Exchange Area Transmission - New Combined Telephone Set for General Use Having Improved Efficiencies on the Longer Loops.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

195 Broadway, New York 7, N.Y.

EXchange 3-9800

May 20, 1947

Mr. D. F. Smith, Chief Engineer
The Pac. Telephone and Telegraph Company
San Francisco 5, California

Dear Mr. Smith:

We have discussed from time to time with your people the matter of a higher efficiency station set for use on long loops. This is to advise you that the development of a new combined telephone set for general use, which will provide substantially improved transmission on long loops, as well as other advantages, is now well under way. This new set may be available in limited quantities some time in 1949, and will be made in progressively larger quantities as production can be built up. It appears desirable to inform you at this time of the tentative picture of its transmission performance as indicated by the design objectives and the status of the development work to date. This information may be helpful for use with certain projects to be engineered in the next two years.

The anticipated transmission features of the new set are:

1. Possibly 4-5 db higher volume efficiency in both transmitting and receiving on the longer loops as compared with the present F1A set, with decreasing gain on the shorter loops, and possibly a slight loss on very short loops.
2. A new anti-sidetone induction coil with an improved arrangement of balancing network. This will provide better sidetone balance on long loops thus allowing full realization of increased efficiency of the new instruments on long loops.
3. A frequency response extended somewhat above 3,000 cycles.
4. Click reduction built into the receiver circuit.

It is now expected that the full improvement of the new sets will be attainable only on loops where the transmitter currents are less than about 40 mils, corresponding approximately to the following ranges of outside plant facilities:

24-volt manual or panel local grade	over 450 ohms
48-volt step-by-step or crossbar local grade	over 700 ohms
48-volt toll grade, any office	over 1050 ohms

On loops of lengths less than indicated above, the additional volume efficiency of both the transmitter and receiver is to be progressively reduced to the extent that on very short loops the volume of the new set may be no better or possibly slightly poorer than the performance of the F1A set for a similar condition. With 48-volt toll grade battery supply, only a nominal volume improvement over the F1A set is indicated for loops of less than about 600 ohms.

Based on the above transmission considerations, the new set would appear to have outstanding advantages for the following purposes:

1. To restore the loop plant to the present design objectives with normal margins in the many cases where the circumstances of the past few years necessitated use of tolerances.
2. To largely eliminate the need for local battery talking sets on common battery lines and at the same time to obtain better transmission margins and maintenance savings.

The reaction of this new telephone set on standards and the possibilities of plant economies cannot be evaluated until final production type sets are available and adequate tests can be completed of their actual transmission characteristics and performance under various plant conditions. However, it can be expected that these reactions will vary widely in different areas depending upon loop length distributions and on the design value of the limiting loop.

Until more definite data become available, it is suggested that you may wish to review with us any cases where it appears desirable to include the new set as a major design consideration. In the meantime, we are continuing studies of the possible general reactions on the plant due to the use of this new set and will, of course, keep you advised as more definite information is developed.

Yours very truly,

(Signed) J. J. Pilliod

Assistant Chief Engineer

To all Chief Engineers

File: 482-5

February 25, 1949

MEMORANDUM:

This memorandum summarizes some tentative transmission considerations which might find application in the design of a loop plant to realize immediate plant economies in anticipation of the availability of the new 500-type subscriber set.

A new subscriber telephone set, coded in the 500 Series and designed to provide increased volume efficiency on the long loops as compared with the present 302 sets, is under development at the Laboratories. The design objectives of this new set were discussed in letters to Chief Engineers dated May 20, 1947 and November 10, 1948. Precise data as to the transmission performance of the set, of course, cannot be available until the Western manufactured production is available and tested which currently appears to be about the Third Quarter of 1949.

In the meantime, considerable work has been done by the O. & E. Department on the assumption of an increased volume efficiency for the new set of 4 db (T + R)/2 on loops over about 700 ohms with a 48-volt local grade battery supply, with proportionately lower efficiencies on shorter loops as follows:

Resistance of Loops Ohms	Gain of 500 Set Over 302 Set db (T + R)/2
0 - 180	0
181 - 360	1
361 - 540	2
541 - 720	3
Over 720	4

From a purely transmission standpoint, disregarding the supervision limitations of the various type offices, the new set on the long loops for equal design limits appears to be worth a reduction in gauge; i.e., the new set on 26 gauge will be better than the 302 set on 24 gauge for the same length. Similarly, the new set on 24 and 22 gauges will be better than the 302 set on 22 and 19 gauges, respectively.

Because of the wide variety in length and gauge of cables at the office end of open wire subscriber extensions, it is difficult to generalize on the effects of the new set as has been done above in the case of all cable construction. However, it does appear that the new set on any given iron wire loop up to a total loop resistance of 1,200 to 1,500 ohms will provide as good transmission as the present local battery talking set. Also, it would appear that, for any given loop where copper-steel wire has been used for transmission purposes only with a common battery station, the new set on iron wire will give equal performance.

It appears impractical to interpret the reaction of the new set in terms of future standards until data for the actual efficiencies of production models have been determined, and until transmission design studies can be made to indicate the extent these efficiencies can be realized, particularly in large multi-office areas where the maximum lengths of subscriber loops in an office area generally do not exceed 20 kilofeet. When this information becomes available consideration can be given to reviewing loop and trunk studies in the metropolitan areas.

With respect to small office areas, such as CDO's and other tributaries, where the plant design is controlled by the toll terminal loss or a tandem terminal loss, the realizable amount of the increased set efficiency will need to be determined for the particular case. Obviously in office areas having large local battery talking zones, maintenance economies should be realized immediately by replacing the local battery set with the new common battery set. Under such circumstances only a small amount of the set efficiency would be available for improved standards or more economical trunks, thus the present limiting condition could remain substantially unchanged with the change in station apparatus.

Where the tributary or CDO loop losses are highly negative only a small part of the available improved efficiency of the new set will be realized, generally due to the coarse gauges required. In such cases a review of the magnitude of the toll terminal loss and its allocation between the trunks and loops may indicate the desirability of some changes. Where the toll terminal loss cannot be increased because of limitations of the end link, it may be possible to obtain a 2 to 4 db gain by the use of E1 repeaters in the tributary trunks, thereby permitting a corresponding extension of the loop limit and a more economical loop plant. These considerations are also covered in AB22.150, on the E1 repeater which will be issued in March.

Throughout the System there will be a large subscriber cable construction program during the next two years with completion generally in advance of the expected availability of the new set. Unless some action is taken at this time, in the use of revised design values which will anticipate the transmission advantages

of the new set, possibilities of copper economies on this large block of plant will be sacrificed indefinitely. Since the new set may not be available in reasonable quantity until the end of 1950 or 51, the extent of tolerance to be taken, in current construction, is of great importance. It would appear imprudent to take the full expected gain of the set at this time, however, substantial benefits would result by generally taking a 2 db (T + R)/2 tolerance on new construction in anticipation of the new set. In certain cases where margins are known to exist in the trunk plant, this tolerance may be extended to 3 or 4 db depending on the magnitude of the trunk transmission margins. Also, where a 2 or 3 db tolerance in the subscriber loop design would permit a reduction in gauge from 19 to 22 and the latter would be adequate with the new set, it should be adopted provided means are available, such as local battery set or loading (if not required in the basic design) to later eliminate this tolerance where it may develop subscriber reactions in specific cases prior to the availability of the new set. In small office areas with maximum loops of about 20 kilofeet, the possibility of substituting 24 for 22 gauge should not be overlooked. The relative economies are somewhat less than for 22 vs. 19 gauge due to lower differential copper saving and the possible higher ratio of subscriber long line circuits required in 885-ohm offices.

In situations where considerations are being given to recentering an office, which usually involves major plant additions and rearrangements, it would be desirable to consider the effect of a 4 db as well as the 2 db tolerance. Where additional cooper savings over the 2 db tolerance are substantial, the timing of the project with respect to the availability of the new set should be considered and if determined to be too long an interval from the standpoint of service reaction, the cost of temporary measures, such as local battery sets or loop loading to reduce the tolerance, should be determined. If the time interval is negligible or the cost of interim measures is unimportant, as related to additional copper savings for the 4 db tolerance, it would appear practicable to base the design on the higher tolerance value.

LBB:NG

Distribution of 500-Type Telephone Sets.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

195 BROADWAY, NEW YORK 7, N.Y.

EXCHANGE 3-9800

May 1, 1950

J. E. WAIDLICH
ASSISTANT VICE PRESIDENT

Mr. Kappel is writing to all Operating Vice Presidents announcing the availability of limited quantities of the new 500-type telephone set.

Only one code, 500B (dial type), which may be used on individual lines, 2-party selective lines, 4-party semi-selective lines, and multi-party lines with bridged or divided code ringing, is at present available and the quantity which can be shipped during the second quarter is about 23,000. Based upon your Chief Engineer's reply to Mr. Pilliod's letter of November 10, 1948, which requested a review be made in your Company of the need for the 500-type set to meet special conditions, the quantity which will be available to your Company will be during the second quarter.

For the third quarter about 49,000 of the 500B sets will be available and for the fourth quarter about 93,000 together with approximately 20,000 of a second code, 501B, which is a dial set with a tube in the ringer circuit for use on 4-party selective and 8-party semi-selective lines and for lines with severe inductive conditions.

In view of the limited supply of the new sets it will be desirable to confine their use to locations where the greatest benefit will be obtained. The following three categories can be used as a guide in this connection.

1. Cable and wire extensions and rearrangements where the use of the 500-type set will result in economies in loop plant due to finer gauge pairs, reduced loading or substitution of steel for copper open wire.

   This would include future dial cutovers where outside plant savings can be realized by the use of the 500-type set.

2. Where new local battery sets would otherwise need to be purchased to meet the inward station movement in existing local battery zones.

3. In individual cases in areas zoned for the 500-type sets where repeated visits due to reports of inadequate transmission could be avoided by the use of the new set.

Note: Requirements for the 500-type sets on special service lines should be included in the above categories.

Mr. Pilliod's letter to the Chief Engineers discusses a zoning plan which can be applied initially to insure proper use of the 500-type sets as covered in these categories. However, due to the limited production for the balance of this year it is suggested that the requirements for the third and fourth quarters under category #1 be limited to areas zoned for the 500-type set where a transmission tolerance in excess of 2 db would be experienced with the F1A set.

In addition to the regular quarterly forecast which is furnished to the Distributing Houses, it would be helpful if you will advise us by June 1, 1950, your estimated requirements separately for the third and fourth quarters divided into each of the three categories listed above. The requirements under category #1 for these periods should, of course, reflect the additional limitations mentioned above. Similar information should be furnished for the fourth quarter for the 501B set. Your Chief Engineer will be glad to cooperate in preparing this estimate.

It should be noted that shipments of the 500-type sets will not be in addition to normal shipments of 300-type sets, but are a portion of the total program as discussed at the Operating Vice President's Conference here in New York on January 31. Thus, your forecast of 500-type set requirements will be in effect an added code, and in the fourth quarter two added codes, to be included in your over-all set requirement forecast. However, it is requested that total 500-type sets be shown in your requirements forecast to the Distributing House as a separate principal item. This total should be in agreement with the total for the three categories mentioned above.

As stated in Mr. Kappel's letter, the 500B set will be priced initially at $14.30, which is $3.00 more than the current price of the individual line 300-type set. Considering this added cost and the benefits to be derived from restricting the early receipts of the new sets to specific locations, it seems desirable that a procedure be established to control the movement of the sets in plant. With this in mind it is planned to send to you in the near future a suggested routine which we believe will provide the necessary control until full scale production has been attained. The principal features of such control would include:

1. Establishment of records to control issue and recovery of the new sets.
2. Assignment of sets to service orders on zone or plant condition basis.
3. Subscriber line cards to indicate 500-type set in service.

4. Card inventory record to be maintained for each set installed. (Probably at Test Desk.)

5. Upon disconnection of service, sets to be immediately removed and returned to the Distributing House or other major supply center. Test Center to notify supply representative of such disconnect to insure removal and return of each set.

6. All installations and removals of 500-type sets to be shown on daily time and material reports by code number.

7. Until full production is in effect, sets should not be included as standard load items in lockers, on vehicles or at other storage locations.

8. Accounting Department establish the 500-type set as a separate item in the average price and perpetual inventory record, with frequent checks to aid in controlling losses.

Mr. Pilliod is writing to the Chief Engineers relative to various engineering aspects of the introduction of the new sets and attaching a copy of this letter. A copy of his letter is attached for your information. At the request of Mr. W.J. McWilliams, Assistant Comptroller, a copy of this letter is included for your Comptroller's Department. Copies are also included for the General Commercial Manager and General Traffic Manager at the request of Mr. Hanselman and Mr. Ryan, respectively.

We should appreciate receiving promptly any suggestions or comments that you think will be of general interest relative to the introduction and control of these sets.

Yours very truly,

J. Waidelich

Assistant Vice President.

Attached:
Mr. J.J. Pilliod's Letter.

To all General Plant Managers
(Copies included for the Comptroller's Department, General Commercial and Traffic Managers.)

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

195 BROADWAY. NEW YORK 7. N.Y.

EXCHANGE 3-9800

J. J. PILLIOD
ASSISTANT CHIEF ENGINEER

May 1, 1950

P.E.L. 4692

Topical Index Code 1C2B2

Mr. Kappel's letter of April 28, 1950, relative to the 500-type telephone set, advised that Western's present production schedules would permit starting shipment of the sets in the second quarter. It is anticipated that about 23,000 sets will be available by the middle of the year and 162,000 during the last six months. A description of the new set and its expected advantages were covered in my letters to all Chief Engineers of May 20, 1947, November 10, 1948 and November 15, 1949.

The initial production will all be of the 500B type which is a dial set for use on individual lines, two-party selective and four-party semi-selective lines and multi-party lines with bridged or divided code ringing. It is expected that about 20,000 sets out of the total production for the fourth quarter will be of the 501B type which is a dial set with a tube in the ringer circuit for use on four-party selective and eight-party semi-selective lines and for lines with severe inductive situations.

As discussed in my letter of May 20, 1947, it was expected that the increased volume efficiency of the new set over the present F1A instruments on long loops would be 4 to 5 db (T + R)/2. The results of the field and laboratory tests made so far have indicated that the maximum gain of 5 db (T + R)/2 will be realized. It is suggested that the design of future plant be based on this value. The attached memorandum contains preliminary transmission data for the 500-type set which may be used for this purpose.

As mentioned in my letter of November 15, 1949, additional trial installations of about 4,000 of the new sets in various locations and under different operating conditions are under way. These trials will be continued for some time and so far have shown performance comparable to the earlier trials and design expectations.

Mr. Waidlich is writing the General Plant Managers giving an initial distribution for your Company of the sets to become available in the second quarter. This distribution is based principally on the Companies' estimated requirements for special transmission conditions indicated in the replies to my letter of November 10, 1948. Although the supply of sets for the balance of this year will be limited, it would appear that there should be enough production so that current loop design work can, in general, be based on having sets available to take care of minimum requirements from the standpoint of transmission. It will

be desirable, therefore, to limit the use of the new sets to those locations where the greatest benefit will be obtained. The following three categories can be used as a guide in this connection.

1. Cable and wire extensions and rearrangements where the use of the 500-type set will result in economies in loop plant due to finer gauge pairs, reduced loading or the substitution of steel for copper open wire.

   This would include future dial cutovers where outside plant savings can be realized by the use of the 500-type set.

2. Where new local battery sets would otherwise need to be purchased to meet the inward station movement in existing local battery zones.

3. Individual cases in areas zoned for the 500-type sets where repeated visits due to reports of inadequate transmission could be avoided by the use of the new set.

The attached memorandum also discusses a zoning plan which can be applied initially to insure proper use of the 500-type sets as covered in these categories.

Mr. Waidlich's letter also outlines the manner in which the requirements for the new sets would be worked into the overall set requirement forecast. In addition to the regular quarterly forecast furnished to the Distributing Houses, he is requesting that your Company furnish him an advance estimate of minimum requirements by categories for the 500B set for the third and fourth quarters and for the 501B set for the fourth quarter. These minimum requirements include:

(a) Areas zoned for the 500 set where a transmission tolerance in excess of 2 db would be experienced with the F1A set (Item A (c) of attached zoning plan).

(b) Present local battery zones where new local battery sets would otherwise need to be purchased to meet the inward movement (Item B (a) of attached zoning plan).

(c) Category 3 above.

Note: Requirements for the 500-type sets on special service lines should be included in the above categories.

We should be glad to receive any suggestions or comments which you may have regarding the new set or the recommendations made in the attachment to this letter and to learn of any outstanding items which are developed in connection with its use in service. A copy of Mr. Waidlich's letter to the General Plant Managers is attached and a copy of this Plant Engineering Letter is being attached to his letter.

Yours very truly,

Attached Memo filed in "BSP" binder with "AB" sections

J.J. Pilliod

Assistant Chief Engineer.

Attached:
Memorandum.
Letter of Mr. J.E. Waidlich.

To all Chief Engineers

Savings from Use of 500-Type Telephone Set

COPY

San Francisco, October 13, 1950

J. W. POWELL, CHIEF ENGINEER, San Francisco:

At the conference of Plant Extension Engineers in San Francisco on August 15 and 16, 1950, some preliminary notes on the economics of use of the 500-type telephone set were presented orally. Since then it has appeared that the area organizations might find the content of these notes of sufficient interest to warrant their distribution.

Accordingly, the notes have been reproduced and a copy is attached for your information. These notes are not expected to apply to the areas as presented but rather to show a method that has been used in preliminary discussions. The assumptions made in the attached notes should be revised as necessary when applied to a particular area.

We should be glad to receive any comments or suggestions you may have in this connection and would appreciate reviewing any studies you may undertake regarding the use of the 500-type set in plant..

(Signed) T. A. Taylor
Assistant Vice President

HKF:NH
Attachment

Joint: Four Chief
Engineers

NOTES ON SAVINGS FROM USE OF 500-TYPE TELEPHONE SET

Although it is too early to estimate accurately the savings which will result from use of the new 500-type telephone set, preliminary estimates have been made as described herein. The calculations included are based on assumptions which may be changed when more information becomes available. However, the method shown may be found useful and the calculated savings may be taken as approximations useful until more accurate information is at hand.

Savings are expected to result chiefly from:

1. Smaller investment in loop plant
2. Reduction in number of local talking-battery sets used in plant
3. Lower trouble expectancy than with 300-type sets.

The first item, saving in loop conductor investment, may be calculated from the expression - $P = \frac{p_1 p_2 LS}{p_3 NY}$

where P = loop conductor investment saving in dollars per station

P1 = % of loops over 20,000 feet long

P2 = % of above loops in cable

P3 = % of loop cable conductors in use

L = Average loop length in miles

S = Annual charge difference between 22 and 19 gauge cable conductors in dollars per mile

N = Average number of stations per loop

Y = Annual charge per cent on loop cable plant.

The saving in loop conductor investment has been calculated on the following assumptions:

1. 500-type sets will be used on loops over 20,000 feet long and that loops of this length represents 5% of loop growth.
2. 75% of loop growth will be in cable.
3. 70% of loop conductors are in use.
4. Average length of loops on which 500-type sets are used is 5 miles.
5. Annual charge on 22 gauge loop cable conductors is $3 per year less than on 19 gauge loop cable conductors and that the loops on which 500-type sets are used will be 22 gauge whereas 19 gauge would have been required for 300-type sets.

6. The average number of stations per loop is 1.8.

7. The annual charge rate on loop cable plant is 15%

On the basis of the assumptions stated, the calculated loop plant saving is $2.97 per station.

The saving resulting from the reduction in use of local talking-battery sets has been estimated as follows:

1. Annual labor and material charges for maintenance of local battery sets and replacement of batteries	$1.88
2. Other annual charges on the approximately $7.70 e xcess cost of local battery set (not including battery) over 500-type set at 15%	1.15
Total	$3.03

This saving would accrue in each case when use of a 500-type set avoided the use of a local talking-battery set. If 2% of growth stations are in this category, the average annual saving per growth station would be $ .06. If this is capitalized at 15%, the equivalent plant investment saving is $ .40.

The saving resulting from lower trouble expectancy is about $ .10 per growth station per year. This is equivalent, at an annual charge rate of 15%, to a plant investment of about $ .67 per growth station.

A further small saving results from the fact that the 500-type set is equipped with a built-in dial induction suppression filter. This eliminates, of course, the cost of adding the 61-type filter to the 300-type set. The saving per instrument as a result of this is difficult to estimate accurately but for these notes it has been assumed to be $ .10.

The sum of these various estimated savings is -

1.	Loop investment	$2.97
2.	Reduction of local battery sets	.40
3.	Lower trouble expectancy	.67
4.	Built-in filter	.10
	Total	$4.14

As the 500-type sets cost about $3.00 more than the corresponding 300-type sets, the net plant investment saving is more than one dollar for each 500-type set used under the assumptions stated.

It should be emphasized that the assumptions made herein, particularly those relating to loop investment saving, are not expected to be highly accurate for any particular area. It is assumed that when the method outlined is used, data applying to the area involved will be substituted for those given here.

10-11-50