APPENDICES

RETIREMENT BENEFITS

In Section III, we provided a general description of how to assess total compensation comparability using the results of a pay level survey, and valuing fringe benefits using the Standard Population Method. This included an illustration, for retirement benefits, of how to derive the Benefit Value Per Employee in the Standard Population. To derive the Benefit Value Per Employee, we first calculate the benefit value for each employee, then combine the results and divide by the number of employees or total payroll as appropriate.

In this Appendix, we describe the approach to calculating the benefit value for each employee in the case of retirement benefits.

There are two distinct types of retirement benefit plans:

-- defined contribution (or provident fund) plans

-- defined benefit plans

Under the first type, the employer and, usually, employees each pay a percentage of pay into a fund. At retirement, the employee receives a benefit equal to the accumulation of contributions over his career plus investment earnings.

Under the second type, the benefit is defined in advance of retirement, often by means of a formula which expresses the benefit in terms of pay near retirement and the employee's service. Since most employees are still many years from retirement, actuarial techniques must be used to determine the value to the employee today, for a benefit payable in the future.

Retirement plans also exist which combine defined contribution and defined benefit features. In any type of plan, partial (or no) benefits may be payable on leaving service before retirement. Two plans which are otherwise identical, but have different leaving service benefits, have a different value to the employee.

The general form of a formula for determining the value of the retirement benefit is:

$$\frac{\sum \text{AMOUNT OF BENEFIT} \times \text{DISCOUNT FACTOR}}{\text{SPREADING FACTOR}}$$

In this general formula, the AMOUNT OF BENEFIT is based on the formula in the retirement plan. For example, if the plan provides a lump sum retirement benefit determined as:

$$1.5 \times \begin{matrix}\text{FINAL}\\ \text{MONTHLY}\\ \text{SALARY}\end{matrix} \times \begin{matrix}\text{SERVICE FROM}\\ \text{HIRE TO}\\ \text{RETIREMENT}\end{matrix}$$

then substituting salary and service amounts into the formula will determine the dollars of benefit payable at retirement. Since the employee is likely to be several years away from retirement, it is necessary to make an assumption regarding the rate of future salary increases.

The DISCOUNT FACTOR in the general formula is required to reflect two facts:

-- the employee may not reach retirement (e.g. an employee hired at age 25 has a 15% chance of dying before 55)

-- it is not necessary to make contributions equal to the full retirement benefit, since monies set aside before retirement will earn interest.

Therefore the DISCOUNT FACTOR must combine the probability of reaching retirement age with an assumed rate of investment earnings.

The SPREADING FACTOR is designed to allocate the total value of the retirement benefit over some or all of the employee's career. This SPREADING FACTOR is critical in the valuation of fringe benefits since several alternatives are available which lead to different results. For fringe benefit valuation purposes, therefore, we wish to select that method which gives a fair and consistent value when applied plan-by-plan, year-after-year. The method must derive the level percentage of pay which, if paid over the employee's entire career, would accumulate to provide the benefits payable at retirement.

In other words, the value of retirement benefits is expressed as:

$$\frac{\sum \text{AMOUNT OF BENEFIT} \times \text{DISCOUNT FACTOR}}{\text{VALUE OF EARNINGS FROM HIRE TO RETIREMENT}}$$

Using actuarial techniques, the denominator will incorporate:

-- the same rate of salary increase as that used in the numerator

-- the probability that the employee is still employed to earn each salary

-- the same assumed rate of investment earnings as is used in the numerator.

MATHEMATICAL DEVELOPMENT

Define the following terms:

EA = Entry age

CA = Current age

RA = Retirement age

QD(x) = The death rate at age x to x+1

QW(x) = The turnover rate at age x to x+1

L(x) = Number alive at age x according to service table created

$$QD(x) = CQD(x) * (1 - \tfrac{1}{2} * CQW(x))$$

$$QW(x) = CQW(x) * (1 - \tfrac{1}{2} * CQD(x))$$

where CQD(x), CQW(x) are taken from tables of death and turnover rates according to the actuarial assumptions.

$$L(x+1) = L(x) * (1 - QD(x) - QW(x))$$

where L(0) = 1,000,000

i = Interest rate

s = Salary increase rate

AS(CA) = Annual base salary at current age

AS(EA) = Annual base salary at entry age

$$= AS(CA) * \left(\frac{1}{1+s}\right)^{CA - EA}$$

TSAL = spreading factor

= value of earnings from hire to retirement

$$= AS(EA) * \left[1 + \left(\frac{1+s}{1+i}\right) * \frac{L(EA+1)}{L(EA)} + \left(\frac{1+s}{1+i}\right)^{2} * \frac{L(EA+2)}{L(EA)} + \ldots . \right.$$

$$\left. + \left(\frac{1+s}{1+i}\right)^{RA-EA-1} * \frac{L(RA-1)}{L(EA)}\right]$$

$$PVBEN = \sum \text{amount of benefits x discount factor}$$

$$= \sum_{x=EA}^{x=RA-1} \left[BEN_x * \frac{L(x)}{L(EA)} * QW(x) * \left(\frac{1}{1+i}\right)^{x-EA} \right]$$

$$+ BEN_{RA} * \frac{L(RA)}{L(EA)} * \left(\frac{1}{1+i}\right)^{RA-EA}$$

where BEN_x = leaving service benefit at age x

BEN_{RA} = benefit payable at retirement age

Any employee contribution to defined benefit plans would be deducted from this amount.

In this development, BEN can take several forms:

BEN = the lump sum payable according to the plan formula for defined benefit lump sum plans

BEN = the annual pension multiplied by a capitalization factor for defined benefit pension plans

BEN = the accumulated fund balance arising from employer contributions to defined contribution plans.

These are discussed further below.

1. Defined Benefit Lump Sum Plans

An example of this type of plan is one which provides a lump sum benefit on retirement equal to:

1.5 x Monthly Salary at Retirement x Service

and a lump sum on leaving service equal to:

Multiple x Monthly Salary at Termination x Service

where the Multiple is determined from the following schedule:

Years of Service	Multiple
0 - 5	0.00
5 - 10	1.00
10 - 20	1.25
>20	1.50

In this case:

$$BEN_{RA} = 1.5 * AS(EA) * (1+s)^{RA-EA} * (RA - EA)$$

and

$$BEN_{x} = Multiple * AS(EA) * (1+s)^{x-EA} * (x - EA)$$

Clearly, the provisions of each plan will need to be examined to determine the potential benefit payments payable at each age. If a plan bases benefits on the average of earnings over a period prior to retirement (e.g. 3 years), then the projected earnings would be averaged taking the salary increase assumption into account.

2. Defined Benefit Pension Plans

Structurally, the benefit formulas used for defined benefit pension plans resemble those for defined benefit lump sum plans. However, since the benefits are paid as a pension, the benefit amount must be multiplied by a capitalization factor. The capitalization factor can be represented by one of:

-- an annuity payable for life, with or without a guarantee period

-- an annuity payable for life with a survivor's pension payable to a dependent on the death of the retiree.

For the purposes of fringe benefit valuation, the second form can be accurately represented by the first, with an appropriate guarantee period (e.g. 15 years). Therefore, it is only necessary to provide a general formula for the first type.

For this purpose define the following terms:

$$LL(x + 1) = LL(x) * (1 - QD(x))$$

where $LL(0) = 1{,}000{,}000$

$$P(x) = \begin{cases} 1.0 \text{ if } x - RA \text{ is less than the guarantee period} \\ \frac{LL(x)}{LL(RA)} \text{ otherwise} \end{cases}$$

Then the capitalization factor, at retirement age is:

$$C(RA) = P(RA) + \frac{P(RA+1)}{(1+i)} + \frac{P(RA+2)}{(1+i)^2} + \ldots \text{ to end of mortality table}$$

In extremely rare cases, the leaving service benefit is a pension which commences at the plan's retirement age. To allow for this deferral period, the capitalization factor at age x is:

$$C(x) = \frac{1}{(1+i)^{RA-x}} * \frac{LL(RA)}{LL(x)} * C(RA)$$

3. Defined Contribution Plans

In these plans, the employer generally pays either a flat percentage of the employee's pay or a percentage which varies by service. For example, the employer contribution could vary according to the following schedule:

Years of Service	Employer Contribution As % of Pay
1 - 5	5%
5 - 10	7.5%
>10	10%

Then if CN(x - EA) = contribution % at age x

$$BEN_{RA} = AS(EA) * [CN(1) * (1+i)^{RA-EA} + CN(2) * (1+s)(1+i)^{RA-EA-1} + CN(3) * (1+s)^2 * (1+i)^{RA-EA-2} + \ldots + CN(RA-EA) * (1+s)^{RA-EA-1} (1+i)]$$

For leaving service benefits, it is often the case that a portion of the full fund balance is payable. For example, benefits may be payable depending on service at termination such as:

Years of Service at Termination	% of Accummulated Employer Contribution Vested
<5	0%
5 - 10	50%
>10	100%

In these cases, BEN_X, the benefit payable on leaving service at age x is calculated as:

$$BEN_X = VT(x-EA) * AS(EA) * [CN(1) * (1+i)^{x-EA} + CN(2) * (1+s) * (1+i)^{x-EA-1} + ... + CN(x-EA) * (1+s)^{x-EA-1} (1+i)]$$

where VT(x-EA) is the vested percentage from the table above.

ACTUARIAL ASSUMPTIONS

It will be evident that, in order to complete the calculations shown in the mathematical development, it will be necessary to develop actuarial assumptions. Broadly speaking, there are two main types of assumptions -- the economic factors and the demographic factors. We shall deal with each of these in turn.

Economic Factors

The economic factors are those which have an impact on salary increases and the time-value of money. A reasonable model for these items, as applied to retirement plans, would identify the following factors:

Pre-Retirement		Post-Retirement	
Interest Rate	Salary Increase Rate	Interest Rate	Pension Increase Rate
1. Pure interest	1. "Real" increase	1. Pure interest	1. "Real" increase
2. Inflation	2. Inflation	2. Inflation	2. Inflation

This is a simplified model of a more general model which would include such items as risk and performance premiums. However, for purposes of fringe benefit valuation, this model is fully adequate. Note that for the vast majority of plans in Hong Kong, the right-hand side is irrelevant since benefits are payable in the form of, or commutable to, a lump sum.

In this model, inflation is a common element. Because of this, for purposes of fringe benefit valuation, suitable benefit values will result from calculations which either include or exclude inflation. This permits us to remove the necessity for making an assumption regarding inflation since it generally has no material impact on the final result.

In the case of the civil service retirement plan, the valuation could best proceed by splitting the retirement benefit into two components -- that part which is commutable and that part which is payable in the form of a pension. Since virtually all retirees commute the maximum amount allowed, this portion of the benefit would be valued as a lump sum plan. The balance would be valued as a pension which preserves its value in real terms by using the above model.

To complete the process, it is necessary to specify the values to be used. For this purpose, it is necessary to recognize that retirement benefits are very long-term obligations which accrue over the working lifetime of employees and extend into retirement where benefits are paid as a pension. Long-term studies over many economic cycles suggest that, for purposes of retirement benefits, the following assumptions would be appropriate:

-- pure interest, pre- and post-retirement: 3%

-- "real" salary increases: 2%

For those rare plans in the private sector which are denominated in pension form, but which are neither commutable nor have evidence of pension increases, an interest rate of 6% will be used for the capitalization factor. This difference will have no material impact on the final fringe benefit value for the private sector when all results have been aggregated.

Demographic Factors

Generally, the demographic factors have less impact on the final benefit value than the economic factors. The two principal demographic factors are rates of mortality and termination of service. Of these two factors, mortality has the smaller impact. In fact, the change in the final value of total compensation will not be materially changed by the minor differences which will result from choosing different mortality tables. For our purposes, therefore, we recommend using Hong Kong Life Tables 1981. This will provide values of CQD(x) described earlier.

The civil service publishes personnel statistics which include the numbers of employees resigning or terminating service. These statistics should be refined to determine termination rates which vary by age to give a table showing value of CQW(x), as defined earlier.