Specification of Equipment

for the Rural and Metropolitan

Case Studies

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Switching Systems

Type: **SPC**   Size: **1200 lines + 110 trunks**

Item	Purchasing Cost	Taxes	Installation	Total Investment	Replace-ment	Mainten-ance	Total Present Worth
Subscriber Stage	**17.0**	3.4	1.7	22.1	2.2	8.5	**32.8**
Inlet	**10.8**	2.1	1.1	14.0	1.4	5.4	**20.8**
Outlet	**10.8**	2.1	1.1	14.0	1.4	5.4	**20.8**
Analog trunk	**49.3**	9.9	5.0	64.2	6.4	24.6	**95.2**
Digital trunk	**9.8**	2.0	1.0	12.8	1.3	4.9	**19.0**
Common equipment	**3288**	658	329	4274	434	1644	**6353**

(Taxes)   = 20% of purchasing cost

(Installation)   = 10% of purchasing cost

(Total investment)   = Purchasing cost + Taxes + Installation

(Replacement) $= \dfrac{\text{(Total investment)}}{(1+i)^{T} - 1}$

(Maintenance) $\dfrac{u}{i} \times$ (Purchasing cost)

(Present Worth)   (Total investment) + (Replacement) + (Maintenance)

T = 25 years   Service life of plant

u = 5%   Annual operating plus maintenance cost in relation to purchasing cost

i = 10%   = Interest rate

Switching Systems

Type: **SPC**   Size: **15000 lines + 1900 trunks**

Item	Purchasing Cost	Taxes	Installation	Total Investment	Replace-ment	Mainten-ance	Total Present Worth
Subscriber Stage	**17.0**	3.4	1.7	22.1	2.2	8.5	32.8
Inlet	**10.8**	2.1	1.1	14.0	1.4	5.4	20.8
Outlet	**10.8**	2.1	1.1	14.0	1.4	5.4	20.8
Analog trunk	**49.3**	9.9	5.0	64.2	6.4	24.6	95.2
Digital trunk	**9.8**	2.0	1.0	12.8	1.3	4.9	19.0
Common equipment	**30000**	6000	3000	39000	3865	15000	57965

(Taxes) $\qquad$ = 20% of purchasing cost

(Installation) $\qquad$ = 10% of purchasing cost

(Total investment) $\qquad$ = Purchasing cost + Taxes + Installation

(Replacement) $\qquad$ $= \dfrac{\text{(Total investment)}}{(1+i)^T - 1}$

(Maintenance) $\qquad$ $\dfrac{u}{i} \times$ (Purchasing cost)

(Present Worth) $\qquad$ (Total investment) + (Replacement) + (Maintenance)

T = 25 years $\qquad$ Service life of plant

u = 5% $\qquad$ Annual operating plus maintenance cost in relation to purchasing cost

i = 10% $\qquad$ = Interest rate

Switching Systems

Type: **SPC**   Size: **50000 lines + 9000 trunks**

Item	Purchasing Cost	Taxes	Installation	Total Investment	Replace-ment	Mainten-ance	Total Present Worth
Subscriber Stage	**17.0**	3.4	1.7	22.1	2.2	8.5	32.8
Inlet	**10.8**	2.1	1.1	14.0	1.4	5.4	20.8
Outlet	**10.8**	2.1	1.1	14.0	1.4	5.4	20.8
Analog trunk	**49.3**	9.9	5.0	64.2	6.4	24.6	95.2
Digital trunk	**9.8**	2.0	1.0	12.8	1.3	4.9	19.0
Common equipment	**42145**	8429	4214	54788	5571	21072	81432

(Taxes)   = 20% of purchasing cost

(Installation)   = 10% of purchasing cost

(Total investment)   = Purchasing cost + Taxes + Installation

(Replacement) $= \dfrac{\text{(Total investment)}}{(1 + i)^{T} - 1}$

(Maintenance) $\dfrac{u}{i} \times$ (Purchasing cost)

(Present Worth)   (Total investment) + (Replacement) + (Maintenance)

T = 25 years   Service life of plant

u = 5%   Annual operating plus maintenance cost in relation to purchasing cost

i = 10%   = Interest rate

Switching Systems

Type: **Analog**   Size: **10000 lines + 2000 trunks**

Item	Purchasing Cost	Taxes	Installation	Total Investment	Replace-ment	Mainten-ance	Total Present Worth
Subscriber Stage	**13.6**	2.7	2.7	19.0	1.9	10.9	31.8
Inlet	**7.0**	1.4	1.4	9.8	1.0	5.6	16.4
Outlet	**7.0**	1.4	1.4	9.8	1.0	5.6	16.4
Analog trunk	**18.0**	3.6	3.6	25.2	2.6	14.4	42.2
Common equipment	**5860**	1172	1172	8204	829	4688	13721

(Taxes)   = 20% of purchasing cost

(Installation)   = 20% of purchasing cost

(Total investment)   = Purchasing cost + Taxes + Installation

(Replacement) $= \dfrac{\text{(Total investment)}}{(1+i)^T - 1}$

(Maintenance) $\dfrac{u}{i} \times$ (Purchasing cost)

(Present Worth)   (Total investment) + (Replacement) + (Maintenance)

T = 25 years   Service life of plant

u = 8%   Annual operating plus maintenance cost in relation to purchasing cost

i = 10%   = Interest rate

Switching Systems

Type: **Analog**   Size: **5000 lines + 1000 trunks**

Item	Purchasing Cost	Taxes	Installation	Total Investment	Replace-ment	Mainten-ance	Total Present Worth
Subscriber Stage	**13.6**	2.7	2.7	19.0	1.9	10.9	31.8
Inlet	**7.0**	1.4	1.4	9.8	1.0	5.6	16.4
Outlet	**7.0**	1.4	1.4	9.8	1.0	5.6	16.4
Analog trunk	**18.0**	3.6	3.6	25.2	2.6	14.4	42.2
Common equipment	**3420**	684	684	4788	487	2736	8011

(Taxes)   = 20% of purchasing cost

(Installation)   = 20% of purchasing cost

(Total investment)   = Purchasing cost + Taxes + Installation

(Replacement) $= \dfrac{\text{(Total investment)}}{(1+i)^{T}-1}$

(Maintenance) $\dfrac{u}{i} \times$ (Purchasing cost)

(Present Worth)   (Total investment) + (Replacement) + (Maintenance)

T = 25 years   Service life of plant

u = 8%   Annual operating plus maintenance cost in relation to purchasing cost

i = 10%   = Interest rate

Remote Subscriber Unit

Item	Purchasing Cost	Taxes	Installation	Total Investment	Replace-ment	Mainten-ance	Total Present Worth
RSU 128	**1200**	240	120	1560	159	600	2319
RSU 256	**2050**	410	205	2665	271	1025	3961
RSU 1000	**5200**	1040	520	6760	687	2600	10047
RSU 2000	**8000**	1600	800	10400	1057	4000	15457

(Taxes) $= 20\%$ of purchasing cost

(Installation) $= 10\%$ of purchasing cost

(Total investment) $=$ Purchasing cost + Taxes + Installation

(Replacement) $= \dfrac{\text{(Total investment)}}{(1+i)^T - 1}$

(Maintenance) $\dfrac{u}{i} \times$ (Purchasing cost)

(Present Worth) (Total investment) + (Replacement) + (Maintenance)

T = 25 years Service life of plant

u = 5% Annual operating plus maintenance cost in relation to purchasing cost

i = 10% $=$ Interest rate

Line Concentrator

Capacity: **160 lines + 28 trunks**

Item	Purchasing Cost	Taxes	Installation	Total Investment	Replace-ment	Mainten-ance	Total Present Worth
Basic cost	**1050**	210	178	1438	251	630	2319
Subs unit for 16 subs	**70**	14	12	96	16.8	42	155
Line unit for 17 trunks	**22**	4.4	3.8	30.2	5.3	13.2	48.7
Interface for carrier system (12 trunks)	**700**	140	120	960	168	420	1548

(Taxes)	= 20% of purchasing cost
(Installation)	= 17% of purchasing cost
(Total investment)	= Purchasing cost + Taxes + Installation
(Replacement)	$= \dfrac{\text{(Total investment)}}{(1+i)^T - 1}$
(Maintenance)	$\dfrac{u}{i} \times$ (Purchasing cost)
(Present Worth)	(Total investment) + (Replacement) + (Maintenance)
T = 20 years	Service life of plant
u = 6%	Annual operating plus maintenance cost in relation to purchasing cost
i = 10%	= Interest rate

Cost of cables

Type: **Buried Cable**

Mean size :
∅ 0.4	150 pairs
∅ 0.6	70 pairs
∅ 0.8	50 pairs
∅ 1.0	30 pairs

Item	Purchasing Cost	Digging (ducts)	Jointing Superv.	Misce-laneous	Total Investment	Replace-ment	Mainten-ance	Total Present Worth
∅ 0.4	**534**	1200	260	50	2044	75	107	2226
∅ 0.6	**467**	1200	300	85	2052	75	93	2220
∅ 0.8	**635**	1200	380	100	2315	85	127	2527
∅ 1.0	**646**	1200	300	100	2246	83	129	2458

	Mean size	Fill at relief	Present Worth per pair at f.a.r.
∅ 0.4	150 pairs	85 %	17.4
∅ 0.6	70 pairs	85 %	37.3
∅ 0.8	50 pairs	90 %	56.1
∅ 1.0	30 pairs	95 %	86.2

(Total investment) = Purchasing cost + Digging + Jointing + Miscellaneous

(Replacement) $= \dfrac{\text{(Total investment)}}{(1+i)^{T} - 1}$

(Maintenance) $\dfrac{u}{i} \times$ (Purchasing cost)

(Present Worth) (Total investment) + (Replacement) + (Maintenance)

T = 35 years Service life of plant

u = 2% Annual operating plus maintenance cost in relation to purchasing cost

i = 10% = Interest rate

Cost of Cables

Type: **Cable in DUCT**   Mean size :   ∅ 0.4   300 pairs
                                                                                       ∅ 0.6   300 pairs
                                                                                       ∅ 0.8   750 pairs

Item	Purchasing Cost	Digging (ducts)	Jointing Superv.	Misce-laneous	Total Investment	Replace-ment	Mainten-ance	Total Present Worth
∅ 0.4	**723**	1100	361	100	2284	84	144	2513
∅ 0.6	**1340**	1100	496	120	3056	113	268	3437
∅ 0.8	**4864**	1100	972	486	7422	275	972	8669
∅ 0.8L	**5107**	1100	1000	500	7707	284	1021	9013

	Mean size	Fill at relief (f.a.r.)	Present Worth per pair at f.a.r.	
∅ 0.4	300 pairs	80 %	10.5	$$(\text{PW/pair at f.a.r.}) = \frac{PW}{(Mean\ size) \times (f.a.r.)}$$
∅ 0.6	300 pairs	80 %	14.3	
∅ 0.8	750 pairs	90 %	12.8	
∅ 0.8L	750 pairs	90 %	13.4	

(Total investment)   = Purchasing cost + Digging + Jointing + Miscellaneous

(Replacement) $$= \frac{(\text{Total investment})}{(1+i)^T - 1}$$

(Maintenance) $\dfrac{u}{i} \times (\text{Purchasing cost})$

(Present Worth)   (Total investment) + (Replacement) + (Maintenance)

T = 35 years   Service life of plant

u = 2%   Annual operating plus maintenance cost in relation to purchasing cost

i = 10%   = Interest rate

PCM

Capacity: **30 circuits**

Item	Purchasing Cost	Taxes	Installation	Total Investment	Replace-ment (infinite)	Mainten-ance	Total Present Worth
Terminal	**850**	170	127.5	1147	361	425	1933
Signalling Interface Unit	**300**	60	45	405	127	150	682
LTE1	**172**	34.4	26	232	73	86	391
Regenerator (one way)	**15**	3	2.2	20.2	6.5	7.5	34
Regenerator housing (10 repeaters)	**150**	30	22.5	202.5	63.6	75	340

(Taxes)   = 20% of purchasing cost

(Installation)   = 15% of purchasing cost

(Total investment)   = Purchasing cost + Taxes + Installation

(Replacement) $= \dfrac{\text{(Total investment)}}{(1+i)^T - 1}$

(Maintenance) $\dfrac{u}{i} \times$ (Purchasing cost)

(Present Worth)   (Total investment) + (Replacement) + (Maintenance)

T = 15 years   Service life of plant

u = 5%   Annual operating plus maintenance cost in relation to purchasing cost

i = 10%   = Interest rate

Cost of Buildings

New Buildings	Size in m^2	Cost
	500	51000
	1000	95000
	2000	175000
	3000	250000

Extensions	Size in m^2	Cost
	300	12000
	500	18500
	700	25000
	900	31000

Conversion of Subscriber Lines to Building Size

Analogue Exchanges	Subscribers	Floor space in m^2
	10000	550
	15000	830
	20000	1120

SPC Exchanges	Subscribers	Floor space in m^2
	10000	180
	15000	260
	20000	325
	30000	390
	40000	455
	50000	520

Parameters of Telecommunication Cables

Unloaded	Conductor size (mm)	Capacitance (nF / km)	Loop resistance (Ω / km)	Loss at 800 Hz (dB / km)	Type
	0.4	45	280	1.55	U, D
	0.6	50	130	1.1	U, D
	0.8	38.5	72	0.72	U, D
	1.0	38.5	46	0.57	U, D

An approximate formula for the calculation of the loss of the pairs providing very good results in the voice band (0 - 4 kHz) is:

$$a = \sqrt{\pi f R C} \qquad \text{in Neper / km}$$

Loaded	Conductor size (mm)	Capacitance (nF / km)	Loop resistance (Ω / km)	Loss at 800 Hz (dB / km)	Type
	0.8	38.5	72	0.28	U, D

The calculation the loss in the voice band is performed throgh the formula:

$$a = \frac{R}{2} \sqrt{\frac{SC}{L_p}} \qquad \text{in Neper / km}$$

S = 1.83 km

L_p = 88mH

R = Loop resistance

C = Capacitance of the pair

f = Frequency in Hz (800 Hz)

U = Underground cable

D = Cable in duct

Signalling Requirements

	Subscriber loop resistance	Trunk loop resistance
SPC	2000 Ω	-
Analogue	1200 Ω	2000 Ω