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GENERAL CHARACTERISTICS OF NATIONAL SYSTEMS FORMING PART OF INTERNATIONAL CONNECTIONS

CIRCUIT NOISE IN NATIONAL NETWORKS

ITU-T Recommendation G.123

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.123 was published in Fascicle III.1 of the *Blue Book*. This file is an extract from the *Blue Book.* While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

2 In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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Recommendation G.123

CIRCUIT NOISE IN NATIONAL NETWORKS

(Geneva, 1964; amended at *Mar del Plata, 1968, Geneva, 1972, 1976 and 1980 and Melbourne 1988)*

1 Noise induced by power lines

The network performance objective for the psophometric e.m.f. of the noise produced by magnetic and/or electrostatic induction from all the power lines affecting one or more parts of a chain of telephone lines[1)] joining a subscriber's set to its international centre should not exceed 1 millivolt, this being the value at the line[1)] terminals of the subscriber's set (when receiving), it being assumed that the telecommunication installations inserted in that chain are balanced to earth as perfectly as possible, in conformity with the most modern equipment construction.

It should be noted that, even in the case of perfectly balanced lines[1)], the insertion of equipment having too great a degree of unbalance to earth may cause unacceptable noise at the terminals of a subscriber's receiver.

In every national network, it is usually possible, in practice, to find switching centres such that some of the lines[1)] that terminate at those centres (lines[1)] in cable, conforming to CCITT specifications) are free from noise arising from neighbouring power lines. It is then sufficient to determine the psophometric e.m.f.s arising from all the power lines[1)] affecting one or more parts of the chain of lines[1)] joining such a centre to the subscriber's set.

2 Noise contributed by transmission systems

2.1 *Analogue systems*

2.1.1 *Very-long-distance circuits* (about 2500-25 000 km)

If an extension circuit more than 2500 km long is used in a large country, it will have to meet all the recommendations applicable to an international circuit of the same length (Recommendation G.153). This implies that the equipment design objective for the line noise in channels used to provide these circuits should not exceed 2 pW0p/km.

2.1.2 *Circuit ranging in length from very short distances up to 2500 km*

These circuits should meet the requirements of Recommendation G.152. This implies that according to the noise objectives of Recommendation G.222 [l] the accumulated line noise should correspond to an average of not more than 3 pW0p/km and the noise power produced by the various modulating equipments should meet the provisions of the Recommendation cited in [2].

Taking account of the particular structure of a real circuit the pertinent Recommendations CCITT/G.226 [3] (for cable systems) or CCIR/395 [4] (for radio-relay systems) must be applied when assessing its noise performance.

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1) "Line" as used in this § 1 should be understood as meaning subscriber's line, trunk junction or trunk circuit.

Note 1 - The permissible noise contributions from equipment do not depend on whether the circuits form part of the international 4-wire chain or are connected to it by 2-wire switching. However, the circuit noise powers assume that the hypothetical reference connections of Recommendation G.103 are, or will be in future, reasonably typical of connections. They also assume that the total length of circuits connecting the local exchange to the primary centre is not excessive. The attention of Administrations is drawn to a conclusion of studies carried out by the CCITT during the 1964-1968 Study Period, that if the additional percentage of "poor or bad" opinions on the quality of connections due to noise introduced by the circuits connecting the local exchange to the primary centre is not to exceed one half of that caused by the presence in the connection of all other sources of circuit noise, then the noise contributed by each one of these circuits should be limited to about 500 pW0p (mean for all the channels of the system during any hour).

Note 2 - Under the above conditions and assuming the maximum noise values permitted for pairs of channel modulators (200 pW0p), group modulators (80 pW0p) and supergroup modulators (60 pW0p), a total noise power of 500 pW0p will not be exceeded by a circuit connecting the local exchange to the primary centre (Figure 1/G.103) when its length is less than about 50 to 100 km.

Note 3 - In the case that those circuits are operated with compandors conforming to Recommendation G.162, the permitted noise powers are to be understood inclusive of the effect of the compandor gain.

2.2 *Digital system*

Circuits provided by PCM systems which accord with the G.700 Series of Recommendations, in particular Recommendation G.712 [5], will have an acceptable noise performance which is substantially independent of their length.

2.3 *Mixed circuits*

The noise value in a circuit provided by both analogue and digital transmission systems depends on the whole length of analogue sections and of the number of codecs in a circuit.

Noise limits and measurement methods for a mixed circuit are studied under Questions 26/XII, 16/IV and 18/IV.

3 Noise in a national 4-wire automatic exchange[2)]

3.1 *Definition of a* **connection through an exchange**

Noise conditions in a national 4-wire automatic exchange are defined by reference to a "connection" through this exchange. By "connection through an exchange" is to be understood the pair of wires corresponding to a direction of transmission and connecting the input point of a circuit incoming in the exchange to the output point of a different circuit outgoing from the exchange. These input or output points are those defined in Recommendation Q.45 (points A and D of Figure 1/Q.45 [8]) and are not necessarily the same as the text access points defined in Recommendation M.640 [9].

3.2 *Equipment design objective for the mean noise power during the busy-hour*

The mean of the noise over a long period during the busy-hour should not exceed the following values:

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2) In accordance with Recommendation Q.31 [6], the limits are the same as in Recommendation Q.45 [7].

1) Psophometrically weighted noise: -67 dBm0p (200 pW0p),

2) Unweighted noise: - 40 dBm0 (100 000 pW0) measured with a device with a uniform response curve throughout the band 30-20 000 Hz.

Note - A sufficient variety of connections should be chosen to ensure that the measurements are representative of the various possible routes through the exchange.

3.3 *Equipment design objective for the impulsive noise during the busy-hour*

Noise counts should not exceed 5 counts in 5 minutes at the threshold level of -35 dBm0 (see the Recommendation cited in [10] for measurement procedure).

Note - Figure 3/Q.45 [11] shows the maximum number of impulsive noise counts acceptable in a 5-minute period.

4 **Noise allocation for a national system** (guide for planning purposes)

The noise powers indicated in the following text are nominal values.

Network planning should be such that the noise power entering the international network and attributable to national sending systems meets the limits of the following rule:

The psophometric noise power introduced by the national sending system at a point of zero relative level on the first international circuit must not exceed either $(4000 + 4L)$ or $(7000 + 2L)$ pWp, whichever is less, and where L is the total length in kilometres of the long-distance FDM carrier systems in the national chain. The corresponding quantities referred to the send virtual switching point are $(1800 + 1.8L)$ and $(3100 + 0.9L)$ pWp.

The derivation of this rule is explained in Annex A.

Note - A problem, which has already arisen in some national networks, as regards the receiving direction, is that when losses are reduced the circuit noise becomes more noticeable, particularly during periods of no conversation. This is particularly relevant in the case of large countries in which the noise contribution from line systems is high. Hence if an Administration complies with a recommendation concerning national noise power levels and then subsequently improves transmission, perhaps by introducing 4-wire switching in lower-order exchanges, it may find itself in a worse situation as regards noise. It follows that it is important to preserve a proper balance between noise and loss.

ANNEX A

(to Recommendation G.123)

Noise allocation for a national system

A.1 It is desirable that the noise power arising in national networks be limited in terms of the level appearing at the virtual switching points - the agreed interface between the national and the international network. In order to do this, some particular distribution of losses within the national network must be assumed. The solution is to adopt an agreed

reference connection in order to specify maximum noise power levels from national sources referred to the virtual switching point of the international circuit.

A.2 Having regard to the way in which national networks are constructed, it is appropriate to express the noise allowance in the form $A + BL$ where A is a fixed allowance resulting from noise in exchanges and from short-haul multiplex systems, B is an allowance for a noise rate per unit length from long-haul multiplex systems and L is the total length of these latter systems in the national portion of the international connection. Two such expressions are necessary, one for countries of average size and another for large countries (in the sense of Recommendation G.121).

A.3 This approach is comparatively straightforward in the national sending system and serves to limit the amount of noise injected into the international connection.

A.4 *Average-sized countries* (i.e. not greater than 1500 km from the CT3 to the most remote local exchange)

The relevant hypothetical reference chain for the national sending system is given in Figure A-1/G.123[3] . The circuit between the local exchange and the primary centre is assumed to be routed on an FDM carrier system of length not exceeding 250 km and operated at a nominal loss of 3 dB. The noise power on this circuit is taken to be the maximum value of 2000 pW0. The circuit between the primary centre and the secondary centre is also assumed to be routed on an FDM carrier system of the same type.

The line noise power rate of the two long-distance trunk circuits is assumed to be 4 pW/km and the total line length of these two circuits ($L_1 + L_2$ in Figure A-1/G.123) approaches the limit of 1500 km arbitrarily defining "a country of average size" in Recommendation G.121. It is thus assumed that the distance covered by the two short-haul systems is a very small proportion of the total length of the complete national sending system.

Each exchange is assumed to contribute 200 pWp in accordance with § 3 of the text, or Q.31 [6].

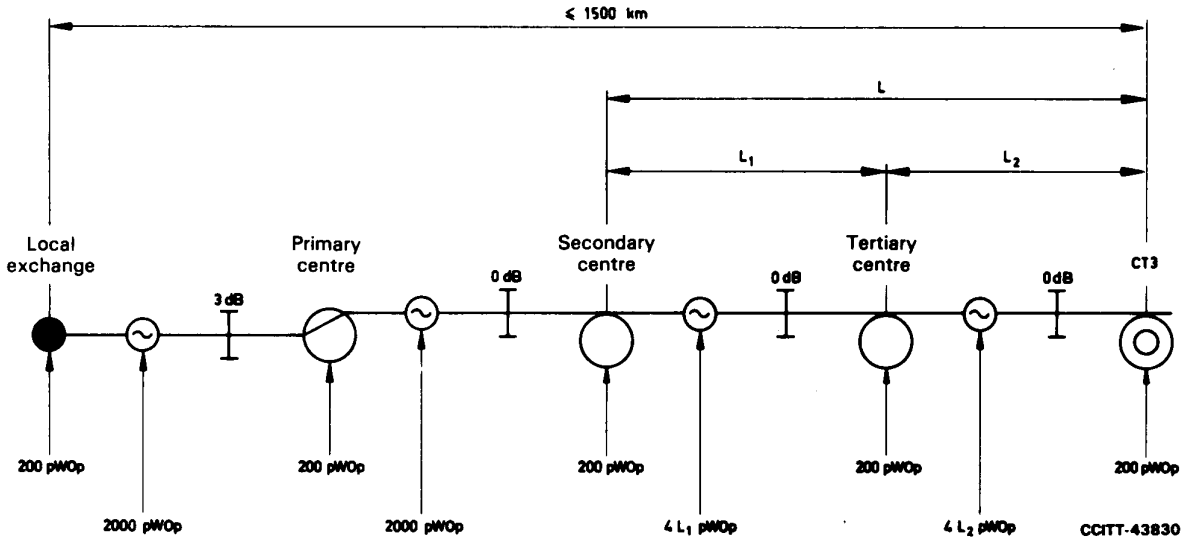

FIGURE A-1/G.123

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3) *Note by the CCITT Secretariat* - The noise values shown in this figure are maximum values; see also the corresponding element of Figure 1/G.103.

The total noise power level referred to a point of zero relative level on the first international circuit at the CT3 is (moving from right to left and adding in each successive noise contribution encountered):

$$200 + 4L_2 + 200 + 4L_1 + 200 + 2000 + 200 + ½\,(2000) + ½\,(200) = 3900 + 4L \text{ pW0}$$

where $L = L_1 + L_2$. This may be conveniently rounded off to $4000 + 4L$ pW0.

This expression is valid for L not exceeding 1500 km leading to, at that distance, 10 000 pW0.

A.5 *Large countries*

When L is in excess of 1500 km the additional long-distance circuits in the national network should in principle be engineered to international standards, and in particular some large countries have found it necessary to plan national systems with noise power rates lower than 4 pW/km.

A convenient value to assume is 2 pW/km; this is in rough agreement with the practice of one such large country and is also in line with Recommendation G.153.

The rule for large countries has been established as shown in Figure A-2/G.123 in which the $4000 + 4L$ rule is shown passing through the point (1500 km, 10 000 pW). A line with a slope of 2 pW/km is constructed to pass through the same point and its intercept is seen to be 7000 pW. Hence the rule for large countries is $7000 + 2L$ pW0. (The 0.5-dB nominal loss of the last national circuit has been ignored for simplicity's sake.)

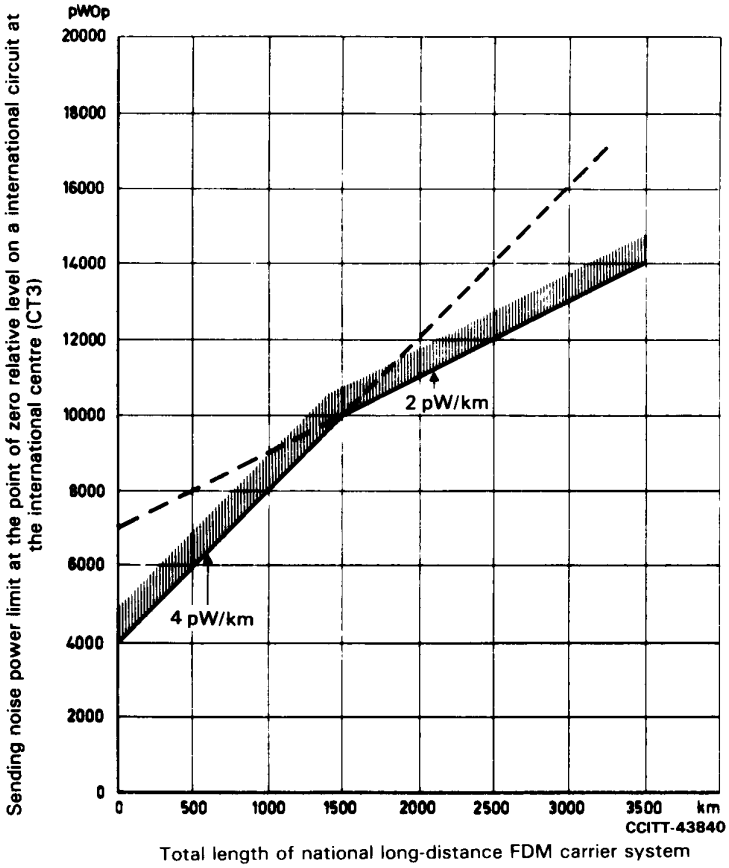

FIGURE A-2/G.123

References

[1] CCITT Recommendation *Noise objectives for design of carrier-transmission systems*, Vol. III, Rec. G.222.

[2] *Ibid.*, § 4.

[3] CCITT Recommendation *Noise on a real link*, Vol. III, Rec. G.226.

[4] CCIR Recommendation *Noise in the radio portion of circuits to be established over real radio-relay links for FDM telephony*, Vol. IX, Rec. 395, ITU, Geneva, 1986.

[5] CCITT Recommendation *Performance characteristics of PCM channels between 4-wire interfaces at voice frequencies,* Vol. III, Rec. G.712.

[6] CCITT Recommendation *Noise in a national 4-wire automatic exchange,* Vol. VI, Rec. Q.31.

[7] CCITT Recommendation *Transmission characteristics of an international exchange*, Vol. VI, Rec. Q.45.

[8] *Ibid.*, Figure 1/Q.45.

[9] CCITT Recommendation *Four-wire switched connections and four-wire measurements on circuits,* Yellow Book, Vol. IV, Rec. M.640, ITU, Geneva, 1981.

[10] CCITT Recommendation *Transmission characteristics of an international exchange,* Vol. VI, Rec. Q.45, Annex A.

[11] *Ibid.,* Figure 3/Q.45.