Television - Facilities for Local Television Channels

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway, New York 7, N. Y.
Exchange 3-9800

COPY

November 22, 1946

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

Dear Mr. Smith:

This supplements my letter to all Chief Engineers dated August 9, 1946, subject: "Television - Facilities for Local Television Channels" which gave preliminary information regarding the new polyethylene string insulated shielded 16-gauge pairs designed to provide low loss facilities for television transmission. As noted in this letter, the video pairs may be obtained in combination with other types of toll and exchange conductors. In the case of non-quadded exchange cables, preliminary engineering designs of cable make-ups indicate that the maximum number of pairs of various gauges readily obtainable with different complements of video pairs will be as shown in the following table:

Video Pairs	CNB (19)	CSA (22)	DSM (24)	BST (26)
2	404	859	1414	1919
3	404	808	1313	1869
4	404	808	1313	1818
5	385	783	1263	1768
6	343	758	1212	1717
8	278	657	1111	1616

In the case of toll cables, it is not practicable to list all of the combinations which may be obtained but we shall be glad to discuss with you the make-up of specific cables in which you desire to include video pairs.

Firm price information is not yet available but for purposes of preliminary engineering estimates a figure of twenty cents per pair-foot based on June 10, 1946, price levels may be assumed. Costs of the CNB, CSA and DSM exchange pairs in the above exchange cables may be estimated in accordance with Curve Sheet 4 accompanying my letter of October 1, 1946. To put BST pairs on a comparable basis regular published prices should be increased by about 25 percent.

Costs estimated in this way will, of course, be subject to the changes in general cable price levels as discussed in Mr. Stoll's letter to the Presidents dated November 18, 1946.

The Western Electric Company is now considering production plans for this type of facility in 1947. In this connection, it would be desirable to have a broad estimate of your expected requirements expressed in pair-feet for the first half and last half of 1947. This preferably should be reported separately for video pairs included in toll cables either quadded or coaxial, and these included in non-quadded exchange cables. It is assumed that these requirements will be coordinated with the expected toll and exchange cable allotments for your Area.

It would be appreciated if these data could be made available by January 3, 1947.

Yours very truly,

(Signed) J.J. Pilliod

Assistant Chief Engineer

To all Chief Engineers
(Copies included for
General Commercial and
Plant Managers)

Television - Facilities for Local Television Channels.

File: 118-6

AMERICAN TELEPHONE AND TELEGRAPH COMPANY

195 Broadway, New York 7, N.Y.

COPY

August 9, 1946

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

Dear Mr. Smith:

Attached is a copy of a memorandum which discusses the engineering aspects of various methods of providing Metropolitan Area facilities such as studio-transmitter channels, out-of-studio pick-up channels and distribution networks suitable for the transmission of television signals. In addition to the currently available techniques, the memorandum covers the general trend of new technical developments as well.

Section E47.400 describing the Type A1 video amplifier referred to in the memorandum and Section E37.400 covering the equalization, line-up, and maintenance of video circuits are being issued in the regular manner. Bell System Practices relating to the transmission aspects of the Type A2 video amplifier are under preparation and are expected to be made available shortly.

Yours truly,

(Sgd.) J. J. PILLIOD (FAC)
Assistant Chief Engineer

Attached:
Memorandum.

To all Chief Engineers
(Copies included for
General Plant Managers.)

Television - Engineering of Television Facilities in Metropolitan Areas

Accompanying Letter to
Chief Engineers dated August 9, 1946

MEMORANDUM:

This memorandum discusses the general engineering considerations involved in establishing facilities suitable for the transmission of television signals in metropolitan areas.

The transmission of television signals of the present black and white standards - 525 lines, 30 frames per second - requires a frequency band approximately 4 megacycles wide. In metropolitan areas the circuits are relatively short and carrier methods cannot economically be applied with the result that such circuits are engineered for the transmission of "video frequencies," that is, those in the range of about 40 cycles to about 4 megacycles. The associated sound channel is provided over separate facilities engineered to the usual program circuit requirements. In the case of studio-transmitter circuits the sound channel will be engineered to the same objectives as for FM broadcasting stations as covered in a letter to all Chief Engineers dated June 4, 1941.

Television facilities in metropolitan areas can be established by using regular telephone cable pairs with suitable amplifiers at frequent intervals, by the use of specially designed shielded low-loss facilities, and under certain conditions, by radio links.

Use of Telephone Cable Pairs

The adaption of regular telephone cable pairs for television transmission requires -

1. Removal of any loading which may be present.

2. Clearing all bridged taps and all stubs over 10 feet in length. Stubs less than 4 feet in length may be left on the pair but ordinarily not more than one stub between 4 feet and 10 feet in length may be tolerated in any one section of line.

3. Selection of pairs for low-noise. Pending the availability of suitable noise measuring and monitoring equipment, selection can be made on the basis of pairs giving the lowest readings on a 2B noise set modified for 15 kc flat weighting, monitoring with a head receiver during measurement to identify the character of the noise. In so far as practicable, it is desirable to avoid cables carrying the telegraph circuits and to avoid cables with a large number of drops in the vicinity of broadcasting stations. In some cases where line sections are long and terminate in dial central offices, it may be necessary to provide special entrance cable from a point possibly as far as 500 feet from the office.

The engineering layout of local television channels in telephone cables involves consideration of a number of factors which are discussed in the following. This will serve as a general guide but it will be appreciated that in any particular case local conditions may indicate that some deviation from the stated objectives could be tolerated.

1. Amplifier spacings on the average should not exceed 60 db at 4 megacycles. While higher losses can be tolerated, it is generally not desirable to assume more than one 65 db section in any one circuit. Representative losses at 4 megacycles of telephone cable pairs which may be used for layout work are:

	Loss - db	
Gauge	Per Mile	Per Kilofoot
26	94	18
24	79	15
22	71	13
19 CNB	57	11
19 DNB	47	9
16	36	7
13	29	5
10	22	4

2. In view of the high losses in telephone cables, it may frequently be desirable to make special splices between various cables to take advantage of any large gauge conductors which may be available and to shorten the route distance between the points to be connected, thus reducing the number of amplifiers to a minimum.

3. It will frequently be found that even taking advantage of the most favorable routing, desired amplifier points will not coincide with central office locations. Such situations can be taken care of by installing the amplifiers on private property close to the cable route since the present types of amplifiers are not suitable for installation in manholes. The use of private property for amplifier locations involves a number of special problems such as finding suitable space near the desired amplifier location, provision of adequate power supply, access for maintenance during all hours and telephone cable entrances. Consequently, it is desirable that such installations be avoided wherever practicable.

4. At amplifier points a circulating path exists through the crosstalk coupling between the pair connected to the output of the amplifier and the other pairs in the same cable sheath and between these pairs and the pair connected to the input. This interaction crosstalk imposes a limitation on the gain which may be employed. Until further experience is obtained, this limitation cannot be precisely determined, but as a general guide a figure of 40 db may be used as the maximum level difference between the input and output pairs in a given sheath. While there is a possibility that this figure might be increased if the in and out pairs are assigned to non-adjacent color groups, it will usually be necessary to take full advantage of the gain available in the amplifiers, to route the in and out pairs in different sheaths, if available, or to reduce the output level if the subsequent line section is short and noise is not controlling. In the case of amplifiers located on private property where usually there is only a single entrance cable, interaction crosstalk will ordinarily require placing a separate entrance cable.

5. Because of the high crosstalk coupling in regular telephone cables at the higher television frequencies, the number of television circuits which can be operated in one cable is limited. Available data indicate that operation in the same direction may be restricted to one circuit per 100-pair color group but that opposite direction transmission in the same sheath is generally not feasible except under certain very restricted conditions.

Amplifiers and Equalization

Amplifiers for use in establishing local television circuits are functionally of three types - transmitting, receiving and intermediate. With present techniques, the transmitting and receiving

amplifiers are provided by the Telephone Company and furnish a means for coupling the customers' studio and broadcast transmitter equipment, which usually is unbalanced, to the balanced telephone lines. The intermediate amplifiers which operate between telephone lines are balanced in both input and output circuits. The equalization arrangements are incorporated in the amplifier assemblies. When required to reduce the effects of noise a predistorting network is included in the transmitting amplifier and a restoring network in the receiving amplifier.

The standard video amplifier will be known as the Type A2 and is described in Section AA265.501 which includes also information required for engineering amplifier installations. Sections of Bell System Practices, describing the transmission aspects of the A2 amplifiers, their application to video circuits and methods of adjustment, maintenance and equalization are under preparation.

A preliminary laboratory model of video amplifier, known as the Type A1, made up before the war for use in connection with the development of techniques to adapt telephone cable pairs for television transmission, is described in Section E47.400, and equalization and line-up procedures in Section E37.400 which are being issued in the usual way. In view of the special nature of these Sections it appears desirable to limit their distribution to personnel requiring them in current television activities.

The A1 and A2 amplifiers are similar in their general transmission aspects, the A2 representing an improved design in the physical arrangements and type of components. Both the A1 and A2 amplifiers operate from nominal 60-cycle 110-volt power supply. The A1 amplifier is available only in portable cabinets but the A2 amplifier will be

available either in a portable cabinet or arranged for duct-type relay rack mounting. With either type of amplifier it is customary to cable directly from the protectors on the main frame to the amplifier location. For this purpose 720-type cable is employed using twin coaxial jacks and plugs - one for each conductor - to facilitate patching between amplifiers and lines.

The fixed and variable equalizer sections now furnished with the A1 and A2 amplifiers will ordinarily be adequate to equalize a circuit consisting of two line sections. Where more than two sections are involved, a special mop-up equalizer may frequently be required. This mop-up equalizer is designed for the specific case on the basis of the best measured characteristic obtainable with the normal equalizers supplied. Where a mop-up equalizer is required, it will be necessary to allow one to two weeks for its design and manufacture.

For purposes of preliminary cost estimates, the following prices can be assumed for the amplifiers, to which will need to be added the cost of engineering and installation:

Transmitting Amplifier	$1,500
Receiving "	$2,300
Intermediate "	$2,300
Mop-up Equalizer	$ 350 to $600 (Depending on number of line sections)

The present supply of A1 amplifiers is limited. With respect to the A2 amplifiers (J44001) and associated accessory materials the Western Electric Company advises that these are now available in limited quantities from factory stock with approximately normal stock conditions expected by January 1, 1947. Orders should be worded in accordance with Section AA265.501 (J44001).

Future Developments

Line Facilities

There is under development a shielded low-loss conductor designed for installation either separately in cables or in combination with regular telephone pairs to provide television facilities in metropolitan areas. One type of structure which appears promising consists of two 16-gauge conductors with polyethylene strings wrapped around each wire and with polyethylene tape then applied spirally over the string. These conductors, with polyethylene strings in the interstices, are then twisted to form a pair and a polyethylene tape is used to hold the pair together. Over this two copper tapes are applied spirally with overlap in opposite directions. It is expected that the loss of this facility at 4 megacycles will be in the order of 18 db per mile. This unit has a cross-sectional area equivalent to 16 or 18 22-gauge pairs although the actual number of pairs which would be displaced in a combination cable will depend on the make-up in the particular case.

An experimental length of cable including 4 units and a layer of 22-gauge pairs has been manufactured and is now being tested to obtain information on attenuation, impedance irregularities over the video frequency band and crosstalk and to gain experience in handling and splicing. Further detailed information including cost and availablity of this new type of facility will be made available upon completion of this work.

It is expected that the shielded string-insulated pair will be used extensively to form a backbone network of television facilities in cities. Ultimately it will generally be used for such permanent types of circuits as studio-transmitter circuits, network loops and

pick-up circuits from points which are frequently recurring sources of program. In those cases where the shielded pair cannot be justified, use can be made of regular telephone cable pairs to connect to the low-loss backbone network.

Anticipating the development of television requirements, it seems desirable to review future trunk cable projects to see whether it would be appropriate to include a complement of the shielded string insulated pairs. This would generally be particularly desirable along routes where the next cable relief would be some years off. Some cable projects on routes where a television requirement is now strongly indicated, scheduled for service for the latter part of this year, have been engineered to include the shielded pairs. Initially, manufacturing capacity will be limited but for engineering work the new structure can be assumed to be available in quantity for use in cables to be placed in 1947.

Amplifiers

Development is proceeding on a new type video amplifier with improved transmission and equalization characteristics. It is being designed to operate on direct current supplied from the central office over separate cable pairs. This, together with the fact that it will be arranged for installation in manholes, should simplify the problems now encountered in locating amplifiers at other than central office locations. The present view is that the gain will be somewhat lower than that of the A2 amplifiers. While this would appear to increase the number of amplifiers in a circuit there are a number of offsetting factors -

1. Less expensive amplifier design.
2. Arrangements for mounting in manholes makes it possible to avoid backhauls into central offices which, in many cases, are some distance off the cable route and involve splicing

between the through cable and laterals to the central office.

Development of the new amplifier is not sufficiently advance to make available at this time information on its application in video circuits, cost and production schedules. Such information will be forwarded in the usual way when available.

Radio Systems

In the cases of circuits of considerable length, and where special construction primarily for video channels would be involved, results of studies of specific inquiries indicate that a single link radio system might have advantages. A system of this type operating in the 4,000 megacycle range is now under development and a field trial is being conducted this summer between Hollywood and the summit of Mt. Wilson, California. While in the present state of this development, it is too early to provide firm price information and determine the general economic field of use of radio, it may be assumed in making preliminary estimates for engineering purposes that on a broad average basis the costs will be in the vicinity of $30,000 installed for a two-channel system (regular and emergency). On the same basis a single channel system would cost around $20,000 installed. In these estimates no allowance is included for sites or buildings, 110-volt a-c power supply connections or any wire video facilities which may be required between the radio terminals and the customer's television equipment. Pending the availability of more detailed engineering information and cost estimates, it will be desirable to review with the O. and E. Department any cases in which radio would appear attractive.

Testing Equipment

Testing equipment required for equalization, line-up and maintenance of video circuits consists principally of an oscillator and a measuring set covering the video frequency band and an oscilloscope. Development of suitable equipment is under way, but pending its availability, laboratory models can be furnished on a loan basis to handle such jobs as may materialize.

Coaxial Cable

While coaxial cable is expected to play an important part in intercity television, its field of use in local circuits appears rather limited. This results from the fact that transmission in the local plant will be at video frequencies and that at the lower video frequencies the shielding of the coaxial structure is relatively ineffective, making the circuit susceptible to low frequency noise and crosstalk. While corrective measures have been devised to minimize the low frequency pick-up, they will be effective for only relatively short lengths of cable, say up to about two miles. Cross-induction at the lower video frequencies between coaxial units in the same sheath is sufficiently high as to make simultaneous operation of more than one circuit questionable even when the direction of transmission is the same in both units. However, coaxial cables have been placed, in a few cases, in establishing studio-transmitter circuits of relatively short length which have been equalized and are furnishing satisfactory service.