Public WH Design (Problem 24)

$$(b)\quad AC_{\$/\text{slot-yr}} = \frac{K_{\$/\text{yr}}}{M_{\text{slot}}}$$

Demand assumed uncorrelated since it belongs to different customers $\Rightarrow$

$$M = \left\lfloor \sum_{i=1}^{N} \left(\frac{M_i - SS_i}{2} + SS_i \right) + \frac{1}{2} \right\rfloor$$

$$= \left\lfloor 4,800 \left(\frac{250 - 0.06(250)}{2} + 15 \right) + \frac{1}{2} \right\rfloor = 636,000 \text{ slots}$$

$$IV_{0,\text{bldg}} = SV_{N,\text{bldg}} \Rightarrow K_{\$/\text{yr}} = i\, IV_{0,\text{bldg}} = 0.05\, IV_{0,\text{bldg}}$$

$$IV_{0,\text{bldg}} = \$15.50\, TA' \Rightarrow TA' = 1.15\, TA \Rightarrow$$

$$TA(D) = xL(D) \cdot \left(yD + \frac{A}{2} \right) = \frac{42}{12} L(D) \cdot \left(\frac{40}{12} D + \frac{7}{2} \right) \Rightarrow$$

Public WH Design (Problem 24)

$(b, cont)$

$$L(D) = \left\lceil \frac{M + NH\left(\frac{D-1}{2}\right) + N\left(\frac{H-1}{2}\right)}{DH} \right\rceil$$

$$= \left\lceil \frac{636{,}000 + 4800H\left(\frac{D-1}{2}\right) + 4800\left(\frac{H-1}{2}\right)}{DH} \right\rceil \Rightarrow$$

$$H = \left\lfloor \frac{18}{z} \right\rfloor = \left\lfloor \frac{18}{42/12} \right\rfloor = 5 \quad \text{(building clear-height constraint)}$$

$$D = D^* = \left\lfloor \sqrt{\frac{A(2M - N)}{2NyH}} + \frac{1}{2} \right\rfloor = \left\lfloor \sqrt{\frac{7\left(2(636{,}000) - 4800\right)}{2(4800)\frac{40}{12}(5)}} + \frac{1}{2} \right\rfloor = 7$$

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$(b, cont)$

$$\Rightarrow L = 20,503 \Rightarrow TA = 1,925,573 \Rightarrow TA' = 2,214,409 \Rightarrow$$

$$\Rightarrow IV_{0,\text{bldg}} = \$15.50\, TA' = \$15.50\,(2,214,409) = \$34,323,346$$

$$\Rightarrow K_{\$/\text{yr}} = 0.05\, IV_{0,\text{bldg}} = \$1,716,167 \Rightarrow$$

$$AC_{\$/\text{slot-yr}} = \frac{K_{\$/\text{yr}}}{M_{\text{slot}}} = \$2.70 \text{ per slot-yr}$$

Public WH Design (Problem 24)

$(a, cont)$

$$TA' = 2,214,409 \text{ ft}^2 \Rightarrow$$

$$d_{SC} = \sqrt{2}\sqrt{TA'} = \sqrt{2}\sqrt{2,214,409} = 2,104 \Rightarrow$$

$$t_{\text{min/mov}} = \frac{d_{SC}}{616} + 2\left(\frac{35}{60}\right) = 4.58$$

$$H' = 2(8)5(50) = 4000 \text{ hr/yr} \quad (\text{already using } H)$$

$$r_{peak} = 1.25\frac{f_{\text{mov/yr}}}{H'} = 1.25\frac{2,000,000}{4000} = 625 \text{ mov/hr}$$

$$m_{\text{tr}} = \lfloor r_a t_e + 1 \rfloor = \lfloor r_{peak} t_{\text{hr/mov}} + 1 \rfloor = \left\lfloor 625\frac{4.58}{60} + 1 \right\rfloor = 48 \text{ tr}$$

$$IV^{eff} = IV_0 - SV\left(1+i\right)^{-N} = 35,000 - 0.25(35,000)\left(1+0.05\right)^{-10}$$

$$= \$29,628$$

Public WH Design (Problem 24)

$(a, cont)$

$$K_{\text{tr/yr}} = IV^{eff}\left[\frac{i}{1-(1+i)^{-N}}\right] = 29,628\left[\frac{0.05}{1-(1+0.05)^{-10}}\right] = \$3,837$$

$$c^{\text{lab}}_{\$/\text{lab-yr}} = 15.00H' = \$60,000$$

$$TC_{\$/\text{yr}} = m_{\text{tr}}K_{\$/\text{tr-yr}} + \left(m_{\text{tr}} + 12\right)c^{\text{lab}}_{\$/\text{lab-yr}} + 2.75(2{,}000{,}000)\frac{t_{\text{min/mov}}}{60}$$

$$= 48(3,837) + \left(48+12\right)60,000 + 2.75(2{,}000{,}000)\frac{4.58}{60}$$

$$= \$4,204,286.27 \Rightarrow$$

$$AC_{\$/\text{mov}} = \frac{TC_{\$/\text{yr}}}{f_{\text{mov/yr}}} = \frac{4,204,286.27}{2{,}000{,}000} = \$2.10 \text{ per move}$$

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- (c) What are other costs that should be added to each charge to better reflect the true costs of each activity?
  - most significant missing costs are the facility non-move-related operating costs, which should be added to the slot-year charge
- What about average unit cost of $46.75?
  - only possible impact of unit cost would be for any insurance coverage provided by the warehouse for items stored in the warehouse
- *Note*: Number of slots of max inventory, M, used to determine $AC_{\$/\text{slot-yr}}$ instead of the total slots in warehouse since unused HCL slots would underestimate cost:

$$\text{Total Slots} = L \times D \times H = 717,605$$

$$M = 636,000$$

$$HCL = 81,605$$