

# LEVEL INDIVIDUAL COST METHODS

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## I. NORMAL COST CALCULATION

- A. Done once per employee
- B. Independent of assets

## II. ACCRUED LIABILITY

- A. Directly defined
- B. Retrospective = accumulated past normal costs
- C. Prospective =  $PVB - PVNC$
- D.  $UAL = AL - AAV$

## III. GAINS AND LOSSES

- A. Define as  ${}_eUAL_1 - UAL_1$
- B. Must fund G/L plus NC
  - 1. assume pre-ret  $q_x^{(d)}$
  - 2. employee survives to retirement age
  - 3. NC funds  ${}_{65-x}P_x$  retirees at 65
  - 4. G/L amort covers all mortality losses

# LEVEL COST FUNDING EQUATION

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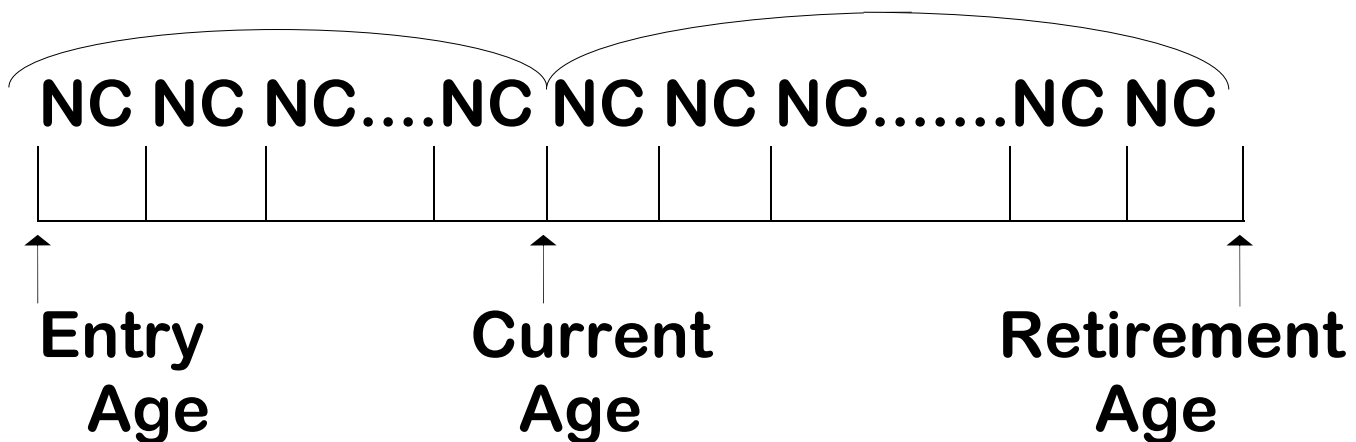
Calculate PV of projected benefit, based on total service, at current age.

Level cost method calculates normal cost based on funding starting at entry age or current age.

For any cost method, we have

$$\text{Accrued Liability} = \text{PVFB} - \text{PVFNC}$$

Retrospective: AL      Prospective: PVNC



# **COST ALLOCATION METHOD**

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- 1. Define Projected Benefit**
- 2. Normal Cost Calculation**
  - a. Level dollar amount**
  - b. Level percentage of payroll**
- 3. Funding Period**
  - a. Current age to ARA**
  - b. Entry age to ARA**
- 4. Individual vs. Aggregate NC calculation**

**(Unit Credit: Benefit allocation method)**

# ENTRY AGE NORMAL

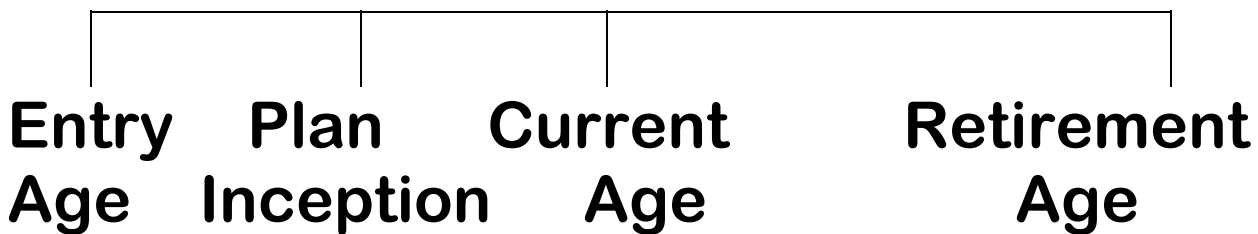
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Method defines normal cost:

Level \$ EANC:  $PVB_{EA} / \ddot{a}_{EA:RA-EA}$

$PVE_{EA} = PAY_{EA} ({}^s\ddot{a}_{EA:RA-EA})$

Level %EANC:  $PVB_{EA} / PVE_{EA}$



Fund normal cost over period from EA to RA.  
Assume that funding started at entry, even though plan was not in existence.

## ENTRY AGE NORMAL ACCRUED LIABILITY

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$$\begin{aligned}\text{Accrued Liability Level \$} &= \sum_{t=EA}^{CA-1} EANC (1+i)^{CA-t} / {}_{CA-t}p_t \\ &= \sum_{t=EA}^{CA-1} EANC (D_t / D_{CA}) \\ &= PVFB - PVNC\end{aligned}$$

Accrued Liability represents theoretical fund assets if all assumptions were met. The retrospective definition is accumulated EANC at valuation date.

## **ENTRY AGE NORMAL ACCRUED LIABILITY**

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**When projected benefit changes, the entry age normal cost is recalculated. This affects the prior assumed normal cost payments, changes the Accrued Liability.**

**Other items that change normal cost, and force recalculation of Accrued Liability:**

- 1. Salary increase different than Salary Scale assumption**
- 2. Change in plan benefit formula**
- 3. Change in Social Security law for integrated plan benefit formula**
- 4. Change in actuarial assumptions**

# ENTRY AGE NORMAL

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For pay related plans, normal cost is calculated as level % of pay:

$$EANC_{EA} = PVB_{EA} / \ddot{s}_{EA:RA-EA}$$

$$PVE_{EA} = PAY_{EA} * \ddot{s}_{EA:RA-EA}$$

$$EANC \% = PVNC_{EA} / PVE_{EA}$$

$$EANC_{EA} = EANC \% * PAY_{EA}$$

$$\begin{aligned} EANC_{CA} &= EANC \% * PAY_{CA} \\ &= EANC_{EA} * (1+s)^{CA-EA} \end{aligned}$$

EANC is increasing dollar amount, but a level percentage of pay.

# ENTRY AGE NORMAL

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Level \$ EANC	Level % EANC								
$EANC_{EA} = \frac{PVB_{EA}}{\ddot{a}_{EA:\overline{RA-EA} }}$	$EANC_{EA} = \frac{PVB_{EA}}{{}^s\ddot{a}_{EA:\overline{RA-EA} }}$								
$\ddot{a}_{EA:\overline{RA-EA} } = \frac{N_{EA} - N_{RA}}{D_{EA}}$	${}^s\ddot{a}_{EA:\overline{RA-EA} } = \frac{{}^sN_{EA} - {}^sN_{RA}}{{}^sD_{EA}}$								
$D_x = v^x I_x$ $N_x = \sum D_t$	${}^sD_x = v^x I_x s_x$ ${}^sN_x = \sum {}^sD_t$ <table> <tr> <th><u>X</u></th><th><u>s<sub>x</sub></u></th></tr> <tr> <td>60</td><td>.85</td></tr> <tr> <td>61</td><td>.88</td></tr> <tr> <td>62</td><td>.90</td></tr> </table>	<u>X</u>	<u>s<sub>x</sub></u>	60	.85	61	.88	62	.90
<u>X</u>	<u>s<sub>x</sub></u>								
60	.85								
61	.88								
62	.90								



# ENTRY AGE NORMAL ACCRUED LIABILITY RETROSPECTIVE

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$$\begin{aligned}
 \text{Accrued Liability Level \$} &= \sum_{t=EA}^{CA-1} EANC_{CA} (D_t / D_{CA}) \\
 &= \sum_{t=EA}^{CA-1} EANC_{CA} (1+i)^{CA-t} / {}_{CA-t}p_t \\
 &= EANC_{CA} * \ddot{S}_{EA:\overline{CA-EA}|}
 \end{aligned}$$

$$\begin{aligned}
 \text{Accrued Liability Level \%} &= \sum_{t=EA}^{CA-1} EANC_{CA} ({}^SD_t / {}^SD_{CA}) \\
 &= \sum_{t=EA}^{CA-1} EANC_{CA} (S_t / S_{CA}) (1+i)^{CA-t} / {}_{CA-t}p_t \\
 &= EANC_{CA} * {}^S\ddot{S}_{EA:\overline{CA-EA}|}
 \end{aligned}$$

$$EANC \% = PVNC_{EA} / PVE_{EA}$$

$$EANC_{CA} = EANC \% * PAY_{CA}$$

# ENTRY AGE NORMAL ACCRUED LIABILITY FORMULAS

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Level \$ EANC:

$$\begin{aligned}
 AL &= EANC_{CA} * \ddot{s}_{EA:\overline{CA-EA}|} \\
 &= \frac{PVB_{EA}}{\ddot{a}_{EA:\overline{RA-EA}|}} * \ddot{s}_{EA:\overline{CA-EA}|} \\
 &= PVB_{CA} * \frac{\ddot{a}_{EA:\overline{CA-EA}|}}{\ddot{a}_{EA:\overline{RA-EA}|}}
 \end{aligned}$$

# ENTRY AGE NORMAL ACCRUED LIABILITY FORMULAS

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Level % EANC:

$$\begin{aligned}
 AL &= EANC_{CA} * \ddot{s}_{EA:CA-EA} \\
 &= PVB_{EA} * (1+s)^{CA-EA} * \ddot{s}_{EA:CA-EA} \\
 &\quad \ddot{s}_{EA:RA-EA}
 \end{aligned}$$

$$PVB_{CA} = PVB_{EA} * \frac{D_{EA}}{D_{CA}}$$

$$\begin{aligned}
 AL &= PVB_{CA} * \ddot{s}_{EA:CA-EA} \\
 &\quad \ddot{s}_{EA:RA-EA}
 \end{aligned}$$

Level \$ EANC:

$$\begin{aligned}
 AL &= PVB_{CA} * \ddot{a}_{EA:CA-EA} \\
 &\quad \ddot{a}_{EA:RA-EA}
 \end{aligned}$$

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