NATIONAL TELEPHONE NETWORK
NOISE OBJECTIVES FOR INTER-EXCHANGE CIRCUITS

1. PURPOSE.

1.1 This E.I. describes the overall objectives for psophometric noise produced in switched inter-exchange telephone circuits, irrespective of the techniques by which the circuits are provided. The design of transmission systems to ensure compliance with the objectives is described elsewhere.

2. INTRODUCTION.

2.1 In a telephone connection comprising a number of circuits interconnected at telephone exchanges, each circuit generates noise which is then transmitted to the listener through the intervening circuits, each of which also contributes attenuation. Noise contributed by telephone exchanges can be regarded as being injected at the beginning or end of each circuit. The noise heard by the listener is the sum of the noises contributed by the respective sources.

2.2 As the received noise level increases it degrades the quality of the telephone conversation, the degradation increasing with increasing overall reference equivalent (i.e., as received speech becomes fainter). If the reference equivalent and the received noise level are known, the "adverse opinions" likely to be expressed by subscribers can be calculated.

2.3 A transmission system designed to give low noise is generally more expensive than one which produces a higher noise. There is therefore an economic incentive to allow more noise in the more numerous lower-order circuits in the network.

2.4 The noise power N produced by a given transmission system can be regarded as comprising two parts, and may be described by $N = A + BL$ where A and B are constants and L is the length of circuit.

2.5 The approach to the determination of noise objectives has therefore been to test various combinations of noise formulas (based on known performance of various types of transmission equipment) in hypothetical connections yielding a range of distances and overall reference equivalents (allowing more noise in terminal circuits) and then calculating the adverse opinions likely to be expressed by subscribers, relative to those which might be expressed in the absence of noise.

2.6 If all circuits of a connection contribute the maximum noise permitted by the objectives below, and if the highest permissible reference equivalents are encountered the adverse opinions are unlikely to exceed 6% for connections within a secondary switching area and 10% for transcontinental connections. The average connection will incur less than ½% adverse opinions when each circuit contributes the maximum permitted noise.

2.7 The C.C.I.T.T. has developed objectives for the maximum noise which may be transmitted to an international circuit by a national chain. (4.3) The noise objectives of this E.I. should yield noise levels on international circuits lower than the maxima recommended by the C.C.I.T.T.

2.8 The following objectives are in terms of mean psophometric noise; further objectives will be developed to cover impulsive noise which affects data transmission over the switched interexchange network.

3. NOISE OBJECTIVES.

The in-service noise power of any inter-exchange circuit (measured as a mean over any hour, in each direction of transmission at the receiving end of the circuit) shall not exceed:

Circuits serving a local (terminal) exchange	:	(4000 + 5L) pWOp
All other circuits	:	(2000 + 5L) pWOp

where L is the route length of the circuit in miles, and pWOp is picowatts referred to a point of zero relative level, psophometrically weighted. Two notes of caution are necessary:

Note 1: As this is an in-service objective, it includes the effects of:

- deterioration of performance with time;
- exchange noise (allow 100 pWp per circuit effective at receiving end);
- (pWp = absolute power in picowatts, psophometrically weighted.)
- crosstalk and intermodulation from all sources;
- real traffic (including signalling and other non-speech signals), as opposed to the assumptions normally made with respect to conventional loading of transmission systems;
- the tandem connection of different transmission media to provide a circuit. For example: a circuit between exchanges A and C may be provided by the interconnection at voice frequency at B of two carrier systems A-B and B-C.

Note 2: When measuring and calculating noise power, it is essential to take account of the receive relative level of the circuit at the distant end. (4.4)

4. REFERENCES.

4.1 Information Bulletin - Planning - No. 26 : "Noise objectives for inter-exchange circuits". (1969)

4.2 A.P.O. E.I. PLANNING, Communication Networks C 0008 "Definition of Basic Telephone Switching and Network Terms".

4.3 C.C.I.T.T. Recommendation G 123 - Mar del Plata 1968 White Book, Volume III.

4.4 A.P.O. E.I. LONG LINE EQUIPMENT, Transmission, B 2000.

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