating minimum vesting and funding requirements. The law itself, followed by an avalanche of regulations and additional legislation over the ensuing 19 years, has placed a heavy burden on employers who operate qualified defined benefit plans in accordance with its massive and complex rules, with one of the most significant sets of rules being enacted under the Omnibus Budget Reconciliation Act of 1987 (OBRA '87). Some experts believe that, despite laudable intentions, ERISA, expanded by subsequent legislation and stupefying regulations, is self-defeating, as evidenced by the large number of plans that have been terminated since its enactment.

This chapter discusses only a relatively small part of pension legislation, namely, the rules associated with minimum required contributions and maximum tax deductible contributions for single-employer pension plans.[1]

[1]For a comprehensive treatment of pension plan legislation, see Dan M. McGill and Donald S. Grubbs, Jr., *Fundamentals of Private Pensions*, 6th ed. (Homewood, Ill.: Richard D. Irwin, 1989).

MINIMUM REQUIRED CONTRIBUTIONS

The enrolled actuary for the plan is required to keep a running balance of the contributions made to the plan each year as compared to the minimum required contributions. A *funding standard account* (FSA) is used for this purpose and is reported to the IRS in Schedule B of Form 5500. If cumulative contributions exceed the minimum required contributions, the funding standard account will show a *credit balance;* if contributions fall short of the required minimum, the FSA shows a *funding deficiency*. In either case, next year's minimum contribution is affected by the prior year's FSA balance.

The minimum required contributions due at the end of year t (indicated by using $t + 1$), can be expressed as follows:

$$
{}^{Min}(EC)_{t+1} = Min \left\{ \begin{array}{c} \left[(NC)_t + (\sum SC)_t - (FSA)_t\right](1+i) + (AFC)_t(1+i') \\ {}^{AL}(FFL)_{t+1} - (FSA)_t(1+i) \\ {}^{CL}(FFL)_{t+1} - (FSA)_t(1+i) \end{array} \right\} \tag{10.1}
$$

where

$^{Min}(EC)_{t+1}$ = minimum required contribution determined as of the end of year t

$(NC)_t$ = normal cost under a statutory funding method

$(\sum SC)_t$ = sum of explicit supplemental costs

$(FSA)_t$ = funding standard account balance from end of prior year (i.e., beginning of year t), with credit balances positive and funding deficiencies negative

$(AFC)_t$ = additional funding charge for year t

i = valuation interest rate

i' = current liability interest rate

$^{AL}(FFL)_{t+1}$ = year-end value of full funding limit based on actuarial liability of statutory funding method

$^{CL}(FFL)_{t+1}$ = year-end value of full funding limit based on current liability.

Equation (10.1) indicates that the minimum required contribution includes (1) the *normal cost* under one of the statutory funding methods yet to be discussed, plus (2) the *supplemental costs* (both positive and negative) based on amortization periods set forth by statute, less (3) the *funding standard account balance* from the prior year (credit balances being positive and deficiencies being negative), plus (4) an *additional funding charge* if the plan's funded status falls below a specific target, as discussed later in this chapter. These four components are increased by interest to the end of the year, the first three being increased by the valuation rate of interest and the fourth by the interest rate used in calculating the plan's *current liability* (see later discussion). In no event, however, is the minimum required contribution greater than the full funding limit defined by the actuarial liability under the statutory funding method or the full funding limit defined by the current liability, both of which are reduced by the funding standard account balance from the prior year adjusted with interest. These two full funding limits are defined in this chapter.

If employer contributions are paid prior to year end, the minimum required contribution is reduced for interest at the valuation interest rate. For example, if uniform contributions are made at the end of each quarter, then the minimum quarterly payment would be

$$ {}^{Qrt}(EC)_t = \frac{{}^{Min}(EC)_{t+1}}{s\overline{1|}^{(4)}} \qquad (10.2) $$

where

$ {}^{Qrt}(EC)_t $ = minimum required quarterly contribution

$ s\overline{1|}^{(4)} = (1+i)^{3/4} + (1+i)^{1/2} + (1+i)^{1/4} + 1 . $

As noted previously, if contributions are less than the minimum required amount, an *accumulated funding deficiency* will result. This deficiency must be corrected within 8 1/2 months after the plan year, otherwise the IRS will impose a 10 percent excise tax and will give the plan sponsor a specified time period by which the deficiency and excise tax must be paid. If the deficiency is not paid within this period, a 100 percent excise tax will be imposed.

A waiver of the funding deficiency may be granted by the IRS if a substantial, but temporary, business hardship exists such that contributions equal to the minimum funding requirement are deemed to be adverse to participants. Three waivers are permitted during any 15-year period, with the dollar amount of each waiver being amortized over five years. The interest rate used in amortizing a waiver must be the larger of 150 percent of the federal midterm rate in effect at the beginning of the plan year, the valuation interest rate or the current liability interest rate.

The following sections define and/or elaborate on each of the components making up the minimum required contributions given by (10.1).

Statutory Funding Methods

ERISA and IRS regulations identify the various funding methods that may be used in determining the normal and supplemental cost components of equation (10.1). Table 10–1 identifies each method using the terminology recommended by the Joint Committee on Pension Terminology (JCPT).[2] The statutory term for each method, along with the generic terms developed in this book, are also provided. The characteristics of each method are given in Table 10–2.

The actuarial assumptions used with a statutory funding method must represent the actuary's best estimate of future experience under the plan.[3] In addition, the benefit limits, IRC §415, and the maximum limit on compensation, IRC §401(a)(17), must be included without projection of future increases.

Unit Credit Method (Unprojected). Both the JCPT and ERISA use the term *unit credit* to refer to two different funding methods, one without a benefit projection (described in this section) and one with a benefit projection (described in the next section). The unit credit method (unprojected) is equivalent to the following:

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[2]The Pension Terminology report of the JCPT was published in 1981 and adopted by the American Academy of Actuaries, the Conference of Actuaries in Public Practice, the Society of Actuaries, and the American Society of Pension Actuaries.

[3]ERISA initially allowed the use of actuarial assumptions that, in the aggregate, represented the actuary's best estimate of future experience under the plan. TRA '86 imposed the requirement that each individual assumption represent the actuary's best estimate.

TABLE 10–1

Statutory Funding Method Terminology

JCPT Term	*Statutory Term*	*Generic Term*
Unit Credit Method (unprojected)	Unit Credit Method (unprojected)	Accrued Benefit Method with Explicit Supplemental Costs
Unit Credit Method (projected)	Unit Credit Method (projected)	Benefit Prorate Method with Explicit Supplemental Costs (only Constant Dollar version approved)
Entry Age Method	Entry Age Normal Method	Cost Prorate Method with Explicit Supplemental Costs (Constant Dollar or Constant Percent)
Attained Age Method	Attained Age Normal Method (individual calculations)	Cost Prorate Method (Constant Dollar or Constant Percent) Explicit supplemental costs applied to Unit Credit unfunded actuarial liability at plan formation, plan amendment, and assumption changes; implicit supplemental costs on all other sources
Individual Level Method	Individual Level Premium Method	Cost Prorate Method (Constant Dollar or Constant Percent) Implicit supplemental costs on all sources except non-benefit based gains and losses for which explicit supplemental costs are used
Frozen Entry Age Method	Frozen Initial Liability Method	Cost Prorate Method (Constant Dollar or Constant Percent; group-based calculations) Explicit supplemental costs applied to entry age unfunded actuarial liability at plan formation, plan amendment ,and assumption changes; implicit supplemental costs on all other sources
Frozen Attained Age Method	Attained Age Normal Method (group calculations)	Same as Attained Age Method but with group-based calculations
Aggregate Method	Aggregate Method	Cost Prorate Method with Implicit Supplemental Costs (Constant Dollar or Constant Percent; group-based calculations)
Individual Aggregate Method	Individual Aggregate Method	Same as Aggregate Method but with individual-based calculations

TABLE 10–2

Characteristics of Statutory Funding Methods

JCPT Term	*Basic Methodology*	*Census Calculation*	*Supplemental Cost Methodology for:*			
			Initial Unfunded Liability	*Plan Changes*	*Assumption Changes*	*Actuarial Gains and Losses*
Unit Credit Method (unprojected)	Accrued Benefit	Individual	Explicit	Explicit	Explicit	Explicit
Unit Credit Method (projected)	Benefit Prorate	Individual	Explicit	Explicit	Explicit	Explicit
Entry Age Method	Cost Prorate	Individual	Explicit	Explicit	Explicit	Explicit
Attained Age Method	Cost Prorate	Individual	Explicit (based on unit credit act. lib.)	Explicit (based on unit credit act. lib.)	Explicit (based on unit credit act. lib.)	Implicit
Individual Level Method	Cost Prorate	Individual	Implicit	Implicit	Implicit	Benefit-based: Implicit Other: Explicit
Frozen Entry Age Method	Cost Prorate	Group	Explicit	Explicit	Explicit	Implicit
Frozen Attained Age Method	Cost Prorate	Group	Explicit (based on unit credit act. lib.)	Explicit (based on unit credit act. lib.)	Explicit (based on unit credit act. lib.)	Implicit
Aggregate Method	Cost Prorate	Group	Implicit	Implicit	Implicit	Implicit
Individual Aggregate Method	Cost Prorate	Individual	Implicit	Implicit	Implicit	Implicit

Normal Cost:	Accrued Benefit Method
Supplemental Cost:	Explicit methodology on all unfunded liability sources.

The unit credit method (unprojected) can be used with flat dollar unit benefit and career average benefit formulas; however, it is not acceptable for use with benefit formulas based on final average salary.

Unit Credit Method (Projected). The unit credit method (projected) is equivalent to:

Normal Cost:	Benefit Prorate Method (constant dollar version only)
Supplemental Cost:	Explicit methodology on all unfunded liability sources.

As noted in Chapter 11, pension accounting requires a variation of this method to be used in determining pension expense; hence, many plans have adopted this approach for ERISA purposes even though the amortization methodologies are different and, often, the interest rates will be different.

The constant percent version of the benefit prorate method is not permitted in determining ERISA contribution limits.[4]

Entry Age Method. The entry age normal method has the following components:

Normal Cost:	Cost Prorate Method (constant dollar or percent version)
Supplemental Cost:	Explicit methodology on all unfunded liability sources.

The constant percent version is typically used with salary-based benefit formulas, while the constant dollar version is used with flat dollar unit benefit formulas.

Attained Age Method. The attained age method is equivalent to the following:

Normal Cost:	Cost Prorate Method (constant dollar or percent version)
Supplemental Cost:	Explicit methodology on unfunded liability at plan formation, plan changes and assumption changes based on unit credit actuarial liability. Implicit methodology on gains and losses and difference between unit credit actuarial liability and cost prorate actuarial liability.

[4]The prohibition of a given funding method for determining IRS contribution limits does not preclude the plan sponsor from using that method to establish contributions to the plan, provided, of course, that such contributions fall within the ERISA limits.

As noted, unit credit actuarial liability is used to determine the initial unfunded liability (or when ERISA became applicable, if later), plan changes and assumption changes. Explicit supplemental costs are used for these unfunded liability sources. The excess of the entry age actuarial liability over the unit credit actuarial liability is amortized by the implicit methodology, along with actuarial gains and losses.

Individual Level Method. The individual level method is equivalent to the following:

Normal Cost:	Cost Prorate Method (constant dollar or percent version)
Supplemental Cost:	Implicit methodology on all unfunded liability sources except non-benefit based actuarial gains and losses for the explicit methodology is used.

The implicit amortization period runs from the employee's attained age to retirement, as opposed to the *open group* methodology that amortizes unfunded liabilities over the future lives or compensation of each year's group of active employees.

Frozen Entry Age Method. The frozen entry age method is based on a group (or aggregate) calculation methodology and is equivalent to the following:

Normal Cost:	Cost Prorate Method (constant dollar or percent version)
Supplemental Cost:	Explicit methodology on all unfunded liability sources except actuarial gains and losses.

Explicit supplemental costs are used on the initial unfunded liability and the unfunded liability associated with plan amendments and assumption changes.[5] In determining the initial unfunded liability to be amortized explicitly, the entry age method's actuarial liability is used. The implicit supplemental cost methodology is used on actuarial gains and losses.

Frozen Attained Age Method. The frozen attained age method is identical to the attained age method except that it involves a group calculation rather than an employee-by-employee calculation. It is equivalent to the following:

[5]Some experts believe that assumptions changes can be amortized explicitly or implicitly under the frozen initial liability method, provided they are treated consistently from year to year.

Normal Cost:	Cost Prorate Method (constant dollar or percent version)
Supplemental Cost:	Same as Attained Age Method, but with group calculation methodology.

Aggregate Method. This method is equivalent to the following:

Normal Cost:	Cost Prorate Method (constant dollar or percent version)
Supplemental Cost:	Implicit methodology on all unfunded liability sources.

Unlike the individual methods, where the normal cost and actuarial liability are determined on a participant-by-participant basis and then summed for the entire plan, the aggregate method is based on a group calculation (i.e., the present value of future benefits for all participants is divided by the present value of future payroll or future lifetimes, depending on which version is being used).[6] The total cost so determined is referred to by ERISA as the "normal cost" of this method, even though it equals an underlying normal cost plus an implicit supplemental cost.

Since the aggregate method has only a "normal cost" (which, by definition, includes the implicit supplemental costs), the minimum and maximum contribution limits are virtually identical.[7] Under this method, the implicit amortization period depends on the age composition of active employees. If the active group is overmature, the amortization period could be the equivalent of 10 years or less, whereas if the group is undermature, the period might equate to 15 or even 20 years. In any case, this method almost assuredly amortizes experience variations over a longer period than the explicit amortization requirement of 5 years for minimum contributions, and it amortizes plan amendments over a shorter period than the explicit requirement of 30 years (see subsequent discussion of statutory amortization periods). On the other hand, since this methodology funds each

[6]The term "aggregate" is not clearly defined in either the actuarial literature or ERISA. In most contexts the term refers to aggregating normal costs and supplemental costs, while in others it refers to the use of a group calculation. As noted previously, the term aggregate is used in this book to refer only to the group calculation methodology.

[7]Maximum tax deductible contributions are determined as of the end of the year, whereas minimum required contributions are determined on a basis that assumes quarterly payments throughout the year; hence, the minimum will be somewhat smaller than the maximum due to the interest assumed on contributions made prior to year end.

year's *remaining* unfunded liability over each year's future salaries (or lifetimes) of active employees, the amortization period theoretically extends over an infinite time period, even though the vast majority of the liability is funded during the first 10 to 20 years.

Individual Aggregate Method. This is the same as the Aggregate Method but with individual instead of group calculation methodology. This method requires that assets be allocated to plan participants in a reasonable and consistent manner. This method is equivalent to the following:

Normal Cost:	Cost Prorate Method (constant dollar or percent version)
Supplemental Cost:	Implicit methodology on all unfunded liability sources using individual calculations with assets allocated to participants.

Statutory Amortization Periods

The second component of equation (10.1) is the supplemental costs associated with prior increases or decreases in the unfunded liability that are not yet fully amortized. As noted in the previous section, some statutory funding methods amortize one or more of the unfunded liability sources with *implicit supplemental costs*, whereby the amortization schedule is determined by the same methodology used to determine the method's normal cost.[8] For these methods, the statutory amortization period is, in fact, the implicit period. However, for funding methods that use explicit supplemental costs (i.e., an n-year, level dollar, amortization) for one or more of the unfunded liability sources, the maximum amortization period is set by statute.

ERISA and IRS regulations define the maximum amortization periods to be used in determining explicit supplemental costs, as indicated in Table 10–3. OBRA '87 shortened the amor-

[8]See Chapter 7 for a detailed description of supplemental cost methodologies. The implicit supplemental cost methodology is often referred to as the *spread gain method*, since the amortization of the unfunded liability is spread out over future normal costs. The explicit supplemental cost methodology is often referred to as the *immediate recognition method*, because the unfunded liability is immediately recognized (or determined) and then amortized over n years.

TABLE 10–3

Amortization Periods for Minimum Required Contributions

Unfunded Liability Source	*ERISA*	*OBRA '87 (After 1/1/88)*
Initial Unfunded Liability for plans existing as of 1/1/74	40 years	
Initial Unfunded Liability for plans formed after of 1/1/74	30 years	
Plan Amendments	30 years	
Assumption Changes	30 years	10 years
Actuarial Gains and Losses	15 years	5 years
Funding Waivers	15 years	5 years
Change in Funding Method	See Text	
Current Liability Full Funding Limit applicable when Minimum Required Contribution would otherwise apply	n/a	10 years

tization periods for changes in actuarial assumptions, actuarial gains and losses, and funding waivers that occur after January 1, 1988; however, the longer periods initially established under ERISA continue to apply to previously identified unfunded liabilities.

The rules for amortizing the unfunded liability due to a change in funding methods (the penultimate entry in Table 10–3) depend on whether the unfunded liability increases or decreases as a result of the change. The amount of the unfunded liability change is equal to the total unfunded liability under the new method less the sum of the outstanding amortization balances as of the date of the change, less the FSA credit balance or plus the funding deficiency. If the unfunded liability decreases, the amortization period for minimum required contributions is 30 years. If the unfunded liability increases, the period is 40 years (or 30 years if the plan was started after January 1, 1974) less the time interval from the application of ERISA to the current date or, if longer, the lesser of 15 years or the weighted average future working lifetime of active employees.

The last entry in Table 10–3 relates to the case where the current liability full funding limit (see subsequent discussion) reduces the minimum required contribution that would otherwise apply. This reduction is amortized over 10 years.

The supplemental cost at the beginning of year t during an m-year amortization period under the explicit method was given in Chapter 7 by equation (7.8b):

$$(SC_n)_t = \frac{(\Delta_n UL)}{\ddot{a}_{\overline{m}|}} \qquad (1 \le t \le m) \qquad (7.8b)$$

where

$(\Delta_n UL)$ = nth unfunded liability (positive or negative) developed during a prior year

$\ddot{a}_{\overline{m}|}$ = m-year period certain annuity.

The sum of such supplemental cost payments, with the amortization periods equal to the statutory maximums set forth in Table 10–3, represents the second component making up the minimum required contribution in (10.1).

If the valuation rate of interest changes, new supplemental cost limits are determined by dividing the beginning-of-year outstanding balance for each amortization by an annuity evaluated at the new interest rate for the period remaining in the amortization schedule.

If the statutory funding method uses explicit supplemental costs for one or more of the unfunded liability sources, a large number of supplemental cost schedules can develop. These schedules can be combined, as follows. First, the positive unfunded liabilities and negative unfunded liabilities are aggregated separately. Then, for the larger of the two, an amortization period is derived such that the corresponding supplemental costs amortize the unfunded liability balance.[9] Finally, the net unfunded liability (i.e., the sum of the positive and negative amounts) is amortized over the derived amortization period in determining the new, net, supplemental cost amount.

As a general rule, it is not beneficial to combine supplemental cost schedules for determining minimum contributions, especially those associated with plan design changes, as these are needed explicitly in determining the additional funding charge, as discussed below.

[9]The derived amortization period may be fractional or it can be rounded down if the larger of the two amortization bases is positive or rounded up if the larger is negative.

Additional Funding Charge

The fourth component of the minimum required contribution given by (10.1) is designed to speed up the funding of underfunded plans. The formula is as follows:

$$(AFC)_t = Min \left\{ \begin{array}{c} {}^{Old}(SC)_t + {}^{New}(SC)_t + {}^{CE}(SC)_t - {}^{I/PA}(SC)_t \\ (UCL)_t \end{array} \right\} \quad (10.3)$$

where

$(AFC)_t$ = additional funding charge

${}^{Old}(SC)_t$ = supplemental cost associated with *old* unfunded current liability established in 1988 and amortized over the succeeding 18 years

${}^{New}(SC)_t$ = supplemental cost associated with the *new* unfunded current liability as of the current year (excluding any remaining *old* unfunded current and any unfunded contingent event liabilities)

${}^{CE}(SC)_t$ = supplemental costs associated with contingent events

${}^{I/PA}(SC)_t$ = sum of all explicit supplemental costs for the initial unfunded actuarial liability and plan amendments that are not yet fully amortized

$(UCL)_t$ = unfunded current liability.

The unfunded current liability, $(UCL)_t$, is used explicitly in equation (10.3) and the current liability is involved in determining the old and new supplemental costs; hence, it is appropriate to define this liability before discussing the other components of (10.3).

Current Liability

The current liability for participants in pay status at age x, having earned a benefit of B_r, is given by

$$(CL)_x = B_r \, \ddot{a}_x. \quad (x \geq r) \quad (10.4a)$$

If the participant in question terminated employment through a disability, then the annuity factor in (10.4a) should reflect disabled-life mortality. The current liability for non-active parti-

cipants who terminated at age z with a vested benefit of B_z and who are currently age x with benefits payable at age r is given by

$$(CL)_x = B_z \; {}_{r-x}p_x^{(m)} \; v^{r-x} \; \ddot{a}_r. \quad (z \le x \le r) \qquad (10.4b)$$

This assumes that the participant has elected out of the mandatory 50 percent survivor benefit required by the Retirement Equity Act (REA) of 1984 or, equivalently, that the survivor benefit is provided on an actuarially equivalent basis. If the survivor benefit is subsidized by the plan sponsor, then a death benefit representing the value of the survivor annuity would be included in (10.4b).

The current liability for active employees is not precisely defined by statute or regulations; however, the calculation must be based on an ongoing rather than a terminating plan scenario. A reasonable interpretation would be to include all ancillary benefits; however, some experts believe that some benefits (e.g., disability and death benefits) need not be included in this calculation. With the broader interpretation, the current liability for active employees can be expressed as follows:

$$(CL)_x = B_x \sum_{k=x}^{r''} {}_{k-x}p_x^{(T)} \; v^{k-x} \cdot \left(q_k^{(t)} \; {}^{v}F_k + q_k^{(d)} \; {}^{d}F_k + q_k^{(m)} \; {}^{s}F_k + q_k^{(r)} \; {}^{r}F_k \right) \qquad (10.4c)$$

where each F_k function represents the value of the benefit payable at each decrement. These values for the model pension plan were defined in equation (8.7) of Chapter 8.

Each actuarial assumption, except for the interest rate, must reflect the actuary's best estimate of the plan's future experience solely with respect to that assumption. The interest rate is mandated by law to fall between 90 and 110 percent of the weighted average yield on 30-year Treasury bonds. The weights begin at 40 percent for the most recent year and equal 30, 20, and 10 percent, respectively, for the prior three years.

The unfunded current liability, which is used in determining the *additional funding charge* for underfunded plans, is defined as

$$(UCL)_t = Max \begin{cases} (CL)_t - \left[(AV)_t - {}^{CB}(FSA)_t \right] \\ 0 \end{cases} \qquad (10.5)$$

where

$(AV)_t$ = actuarial value of assets at beginning of year t[10]

${}^{CB}(FSA)_t$ = credit balance in the funding standard account at beginning of year t (i.e., from the end of prior year).

The *additional funding charge* defined by (10.3) is equal to the sum of three supplemental costs less a fourth, but in no case is it greater than the plan's unfunded current liability as defined by (10.5).

The first three supplemental cost components of the additional funding charge are discussed below. The fourth component represents a subtraction of the supplemental cost for unfunded liabilities associated with the initial unfunded liability and for plan amendments.

Old Supplemental Costs. This component of (10.3) represents the supplemental costs associated with the unfunded current liability, if any, that existed in 1988 (the *old* unfunded current liability). The amortization period for this liability is 18 years, beginning in 1989:

$$ {}^{Old}(SC)_t = \frac{{}^{Old}(UL)_t}{\ddot{a}_{\overline{18-(t-89)}|\, i'_t}} \tag{10.6}$$

where

${}^{Old}(UL)_t$ = balance of unfunded *old* current liability

$\ddot{a}_{\overline{18-(t-89)}|\, i'_t}$ = annuity certain for the remaining years in the 18-year amortization period, based on the interest rate used with the current liability.

If the current liability interest rate never changed, this supplemental cost would not have to be recalculated. However, the current liability interest rate changes almost yearly, therefore, it is necessary to accumulate last year's outstanding balance to the beginning of the current year (i.e., last year's balance less last year's supplemental cost, all accumulated with last year's current liability interest rate) and then divide this balance by an annuity certain for the remainder of the 18 years at the new current liability interest rate.

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[10]The actuarial value of assets is discussed in the final section of this chapter. It may represent the market value of assets or a smoothing of market and/or book values.

New Supplemental Costs. This component of (10.3) represents the supplemental cost associated with the new, or current year's, unfunded current liability, if any:

$$^{New}(SC)_t = \left[(UCL)_t - {}^{CE}(UL)_t - {}^{Old}(UL)_t\right] \cdot \left[.30 - .25\ Max\left\{{}_{0}^{(FR)_t - .35}\right\}\right] \qquad (10.7)$$

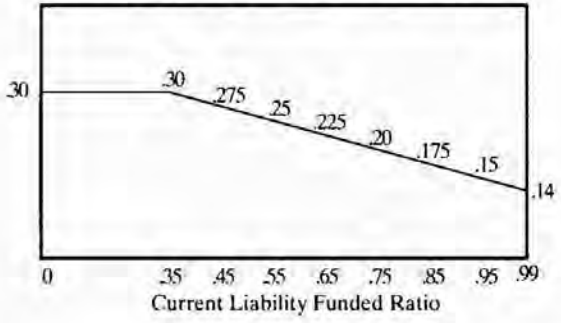
where,

$^{CE}(UL)_t$ = unfunded liability associated with prior contingent events

$(FR)_t$ = funded ratio equal to actuarial value of assets less the FSA credit balance, all divided by the current liability.

This cost represents a percentage of the *adjusted* unfunded current liability. The adjustment involves subtracting the unfunded liability associated with contingent events and the *old* unfunded liability, since these supplemental costs are explicitly included in the additional funding charge in (10.3). The adjusted unfunded current liability is multiplied by a percentage [the second row of (10.7)] that runs from a high of 30 percent for plans that have a funded ratio of 35 percent or less, to a low of 14 percent for plans that have a 99 percent funded ratio. A graph of this percentage for various funded ratios is given in Figure 10–1.

FIGURE 10–1
Percent of Adjusted Unfunded Current Liability



Contingent Event Supplemental Costs. An unpredictable contingent event benefit is any benefit not contingent upon age, service, compensation, death, disability, or other event that is reasonably and reliably predictable. For example, a plant shutdown

or massive layoff would constitute an unpredictable contingent event. If the plan experiences such events that are not assumed in the actuarial assumptions, then the additional funding charge must reflect the amortization of the associated liability. The supplemental cost, which represents a component of the additional funding charge in (10.3), is the greater of two values:

$$^{CE}(SC)_t = Max \begin{Bmatrix} ^{CE}B_t\,[1 - (FR)_t]\,(TP)_t \\ {}_{7\text{-}pay}^{CE}(SC)_t \end{Bmatrix} \qquad (10.8)$$

where

$^{CE}B_t$ = current year's benefit payments associated with all contingent events

$(TP)_t$ = transition percentage, equal to 20 percent for 1993 and increasing by 10 percent per year to 100 percent by 2001

${}_{7\text{-}pay}^{CE}(SC)_t$ = supplemental costs associated with amortizing contingent event liabilities over 7 years.

The first value in (10.8) is a percentage (i.e., fraction) of the current year's benefit payments associated with prior contingent events, where the percentage is equal to the complement of the current liability funded ratio times a transition percentage. The transition percentage is 20 percent for 1993, increasing by 10 percentage points per year to 100 percent by year 2001. Alternatively, if the aggregate supplemental cost associated with amortizing each contingent event liability over a 7-year period from the date of the contingent event is greater, then this amount represents the contingent event supplemental cost.

Table 10–4 summarizes the equations discussed thus far for determining the minimum required contribution. The two full funding limit tests are also shown on this summary, and discussed in the following two sections.

Actuarial Liability Full Funding Limit

The actuarial liability under the statutory funding method used by the plan sponsor is used to define one of two *full funding limits* (FFL) associated with minimum required contribu-

TABLE 10–4

Minimum Required Contribution (End of Year)

$$^{Min}(EC)_{t+1} = Min\left\{\begin{array}{c}\left[(NC)_t + (\sum SC)_t - (FSA)_t\right](1+i) + (AFC)_t(1+i') \\ {}^{AL}(FFL)_{t+1} - (FSA)_t(1+i) \\ {}^{CL}(FFL)_{t+1} - (FSA)_t(1+i)\end{array}\right\}$$

where

$$(AFC)_t = Min\left\{\left[{}^{Old}(SC)_t + {}^{New}(SC)_t + {}^{CE}(SC)_t - {}^{I/PA}(SC)_t\right] \text{ or } (UCL)_t\right\}$$

where

$${}^{Old}(SC)_t = {}^{Old}(UL)_t \div \ddot{a}_{\overline{18-(t-89)}|\,i'_t}$$

$${}^{New}(SC)_t = \left[(UCL)_t - {}^{CE}(UL)_t - {}^{Old}(UL)_t\right]\left[.30 - .25\ Max\left\{\begin{array}{c}(FR)_t - .35 \\ 0\end{array}\right\}\right]$$

$${}^{CE}(SC)_t = Max\left\{\left[{}^{CE}B_t\,(1 - (FR)_t)\ (TP)_t\right] \text{ or } {}_{7\text{-pay}}^{CE}(SC)_t\right\}$$

$$(UCL)_t = Max\left\{\begin{array}{c}(CL)_t - \left[(AV)_t - {}^{CB}(FSA)_t\right] \\ 0\end{array}\right\}$$

where

$${}^{AL}(FFL)_{t+1} = \left[\left\{(AL)_t + (NC)_t\right\} - Min\left\{\begin{array}{c}(MV)_t - {}^{CB}(FSA)_t \\ (AV)_t - {}^{CB}(FSA)_t\end{array}\right\}\right](1+i)\,.$$

$${}^{CL}(FFL)_{t+1} = 1.5\left[\left\{(CL)_t + {}^{CL}(NC)_t\right\}(1+i') - E(B)_t\,(1+\tfrac{1}{2}i')\right] - \left[Min\left\{\begin{array}{c}(MV)_t - {}^{CB}(FSA)_t \\ (AV)_t - {}^{CB}(FSA)_t\end{array}\right\}(1+i) - E(B)_t\,(1+\tfrac{1}{2}i)\right]$$

tions.[11] The FFL based on the plan's actuarial liability will be referenced by ${}^{AL}(FFL)_t$. The second FFL, defined by the current liability yet to be discussed, will be referenced by ${}^{CL}(FFL)_t$.

The ${}^{AL}(FFL)_t$ is equal to the year-end value of the liability *less* the smaller of the market value or actuarial value of assets (excluding any contributions for the current year and less any credit balance in the funding standard account). If the adjusted asset value exceeds the actuarial liability, the minimum required contribution is zero. The FFL based on the statutory funding method's actuarial liability can be represented as follows:

$$
\begin{aligned}
{}^{AL}(FFL)_{t+1} = &\left[\{(AL)_t + (NC)_t\}(1+i) - E(B)_t(1+\tfrac{1}{2}i)\right] \\
&- \left[Min\begin{Vmatrix}(MV)_t - {}^{CB}(FSA)_t\\(AV)_t - {}^{CB}(FSA)_t\end{Vmatrix}(1+i) - E(B)_t(1+\tfrac{1}{2}i)\right] \qquad (10.9a)
\end{aligned}
$$

where

${}^{AL}(FFL)_{t+1}$ = year-end full funding limit based on the statutory funding method's actuarial liability for year t

$E(B)_t$ = expected benefit payments during year t

$(MV)_t$ = market value of assets at beginning of year t

$(AV)_t$ = actuarial value of assets at beginning of year t

${}^{CB}(FSA)_t$ = credit balance in the funding standard account at beginning of year t (i.e., from the end of prior year).

Since both the actuarial liability and plan assets in (10.9a) are adjusted for expected benefit payments, the benefit terms cancel and the full funding limit can be expressed by

$$
{}^{AL}(FFL)_{t+1} = \left[\{(AL)_t + (NC)_t\} - Min\begin{Vmatrix}(MV)_t - {}^{CB}(FSA)_t\\(AV)_t - {}^{CB}(FSA)_t\end{Vmatrix}\right](1+i). \qquad (10.9b)
$$

The actuarial value of plan assets can represent any valuation method that takes into account fair market value. Several such methods are discussed in the final section of this chapter.

---

[11] If the statutory funding method involves implicit supplemental costs (e.g., individual level premium, frozen entry age, attained age, or aggregate methods), the ${}^{AL}(FFL)_t$ is based on the actuarial liability under the entry age normal method, and the normal cost for that method is also used in the calculation.

Current Liability Full Funding Limit

The current liability is used in defining a second full funding limit (FFL):

$$
\begin{aligned}
{}^{CL}(FFL)_{t+1} = {} & 1.5\left[\left\{(CL)_t + {}^{CL}(NC)_t\right\}(1+i') - E(B)_t\,(1+\tfrac{1}{2}i')\right] \\
& - \left[Min\begin{Bmatrix}(MV)_t - {}^{CB}(FSA)_t \\ (AV)_t - {}^{CB}(FSA)_t\end{Bmatrix}(1+i) - E(B)_t\,(1+\tfrac{1}{2}i)\right] \qquad (10.10)
\end{aligned}
$$

where

$^{CL}(FFL)_{t+1}$ = year-end full funding limit based on the current liability for year t

$(CL)_t$ = current liability at beginning of year t

$^{CL}(NC)_t$ = current liability normal cost at beginning of year t, equal to (10.4c) evaluated with b_x instead of B_x

i' = current liability interest rate

i = valuation interest rate.

The interest rate used in projecting the current liability to year end is the rate used in calculating the current liability, while the interest rate used to adjust assets is the valuation rate of interest.

If the full funding limitation based on the actuarial liability is reached, then all supplemental cost schedules in the FSA are eliminated for future years.[12] This is the case even if credits exceed charges, implying that when the plan comes out of full funding, such credits are not available to reduce future contributions. If the full funding limitation based on the current liability is reached, while the actuarial liability FFL is not, then the amortization bases are maintained and an additional basis is established to fund the contribution that would be required without regard to the current liability FFL over 10 years.

[12] If contributions are constrained by the full funding limitation, any accumulated funding deficiency resulting from the normal operation of the FSA is eliminated by a *full funding credit* which results in the FSA having a non-negative balance for the year in question.

Funding Standard Account

The FSA, which is reported in Schedule B of Form 5500, shows the charges and credits for the applicable year, as indicated in Table 10–5a for which the plan year is assumed to run from 1/1/xx to 12/31/xx. Table 10–5a can also serve as a worksheet in determining the current year's minimum contribution. By completing the schedule with employer contributions assumed to be zero (line i), any funding deficiency that results represents the minimum required contribution payable at the end of the year. Table 10–5b shows a schedule for developing the additional funding charge (item e) in the FSA.

Additional Interest Charge Due to Late Quarterly Contributions

The plan sponsor must make quarterly pension contributions by the 15th day following the end of each plan-year quarter. The amount of the quarterly contributions can be 25 percent of the prior year's minimum contribution or 22.5 percent (90 percent of 25 percent) of the current year's minimum. The prior year's minimum for this purpose is the year-end value determined without considering the credit balance or funding deficiency. The current year's minimum for this purpose is the minimum as of the beginning of the year without considering the credit balance or funding deficiency, unless the latter is not eliminated by payment within 8 1/2 months after year end. If the plan has unfunded contingent event liabilities, the supplemental costs for these liabilities are not included in the minimum required calculation for quarterly contribution purposes. Instead, the quarterly contributions are increased by the larger of (1) 25 percent of the 7-year supplemental costs associated with the contingent event unfunded liabilities, or (2) the unfunded percentage of the unfunded contingent event benefit payments for 3 months prior to the month of the quarterly payment. The prior year's credit balance, if any, can be used in lieu of quarterly contributions.

As indicated by item f in Table 10–5a, the FSA is charged for any interest penalty paid on late quarterly contributions, with the offsetting credit, of course, being an increase in employer contributions equal to the interest charge. The penalty interest rate is equal to the greater of the current liability rate or 175 percent of

TABLE 10–5a
Funding Standard Account

Charges	
a. Prior year funding deficiency, if any	_____
b. Normal cost as of 1/1/xx	_____
c. Amortization charges:	
(i) Funding waivers	_____
(ii) Other than waivers	_____
d. Interest to 12/31/xx on a, b, and c	_____
e. Additional funding charge, if applicable (see Table 10-5b)	_____
f. Additional interest charge due to late quarterly contributions	_____
g. Total charges (a through f)	_____
Credits	
h. Prior year credit balance, if any	_____
i. Employer contributions during the period from 1/1/xx to 12/31/xx	_____
j. Amortization credits	_____
k. Interest to 12/31/xx on h, i and j	_____
l. Miscellaneous credits:	
(i) FFL credit before reflecting 150% of current liability component	_____
(ii) Additional credit due to 150% of current liability component	_____
(iii) Waived funding deficiency	_____
(iv) Total miscellaneous credits	_____
m. Total credits (h through l)	_____
n. Credit balance: (if m < g, show difference) or funding deficiency: (if g < m, show difference)	_____
Reconciliation	
p. Current year's accumulated reconciliation account:	
(i) Due to additional funding charge as of 1/1/xx	_____
(ii) Due to additional interest charges as of 1/1/xx	_____
(iii) Due to waived funding deficiency	_____
(iv) Total as of 12/31/xx	_____

the federal midterm rate as of the first month of the plan year. The additional interest charge is equal to the short fall amount times the penalty rate from the quarterly contribution due date to the actual contribution date, less the valuation rate from the

TABLE 10–5b

Development of Additional Funding Charge

a. Current liability as of 1/1/xx	
b. Adjusted assets as of 1/1/xx (actuarial value – prior year credit balance)	
c. Funded current liability percentage (100 b ÷ a)	%
d. Unfunded current liability as of 1/1/xx (b – a)	
e. Outstanding balance of unfunded old liability as of 1/1/xx	
f. Liability attributable to any unpredictable contingent event benefit	
g. Unfunded new liability (d – e – f)	
h. Unfunded new liability amount (___% of g)	
i. Unfunded old liability amount	
j. Deficit reduction contribution (h + i)	
k. Net amortization charge for certain bases	
l. Unpredictable contingent event amount:	%
(i) Benefits paid during year due to unpredictable contingent event	
(ii) Unfunded current liability percent (1 – % in c)	
(iii) Transition percentage	
(iv) Product of (i), (ii) and (iii)	
(v) Amortization of all unpredictable contingent event liabilities	
(vi) Greater of (iv) or (v)	
m. Additional funding charge as of 1/1/xx [excess of j over k plus l(vi)]	
n. Assets needed to increase current liability percentage to 100% (line d)	
o. Lesser of m or n	
p. Interest to 12/31/xx on item o at current liability interest rate	
q. Additional funding charge (o + p)	

quarterly contribution due date to the earlier of the actual contribution date or the end of the plan year.

Miscellaneous Credits

Miscellaneous credits shown in Table 10–5a allow one to keep the funding standard account in balance. The miscellaneous credits involve three parts:

$$(MC)_t = Max\left\{\begin{matrix}\left[{}^{FD}(FSA)_{t+1} - {}^{AL}(FFL)_{t+1}\right] \\ 0\end{matrix}\right\} +$$

$$Max\left\{\begin{matrix}Max\left\{\begin{matrix}\left[{}^{FD}(FSA)_{t+1} - {}^{CL}(FFL)_{t+1}\right] \\ 0\end{matrix}\right\} - Max\left\{\begin{matrix}\left[{}^{FD}(FSA)_{t+1} - {}^{AL}(FFL)_{t+1}\right] \\ 0\end{matrix}\right\} \\ 0\end{matrix}\right\}$$

$$+ {}^{FD}(Waiver)_t \qquad (10.11)$$

where

$(MC)_t$ = miscellaneous credits

${}^{FD}(FSA)_{t+1}$ = year-end funding deficiency, determined without regard to prior year credit balance and current year contribution

${}^{AL}(FFL)_{t+1}$ = year-end full funding limit based on actuarial liability under statutory funding method

${}^{CL}(FFL)_{t+1}$ = year-end full funding limit based on current liability

${}^{FD}(Waiver)_t$ = funding deficiency waiver.

The first credit is the excess of the funding deficiency over the actuarial liability FFL, if any. In other words, if this FFL is applicable, then the funding deficiency (which would otherwise be a required minimum contribution) must be offset by a credit in the FSA. Secondly, if the current liability FFL is lower than the actuarial liability FFL, then this amount likewise must be offset by a credit in the FSA. Finally, the minimum required contribution is reduced by any funding waiver granted by the IRS for the current year.

An equation of equilibrium can be used to check if the FSA has been properly completed; namely, the unfunded actuarial liability must equal the outstanding unamortized liability balance less the FSA balance:

$$(AL)_t - (AV)_t = (ULB)_t - (FSA)_t \qquad (10.12a)$$

where

$(AL)_t$ = actuarial liability under statutory funding method at beginning of year t

$(AV)_t$ = actuarial value of assets at beginning of year t

$(ULB)_t$ = unamortized liability balance at beginning of year t

$(FSA)_t$ = funding standard account balance at beginning of year (i.e., from end of prior year, with credit balances assumed to be positive and funding deficiencies assumed to be negative).

However, this equation will not balance if there has been (1) additional funding charges, (2) additional interest charges on late contributions, or (3) waived funding deficiencies. The reconciliation account in the FSA (see the bottom of Table 10–5a) is used to account for these differences.

The entries for the additional funding charge and additional interest charge are determined by accumulating each prior year's outstanding balance in the reconciliation account with interest at the valuation rate and adding to these balances any prior year charges. The outstanding balance due to waivers equals the prior year's outstanding balance increased at the valuation interest rate less any year-end amortization amount.

Hence, the FSA equation of equilibrium becomes

$$(AL)_t - (AV)_t = (ULB)_t - (FSA)_t - (RA)_t \qquad (10.12b)$$

where

$(RA)_t$ = reconciliation account balance.

Alternative Minimum Funding Standard

As an alternative to the minimum contribution derived from (10.1), or equivalently, the FSA, the plan may elect to contribute according to an *alternative minimum funding standard.* The charges to the alternative account are equal to

- the accrued benefit normal cost (or, if lower, the normal cost under the funding method in use), plus
- the excess, if any, of the accrued benefit actuarial liability over the market value of plan assets.

This alternative is available only if the statutory funding method is the entry age normal method. The regular FSA must be maintained while the alternative is in use, with its accumulated fund-

ing deficiency being amortized over 5 years if the plan reverts back to the regular FSA for determining minimum contributions.

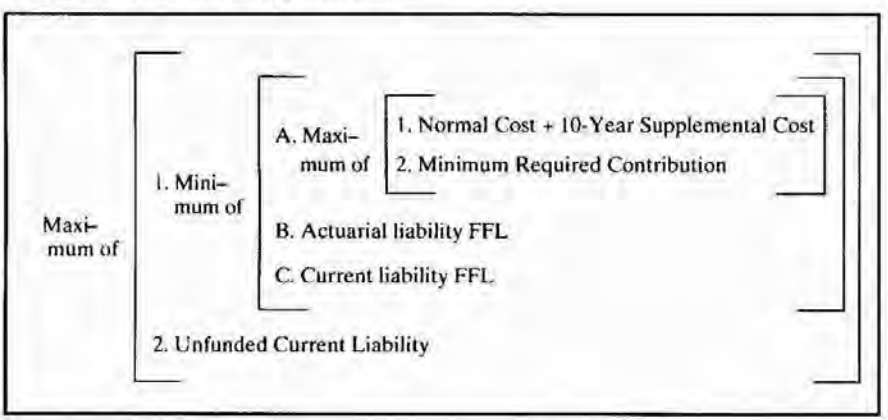
If the alternative FSA produces a lower required contribution, then the difference, multiplied by the complement of the employer's marginal tax rate, can be viewed as a loan to the employer, with loan interest rate equal to the valuation rate of interest multiplied by the compliment of the employer's marginal tax rate. This might represent an attractive loan in some cases, depending on the employer's tax rate and cash requirements.

MAXIMUM TAX DEDUCTIBLE CONTRIBUTIONS

There are statutory limitations on the amount of contributions to a qualified pension plan that an employer can deduct, with a 10 percent excise tax being imposed on contributions in excess of such limits.[13] Figure 10–2 sets forth this contribution limit.

FIGURE 10–2

Maximum Tax Deductible Contribution



In words, the maximum contribution is equal to the lesser of items (1) and (2), or, if larger, item (3):

(1) the normal cost under the statutory funding method plus maximum limit adjustments based on 10-year amortiza-

[13]Excess contributions may be deducted in future tax years (*carry-over contributions*), but are subject to the 10 percent excise tax for each tax year they remain nondeductible.

tions of the various unfunded liability balances, or if larger, the minimum required contribution

(2) the two full funding limits at year end (without adjustment for any credit balance)

(3) the unfunded current liability at year end, based on the actuarial value of assets.

The two full funding limits applicable to *maximum tax deductible contributions* are nearly identical to equations (10.9b) and (10.10) except that assets are not reduced for the FSA credit balance, but are reduced by any employer contributions that are not yet deductible.

Since experience variations are amortized over 5 years in determining minimum required contributions and over 10 years for determining maximum tax deductible contributions, it is possible that a plan's minimum required contribution could exceed its maximum tax deductible contribution. Under these circumstances, the minimum would be deductible, provided it does not exceed the full funding limits yet to be discussed.

Each year actual employer contributions must be allocated to the outstanding balances for all of the maximum amortizations in order to determine when they becomes zero. The portion of the employer's prior year total contribution applied to the maximum supplemental cost limits can be determined by

$$ {}^{SC}C_{t-1} = \frac{{}^{Qrt}C_{t-1}\, s\overline{|1|}^{(4)}}{(1+i)} - (NC)_{t-1} \qquad (10.13a) $$

where

${}^{SC}C_{t-1}$ = portion of prior year's total contribution applied to the maximum supplemental cost limits

${}^{Qrt}C_{t-1}$ = prior year's quarterly contributions

$s\overline{|1|}^{(4)}$ = factor for accumulating quarterly contributions with interest to end of year[14]

$$ s\overline{|1|}^{(4)} = (1+i)^{3/4} + (1+i)^{1/2} + (1+i)^{1/4} + 1 . $$

[14]If contributions are not both uniform and paid quarterly, then the interest adjustment would be changed accordingly.

$(NC)_{t-1}$ = prior year's normal cost.

The prior year's supplemental cost contributions allocated to each unfunded liability base is prorated to each of the maximum supplemental cost limits as follows:

$$ {}^{SC_n}C_{t-1} = \frac{(SC_n)_{t-1}}{(\sum SC)_{t-1}} \, {}^{SC}C_{t-1} \tag{10.13b} $$

where

${}^{SC_n}C_{t-1}$ = portion of prior year's contribution applied to nth supplemental cost for determining maximum contributions

$(SC_n)_{t-1}$ = nth supplemental cost from prior year for determining maximum contributions

$(\sum SC)_{t-1}$ = aggregate supplemental costs from prior year.

The outstanding balance for the current year is then determined as

$$ (\Delta_n UL)_t = \left[(\Delta_n UL)_{t-1} - {}^{SC_n}C_{t-1}\right](1+i) \tag{10.13c} $$

where

$(\Delta_n UL)_t$ = nth unfunded liability balance in year t.

If the valuation interest rate is changed between the times $t-1$ and t, a revised maximum supplemental cost limit must be determined. The first step is to determine the number of years remaining in the maximum amortization schedule by equating the unfunded liability balance with the present value of future supplemental costs at the prior year's interest rate, and then solving for x in the following: [15]

$$ (\Delta_n UL)_t = (SC_n)_t \, \ddot{a}_{\overline{x}|i_{t-1}}. \tag{10.13d} $$

Once the value of x has been determined, the revised supplemental cost for determining maximum contributions under the new interest rate is simply

$$ (SC_n)_t = \frac{(\Delta_n UL)_t}{\ddot{a}_{\overline{x}|i_t}}. \tag{10.13e} $$

[15]The derived amortization period may be fractional or it can be rounded to an integer.

For maximum tax deductible contributions, supplemental costs of unequal length may also be combined. First, all of the unfunded liabilities (negative and positive amounts) are combined to obtain a net unfunded liability. Then a weighted average amortization period is calculated, as illustrated below assuming only two unfunded liability amounts:

$$Yrs = \frac{|(\Delta_n UL)_t|(Yrs)_n + |(\Delta_{n+1} UL)_t|(Yrs)_{n+1}}{|(\Delta_n UL)_t| + |(\Delta_{n+1} UL)_t|} \qquad (10.14)$$

where

Yrs = years for amortizing the combined unfunded liabilities

$|(\Delta_n UL)_t|$ = absolute value of nth unfunded liability balance

$(Yrs)_n$ = amortization years remaining for the nth supplemental cost.

The net supplemental cost is determined by dividing the net unfunded liability by an annuity certain for the weighted average period found in (10.14).

An alternative to the above procedure when dealing with the supplemental costs for determining the maximum tax deductible contribution, is to use the *fresh start* method. At any time, all amortization bases can be replaced with a single base equal to the plan's unfunded liability amortized over 10 years. The fresh start never produces a larger maximum contribution than was allowed prior to the fresh start.

If employer contributions exceed the maximum contribution limit, the excess may be carried forward and deducted in a future year, but a yearly 10 percent excise tax is applicable on the portion of the excess contribution that remains non-deductible.

NUMERICAL ILLUSTRATION OF STATUTORY FUNDING REQUIREMENTS

An illustrative projection of the minimum required contribution and maximum tax deductible contribution for the model pension plan is given in Table 10–7, based on the valuation and experience assumptions provided in Table 10–6. The return on plan assets is assumed to vary between 5 and 10 percent every 5

TABLE 10–6

Valuation and Experience Assumptions

Valuation Assumptions (same as Model Assumptions):	
Mortality:	71 GAM (Table 2–1), for health lives, Table 2–5 for disabled lives
Termination:	Select and Ultimate (Table 2–3)
Disability:	Table 2–7
Retirement:	Distribution from age 55 to 65 (Table 2–9)
Salary Increase:	5% + Merit Scale (Table 2–10)
Interest Rate:	8% used for all cost and liability calculations
Asset Method:	5-year average of market value
Cost Method:	Constant Dollar Benefit Prorate
FSA:	Zero credit balance
Experience Assumptions:	
Decrements:	Same as Valuation Assumptions
Salary Increase:	Same as Valuation Assumptions
Investment Return:	10% for 5 years, 5% for 5 years, 10% for 5 years, then 5%
Ad hoc COLA:	25% of cumulative inflation every 3 years
Contributions:	ERISA minimum required contribution
Membership:	Population in 25th year from Table 4–7, held constant thereafter

years in order to generate actuarial gains and losses for illustrative purposes. The initial plan membership is equal to the population in the 25th year from Table 4–7; however, the size of the active population is assumed to be constant during the 20 year projection as opposed to the decreasing active membership assumption used beyond year 25 in Table 4–7.

Normal costs remain relatively constant at about 4.4 percent of payroll throughout the 20 year projection period. The initial unfunded liability produces a constant dollar supplemental cost that decreases as a percentage of payroll, beginning at 1.43 percent and reducing to .56 percent after 20 years. *Ad hoc* cost-of-living increases, equal to 25 percent of cumulative inflation, are assumed to be granted every 3 years. These plan amendments have a small impact on costs, amounting to only .5 percent of salary by the end of the 20 year projection period. Actuarial gains and losses, resulting from returns of 5 percent for 5 years, then 10 percent for 5 years, and so forth, have a cumulative impact of just over 2 percent of payroll in the worst year. In most

TABLE 10–7

Projection of ERISA Minimum Required and Maximum Tax Deductible Contribution
(Values Expressed as a Percent of Payroll)

		Supplemental Costs						
Year	*Normal Cost*	*Initial Unfunded Liability*	*Plan Amendment*	*Actuarial Loss (Gain)*	*Minimum Required Contributions*	*Normal Cost (EOY)*	*10-Year Supplemental Costs*	*Maximum Tax Deductible Contribution*
1	4.47	1.43	0.00	0.00	5.89	4.83	2.25	7.08
2	4.39	1.37	0.00	0.40	6.16	4.75	2.42	7.16
3	4.36	1.31	0.00	0.55	6.22	4.71	2.42	7.13
4	4.36	1.24	0.09	0.48	6.17	4.70	2.44	7.15
5	4.36	1.18	0.09	0.22	5.85	4.71	2.17	6.88
6	4.37	1.13	0.08	–0.24	5.34	4.72	1.78	6.50
7	4.38	1.07	0.18	–0.75	4.88	4.73	1.74	6.47
8	4.39	1.02	0.17	–0.79	4.79	4.74	1.70	6.43
9	4.39	0.97	0.17	–0.40	5.13	4.75	1.81	6.56
10	4.40	0.92	0.27	0.35	5.94	4.75	2.28	7.04
11	4.41	0.88	0.26	1.45	7.00	4.76	2.67	7.43
12	4.41	0.83	0.25	2.06	7.55	4.77	2.87	7.63
13	4.42	0.79	0.36	2.13	7.69	4.77	3.09	7.86
14	4.42	0.76	0.34	1.73	7.25	4.77	2.91	7.68
15	4.42	0.72	0.32	0.91	6.37	4.77	2.57	7.34
16	4.42	0.68	0.44	–0.30	5.24	4.78	2.32	7.10
17	4.42	0.65	0.42	–0.97	4.53	4.78	2.03	6.81
18	4.42	0.62	0.40	–1.05	4.40	4.78	1.96	6.74
19	4.42	0.59	0.52	–0.62	4.91	4.78	2.34	7.12
20	4.42	0.56	0.49	0.28	5.76	4.78	2.63	7.41

TABLE 10–8

Projection of ERISA Minimum Required and Maximum Tax Deductible Contribution Under Alternative Funding Methods
(Values Expressed as a Percent of Payroll)

	Unit Credit (Projected)			*Entry Age*			*Frozen Entry Age*			*Aggregate*		
Year	*NC*	*Min*	*Max*	*NC*	*Min*	*Max*	*NC*	*Min*	*Max*	*NC*	*Min*	*Max*
1	4.47	5.89	7.08	4.07	7.45	8.76	3.87	7.25	8.54	6.95	6.95	7.51
2	4.39	6.16	7.16	4.05	7.70	8.82	4.07	7.32	8.59	6.89	6.89	7.45
3	4.36	6.22	7.13	4.04	7.71	8.73	4.16	7.26	8.49	6.75	6.75	7.29
4	4.36	6.17	7.15	4.04	7.59	8.67	4.14	7.19	8.45	6.64	6.64	7.17
5	4.36	5.85	6.88	4.04	7.18	8.30	4.03	6.93	8.14	6.33	6.33	6.84
6	4.37	5.34	6.50	4.04	6.57	7.82	3.84	6.59	7.74	5.96	5.96	6.43
7	4.38	4.88	6.47	4.03	6.02	7.70	3.76	6.49	7.68	5.84	5.84	6.31
8	4.39	4.79	6.43	4.03	5.87	7.59	3.83	6.42	7.57	5.74	5.74	6.20
9	4.39	5.13	6.56	4.02	6.17	7.66	4.01	6.47	7.60	5.76	5.76	6.22
10	4.40	5.94	7.04	4.02	6.98	8.10	4.29	6.74	7.94	6.03	6.03	6.52
11	4.41	7.00	7.43	4.02	6.84	8.47	4.65	5.79	8.18	6.25	6.25	6.75
12	4.41	7.55	7.63	4.02	7.43	8.63	4.86	5.94	8.24	6.32	6.32	6.82
13	4.42	7.69	7.86	4.01	7.56	8.80	4.90	6.05	8.37	6.40	6.40	6.91
14	4.42	7.25	7.68	4.01	7.05	8.21	4.80	5.90	8.12	6.19	6.19	6.68
15	4.42	6.37	7.34	4.01	6.07	6.09	4.59	5.63	7.74	5.87	5.87	6.34
16	4.42	5.24	7.10	4.01	4.79	5.51	4.27	5.39	7.50	5.63	5.63	6.08
17	4.42	4.53	6.81	4.01	3.99	5.22	4.11	5.18	7.20	5.38	5.38	5.81
18	4.42	4.40	6.74	4.01	3.85	5.20	4.13	5.15	6.69	5.29	5.29	5.72
19	4.42	4.91	7.12	4.01	4.41	5.65	4.29	5.40	6.31	5.54	5.54	5.98
20	4.42	5.76	7.41	4.01	5.36	6.04	4.58	5.64	5.84	5.72	5.72	6.17

years, the impact is between negative and positive one percent. Since assets are averaged over five years and actuarial gains and losses are additionally amortized over 5 years, the effects of gains and losses on contribution limits are minimal. As indicated in Table 10–7, minimum required contributions fluctuate in the range of 4.5 to 7.5 percent over the projection period.

Minimum required contributions are determined at the beginning of the year in this projection, while maximum tax deductible contributions are an end-of-year calculation. These values for the illustrative projection are shown in the last portion of Table 10–7. Normal costs are increased to the end of the year by the interest assumption and supplemental costs are based on 10-year schedules. The difference between the minimum and maximum is about 1 percent of payroll in the early years of the projection, increasing to about 2 percent in later years.

Table 10–8 shows the normal costs, minimum required contributions, and maximum tax deductible contributions under three additional funding methods. The entry age (EA) and frozen entry age (FEA) methods have similar minimums and maximums, with FEA generally having a somewhat greater spread between the two limits. The aggregate method has minimums lower than both FEA and EA; however, its maximum is only about .5 percent of payroll greater (a result solely due to beginning-of-year versus end-of-year calculations).

STATUTORY ASSET VALUES

As noted previously, two asset values are used in the various calculations associated with minimum required and maximum tax deductible contributions: *market value* and *actuarial value.* Market value, as the name implies, represents the fair market value of plan assets as of the valuation date. While the plan sponsor may elect to set the actuarial value equal to market value, in many cases an *asset valuation method* is used to establish the plan's actuarial value.

Generally speaking, an asset valuation method is designed to smooth the year-to-year fluctuations in market value, which, in turn, has a smoothing effect on statutory contribution limits. Various asset valuation methods exist for accomplishing this smoothing process, the principal ones of which are discussed in this section. ERISA permits any asset valuation methodology

that *reflects* market value; however, if the actuarial value in any given year falls outside a 20 percent corridor of market value, then the actuarial value must be adjusted to comply with this 20 percent limit.[16]

Weighted Average Method

A weighted average of book value and market value is an asset valuation method that can reduce the volatility of the actuarial value of assets, the degree to which depends on the percent weights and the extent of portfolio turnover. Naturally, if turnover is heavy, especially just before the valuation date, then the difference between market and book values may be quite small. As an aside, a properly designed asset valuation method should have minimal influence, if any, on whether or not gains are realized, a characteristic that the weighted average method does not possess.[17] This method can be expressed as follows:

$$(AV)_t = k\ (MV)_t + (1-k)\ (BV)_t \qquad (10.15)$$

where

$(AV)_t$ = actuarial value of assets at beginning of year t

$(MV)_t$ = market value of assets at beginning of year t

$(BV)_t$ = book value of assets at beginning of year t

k = portion of market value used in weighting.

Average Ratio Method

The average ratio method adjusts the current book value of assets by an n-year average of market-to-book ratios:

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[16]ERISA initially permitted bonds to be evaluated at their amortized book value; however, OBRA '87 eliminated this alternative unless *bond dedication* is being used (i.e., where bond coupon and maturities are matched with expected benefit payments and/or the duration of bonds and liabilities are matched).

[17]For example, if the market value were to increase substantially during the year, there may be a motivation to trade the portfolio near year end only because the book value and, hence, the actuarial value, would reflect the entire increase rather than a weighted average increase, and vice versa, if market assets decreased significantly during the year. Such trading may not be in the best interest of the pension plan; thus, asset valuation methods that have this potential conflict are generally regarded as undesirable.

$$(AV)_t = (BV)_t \frac{1}{n}\left[\frac{(MV)_{t-1}}{(BV)_{t-1}} + \frac{(MV)_{t-2}}{(BV)_{t-2}} + \cdots + \frac{(MV)_{t-n}}{(BV)_{t-n}}\right]. \quad (10.16)$$

This method is sensitive to portfolio turnover, since it utilizes the book value of assets; hence, like the weighted average method, it may not be a desirable technique.

N-Year Moving Average Method

Perhaps the most commonly used method is a 3 to 5 year moving average of market values. The mathematics for this approach is given by

$$(AV)_t = (MV)_t - \frac{n-1}{n}(CG)_{t-1} - \frac{n-2}{n}(CG)_{t-2} - \cdots - \frac{1}{n}(CG)_{t-n+1} \quad (10.17)$$

where

n = averaging period

$(CG)_t$ = capital gains (or losses), both realized and unrealized, during year t.

If the averaging period were 5 years, for example, then 80 percent of the prior year's capital gain (or loss) would be eliminated from the current market value, 60 percent of the gain (or loss) two years prior would be eliminated, and so forth. Conversely, as each year goes by, an additional 20 percent of each year's capital gain (or loss) is recognized in the actuarial value. This approach, while implicitly adjusting for the growth (or decline) in assets over time, places a uniform emphasis on each year's capital gain (or loss) during the averaging period. A variation of this method is to place disproportional weight on more recent experience.

Write-Up Method

Under the write-up method, the prior year's actuarial value of assets, appropriately adjusted for contributions and benefit payments, is increased by a specified yield, typically the interest rate used in the actuarial valuation:

$$(AV)_t = [(AV)_{t-1} + C_{t-1} - B_{t-1}](1 + i) \quad (10.18)$$

where

C_t = employer contributions during year t

B_t = benefit payments during year t.

This method, which ignores both market and book values, produces a smooth progression of valuation assets. If the actuarial value strays beyond the ERISA 20 percent corridor, adjusting assets to the corridor would, of course, produce a discontinuity in this progression.

Corridor Method

A variation on the write-up method is to compute a preliminary actuarial value of assets according to (10.18) and compare this value to a predetermined corridor of market value, e.g., 85 to 110 percent of market. If the preliminary value falls outside the corridor, this method adjusts the preliminary value by $100k$ percent of the difference between the corridor and the preliminary value. Denoting the preliminary value determined by (10.18) with a prime notation, we have

$$(AV)_t = (AV)_t' + k\,[c_1\,(MV)_t - (AV)_t'] \qquad (10.19a)$$

when $(AV)_t' < c_1\,(MV)_t$, and

$$(AV)_t = (AV)_t' - k\,[(AV)_t' - c_2\,(MV)_t] \qquad (10.19b)$$

when $(AV)_t' > c_2\,(MV)_t$

where

k = adjustment fraction

c_1 = proportion of market value defining lower corridor limit

c_2 = proportion of market value defining upper corridor limit.

This method has a number of parameters. The value of k is often set in the range of .25 to .33 and the corridor coefficients, which need not be symmetrical, are frequently in the range of .10 to .20.

Table 10–9 shows the mean and standard deviation of the actuarial value of assets, expressed as a percent of these statistics for market value, under the various asset valuation methods discussed in this section. These results are based on a stochastic simulation of a 50-50 stock-bond portfolio, with standard deviations of annual returns equal to 18 percent for stocks and 10 per-

cent for bonds, or an average of 14 percent for the portfolio. The dividend for stocks is assumed to be 4 percent and the coupon rate for bonds 7 percent. Turnover for each asset class is assumed to be 25 percent per year. The results are based on the 10th year of a stochastic simulation, with contributions defined as the minimum required contribution under the constant dollar benefit prorate method.

TABLE 10–9

Effect of Alternative Asset Valuation Methods on the Actuarial Value of Plan Assets

Valuation Method	*Average*	*Std. Dev.*
Market Value	100.0	17.6
Weighted Average ($k = .5$)	97.5	14.3
Average Ratio:		
$n = 3$	100.2	18.8
$n = 5$	99.7	17.9
Moving Average:		
$n = 3$	98.0	15.6
$n = 5$	96.9	13.9
Write-Up ($i = 8\%$)	95.6	11.7
Corridor ($i = 8\%; c_1 = c_2 = .15$):		
$k = .33$	95.7	11.7
$k = .25$	95.6	11.7

The weighted average method, with the weighting factor equal to .5, shows that valuation assets lag market assets by 2.5 percent on average, with the standard deviation being reduced from 17.6 to 14.3 percent. The average ratio method, under the stated assumptions, has little effect on the actuarial value of assets as compared to market value. The n-year moving average method, evaluated at 3 and 5 years, shows the tradeoff between lower volatility and the lag in actuarial assets as compared to market assets. Both the write-up and corridor methods show a substantial decrease in volatility with about a 5 percent lag in asset values. The relationships shown in Table 10–9, of course, would change under different assumptions; nevertheless, they indicate that any asset valuation method that reduces asset volatility produces, on average, a lower value of assets, assuming a positive growth in such assets. The effect of an asset valuation method on pension costs is similar, namely, lower volatility along with somewhat higher average costs.