Cost Comparison of
Voice Frequency Cable vs. PCM System

Solution of Case Study

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1. Background

1.1 The present value factor μ consists of:

- purchasing cost of equipment,
- charges resulting from the infinite replacement every time the equipment cannot be kept serviceable;
- charges resulting from maintenance and operation of the equipment.

1.2 The factor $\hat{\mu}$ provides the present worth of costs where only the charges reulting from infinite replacement are taken into account.

1.3 The purchasing costs of equipment, if multiplied by *pvf* μ, the capital cost is achieved. This cost includes all kind of charges.

1.4 Costs as taxes, diggging, installation where there is no purchasing expenditures, should be charged only by the expenditures for infinite replacements. So, in technoeconomic studies these values should be multiplied by $\hat{\mu}$.

2. Evaluation of *pvf*

2.1 *Cable*

$$\mu_c = 1 + \frac{1}{(1+i)^{Tc} - 1} + \frac{U_c}{i} = 1 + \frac{1}{1.1^{40} - 1} + \frac{0.02}{0.1} = \underline{\underline{1.222}}$$

$$\hat{\mu}_c = 1 + \frac{1}{(1+i)^{Tc} - 1} = 1 + \frac{1}{(1.1)^{40} - 1} = \underline{\underline{1.022}}$$

2.2 *Relay sets*

2.2.1

$$\mu_r = 1 + \frac{1}{(1+i)^{T_R} - 1} + \frac{U_R}{1} = 1 + \frac{1}{1.1^{20} - 1} + \frac{0.07}{0.1} = \underline{\underline{1.875}}$$

2.2.2

$$\hat{\mu}_r = 1 + \frac{1}{(1+i)^{T_R} - 1} = \underline{\underline{1.175}}$$

2.3 *PCM Systems*

$$\mu_p = 1 + \frac{1}{1.1^{20} - 1} + \frac{0.05}{0.1} = 1.675$$

$$\hat{\mu}_p = 1 + \frac{1}{1.1^{20} - 1} = 1.175$$

3. Evaluation of total costs

3.1 *Cable*

3.1.1 *Basic cost a*

$$a = purchasing\ cost \cdot \mu_c + placement \cdot \hat{\mu}_c = 95 \cdot 1.222 + 600 \cdot 1.022 = 116 + 613 = 729\ MU / km$$

3.1.2 *Incremental cost b*

$$b = purchasing\ cost \cdot \mu_c = 5.8 \cdot 1.222 = 7.1\ MU / pair / km$$

3.2 *Relay sets*

$$Total\ cost\ C_R = purchasing\ cost \cdot \mu_R + installation\ cost\ \hat{\mu}_R = 16 \cdot 1.875 + 5 \cdot 1.75 = 35.9\ MU / relay\ set$$

3.3 *PCM systems*

3.3.1 *Total terminal cost*

$$C = purchasing\ cost \cdot \mu_p + installation\ \hat{\mu}_p =$$

$$= 2200 \cdot 1.675 + 900 \cdot 1.175 = 3685 + 1057 = 4742\ MU / pair\ of\ \text{terminals}$$

3.3.2 *Total cost for line equipment*

$$C_{LE} = purchasing\ cost \cdot \mu_p + installation \cdot \hat{\mu}_p = (regenerators + housing)\ \mu_p + installation$$

$$\cdot \hat{\mu}_p = (100 + 20) \cdot 1.675 + 20 \cdot 1.175 = 201 + 23.5 = 224.5\ MU / reg / spacing$$

Cost per kilometer

$$C = 224.5 / 1.81 = 124\ MU / reg / km$$

4. Evaluation of break-even distance

Using Eq (13), we elaborated Table I giving the break-even distance as a function of demand growth.

In the attached diagram, the function $\lambda_o(\lambda)$ is drawn. This diagram may be used as a nomogramme for a quick decision-making. Assume for a specific link of length 12 km that the demand growth is 17 circuits/year. Which alternative is economical, the VF. cable or PCM system?

For λ = 17 and λ = 12, we find a point on the attached nomogramme. If this point lies in the area marked PCM, the PCM system is economical, otherwise VF cable must be chosen. For this specific case, PCM is advisable (see figure). We must point out that the attached nomogramme is not universal. It is only valid for the specific data that the curve was evaluated.

Table I : Evaluation of break-even distance as a function of demand growth

No.	λ	t_p	S	X(λ)	Y(λ)	Z(λ)	λ_o
1	5	16.8	80	0.413	3587	1660	5.8
2	10	12.8	120	0.233	7174	2324	7.4
3	15	10.8	150	0.162	10761	2925	8.6
4	20	9.5	200	0.125	14348	3504	9.4
5	25	8.6	220	0.101	17935	4044	10.3
6	30	8.0	250	0.085	21522	4578	11.0
7	35	7.4	250	0.073	25109	5082	11.8
8	40	7.0	280	0.064	28696	5594	12.4
9	45	6.6	300	0.057	32283	6094	13.0
10	50	6.3	320	0.052	35870	6587	13.2