DESIGN CRITERIA FOR PLANT REINFORCEMENT UPGRADING FROM FOUR-PARTY TO ALL ONE-PARTY

CONTENTS

1. GENERAL

1.1 This section provides borrowers, consulting engineers, and other interested parties with technical information for use in the design and construction of rural telephone systems. It gives basic considerations for (1) treatment of each existing facility to be retained to meet present day usage, (2) addition of facilities to upgrade existing subscribers to all one-party, and (3) future service requirements.

1.2 Plant reinforcement requirements--Unless they are exchange-wide, have in the past, presented the additional problem of establishing the limits of construction within these two extremes: (1) oversizing which results in idle plant or (2) undersizing which may lead to costly additional reinforcements. It is the intent of this section to eliminate extravagant plant additions by describing (1) an orderly approach to design engineering to prevent confusion during construction and cutover and (2) most important, providing a base for future usage of solid-state pair gain (carrier and electronic switching equipment) and other transmission devices.

1.3 To formulate additions to plant, the design engineer should (1) know the existing system and (2) understand the basic operational

problems which occur daily. These two factors will substantially assist the engineer in recommending the proper construction and cutover sequence.

1.4 The conversion process must be reviewed carefully as upgrading plans develop. In terms of the "flash cutover," (instantaneous) this could mean a substantial oversizing of facilities, or high labor cost outlays that may add little to the operation. It is possible that a "line at a time" cutover is impractical. More often, with careful design and conversion planning, a combination of the two will provide the best features of both. When it is necessary to provide facilities for conversion purposes, they are as much a part of design as those facilities required to meet subscribers' needs. Therefore, "conversion only" facilities need careful planning, and an effort should be made to work this into long range growth patterns.

1.5 When reinforcing and upgrading an existing system and planning to replace either an existing office with common control equipment or the installation of tone-dialing it will require a substantial change in the construction plan and sequence. This section is not intended to cover this.

2. CENTRAL OFFICE EQUIPMENT

2.01 Unbalanced originating traffic caused by improper line assignment is one of the most frequent problems, and yet can be the easiest to correct. A review of peg count readings, or, if not available, a line assignment review can be made in accordance with Exhibit I.

2.02 When power requirements at the busy hour or busy hours are greater than the output of the rectifier, the additional current required must come from the battery, causing the battery to discharge. Charging and discharging may lead to premature deterioration of the battery.

2.03 Loop failure, or "Threshold of Failure," can be determined by (1) adding resistance and (2) checking pulse distortion, using a pulse signaling test set (Northeast Electronics TTS26B and accessories, or equivalent). These tests, when compared with the specifications of the manufacturer, indicate the maintenance level of the operating company and will also assist the engineer with guide lines for costs of upgrading the existing equipment. Caution: Before making tests in paragraph 2.3, lift one lead off voltage meter in charger circuit to determine whether the meter is properly zeroed. Verify that full float voltage (51.5 - 52.8) is supplied to the central office under test.

2.04 Exhibit I--This exhibit proposes a 7 percent linear growth and is intended to be used for review and comparison. Experience has shown it is unwise to fill SxS line finder groups beyond 80 to 85

percent at conversion without accurate traffic data. This fill is based on trunking efficiency at conversion with less than accurate traffic data, and an expected 96 percent usage at the end of 5 years.

2.05 When expanding an existing central office from one- and four-party to all one-party with no accurate originating traffic data, it is suggested that subscribers with the same class of service (Urban Residence, Urban Business, Rural Residence, etc.) be distributed over all line groups subject to restrictions such as CMO, pay-stations, PBX, etc., as shown in Exhibit I. A complete traffic study should start during the busy season and not later than 12 months after upgrading is completed. It should be possible with reasonable record maintenance to achieve a 96 percent optimum fill on line finder groups, although steps should be taken well in advance of the point to assure the maximum fill is not exceeded.

2.06 Ringing machines will depend on the existing plant to be retained. Should existing station equipment be retained, it may be necessary to provide multifrequency ringing machines for the new system when new ringing machines are needed. Vibrator type ringing machines are inadequate with fine gauge design and may cause interference on loop plant. See TE & CM 212.

2.07 Main distributing frame space consideration will require ample lead time. Usually additions can be made to an existing MDF in the following manner: (1) using bunching block space for new pair terminations, (2) changing out old style protectors with new modules and (3) expanding upward.

2.08 Moving entrance cables is not recommended in most situations.

2.09 Single and multifrequency reference tone generators, quiet termination, loop around and remote testing are most important additions to help achieve and maintain quality service. They are essential in preventive maintenance programs.

2.10 Loop extenders, voice frequency repeaters, and traffic registers should be centralized. Peg count meters shall have five digits.

2.11 See Exhibit II for further considerations for central office additions.

2.12 For additional items see Check List for SxS TPS COE Additions (Exhibit II).

3. OUTSIDE PLANT

3.1 Existing cable plant condition will usually range from poor to fair. Major causes are:

(1) Specifications under which system was built (Transmission, housings, splicing, depth, gopher, etc.)

(2) Location in right of way
(3) Quality of construction
(4) Quality of acceptance testing
(5) Quality of maintenance

3.2 Before existing cables and other units of outside plant are considered for future usage, effort by project engineers and plant operating personnel should determine as quickly as possible whether the system is capable of meeting upgrading standards. This can be done effectively by making the following tests:

(1) Transmission (voice frequency and carrier)
(2) Electrical leakage, to ground to pairs.
(3) Resistance and resistance unbalance
(4) Noise (NM) (NG) (noise metallic and noise to ground) and balance
(5) Mutual capacitance (sample)

These tests, if made correctly and properly analyzed, will provide most of the information needed to make a determination as to whether the existing plant can be retained in the upgraded system.

3.3 A review of plant maintenance history is important. The following should be checked:

(1) Road moves (bad splicing, wrong gauges)
(2) Method of repair (conductor insulation, cracking, purging, underground splicing, etc.)
(3) Method of testing (have tests been made on a routine basis, how were tests made)

3.4 A field check of cable housings and condition should be made to determine suitability of existing housings for the upgraded system.

3.5 When making the overlay of plant additions, care should be taken to use pair-gain devices for feeders whenever possible and to use existing wire and cables for distribution purposes. Cable sizing guide lines are recommended in TE & CM 210.

3.6 When consideration is being given to retain an H-88 loading scheme, and the reinforcing facilities are to be part of that scheme, care must be taken that the existing load coil locations when applied to the new facilities will not result in an undesirable voice frequency response, should it be necessary to locate the new loading points at other than the existing load points D-66 loading is recommended. In any event end sections should not exceed 9KF.

3.7 When a reinforcing cable is required, it generally should be feeders. Existing cables are more readily converted to distribution facilities, and substantial recovery of otherwise "bad" or unusable pairs can be realized.

3.8 Existing coarse guage cables are usually not suitable for high efficiency feeder cables due to the following reasons: (1) Entering all pedestal housing.(2) Cable sizes too small in areas where station carrier facilities should be used. (3) Rehabilitation required to provide reliable carrier paths.

4. STATION EQUIPMENT

4.1 Troubles on drops, buried services, protectors, grounds, inside wire and station apparatus frequently account for more than 50% of plant troubles found. While station equipment amounts to 15% or less of the investment in rural systems it accounts for 1/3 to 1/2 of the annual maintenance.

4.2 Telephone sets exposed to open wire, will usually require rehabilitation.

4.3 500 type telephone sets which are served over cable facilities should perform satisfactorily.

4.4 Station items if retained generally require rehabilitation. Aerial drops may be introducing noise. Cords, dials and ringers have a high trouble rate. Existing ringers may be unsuitable for use on loops over 2000 ohms. Conversion to fuseless station protectors may significantly reduce maintenance.

4.5 Multifrequency ringing must be retained initially where old sets with multifrequency ringers are retained.

4.6 Ringers should be bridged. Telephone grounds, electric grounds and water systems should be bonded together.

4.7 General determination can be made from the records but inspection to determine rehabilitation of individual installations should be done as part of staking.

4.8 The testing and rehabilitation of telephone sets to be returned to service can be done in the following manner: (1) Starting with a suitable quantity of new replacement sets. (2) Install the new sets. (3) Bring the old sets back to rehabilitate or junk as necessary. (4) The original telephone sets are now ready to return to service.

5. BUILDINGS

5.1 When making additions to an existing central office building, floor space requirements should generally be based on a 25 year central office life. Floor space requirements must be considered for

the following items:

(1) Battery charging and power board
(2) ANI and CMO
(3) Voice frequency repeaters
(4) Loop extenders
(5) MDF additions
(6) Carrier radio multiplex and concentrators
(7) Connecting company requirements
(8) Mobile radio systems
(9) Register senders
(10) Local message metering equipment
(11) Standby engine generator
(12) Rest room
(13) Cable vault
(14) File cabinet and desk
(15) Switch repair space
(16) Fire reporting equipment
(17) Centralized test equipment
(18) Custom calling equipment
(19) Automatic toll ticketing
(20) Alarm sending equipment.

5.2 Usually the battery must be relocated; therefore, this space could be used in other ways.

5.3 When building additions must be made, plans should include consideration of future replacement of SxS equipment. In replacing an operating system, extra floor space must be provided during the replacement process.

6. CONSTRUCTION TIME

6.1 Construction Time and Sequence Chart--Exhibit III is a guide to use in discussing and coordinating activities. The chart, if properly prepared, will provide work priorities and assist in personnel management, which will keep the project moving without undue interruption of service and at the same time prevent duplication of effort.

6.2 The "Bar Chart" shown in Exhibit III will provide an overall picture of the project. However, it is recommended that a more detailed work plan subdividing the various phases be prepared. Numerous activities can and should be paralleled to convert in the shortest possible time, thereby saving a substantial amount of construction and engineering funds.

7. ACCEPTANCE TESTING

7.1 Testing must be done in stages. The final test should be that of loop checking and recording the results on operating plant records for plant personnel usage. In a major reinforcement the same acceptance tests are required on the retained plant that have been modified as are required on new plant.

LINE GROUPS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
UR (Urban Residence)	+34	34	34	34	35	34	34	34	35	35	34	35	35	34	35	34	35	35	35	35	35	35	34
RR (Rural Residence)	+34	34	34	34	34	34	34	34	34	34	34	34	35	34	34	34	34	34	34	34	34	34	34
UB (Urban Business)	7	7	9	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
KS Key System	+	+	1	1	1	2	2	2	1	1	2	1	1	2	1	2	1	2	1	2	1	1	2
PABX								1	1	1		1		1	1	1	1						
P.S. Pay Phone	4	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Special Lines (S.L.)	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Maximum Fill at Conversion	81	81	80	80	81	80	81	82	82	82	81	82	82	82	82	82	82	82	81	82	81	81	81

Maximum practical fill of 96 percent end of study period (5 years)

Actual Fill, 95.0 percent (Exhibit I has an assumed 7 percent growth)

Example: 1758 existing subscribers at ACS stage

1875 sub lines at conversion

2188 at end of study period

Maximum desirable fill at conversion 83 percent

Actual fill at conversion 81.0 percent

5 Year Subscribers		Conversion Subscribers	
850	Urban Res.	795	
830	Rural Res.	784	
335	Urban Bus.	202	
30	K.S. (80 trunks)	10	(30 trunks)
5	PABX (27 trunks)	2	(8 trunks)
20	P.S.	10	
46	S.L. (Test)	46	(Test)
2116		1849	

EXHIBIT I - COE Maximum-Minimum and Optimum
Line Fills for SxS TPS Equipment

REA TE & CM 207

EXHIBIT II

Suggested Checklist for SxS TPS Additions

1. One-way trunks power requirements, ANI, toll ownership, new trunk groups.

2. Review ACD or SLP for subscriber growth.

3. Inventory existing equipment and revise existing floor plan, if necessary.

4. Revise existing switching schematic to show updated inventory and location of existing equipment.

5. Revise existing switching schematic to show proposed equipment location, quantity of equipment to be ordered, and proposed traffic data. (Caution: Do not plan to move working traffic paths from existing equipment before upgrading.)

6. Consideration should be given to miscellaneous materials such as power wiring, fusing, racks, cabling to bring the office into operating condition.

7. List any materials or equipment to be supplied by owner.

8. How is long line treatment to be handled?

9. Will standby engine generator be installed? Who will furnish? Who will install?

10. Will conversation timing be eliminated?

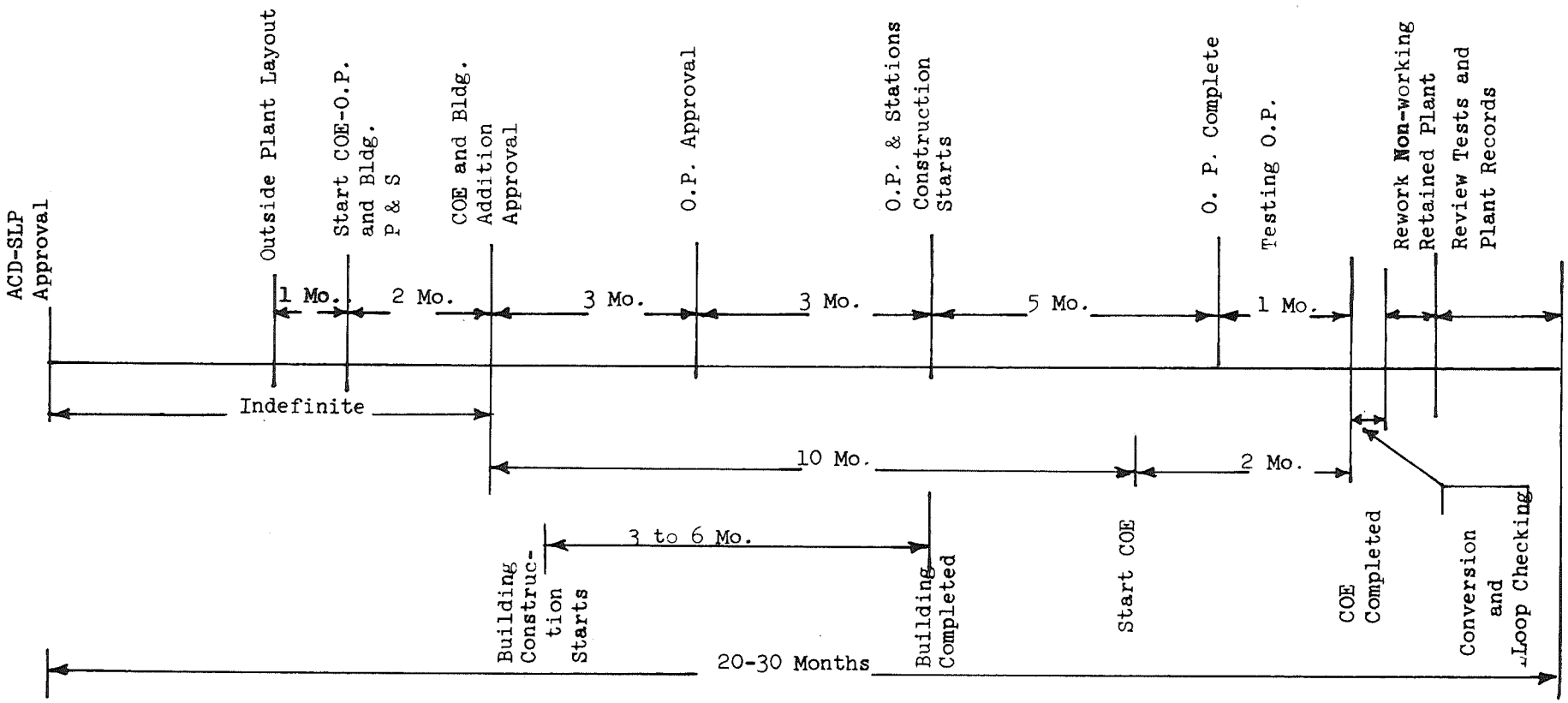
11. How will long line treatment be accomplished?

12. Have all trunk requirements been shown on switching schematic?

13. Will the existing charger and battery be adequate in the new system?

14. How will the MDF be expanded and what changes will be required in entrance cables?

15. Has adequate provision been made for relay racks for carrier, concentrators, etc.



NOTES:

1. COE addition
2. O.P. reinforcement one- and four-party to one-party (210 miles)
3. Telephone sets, some added, some retained. 1758 subscribers at ACS - 1873 at conversion
4. 2188 5 year subscribers

CONSTRUCTION TIME AND SEQUENCE CHART

EXHIBIT III

REA TE & CM 207