THE INTERNATIONAL TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE
(C.C.I.T.T.)

IVth PLENARY ASSEMBLY

MAR DEL PLATA, 23 SEPTEMBER - 25 OCTOBER 1968

WHITE BOOK

VOLUME VI

*

Telephone signalling and switching

Published by
THE INTERNATIONAL TELECOMMUNICATION UNION
1969

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VOLUME VI

Telephone signalling and switching

RECOMMENDATIONS (SERIES Q) — PART I TO PART XVI
QUESTIONS (STUDY GROUPS XI AND XIII)
DOCUMENTARY PART

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1969

CONTENTS OF THE C.C.I.T.T. BOOKS
APPLICABLE AFTER THE IVth PLENARY ASSEMBLY (1968)

(WHITE BOOK)

Volume I — Minutes and reports of the IVth Plenary Assembly of the C.C.I.T.T.
— Resolutions and Opinions issued by the C.C.I.T.T.
— General table of Study Groups and Working Parties for the period 1968-1972.
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— Recommendations (Series A) on the organization of the work of the C.C.I.T.T.
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Volume V — Recommendations (Series P) and Questions (Study Group XII) relating to telephone transmission quality, local networks and telephone sets.

Volume VI — Recommendations (Series Q) and Questions (Study Groups XI and XIII) relating to telephone signalling and switching.

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Signalling system R1

SIGNALLING SYSTEM R2

INTRODUCTION

1. The Recommendations in Volume VI of the *White Book* are in agreement with Series E of the C.C.I.T.T. Recommendations (Volume II of the *White Book*) and with the provisions of the *Instructions for the International Telephone Service.*

2. The following expressions, which are in conformity with the I.T.U. *List of Definitions* (see definitions 16.19, 16.20, 17.53 and 17.54), have been used in Volume VI of the *White Book.*

a) *Semi-automatic service* (or working), to designate a "service in which the calling subscriber's booking is given to an operator in the outgoing exchange, who completes the call through automatic switches".

b) *Automatic service* (or working), to designate a "system in which the switching operations are performed without the intervention of operators, the calling subscriber dialling (or keying) the called subscriber direct". This expression must be used to the exclusion of all others, such as "fully automatic service".

If a recommendation applies to both automatic and semi-automatic working, this should be explicitly specified in each sentence, since the C.C.I.T.T. has not defined a general expression to cover both of these services.

However, it has been agreed that the expressions

"automatic circuit" and
"automatic equipment"

should, unless otherwise stated, be taken to indicate circuits or equipment which may be used either for semi-automatic or for automatic working.

3. To simplify the wording, the term "Administration" has been adopted as a short form indicating a telephone Administration or, equally, a private telecommunications Agency.

PART I

SIGNALLING IN THE INTERNATIONAL MANUAL SERVICE

CHAPTER I

RECOMMENDATION Q.1

SIGNAL RECEIVERS FOR MANUAL WORKING

In 1934 (C.C.I.F. *White Book*, Volume III, Xth Plenary Assembly, Budapest, 1934), a signalling current having a frequency of 500 Hz±2%, interrupted at a frequency of 20 Hz±2%, was provisionally chosen for manually-operated international circuits.

500 Hz was chosen as the frequency to be transmitted, under normal conditions, by carrier terminal equipment and line repeaters. To avoid false operation due to speech currents, it was also considered desirable to interrupt the 500-Hz signalling current at low frequency. The use of a uniform interruption frequency of 20 Hz enables a high degree of selectivity to be obtained in signal receivers.

The effective power produced by the signalling current, when not interrupted, is fixed at 1 milliwatt at a zero relative level point or an absolute power level of zero (with a tolerance of ±1 decibel) which corresponds to an average power for the interrupted signalling current of 0.5 milliwatt, with a tolerance of ±1 decibel.

The power levels specified above were chosen in 1954 (XVIIth C.C.I.F. Plenary Assembly, Geneva, 1954) on the basis of the limit imposed for the maximum energy which can be transmitted by signals during the busy hour; it must not exceed 2.5 microwatthours or 9000 microwattseconds at a zero relative level point. A reasonable value for the number of calls, or attempted calls, on a circuit during the busy hour was assumed and 2 seconds was assumed to be the sending duration of the signalling current to line by operation of the operator's ringing key.

On outgoing circuits from an international exchange, where the 500/20-Hz signals are liable to be sent over wideband carrier systems (coaxial carrier systems) it is desirable, to avoid overloading the repeaters, that the duration of the 500/20-Hz signals sent to line should not exceed 2 seconds and they should be limited to this value by automatic means.

Since, in general, the *Instructions for the International Telephone Service* (Article 32) require the signalling current sent over an international circuit to have a duration of at least 2 seconds to avoid the risk of signals being undetected at the incoming end, the means for limiting the sending duration of the signalling current will generally consist of an arrangement which controls the sending duration independently of the time the ringing key is operated and which automatically fixes that duration at 2 seconds.

Note. — In the case of short two-wire circuits, it may be economical to use, by agreement between the administrations concerned, a low-frequency signalling current (either between 16 and 25 Hz or 50 Hz).

ANNEX

(to Recommendation Q.1)

Basic technical clauses of a model specification for the provision of 500/20-Hz voice-frequency signalling sets (signal transmitters and receivers) intended for manually-operated circuits

a) *Sending of signals*

Power. — The signal transmitter shall supply a sinusoidal current at a frequency of 500 Hz ±2% interrupted at a frequency of 20 Hz±2%.

The effective mean power of the 500/20-Hz current is fixed at 0.5 milliwatt or an absolute power level (ref. 1mW) of −3 decibels (with a tolerance of ±1 decibel) at a zero relative level point.

Every precaution should be taken to avoid unbalance effects in the circuit during the transmission of a 500/20-Hz signalling current.

b) *Reception of signals*

Sensitivity. — The signal receiver shall operate correctly when the 500/20-Hz current at the input to the signal receiver is within the following limits:

$$-8.5 + n \leqslant \mathrm{N} \leqslant +2.5 + n \text{ decibels}$$

where n is the relative power level at the point of the circuit at which the signal receiver is connected.

The limits take account of the tolerances indicated above for the transmitted power level and include a margin of ±4.5 decibels on the nominal absolute power level of the 500/20 Hz current received at the input to the signal receiver. This margin allows for variations in transmission conditions on international circuits.

Tuning. — Tuning should be such that the signal receiver operates only at a frequency of 500 Hz guaranteed to within ±2% and at an interrupting frequency of 20 Hz guaranteed to within ±2%.

Delay. — The delay, i.e. the time which elapses between the application of the signalling voltage and the operation of the signal receiver, must be long enough for the signal receiver to remain insensitive to all speech currents which normally flow in the circuit to which it is connected. The duration of this delay must, however, be less than 1200 milliseconds. (In other words, 1200 milliseconds is the maximum signal recognition time within which a signal has to be recognized.)

Selectivity (resulting from the tuning of the resonant circuit and the delay mentioned above). — The receipt of a speech (or noise) current circulating in the circuit must not give rise to a current liable to cause the operation of the signalling equipment and, in consequence, to cause a wrong indication to be given on the international positions even though the speech (or noise) voltage reaches the maximum value likely to be met in practice. In particular, the signal receiver must not operate when a speech power not exceeding 6 milliwatts is applied at a zero relative level point.

Insertion loss. — The insertion loss introduced by the signal receiver in the circuit with which the signalling set is associated must be less than 0.3 decibel for any frequency effectively transmitted by the circuit.

CHAPTER II

RECOMMENDATION Q.2

SIGNAL RECEIVERS FOR AUTOMATIC AND SEMI-AUTOMATIC WORKING, USED FOR MANUAL WORKING

The directives relating to 500/20-Hz signalling sets are provisional. An Administration intending to purchase new signalling sets for use on international circuits which for the time being are to be operated on a manual basis, may find it advantageous, by agreement with the Administrations interested in the operation of the circuits concerned, to use signal receivers and transmitters conforming to the Specifications for international automatic equipment. This will permit a greater technical uniformity of installations and will avoid having to replace the signal receivers when, ultimately, these circuits are operated on an automatic or semi-automatic basis.

The signal receivers must therefore conform with the Specifications for the applicable recommended C.C.I.T.T. systems.

Sending of signals

The frequency and power level of the signalling current must be in accordance with the Specifications for international automatic equipment. If two-frequency signal receivers are concerned, the two frequencies (compound signal) must be transmitted simultaneously.

The nominal duration of a signal sent to line is fixed at 2 seconds so as to be the same as that specified for 500/20-Hz signalling.

Reception of signals

At the receiving end, provision must be made for a splitting arrangement conforming to the Specifications for international automatic equipment. This splitting arrangement can be:

- either an integral part of the signal receivers, or
- placed at the end of the circuit after the signal receiver.

The signalling equipment (at the output of the signal receiver) which causes the lighting of the calling and clearing lamps shall have a signal recognition time of between 100 and 1200 milliseconds:

- the minimum duration of 100 ms has been chosen so as to avoid the recognition of false signals due to imitation by speech currents;
- the maximum duration of 1200 ms has been chosen so as to permit the partial use of old 500/20-Hz signal-receiver equipment.

Note 1. — The characteristics of signal receivers of the types used for automatic or semi-automatic working could possibly also be used to provide signals and supplementary facilities for operators if the Administrations concerned consider that the operational advantages to be obtained justify the equipment modifications involved at the international exchanges.

Note 2. — The times quoted in this Recommendation for the signal length and the signal recognition times would also be appropriate for out-band signalling systems using discontinuous signals for a manual service.

PART II

GENERAL RECOMMENDATIONS RELATING TO SIGNALLING AND SWITCHING IN THE AUTOMATIC AND SEMI-AUTOMATIC SERVICES

CHAPTER I

C.C.I.T.T. basic Recommendations on international automatic and semi-automatic working

RECOMMENDATION Q.5 *

ADVANTAGES OF SEMI-AUTOMATIC SERVICE IN THE INTERNATIONAL TELEPHONE SERVICE

(Geneva, 1954)

The C.C.I.T.T.,

considering

1. the large economies in personnel that can result from the introduction of semi-automatic service at the incoming exchange;

2. the very small number of faults due to the equipment used for the international semi-automatic service;

3. the improvement in the "efficiency" (ratio of chargeable time to total holding time) of circuits using semi-automatic service compared with the efficiency of manual circuits operated on a demand basis;

4. the improvement in the quality of the service given to users due to the reduction in the time of setting up a call;

5. the fact that any type of call can be set up without difficulty over semi-automatic circuits, so that semi-automatic circuits can be used exclusively on an international relation,

draws the attention of Administrations

to the advantages of semi-automatic service from the point of view of economy and of the quality of service given to subscribers.

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* The substance of this Recommendation also appears in Recommendation E.116 in Volume II-A of the *White Book*.

RECOMMENDATION Q.6 *

ADVANTAGES OF INTERNATIONAL AUTOMATIC WORKING

(New Delhi, 1960)

The C.C.I.T.T.,

considering

1. that the advantages of semi-automatic working mentioned in Recommendation Q.5 apply as well to automatic working in respect of reliability, circuit efficiency and the satisfaction given to subscribers;

2. that the advantages of automatic working are even greater as regards staff economy, since outgoing operators are dispensed with;

3. that the changeover from semi-automatic to automatic working may be accomplished without any major modification to the international circuits or to the switching equipment at transit and incoming exchanges;

4. that by 1960 the above advantages had been widely confirmed by experience on a number of international relations which had been using automatic service up to that time;

5. that such experience has also shown that when a relation changes from demand working (manual or semi-automatic) to automatic working, there is a considerable increase in traffic;

6. that the introduction of an international automatic service follows logically on the introduction of a national automatic service,

draws the attention of Administrations

to the additional advantages resulting from the introduction of an international automatic service.

RECOMMENDATION Q.7

SIGNALLING SYSTEMS TO BE USED FOR INTERNATIONAL AUTOMATIC AND SEMI-AUTOMATIC TELEPHONE WORKING

(Geneva, 1954, Geneva, 1964, and Mar del Plata, 1968)

A. The C.C.I.T.T.

considering

1. that standardization of the signalling systems to be used for international automatic and semi-automatic working is necessary to keep to a minimum the number of different types of equipment serving the various routes at any one exchange;

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* The substance of this Recommendation also appears in Recommendation E.117 in Volume II-A of the *White Book*.

2. that the following systems have been standardized *for general use* in international automatic and semi-automatic working:

— System No. 3 (formerly called "one-frequency system") standardized by the C.C.I.F. in 1954;

— System No. 4 (formerly called "two-frequency system") standardized by the C.C.I.F. in 1954;

— System No. 5, standardized by the C.C.I.T.T. in 1964;

— System No. 5*bis*, standardized by the C.C.I.T.T. in 1968;

— System No. 6, standardized by the C.C.I.T.T. in 1968;

3. that the following systems have been standardized *for regional use* in international automatic and semi-automatic working:

— System R.1 (Regional system No. 1, formerly called the North American System), standardized by the C.C.I.T.T. in 1968;

— System R.2 (Regional system No. 2, formerly called the MFC Bern System), standardized by the C.C.I.T.T. in 1968;

4. that, under the conditions and subject to the reservations stated below, these systems may be expected to give acceptable results for international semi-automatic and automatic working;

desiring

that the C.C.I.T.T. Recommendation concerning the signalling systems for international automatic and semi-automatic working be generally applied by all Administrations;

unanimously recommends

that, in the conditions and subject to the reservations stated below, Administrations should use, for international automatic and semi-automatic working, one or more of the standard systems mentioned in sections 2 and 3 above.

Note 1. — The signalling systems standardized by the C.C.I.T.T. *for general use* are designated by serial numbers as follows:

No. 1:	is assigned to the 500/20-Hz signalling system used in the international manual service (see Recommendation Q.1);
No. 2:	is assigned to the 600/750-Hz signalling system recommended by the C.C.I.F. in 1938 (Volume I*ter* of the *White Book*, Oslo, 1938) for international service on two-wire semi-automatic circuits but which was never used in international service;
No. 3, No. 4, No. 5 and No. 5*bis*:	are assigned to the four in-band systems recommended for semi-automatic and automatic working;
No. 6:	is assigned to the signalling system using a separate channel for all signals and recommended for automatic and semi-automatic service.

Note 2. — The signalling systems standardized by the C.C.I.T.T. *for regional use* are designated by the serial numbers R1 and R2.

B. *Characteristics and field of application of the C.C.I.T.T. standard systems for general use*

SYSTEM No. 3

Described and specified in the *Red Book*, Volume VI, Part V (New Delhi, 1960). *

Standardized in 1954 by the C.C.I.F. and based on the principles described in the *Red Book*, Volume VI, Part V, Annex 1.

Suitable for one-way operation of the circuits.

Uses one "in-band" signalling frequency (2280 Hz) for the transmission of both line and register signals.

Applicable for semi-automatic and automatic working.

Used for terminal traffic on the European continent.

Not to be used for new relations.

SYSTEM No. 4

Fully described and specified in Part IX of this Volume.

Standardized in 1954 by the C.C.I.F. and based on the principles described in the *Red Book*, Volume VI, Part V, Annex 1 (New Delhi, 1960).

Suitable for one-way operation of the circuits.

Uses two "in-band" signalling frequencies (2040 and 2400 Hz) for the end-to-end transmission of both line and register signals.

Applicable for semi-automatic and automatic working.

Initially used for international traffic on the European continent.

Suitable for terminal and transit traffic; in the latter case 2 or 3 circuits equipped with System No. 4 may be switched in tandem.

Suitable for submarine or land cable circuits and microwave radio circuits. Not applicable for TASI-equipped systems. The use of this system via satellite circuits may not be practicable, since the call set-up speed will be slow, due to the compelled digit-by-digit technique.

Capable of interworking with Systems No. 5, No. 5*bis* and No. 6 in the combinations:

No. 4-No. 5 and No. 5-No. 4. See Part XI of this Volume.
No. 4-No. 5*bis* and No. 5*bis*-No. 4. See Part XIII of this Volume.
No. 4-No. 6 and No. 6-No. 4. See Chapter IV, Part XIV of this Volume.

SYSTEM No. 5

Fully described and specified in Part X of this Volume.

Standardized in 1964 by the C.C.I.T.T. and based on the principles described in the *Blue Book*, Volume VI (Geneva, 1964), Introduction to Part X, reproduced in Part X of this Volume.

Suitable for both-way operation of the circuits.

Uses two "in-band" signalling frequencies (2400 and 2600 Hz) for the link-by-link transmission of line signals and six "in-band" signalling frequencies (700, 900, 1100, 1300, 1500 and 1700 Hz) in a two-out-of-six code (numerical information transmitted en bloc) for the link-by-link transmission of register signals.

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* See an amendment in Part VIII of this volume.

Applicable for semi-automatic and automatic working.

Initially used for intercontinental traffic via TASI-equipped submarine cables.

Suitable for terminal and transit traffic; in the latter case two or more circuits equipped with System No. 5 may be switched in tandem (see, however, the note below).

Suitable for submarine or land cable circuits and microwave radio circuits, whether TASI is used or not and for satellite circuits * (see, however, the note below).

Capable of interworking with Systems No. 4, No. 5*bis* and No. 6 in the combinations:

No. 5-No. 4 and No. 4-No. 5: see Part XI of this Volume;
No. 5-No. 5*bis* and No. 5*bis*-No. 5: see Part XIII of this Volume;
No. 5-No. 6 and No. 6-No. 5: see Part XIV, Chapter IV of this Volume.

Note. — When, with automatic working, two or more international circuits equipped with this system are switched in tandem, or when a satellite circuit is used, there is a small probability that the called subscriber will release prematurely because the conditions for effective conversation have not been established quickly enough. The C.C.I.T.T. prefers to reserve its recommendation in the matter of automatic operation over several circuits switched in tandem and equipped with System No. 5 (or No. 5*bis*).

SYSTEM No. 5*bis*

Standardized in 1968 by the C.C.I.T.T. and introduced, as a variant of System No. 5, in order to provide for more facilities.

Fully described and specified in Part XII of this Volume.

Suitable for both-way operation of the circuits.

Uses, in both forward and backward directions, six "in-band" signalling frequencies (700, 900, 1100, 1300, 1500 and 1700 Hz) in a two-out-of-six code in combination with a guard and TASI-locking frequency (1850 Hz) for the link-by-link transmission of register signals, providing forward and backward exchange of information during call set-up **.

Applicable for semi-automatic and automatic working.

Suitable for terminal and transit traffic; in the latter case two or more circuits equipped with System No. 5*bis* may be switched in tandem (see, however, the note).

Suitable for submarine or land cable circuits and microwave radio circuits, whether TASI is used or not and for satellite circuits * (see, however, the note).

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* See also Question 1/XIII.

** The specifications of System No. 5*bis* provide the possibility of using common inter-register signalling equipment on relations using System No. 5 and on those using System No. 5*bis*.

Capable of interworking with Systems No. 4, No. 5 and No. 6 in the combinations:

No. 5*bis*-No. 4 and No. 4-No. 5*bis*: see Part XIII of this Volume;
No. 5*bis*-No. 5 and No. 5-No. 5*bis*: see Part XIII of this Volume;
No. 5*bis*-No. 6 and No. 6-No. 5*bis*: see Part XIV of this Volume.

Note. — When, with automatic working, two or more international circuits equipped with this system are switched in tandem, or when a satellite circuit is used, there is a small probability that the called subscriber will release prematurely because the conditions for effective conversation have not been established quickly enough. The C.C.I.T.T. prefers to reserve its recommendation in the matter of automatic operation over several circuits switched in tandem and equipped with System No. 5*bis* (or No. 5).

SYSTEM No. 6

Standardized in 1968 by the C.C.I.T.T. and based on the principles of "(completely) separate channel signalling" mentioned in the first part of Recommendation Q.20.

Fully described and specified in Part XIV of this Volume.

Suitable for both-way operation of the circuits.

Uses a signalling link, common for a number of speech circuits, carrying all signalling information for the calls using these circuits, by means of a serial mode of data transmission at a speed of 2400 (exceptionally 2000) bits per second.

Applicable for semi-automatic and automatic working.

Suitable for terminal and transit traffic.

Suitable for submarine or land cable circuits and microwave radio circuits, whether TASI is used or not and for satellite circuits * (see, however, the details in the specification).

Capable of interworking with Systems No. 4, No. 5 and No. 5*bis* in the combinations:

No. 6-No. 4 and No. 4-No. 6,
No. 6-No. 5 and No. 5-No. 6 and
No. 6-No. 5*bis* and No. 5*bis*-No. 6.

See Part XIV, Chapter IV of this Volume.

C. *Characteristics and field of application of the C.C.I.T.T. standard systems for regional use*

SYSTEM R1

Fully described and specified in Part XV of Volume VI of the White Book (Mar del Plata, 1968).

Suitable for both-way operation of the circuits.

Uses one in-band signalling frequency (2600 Hz) for the link-by-link, continuous type line signalling and six "in-band" signalling frequencies (700, 900, 1100, 1300, 1500

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* See also Question 1/XIII.

and 1700 Hz) in a two-out-of-six code for the link-by-link transmission of forward register signals.

Applicable for semi-automatic and automatic working.
Suitable for terminal and transit traffic.
Not applicable to TASI equipped systems.

SYSTEM R2

Fully described and specified in Part XVI of Volume VI of the White Book (Mar del Plata, 1968).

Suitable for both-way operation of the circuits.

Uses one "out-band" signalling frequency (3825 Hz) for the link-by-link, continuous type low level line signalling and two groups of "in-band" signalling frequencies (1380, 1500, 1620, 1740, 1860 and 1980 Hz for forward signalling), (1140, 1020, 900, 780, 660, 540 for backward signalling) in a two-out-of-six code for the end-to-end, continuous compelled, transmission of register signals.

Applicable for semi-automatic and automatic working.
Suitable for terminal and transit traffic.
Not applicable to TASI equipped systems or 3-kHz spaced channels. Not recommended for use on satellite circuits.

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PART I	PART II
CHAPTER IV	CHAPTER II

NUMBERING PLAN AND DIALLING PROCEDURES IN INTERNATIONAL SERVICE

RECOMMENDATION E.160 RECOMMENDATION Q.10

DEFINITIONS RELATING TO NATIONAL AND INTERNATIONAL NUMBERING PLANS

1. International prefix

The combination of digits to be dialled by a calling subscriber making a call to a subscriber in another country, to obtain access to the automatic outgoing international equipment.

Examples:

00	in Switzerland
91	in Belgium

Note. — a) In some countries two or more international prefixes may be used:

— to reach different groups of countries;

— to obtain different classes of call (e.g. station call or personal call).

In the first case the use of two or more international prefixes allows the use of different groups of switching equipment and the use of " abbreviated " dialling (i.e. shorter country codes) for the calls to a defined group of countries (see definition No. 2. Country code).

b) Where several countries are included in one integrated numbering plan, the international prefix is not used on a call from one of these countries to another.

2. Country code

The combination of one, two or three digits characterizing the called country.

Examples:

7	U.S.S.R.
54	Argentina
591	Bolivia

Notes. — a) In the case where a country uses different international prefixes abbreviated dialling can be used. In this case, for calls to one country of a defined group of countries, a regional country code, composed of fewer digits than the normal country code, may be used.

Examples:

For traffic between Latin American countries, the following regional country codes might be used:

1	Argentina
2	Brazil
3	Chile
	etc.

b) In the case where several countries are included in one integrated numbering plan, no country code need be dialled for the traffic from one of these countries to another. For access by other countries, these countries:

— may be included under one common country code, or

— may have separate country codes,

always keeping in mind the necessity to avoid exceeding the recommended maximum number of digits in the international number.

3. Trunk prefix

A digit or combination of digits to be dialled by a calling subscriber, making a call to a subscriber in his own country but outside his own numbering area. It provides access to the automatic outgoing trunk equipment.

Examples:

0	in Belgium, Italy, Japan, Netherlands, Switzerland, United Kingdom
1 and 0	in Canada and in the U.S.A.
9	in Finland and Spain
16	in France

Note. — In the case where several countries are included in one integrated numbering plan, the trunk prefix is also used for calls from one of these countries to another.

4. Trunk code

A digit or combination of digits (not including the trunk prefix) characterizing the called numbering area within a country (or group of countries, included in one integrated numbering plan).

The trunk code has to be dialled before the called subscriber's number where the calling and called subscribers are in different numbering areas.

The trunk code varies from one country to another and is composed of:

a) either a " regional code " indicating the geographical zone to which the called subscriber belongs and within which subscribers can call one another by their subscriber numbers.

Example:

In France:

Paris area (Departments of Seine, Yvelines, Seine-et-Marne, Oise, etc.): trunk code 1,
Nice area (Department of Alpes-Maritimes): trunk code 93;

In Belgium:

Brussels area: trunk code 2,
Namur area: trunk code 81;

In the Federal German Republic and the Netherlands:

the geographical area defined above corresponds in general to the local network.
Düsseldorf local network: trunk code 211,
Amsterdam local network: trunk code 20;

In the United Kingdom:

this definition applies to certain networks such as that of London, the trunk code for which is: 1;

In Canada and the U.S.A.:

The geographical area defined above corresponds to a " Numbering Plan Area " (NPA)
Montreal area: NPA code: 514,
New York City area: NPA code: 212;

b) or a " numbering area code " followed by an exchange code when the directory entry of the called subscriber does not include the exchange code;

Example:

in certain areas of the United Kingdom:

Truro (group centre):	trunk code 872
Perranporth (in the Truro group):	trunk code 872 57

5. Subscriber number [1]

The number to be dialled or called to reach a subscriber in the same local network or numbering area.

This number is the one usually listed in the directory against the name of the subscriber.

6. National (significant) number

The number to be dialled following the trunk prefix to obtain a subscriber in the same country (or group of countries, included in one integrated numbering plan) but outside the same local network or numbering area.

The national (significant) number consists of the trunk code followed by the subscriber number.

It should be noted that, in some countries, it is customary to consider *for national purposes* that the trunk prefix is included in the national number (which is then not the national (significant) number). A careful distinction must therefore be made between such national definition or practice and the C.C.I.T.T. definition, which is internationally valid. In order to avoid misunderstanding, the C.C.I.T.T. definition includes the word " significant " between brackets, reading as follows: " national (significant) number ".

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[1] Care should be taken not to use the term " local number " instead of " subscriber number ".

Examples:

Subscriber	National (significant) number
12 34 56 in Brussels	2 12 34 56
12 34 56 in Düsseldorf	211 12 34 56
21 34 56 in Nice	93 21 34 56
870 12 34 in Montreal	514 870 12 34
12 34 in Perranporth	872 57 12 34
248 45 67 in London	1 248 45 67

Note. — Where several countries are included in one integrated numbering plan, only the national (significant) number is to be dialled after the trunk prefix on calls from one of these countries to another.

7. International number

The number to be dialled following the international prefix to obtain a subscriber in another country.

The international number consists of the country code of the required country followed by the national (significant) number of the called subscriber.

Examples:

Subscriber	International number
12 34 56 in Brussels	32 2 12 34 56
12 34 56 in Düsseldorf	49 211 12 34 56
21 34 56 in Nice	33 93 21 34 56
870 12 34 in Montreal	1 514 870 12 34
12 34 in Perranporth	44 872 57 12 34
248 45 67 in London	44 1 248 45 67

Note. — Where several countries are included in one integrated numbering plan, the international number is not used on calls from one of these countries to another. (See the note to definition No. 6.)

RECOMMENDATION E.161

RECOMMENDATION Q.11

NUMBERING FOR INTERNATIONAL SERVICE

1. National numbering plan

1.1 Each telephone Administration should give the most careful consideration to the preparation of a *national numbering plan* [1] for its own network. This plan should be designed so that a subscriber is always called by the same number in the trunk service. It should be applicable to all incoming international calls.

1.2 *Number analysis*

1.2.1 The national numbering plan of a country should be such that an analysis of a minimum number of digits of the national (significant) number [2] :

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[1] See the C.C.I.T.T. *Manual on National Telephone Networks for the Automatic Service* for a comprehensive study of national numbering plans from the national point of view.

[2] See definitions in Recommendations E.160 and Q.10.

a) gives the most economical routing of incoming international traffic from various other countries;

b) indicates the charging area in those countries where there are several.

1.2.2 In the case of a country with a two- or three-digit country code, not more than twe digits of the national (significant) number should be analysed for these purposes.

In the case of a country with a one-digit country code, not more than three digits of the national (significant) number should be analysed for these purposes.

1.2.3 In the case where an integrated numbering plan covers a group of countries the digit analysis specified in 1.2.2 should also determine the country of destination.

1.2.4 For the requirements relating to frontier traffic see Recommendations E.280 and Q.50, paragraph 3.

2. Limitation of the number of digits to be dialled by subscribers

2.1 *International number*

The C.C.I.T.T. recommended in 1964 that the number of digits to be dialled by subscribers in the automatic international service should not be more than 12 (excluding the international prefix). It is emphasized that this is the maximum number of digits and Administrations are invited to do their utmost to limit the digits to be dialled to the smallest possible number.

2.2 *National (significant) number*

Noting that:

a) the international number (excluding the international prefix) consists of the country code followed by the national (significant) number,

b) the smallest possible number of digits to be dialled in the automatic international service is achieved by limiting the number of digits of the country code and/or of the national (significant) number,

c) in some countries where telephony is already developed to an advanced stage, the national numbering plans in force enable the number of digits of the international number to be limited to less than 12,

d) some other countries which drew up their national numbering plans some time ago have taken steps to ensure that the number of digits of the international number will not exceed 12 and may even be less,

the C.C.I.T.T. recommended in 1964 that countries which had not yet established their national numbering plan ensure that, as far as practicable, the maximum number of digits of the international number be 11, at least for a period corresponding approximately to the life of automatic switching equipment (i.e. a minimum of 25 years).

For these countries, the number of digits of the national (significant) number should be equal to a maximum of 11–*n* (at least for the period of consideration), *n* being the number of digits of the country code.

3. Digit capacity of international registers

The C.C.I.T.T. considers it advisable to recommend that the digit capacity of registers dealing with international traffic should allow for future conditions that may arise, but not possible to specify at the present time. In this regard, registers dealing with international traffic should have a digit capacity, or a capacity that can be expanded, to cater for more than the maximum 12-digit international number envisaged at present. The increase in the number of digits above 12 is left as a matter of decision to be taken by individual Administrations *.

4. Use of figures and letters in telephone numbers

4.1 For automatic international service, it is preferable that the national numbering plan should not involve the use of letters (associated with figures). The use of letters in national numbering plans may, however, be necessary for national reasons. For example, countries using letters in their subscriber numbers will naturally use them in their national numbering.

4.2 For automatic international service to countries using letters in telephone numbers, it would be helpful, in a country where letters are not used:

a) to include in the directory a table for converting into figures the letter codes of exchanges in countries with which an automatic service is available;

b) to supply, at the time of opening this automatic service, a booklet of instructions containing the conversion table to the main subscribers to the international service;

4.3 It would also be desirable, in countries with letters in the telephone numbers, that subscribers with considerable international traffic should be asked to show on their letter-heads, next to their telephone number, the international number with figures only. (See general recommendation for letter-heads in 7.3.2.)

5. Rotary dials (see Figure 1)

5.1 For countries which have not yet adopted any specific type of dial, the figures on the dial should be arranged in the following order: 1, 2, 3, ..., 0.

5.2 The dial shown below uses the arrangement of letters and figures employed by some European Administrations. It may be convenient that the dials (or key-sets) used by international operators for semi-automatic operating in Europe have this arrangement of letters and figures.

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* or recognized private operating Agencies.

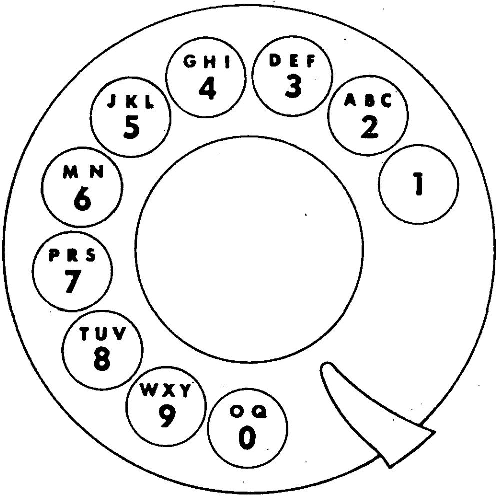

FIGURE 1

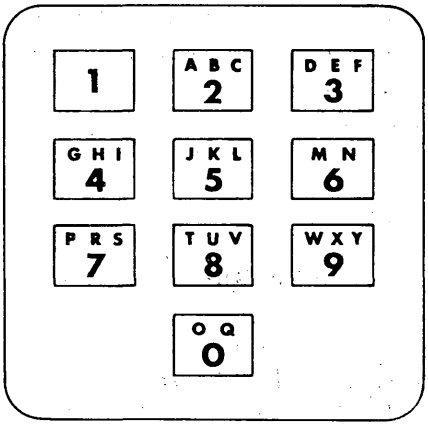

FIGURE 2

On the North-American keysets, the digit 0 is not associated with letters O and Q but with the word "operator", the letter O being associated with digit 6.

6. **Push-button telephone sets** (see Fig. 2)

6.1 *Arrangement of the push-buttons*

The following arrangement of push-buttons corresponding to the digits 0 to 9 is recommended:

1 2 3
4 5 6
7 8 9
0

This arrangement, which corresponds to that already adopted in some countries—and on which a certain number of Administrations have based their standardization—is one found suitable, for a maximum of 12 buttons. This recommendation results from thorough studies made by several Administrations on subscriber reactions to various conceivable push-button patterns.

In view of the fact that purely numerical numbering plans are now recommended and that the association of letters to digits is not the same in different countries, it is undesirable to standardize letter symbols for the push-buttons corresponding to each of the digits. In cases where a mixed letter-and-digit dialling system is still in use in a country, the letters associated with the figures in the dialling system of the country concerned may, of course, be included on the corresponding push-buttons of their country's telephone sets.

6.2 *Additional push-buttons*

The push-button corresponding to the zero in the last line of the arrangement shown above may be flanked by two additional buttons, thus making a pattern with 4 horizontal rows of 3 buttons each.

The functions and designations of the additional buttons cannot yet be defined. Their use may depend on the possibilities offered by the network of the country concerned. For example, a button may be used to permit:

— abbreviated dialling of a select list of subscriber numbers,
— transfer of a call to another subscriber in the same network,
— obtaining conference calls in which several users take part together,
— etc.

Apart from this, various other functions can be conceived for the additional buttons.

7. Prefixes and codes

7.1 *International prefix* [1]

International standardization of a code for access to the international network for automatic international operation has not been possible since it was in conflict with national numbering plans already in existence. (Standardization of a code for access to the international automatic network would have been useful to international travellers.)

7.2 *Country code* [1]

7.2.1 Country codes will be used:

— in semi-automatic working, to route calls to the required country when the calls are transit calls or when, on the outgoing positions, there is common dialling access to all the outgoing routes;
— in automatic working.

7.2.2 A list of country codes was prepared by the C.C.I.T.T. in 1964 within the framework of a world-wide automatic telephone numbering plan.

This list was set up according to the following principles:

a) the number of digits of the country code is one, two or three according to the foreseeable telephonic and demographic development of the country concerned;

b) the nine digits from 1 to 9 have been allocated as the country code or as the first digit of the country code. These digits define *world numbering zones*;

c) in the case of Europe, owing to the large number of countries requiring two-digit codes, the two digits 3 and 4 have been allocated as the first digit of the country codes.

7.2.3 The list of country codes is given at the end of this Recommendation.

7.3 *Trunk prefix* [1]

7.3.1 The national (significant) number (see definition 6 of Recommendations E.160 and Q.10) does not include the trunk prefix. Accordingly, in international service, the trunk prefix of the country of destination must not be dialled.

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[1] See definitions in Recommendations E.160 and Q.10.

It should be noted that, in some countries, it is customary to consider *for national purposes* that the trunk prefix is included in the national number (which is then not the national (significant) number). A careful distinction must therefore be made between such national definition or practice and the C.C.I.T.T. definition, which is internationally valid. In order to avoid misunderstanding, the C.C.I.T.T. definition includes the word " significant " between brackets, reading as follows: " national (significant) number ".

7.3.2 The C.C.I.T.T. recommends that Administrations ask those subscribers likely to receive an appreciable amount of international traffic to indicate on their letter-heads, next to their telephone number as dialled in the national service, a second number for the international service in which:

- the trunk prefix does not appear;
- the letters are converted into digits (where applicable);
- the national (significant) number is preceded by the country code.

Example:

For a subscriber in London whose subscriber number is 340 1234

national number:	0	1	340	1234
international number:	44	1	340	1234

7.3.3 It is recommended by the C.C.I.T.T. that the Administrations of countries that have not yet adopted a trunk prefix for access to their national automatic trunk network should adopt a prefix composed of a single digit, preferably 0.

The reasons for this recommendation are:

- to provide the maximum degree of standardization of the trunk prefixes used in different countries, so that dialling is made as easy as possible for a person travelling in different countries, and
- to minimize the number of digits to be dialled in the national automatic service.

7.3.4 In the automatic international service, following the international prefix and country code of the called country, the caller should dial the national (significant) number of the called subscriber (i.e. without dialling the trunk prefix).

LIST OF COUNTRY CODES FOR THE INTERNATIONAL SEMI-AUTOMATIC AND AUTOMATIC SERVICE

Foreword

In accordance with the decision reached by the IIIrd Plenary Assembly of the C.C.I.T.T. (Geneva, 1964), the international telephone numbering plan should mention only the codes of countries within the jurisdiction of the Members and Associate Members of the International Telecommunication Union, and the names of those countries should be as they appear in the International Telecommunication Convention.

In the list hereunder, the countries in each world numbering zone are not arranged in alphabetical order but in the numerical order of their codes, those with two-digit codes preceding those with three-digit codes.

Each " territory " which has been given a country code, but the telecommunications of which come under the international jurisdiction of another State, is listed:

— either immediately after that State when it is in the same numbering zone,

— or at the end of the code list in the relevant numbering zone when the State responsible for its telecommunications is included in a different numbering zone.

Numbering zone 1 is an integrated numbering area covering the North-American continent and the countries in it are listed in geographical order from North to South, beginning with Canada.

" Territories " the telecommunications of which come under the jurisdiction of other States are listed in the different numbering zones in the order and with the official names used in the " List of countries, territories and groups of territories Members or Associate Members of the International Telecommunication Union ", published by the I.T.U. General Secretariat.

Some countries and territories are represented in the Union by members specifically empowered for this purpose. These countries and territories are followed by (1), (2), (3), (4) or (5), meaning:

(1) Territory represented by the French Overseas Post and Telecommunication Agency.

(2) Spanish Province in Africa.

(3) Portuguese Oversea Province.

(4) Territory of the United States.

(5) Overseas Territory for the international relations of which the Government of the United Kingdom of Great Britain and Northern Ireland are responsible.

Revised list of country codes incorporating amendments proposed by the World Plan Committee, Mexico City, 1967

World numbering ZONE 1

Canada
St. Pierre and Miquelon (1)
United States of America, including Puerto Rico and the Virgin Islands
Jamaica
Costa Rica
El Salvador (Republic of)
French Antilles (France)
Honduras (Republic of)
Nicaragua
Panama
Barbados
Antigua (5)
Cayman Islands (5)
British Virgin Islands (5)
Bermuda (5)
Bahamas (5)
British Honduras (5)
Dominica (5)
Grenada (5)
Montserrat (5)
St. Kitts (5)
St. Lucia (5)
St. Vincent (5)

World numbering ZONE 2

United Arab Republic	20
Algeria (Algerian Dem. and Pop. Rep.)	21
Morocco (Kingdom of)	21
Tunisia	21
Libya (Kingdom of)	21
Gambia	220
Senegal (Republic of the)	221
Mauritania (Islamic Republic of)	222
Mali (Republic of)	223
Guinea (Republic of)	224
Ivory Coast (Republic of the)	225
Upper Volta (Republic of)	226
Niger (Republic of the)	227
Togolese Republic	228
Dahomey (Republic of)	229
Liberia (Republic of)	231
Sierra Leone	232
Ghana	233
Nigeria (Fed. Rep. of)	234
Chad (Republic of the)	235
Central African Republic	236
Cameroon (Fed. Rep. of)	237
Cape Verde Islands (3)	238
St. Thome and Principe (3)	239
Equatorial Guinea (2)	240
Gabon Republic	241
Congo (Rep. of the) (Brazzaville)	242
Congo (Dem. Rep. of the)	243
Angola (3)	244
Portuguese Guinea (3)	245
Sudan (Republic of the)	249
Rwanda (Republic of)	250
Ethiopia	251
Somali Republic	252
French Somaliland (1)	253
Kenya	254
Tanzania (United Rep. of) (mainland)	255
Uganda	256
Burundi (Kingdom of)	257
Mozambique (3)	258
Zanzibar (Tanzania)	259
Zambia (Republic of)	260
Malagasy Republic	261
Reunion (France)	262
Rhodesia	263
Territory of South-West Africa	264
Malawi	265
Lesotho	266
Botswana	267
Swaziland	268
Comoro Islands (1)	269
South Africa (Republic of)	27

Spare codes 28, 29, 230, 246, 247, 248

World numbering ZONES 3 and 4

Greece	30	Denmark	45
Netherlands (Kingdom of the)	31	Sweden	46
Belgium	32	Norway	47
France	33	Poland (People's Republic of)	48
Spain	34	Federal Republic of Germany	49
Hungarian People's Republic	36	Gibraltar (5)	350
*	37	Portugal	351
Yugoslavia (Fed. Rep. Soc. of)	38	Luxembourg	352
Italy	39	Ireland	353
Roumania (Soc. Rep. of)	40	Iceland	354
Switzerland (Confederation of)	41	Albania (People's Republic of)	355
Czechoslovak Socialist Republic	42	Malta	356
Austria	43	Cyprus (Republic of)	357
United Kingdom of Great Britain and Northern Ireland	44	Finland	358
		Bulgaria (People's Republic of)	359

* (It is pointed out that the use of the code 37 has been the subject of bilateral agreements published in I.T.U. notification 980 of 10 March 1966.)

World numbering ZONE 5

Mexico	52	Guyana	592
Cuba	53	Ecuador	593
Argentine Republic	54	French Guyana (France)	594
Brazil	55	Paraguay	595
Chile	56	Peru	596
Colombia (Republic of)	57	Surinam (Netherlands)	597
Venezuela (Republic of)	58	Uruguay (Oriental Republic of)	598
Guatemala	500 [1]	Netherlands Antilles (Netherlands)	599
Bolivia	591		

Spare codes
51
501 to 509
590

[1] The numbering plan for Central America is in preparation.

World numbering ZONE 6

Malaysia	60	Tonga (5)	676
Australia (Commonwealth of)	61	Solomon Islands (5)	677
Indonesia (Republic of)	62	New Hebrides (5)	678
Philippines (Republic of the)	63	Fiji Islands (5)	679
New Zealand	64	Wallis and Futuna (1)	681
Singapore	65	Am. Samoa (4)	684
Thailand	66	Gilbert and Ellice Islands (5)	686
Portuguese Timor (3)	672	New Caledonia (1)	687
New Guinea and Papua (Australia)	675	French Polynesia (1)	689

Spare codes
69,
670, 671, 673, 674, 680, 682, 683, 685, 688

World numbering ZONE 7

Union of Soviet Socialist Republics	7

World numbering ZONE 8

Japan	81	Macao (3)	853
Korea (Republic of)	82	Cambodia (Kingdom of)	855
Viet-Nam (Republic of)	84	Laos (Kingdom of)	856
Hong Kong (5)	852	China	86

Spare codes { 80, 83, 87, 88, 89
850, 851, 854, 857, 858, 859

World numbering ZONE 9

Turkey	90	Saudi Arabia (Kingdom of)	966
India (Republic of)	91	Yemen	967
Pakistan	92	*	968*
Afghanistan	93	Southern Yemen (People's Republic of)	969
Ceylon	94	*	971*
Burma (Union of)	95	Israel (State of)	972
Lebanon	961	**	973**
Jordan (Hashemite Kingdom of)	962	*	974*
Syrian Arab Rep.	963	Mongolian People's Republic	976
Iraq (Republic of)	964	Nepal	977
Kuwait (State of)	965	Iran	98

Spare codes { 99
960, 970, 975, 978, 979

* See I.T.U. notifications 992, 995 and 998 (1967).

** (It is pointed out that the use of the code 973 has been the subject of bilateral agreements published in I.T.U. notification 984 of 10 July 1966.) (See also notification 992.)

ANNEX

Ref. *Notification 980*

In its relations with the German Democratic Republic, the Administrations of the People's Republic of Bulgaria, of the Hungarian People's Republic, of the People's Republic of Poland, of the Socialist Republic of Roumania, of the Czechoslovak Socialist Republic and of the Union of Soviet Socialist Republics will use the following code for telephone traffic:

	Telephone
German Democratic Republic	37

Ref. *Notifications 984, 992, 995, 998*

In its relations with Bahrain, Qatar, the Sultanate of Muscat and Oman, and the Trucial States, the Administration of the United Kingdom of Great Britain and Northern Ireland will use the following codes for telephone traffic:

	Telephone
Bahrain	973
Qatar	974
Sultanate of Muscat and Oman	968
Trucial States	971

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PART I PART II

CHAPTER V CHAPTER III

ROUTING PLAN FOR INTERNATIONAL SERVICE

RECOMMENDATION E.170 RECOMMENDATION Q.12

OVERFLOW — ALTERNATIVE ROUTING — REROUTING — AUTOMATIC REPEAT ATTEMPT

1. When a call cannot find a free circuit in one group of circuits (first choice), technical arrangements can be made to route the call automatically via another group of circuits (second choice), at the same exchange; this process is called *overflow*. There may be also overflow, at the same exchange, from a second choice group of circuits to a third choice group of circuits, etc.

2. When the group of circuits over which the overflow traffic is routed involves at least one exchange not involved in the previous choice route, the process is called *alternative routing*.

3. It should be noted that overflow can occur without alternative routing for cases such as, when there are in one relation two groups of circuits, one group reserved for one-way operation and the other group used for both-way operation. In this case, when all one-way circuits are busy, the call can overflow to the both-way circuit group.

4. When congestion occurs at a transit exchange, arrangements can be made in some signalling systems, at the outgoing international exchange on receipt of a busy-flash signal or a congestion signal sent by the transit exchange, to reroute the call automatically from the outgoing international exchange over another route. This process is called *rerouting* *.

It should be noted that rerouting serves no purpose when congestion conditions exist at the incoming exchange. In the same way, a call must not overflow from a direct route used exclusively for terminal traffic to an alternative transit route if the busy-flash signal or a congestion signal has been received on the direct route.

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* The use of rerouting is not envisaged in the International Routing Plan.

5. When a difficulty is encountered in the setting-up of a connection—such as double seizure on both-way circuits or error detection—arrangements can be provided to make another attempt to set up the connection for that call from the point where the first attempt took place. This process is called *automatic repeat attempt.*

An automatic repeat attempt may take place

— on the same circuit, or

— on another circuit of the same group of circuits, or

— on a circuit in another group of circuits.

RECOMMENDATION E.171 RECOMMENDATION Q.13

THE INTERNATIONAL ROUTING PLAN

1. Introduction

1.1 The following sections contain definitions and recommendations for the International Routing Plan.

Section 2: Structure of the International Routing Plan;

Section 3: Basic rules for routing;

Section 4: Effects of satellite communications;

Section 5: Additional rules for routing.

1.2 The International Routing Plan described in this Recommendation has been revised within the limits of the knowledge available at the time of revision in 1967 and particularly with a view to application during the ensuing five years. It is recognized that future revision will be necessary when further information becomes available concerning demand assignment satellite systems and future methods of routing control including network management.

1.3 The Plan concerns automatic and semi-automatic telephone traffic. An objective in developing the automatic and semi-automatic service is to enable a satisfactory connection between any two stations in the world. The Plan is necessary to allow the objective to be achieved with maximum economy by the most efficient use of costly circuits and switching centres while safeguarding the grade of service and the quality of transmission.

1.4 The Plan should be able to evolve as a function of traffic streams, the establishment of new routes and new international centres. The application of the Plan should be considered well in advance of any change to semi-automatic or automatic operation. However, caution should be exercised against premature decisions on transit points, etc., before the full routing possibilities have been evaluated.

1.5 The International Routing Plan has been established independently of the numbering plan, the rules for charging the calling subscriber, and the rules for the apportionment of charges (international accounting).

2. Structure of the International Routing Plan

2.1 *Switching of international calls*

International calls originated in a national telephone network will be switched to the world-wide telephone network through a transit centre (called hereafter CT) which can interconnect national circuits and international circuits. This CT acts as international originating centre.

A similar transit centre (called hereafter CT) serves the incoming international calls to be switched to the national network. That CT centre acts as international destination centre.

Between an international originating centre and an international destination centre, a number of international transit centres which can interconnect international circuits, may, if necessary, be used to switch the calls through the world-wide telephone network.

2.2 *Transit centres*

There are three categories of transit centres, called CT1, CT2 and CT3.

According to the theoretical final route structure of the network described below, each CT1 and each CT2 interconnects international circuits, thus acting as an international transit centre.

A CT3 normally acts as a transit centre interconnecting only a national network (or part of it) and international circuits. However, there are cases where a CT3, permanently or temporarily, may act as a transit centre of another category for specified routes.

2.3 *Theoretical final route structure (backbone structure) of the network*

The international telephone network has a theoretical final route structure (backbone structure) as illustrated in Figure 1.

2.3.1 A first category transit centre, CT1, may serve a continent or part of it. Each CT1 is connected by low loss probability circuits groups to all CT2s in its zone and to all other CT1s.

2.3.2 A second category transit centre, CT2, serves a part of the zone of the parent CT1. In a very large country the zone of a CT2 may be restricted to its own country or even to a part of it.

Each CT2 is connected by low loss probability circuit groups to all CT3s in its zone and to its homing CT1.

2.3.3 A third category transit centre, CT3, serves a part of the zone of the parent CT2. As a general rule, the zone of a CT3 is restricted to its own country or even to a part of it.

Each CT3 is connected by a low loss probability circuit group to it homing CT2.

2.3.4 The route followed by an international call from any CT of an originating chain (CT3 - CT2 - CT1) to any CT of a terminating chain (CT1 - CT2 - CT3) only via the low loss probability circuit groups of the backbone structure is called the *theoretical final route.* The theoretical final route has no overflow possibilities.

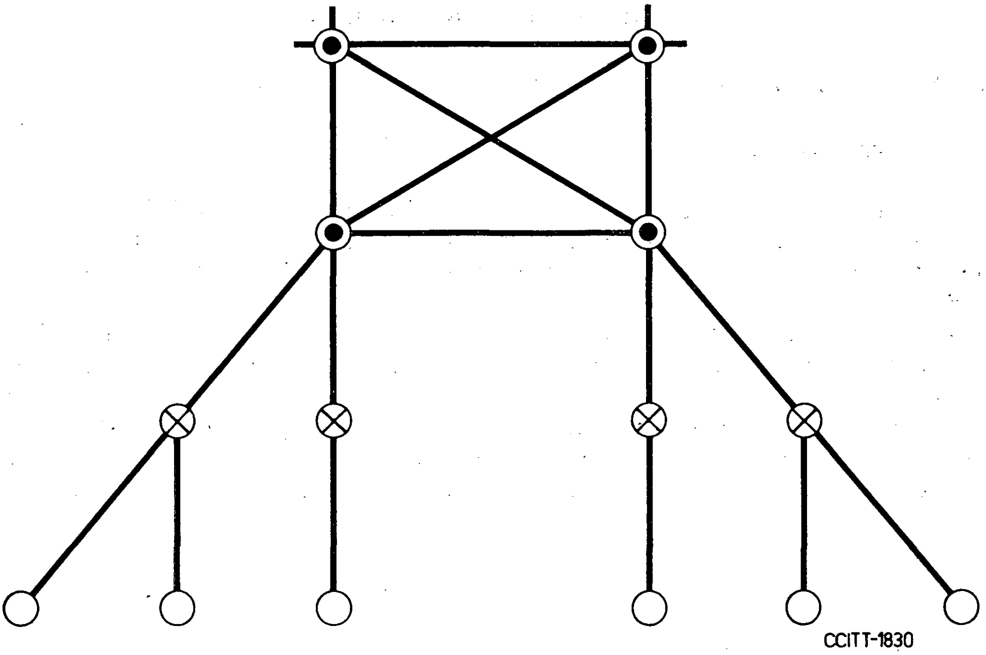

FIGURE 1. — **Theoretical final route structure (backbone structure) of the international telephone network**

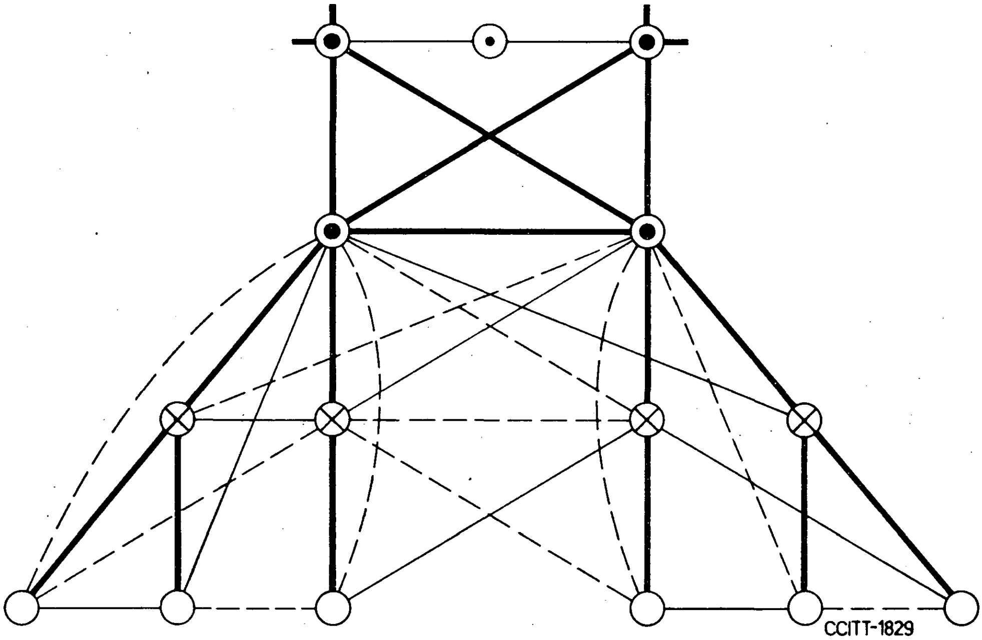

FIGURE 2. — **Example of actual structure of the international telephone network**

◉ CT1 = First category transit centre

⊗ CT2 = Second category transit centre

○ CT3 = Third category transit centre

⊙ CTX = (CT of unspecified category)

▬▬ Theoretical final route

—— Actual final route (low loss probability circuit group)

– – – High-usage route (High-usage circuit group)

2.4 *Actual structure of the network*

The actual network structure will be vastly expanded by the use of direct circuit groups and will not be restricted to its backbone structure. Many CTs will be directly interconnected to fulfil the aims of the International Routing Plan as well as possible.

2.4.1 *International direct circuit groups* may be established between any two CTs of any category in order to effect routing economy and other service benefits. Such direct circuit groups will by-pass the theoretical final route or part of it. These circuit groups may be dimensioned with a low loss probability (without overflow facilities) or they may be set up as high-usage groups (with overflow facilities).

2.4.2 The route followed by an international call from any CT of an originating chain to any CT of a terminating chain only via circuit groups without overflow facilities is called the *actual final route*. An actual final route may coincide with the theoretical final route or parts of it.

2.4.3 In cases where a significant economy may be made and provided that transmission and other quality of service standards are maintained, two CT1s may be interconnected through an intermediate transit centre of unspecified order (hereinafter called CTX). The CTX then acts as a CT1 for this traffic and must be connected to the other two CT1s by low loss probability circuit groups, provided for actual final route grade of service.

2.4.4 The traffic between two countries can be routed either by international direct circuits (as already mentioned in paragraph 2.4.1) or through international transit centres.

To obtain a good loading of the long and costly circuits a substantial fraction of the international traffic may be allowed to overflow from a direct circuit group, called high-usage group, directly or lastly to an actual final route which must be dimensioned to handle this traffic.

An example of the actual structure of the world-wide telephone network, including its backbone structure, is given in Figure 2.

3. Basic rules for routing

3.1 *Number of circuits in tandem*

For reasons of transmission quality and the efficient operation of signalling, it is desirable to limit as much as possible the number of circuits connected in tandem.

The apportionment between national and international circuits in such a chain may vary.

The maximum number of circuits to be used for an international call is 12 with up to a maximum of 6 of the circuits being international.

In exceptional cases and for a low number of calls, the total number of circuits may be 14, but even in this case the maximum number of international circuits is 6.

3.2 *Routing principles*

This paragraph specifies the rules to be followed for routing traffic between two countries which are connected by a high-usage group which cannot act as a part of an actual final route.

3.2.1 The division of the world-wide telephone network into zones of various classes applies directly to the theoretical final route and it is a guide for all traffic routing.

3.2.2 The routing of all outgoing traffic from a CT, whether originating or in transit, is determined by the Administration having that CT. It is assumed that the transit Administration having that CT will have reached prior agreement with the terminal Administrations whose traffic is to be handled in transit, in regard to the general conditions for routing this traffic.

The routing of outgoing traffic may be altered according to the time of day or period of the year; when the routing conditions on leaving a transit CT are changed by the Administration to which the CT belongs it is essential for the Administrations using the CT as a transit point for their traffic to be informed of the changes.

3.2.3 From a CT, the various circuit groups for routing a call are used in the following order:

a) high-usage direct route, if it exists,

b) high-usage transverse routes which by-pass a part of the actual final route. The order of selection of the routes begins with those that end up at the transit centres nearest to the international destination centre) "far-to-near sequence").

c) as a last choice, an actual final route which can be the theoretical final route. The arrangement of the theoretical final route (CT3 - CT2 - CT1) — (CT1 - CT2 - CT3) illustrates the need of 5 international circuits connected in tandem. In cases mentioned in paragraph 2.4.3 there may be the need for connecting in tandem the maximum number of 6 international circuits quoted in paragraph 3.1.

3.2.4 The following rules apply to the use of high-usage circuit groups:

a) As a general rule, a high-usage group is used for traffic to the zone of the CT where this route ends (this includes zones served by CTs of subordinate category in the parent chain);

b) Nevertheless, the same route can be used as a transverse route for traffic to another zone on condition that the route between the second and the third CT is of low loss probability;

c) In the case of a direct route between a CT3 and its CT1, this route can be used as a transverse route to reach any centre connected to this CT1, even if the group of circuits connecting the CT1 to the latter centre is not established with a low loss probability.

4. Effects of satellite communications

4.1 *Use of high altitude satellite circuits*

The introduction of high-altitude satellite circuits on a fixed or time-preassigned basis into the International Routing Plan does not call for any alteration in the basic principles of that Plan[1]. However, the transmission delay associated with such circuits, taken in conjunction with the acceptable limits provisionally specified in Recommendation Q.41 [2] indicates a need for certain precautions:

a) to guard against the inclusion of two or more satellite links in a connection where this can be avoided, and

b) to ensure that the total transmission delay is minimized within the provisions of Recommendation Q.41.

These precautions are enumerated in paragraphs 4.2 and 4.3 respectively.

4.2 *Avoidance of the inclusion of two or more satellite links in an international connection*

Arrangements should be made to prevent the inclusion of two or more satellite links in an international connection. In very exceptional circumstances such a connection may be used, for example where no other reliable means of communication is available or where the connection is required for special purposes.

4.2.1 Where two or more satellite circuit groups are terminated at the same transit centre of whatever category, arrangements should be made to ensure that a connection of two satellite circuits in tandem should not be used except under the most exceptional circumstances.

4.2.2 The exclusive use of satellite circuits in a group used for transit traffic that may be expected to utilize another satellite link elsewhere in the connection should be avoided whenever possible. This applies particularly to a circuit group forming part of an actual final route.

4.3 *Minimizing transmission delay*

4.3.1 In so far as possible, final routes should use terrestrial circuits.

4.3.2 When a circuit group has both terrestrial and satellite circuits, the choice of circuit for use as part of a connection should be governed by:

a) the guidance given in the provisions of Recommendation Q.41, and

b) the possible need to use a satellite circuit in another part of the connection.

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[1] It is recognized that the various forms of demand assignment of satellite circuits may offer a desirable means for providing direct circuits. This subject is under study by the C.C.I.T.T. in the 1968-1972 period under Question 1/XIII and the results of that study may well lead to some revisions of the International Routing Plan.

[2] If circuits are provided using a satellite channel in one direction of transmission and a terrestrial channel in the other, the mean one-way transmission delay will be less.

4.3.3 Where two or more routings are possible, each involving a satellite circuit and one or more terrestrial circuits, that one is to be preferred that has the shortest total transmission delay.

5. Additional rules for routing

5.1 *Introductory notes*

The next paragraph of this section describes supplementary routings which are admissible in the International Routing Plan and which may be introduced as particular arrangements agreed upon by the Administrations concerned. They do not require the provision of any special facilities.

It is emphasized that such routings will apply only in those special cases where significant economic and/or service advantages are to be achieved and will be continued no longer than these benefits remain.

The Administrations concerned should carefully note that special considerations have to be borne in mind, including:

a) procedures for obtaining and employing traffic data and costs associated with supplementary routings may introduce traffic engineering and administration complexities. Great care must be exercised to prevent multiple supplementary routings from disrupting the engineering and circuit provision of the world-wide telephone network;

b) many routing procedures which are admissible in a single traffic flow direction are not reciprocal and may therefore introduce different transit payments in the two traffic flow directions;

c) in some cases the transit facilities may need to be introduced or augmented. This applies in particular when a CT3 has to provide international transit facilities in certain specific relations;

d) the provision of high-usage circuits by-passing portions of the final route is desirable for very long connections in order to reduce the number of switched circuits in tandem. As a consequence the quality of service will be improved;

e) the use of supplementary routes without overflow facilities may result in a reduced grade of service because of the reduced ability to absorb overload.

5.2 *Supplementary routing principles*

5.2.1 The design of supplementary routings should ensure that the route selected or its alternatives will never involve a greater number of circuits in tandem than would be involved by the theoretical final route for the call. Exceptions are allowed for supplementary routings between CT1s (see paragraph 5.2.7).

5.2.2 Supplementary routings should not be combined in tandem to form further supplementary routes.

5.2.3 Special consideration must be exercised to ensure that two satellite circuits will not be inadvertently employed in the same connection (see paragraph 4.2 for complete details).

5.2.4 Calls may leave the originating chain (CT3 - CT2 - CT1) at any centre but only one link in the chain may be traversed in the direction of decreasing category. In this case the outgoing route beyond the mentioned one link must be a low loss probability route without overflow facilities. Figures 3 a and 3 b show such routing from CT A to CT B.

5.2.5 Calls may enter a terminating chain (CT1 - CT2 - CT3) at any centre but may traverse only one link in the direction of increasing category. Such routings are shown in Figures 3 c and 3 d from CT A to CT B.

5.2.6 Calls may be routed over direct or transverse circuits via a transit centre of unspecified category in an intermediate chain, but if this CT is not of higher category than the exit centre of the originating chain, then the terminating chain must be entered by a low loss probability route without overflow facilities. Calls cannot be routed in this way if they have traversed in the direction of decreasing category a link in the originating chain. Figure 3 e gives an example of this type of supplementary routing.

5.2.7 In some cases large time differences in circuit group busy hours may be exploited by permitting additional switching of circuits in tandem at no more than two intermediate CTXs to interconnect two CT1s. Care must be exercised to provide for a sufficient number of circuits to accommodate the total traffic for each interval of the entire day. Figure 3 f illustrates this rule, which applies to both traffic flow directions.

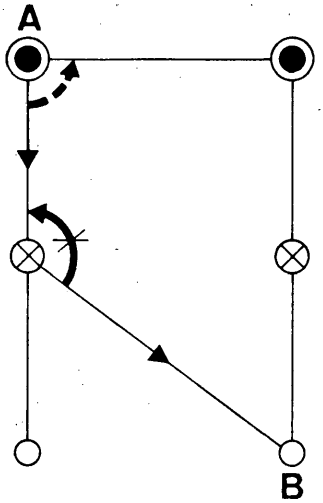

Figure a. — See 5.2.4

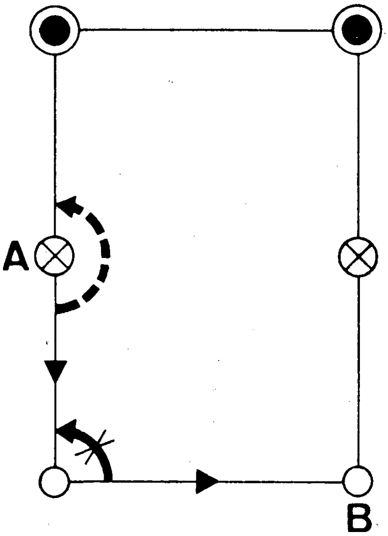

Figure b. — See 5.2.4

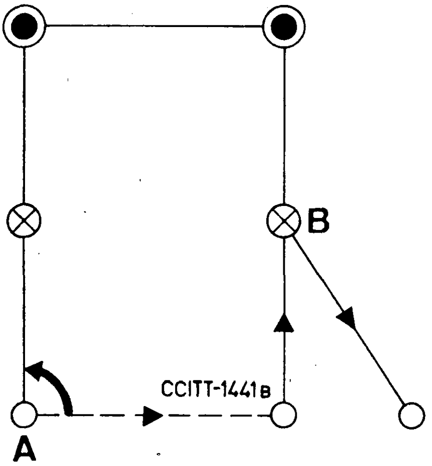

Figure c. — See 5.2.5

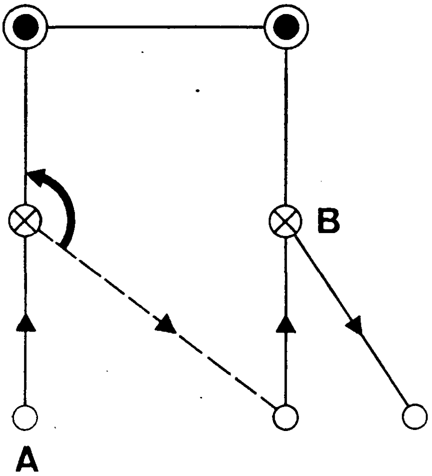

Figure d. — 5.2.5

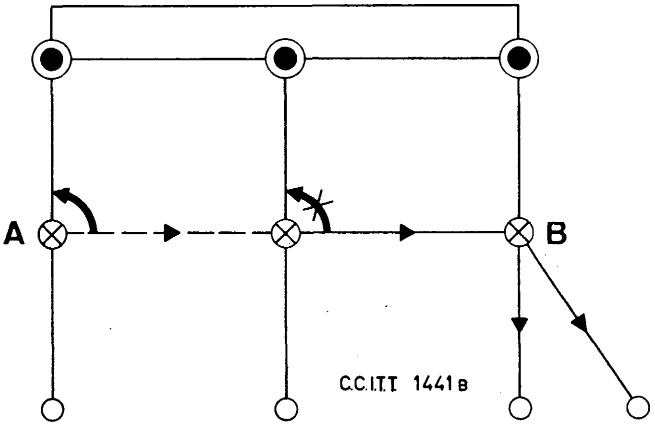

Figure e. — See 5.2.6

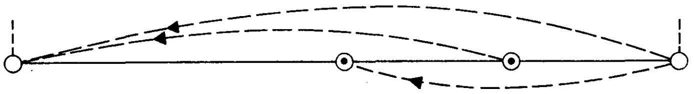

Figure f. — See 5.2.7

FIGURE 3. — **Examples of supplementary routings**

◉ CT1 = First category transit centre

⊗ CT2 = Second category transit centre

○ CT3 = Third category transit centre

⊙ CTX = (CT of unspecified category)

━━━ Theoretical final route

——— Actual final route
(low loss probability circuit group)

- - - - High-usage route
(High-usage circuit group)

↰ Overflow

↰ Possible overflow

↰ Overflow not allowed

CHAPTER IV

General recommendations relative to signalling and switching systems (national or international)

A. *Power limits of signals of a signalling system*

RECOMMENDATION Q.15 *

NOMINAL MEAN POWER DURING THE BUSY HOUR

To simplify calculations when designing carrier systems on cables or radio links, the C.C.I.T.T. has adopted a *conventional* value to represent the *mean absolute power level* (at a zero relative level point) of the speech plus signalling currents, etc., transmitted over a telephone channel in one direction of transmission during the busy hour.

The value adopted for this mean absolute *power* level corrected to a zero relative level point is —15 dBm0 (mean power = 31.6 microwatts); this is the mean with time and the mean for a large batch of circuits.

Note 1. — This conventional value was adopted by the C.C.I.F. in 1956 after a series of measurements and calculations had been carried out by various Administrations between 1953 and 1955. Annex 6 (Part 4 of Volume III of the *White Book*) reproduces the documentation assembled. The adopted value of about 32 microwatts is based on the following assumptions:

- mean power of 10 microwatts for all signalling and tones;
- mean power of 22 microwatts for other currents, namely:
  - speech currents, including echoes, assuming a mean activity factor of 0.25 for one telephone channel in one direction of transmission;
  - carrier leak;
  - telegraph signals, assuming that few telephone channels are used for v.f. telegraphy or phototelegraphy.

On the other hand, the power of pilots in the load of modern carrier systems has been treated as negligible.

Hence, the maximum *energy* which may be transmitted by all the signals and tones ** during the busy hour is:

36 000 microwattseconds for one direction of transmission;
72 000 microwattseconds for both directions of transmission.

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* This Recommendation also appears as Recommendation G.223 in Series G (Line transmission, Volume III of the *White Book*) of the C.C.I.T.T. Recommendations.

** See Supplement No. 1 in the Documentary Part for a calculation of the energy transmitted for the national tones and signals.

Note. — The question of revising the assumptions leading to the conventional value of −15 dBm0 arose in 1968 for the following reasons:

— Changes in the r.m.s. power of speech signals, due to the use of more modern telephone sets, to a different transmission plan, and perhaps also to some change in subscriber habits.

— Change in the mean activity factor of a telephone channel due, inter alia, to different operating methods.

— Increase in the number of v.f. telegraphy bearer circuits and sound programme circuits.

— Introduction of circuits used for data transmission, and rapid increase in their number.

A limited study of measurements of speech signal power was carried out by various Administrations in 1966 and 1967; it produced the results shown in Supplement No. 5 of Volume III of the *White Book*. These results are too fragmentary to warrant a change in the conventional value of −15 dBm0. The IVth Plenary Assembly of the C.C.I.T.T. (Mar del Plata, 1968) agreed to keep this value, since it was considered that the increase in the load of carrier systems due to the growth of uses other than telephony (for which the permissible levels are generally higher than −15 dBm0) will probably be compensated by a reduction in the speech current power and that the margin with which carrier systems are calculated in practice will enable a slight increase in the mean power transmitted per channel to be tolerated without serious inconvenience.

However, this favourable situation may not last indefinitely or may not apply for all systems. Question 11/Sp.C has therefore been set for study with a view to dealing with all aspects of this problem.

RECOMMENDATION Q.16 *

MAXIMUM PERMISSIBLE VALUE FOR THE ABSOLUTE POWER LEVEL OF A SIGNALLING PULSE

The C.C.I.T.T. recommends that, for crosstalk reasons, the absolute power level of each component of a short duration signal should not exceed the values given in Table 1 below:

TABLE I

Maximum permissible value of power at a zero relative level point

Signalling frequency (Hz)	Maximum permissible power for a signal at a zero relative level point (microwatts)	Corresponding absolute power level Decibels referred to 1 mW (dBm0)
800	750	−1
1200	500	−3
1600	400	−4
2000	300	−5
2400	250	−6
2800	150	−8
3200	150	−8
If the signals are made up of two different frequency components, transmitted simultaneously, the maximum permissible values for the absolute power levels are 3 decibels below the above figures.		

The values given in this table result from a compromise between the characteristics of various existing channel filters.

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* This Recommendation also appears as Recommendation G.224 in Series G (Line transmission, Volume III of the *White Book*) of the C.C.I.T.T. Recommendations.

B. *Signalling in the speech frequency band and outside the speech frequency band*

RECOMMENDATION Q.20

COMPARATIVE ADVANTAGES OF "IN-BAND" AND "OUT-BAND" SYSTEMS

Signalling over telephone circuits may be effected *in* the frequency band used for speech ("in-band" signalling), or *outside* it ("out-band" signalling). In the latter case, the same channel carries both the signalling and speech frequency bands, the signalling band being separate from the speech band, and signalling equipment is an integral part of the carrier system.

In a further type of out-band signalling, a circuit, not used for speech, can be used to effect the signalling requirements of a number of speech circuits. This may be termed "separate channel signalling". The separate channel may be:

a) a channel in a carrier system used to effect the signalling requirements of the remaining channels in the same carrier system which are used for speech, signalling equipment being an integral part of the carrier system: this may be termed "built-in separate channel signalling";

b) completely separate, in which case signalling equipment is not an integral part of the carrier system; this may be termed "completely separate channel signalling".

A. *Advantages of in-band signalling*

1. In-band signalling can be applied to any type of line plant. The application of out-band signalling, and built-in separate channel signalling, is limited to carrier systems.

2. Through signalling can be employed at transit points, and at carrier system terminals when a telephone circuit comprises two or more carrier links. No direct current repetition and thus no delay and no distortion of signals arises at such points. Out-band signalling and built-in separate channel signalling require a direct current repetition at such points.

3. Replacement of a faulty line section is easy. In the case of completely separate channel signalling, replacement of a faulty line section is based on security arrangements.

4. It is impossible to set up a connection on a faulty speech path. In the case of completely separate channel signalling, a continuity check of the speech path is required.

5. The full bandwidth of the speech channel is available for signalling. This facilitates the use of more than one signalling frequency. Normally the full bandwidth permits faster signalling than with a smaller signalling bandwidth. With in-band signalling, realization of this advantage is limited to those signals not required to be protected against signal imitation due to speech currents.

B. *Advantages of out-band signalling*

1. Relative freedom from disturbances due to speech currents; freedom from disturbances due to echo-suppressors; freedom from disturbances which might arise from connections to other signalling systems. With in-band signalling it is necessary to take steps to guard against such disturbances.

2. Possibility of signalling, during the setting-up of the call, by either discontinuous or continuous transmission, and the possibility of transmitting those signals during speech. Signalling during speech is not compatible with in-band signalling.

3. Simplicity of terminal equipment due to (1) above and to the possibility of continuous signalling.

Out-band signalling (where the same channel carries both speech and signalling) also has advantage (3) of in-band signalling.

Built-in separate channel signalling has advantages (1), (2) and (3) of out-band, and advantage (3) of in-band signalling.

Completely separate channel signalling has advantages (1) and (2) of out-band signalling and, compared with out-band signalling and built-in separate channel signalling, has the additional advantages that no direct current repetition is necessary, and no distortion of signals arises, at carrier system terminals when a circuit comprises two or more carrier links.

RECOMMENDATION Q.21

SYSTEMS RECOMMENDED FOR OUT-BAND SIGNALLING

When Administrations wish to make mutual agreements to use out-band signalling systems, the C.C.I.T.T. considers it desirable, from the transmission viewpoint, for them to use one of the types of signalling systems (outside the speech band) defined in the following Annexes:

Annex 1. — Normal carrier systems with 12 channels per group.

Annex 2. — Carrier systems with 8 channels per group.

RECOMMENDED CHARACTERISTICS FOR OUT-BAND SIGNALLING SYSTEMS

ANNEX 1

(to Recommendation Q.21)

Out-band signalling systems for carrier systems with 12 channels per group

(The signal levels are quoted in terms of absolute power level (ref. 1 mW) at a zero relative level point.)

Type I (discontinuous signals)

Frequency: virtual carrier (zero frequency).
Level: high,
for example −3 dbm0

Type II

A. (discontinuous signals)
Frequency: 3825 Hz
Level: high,
for example −5 dbm0.

B. (semi-continuous signals)
Frequency: 3825 Hz
Level: low,
for example −20 dbm0.

* * *

The *Type I* signalling system is compatible with only those group and supergroup reference pilots having a displacement from the virtual carrier frequency (zero frequency) of 140 Hz.

Types IIA and IIB are compatible with only those group and supergroup reference pilots having a displacement from the virtual carrier frequency (zero frequency) of 80 Hz.

ANNEX 2

(to Recommendation Q.21)

Out-band signalling systems for carrier systems with 8 channels per group

(The signal levels are quoted in terms of absolute power level (ref. 1 mW) at a zero relative level point.)

Frequency: 4.3 kHz ±10 Hz

Level:

— discontinuous signals: −6 dBm0

— semi-continuous signals: value between −20 dBm0 and −17.4 dBm0.

RECOMMENDATION Q.22

FREQUENCIES TO BE USED FOR IN-BAND SIGNALLING

To reduce the risk of signal imitation by speech currents, the frequencies for an in-band signalling system should be chosen from the frequencies in the band in which speech signal power is lowest, i.e. frequencies above 1500 Hz.

The desirability of this was confirmed by tests carried out in London, Paris and Zurich in 1946 and 1948 to choose the signalling frequencies of systems standardized by the C.C.I.T.T. These tests led to the conclusion that, if relative freedom from false signals was to be obtained other than by undue increase in signal length, frequencies of at least 2000 Hz would have to be used.

C. *Signalling frequencies for push-button telephone sets*

RECOMMENDATION Q.23

TECHNICAL FEATURES OF PUSH-BUTTON TELEPHONE SETS

1. The introduction of push-buttons on telephone sets may have an effect on the operation of international circuits:

a) owing to the greater dialling speed, the post-dialling delay may be longer, since national and international networks will only be gradually adapted to allow for this greater speed;

b) when pressing the buttons after an international call has been set up, the signalling frequencies for push-button sets may cause interference to foreign signalling systems on the connection. However, the subscriber can be warned of the possible disadvantages of touching the buttons in conditions different from those prescribed.

2. There can be no doubt that, owing to the high dialling speed which can be obtained with push-button sets, their use is bound to spread widely and rapidly and it is desirable for the signalling methods for such sets to be internationally standardized.

One factor in favour of such standardization is the advantage it offers for countries which have to import their equipments from various other countries. This argument, admittedly, applies to any type of telephone equipment.

Other advantages of standardization are:

— the possibility of using the push-button of such sets for signalling directly from one subscriber to another subscriber via a national and/or international connection;

— the standardized allocation of signalling frequencies for push-button sets facilitates the choice of signalling frequencies in the frequency band of a telephone circuit for any other use (data transmission, telephone signalling system, etc.) for which provision might have to be made. The risk of mutual interference among the signalling systems (see Recommendation Q.25) makes it necessary to have an orderly arrangement of the spectrum of frequencies used for signalling.

3. The general use of push-button sets for purposes other than telephone dialling is envisaged by some Administrations. However, some Administrations observe that it would seem advisable to reserve such uses for a network of relatively limited extent; in their view the reliability of standards for data transmission should not make any demands on the push-button set system other than those required for the transmission of telephone numerical information to the local exchange, if the design of push-button sets is to remain within economical limits compatible with their widespread use.

However, the C.C.I.T.T. considered, at Mar del Plata in 1968 that, even if the transmission of data from a push-button telephone set is at present to be envisaged in international traffic on a limited scale only, it would none the less be wise not to rule out the possibility of such transmission of data on a general scale.

4. In choosing a signalling system for push-button sets, Administrations may be guided by conditions which vary considerably from one country to another. Economic considerations may, for instance, lead them to prefer a direct current system which might be less expensive than a voice-frequency system. The numerical dialling information would then be transmitted only as far as the telephone exchange to which the subscriber is connected. There are no tones that could affect the connection after its establishment. Data would not be transmitted from the push-button sets unless a suitable converter were used in the exchange.

Standardization of a direct current system for signalling from push-button sets does not seem justified at the international level; it may depend on the conditions peculiar to the local networks of the country concerned.

5. The signalling system for push-button sets recommended by the C.C.I.T.T. applies solely to voice-frequency signals.

A multifrequency code for such signalling is recommended in which the dialling signal is composed of two frequencies emitted simultaneously when a button is pressed. It is planned to have 10 decimal digits and 6 reserve signals, making 16 signals in all. The two frequencies composing each signal are taken from two mutually exclusive frequency groups of four frequencies each, a code known as the "2 (1/4) code".

6. The low group frequencies of this 2 (1/4) code are:

697, 770, 852, 941 Hz.

The high group frequencies are:

1209, 1336, 1477 and 1633 Hz.

These frequencies are allocated to the various digits as follows:

		High group frequencies (Hz)			
		1209	*1336*	*1477*	*1633*
Low group frequencies (Hz)	*697*	1	2	3	spare
	770	4	5	6	spare
	852	7	8	9	spare
	941	spare	0	spare	spare

7. The frequency variation tolerances and the permissible intermodulation products are defined as follows:

7.1 each transmitted frequency must be within ±1.8% of the nominal frequency;

7.2 the total distortion products (resulting from harmonics or intermodulation) must be at least 20 dB below the fundamental frequencies.

8. The C.C.I.T.T. determined, at Mar del Plata in 1968, that it was not practicable to specify a standardization of the levels for the frequencies transmitted when a push-button is pressed, as these level conditions depend essentially on national transmission plans which are not the same in all countries.

However, the sending level conditions must be such that on an international connection they do not exceed the values specified in Recommendation Q.16 (maximum permissible value for the absolute power level of a signalling pulse).

D. *Protection of "in-band" signalling systems against each other*

RECOMMENDATION Q.25

SPLITTING ARRANGEMENTS AND SIGNAL RECOGNITION TIMES IN "IN-BAND" SIGNALLING SYSTEMS

1. *General*

In each "in-band" signalling system precautions should be taken so that, when the signalling in that system is taking place:

1.1 no interference in the voice-frequency range from outside the system can pass into the system (i.e. into the transmission path between the sending end and the receiving end of the voice-frequency signals), and

1.2 as far as possible, no signalling current used in the system can pass into other systems, connected in tandem.

2. *Sending-end splitting arrangements*

2.1 In order to satisfy condition 1.1 above, care should be taken that the correct operation of the signal receiver at the other end of the circuit is not disturbed by:

— surges (transient currents) caused by the opening or closing of direct current circuits connected to the speech wires of the switching equipment, whether these surges precede or follow the sending of a signal;

— noise, speech currents, etc., coming from tandem switched circuits, preceding or during the sending of a signal.

2.2 For this reason the following arrangements have been made in the C.C.I.T.T. standard systems No.3, No. 4, No. 5 and No. 5*bis* for the transmission of voice-frequency signals on the international circuit:

i) The exchange side of the circuit shall be disconnected 30 to 50 ms before a voice-frequency signal is sent over the circuit.

ii) The exchange side of the circuit will not be reconnected for 30 to 50 ms following the end of the sending of a voice-frequency signal over the circuit.

2.3 Arrangements of the same type are required on system R1 and on national in-band systems (see C.4.1 *b*).

3. *Receiving-end splitting arrangements*

3.1 General

3.1.1 In order to satisfy condition 1.2 above, the length of the part of a signal which passes into another system is limited by splitting the speech wires beyond the signal receiver when a signal is received and detected by this receiver.

The time during which the first part (sometimes called *spill-over*) of a received signal passes into another system, until the splitting becomes effective, is called "splitting time".

Too long a splitting time may result in interference to signalling on a tandem system depending on the signal recognition time on the tandem system.

Too short a splitting time may result in an increase in the number of false operations of the splitting device by speech currents *(signal imitation)* and so impair speech transmission.

The splitting time must therefore be a compromise between the above two factors.

The splitting device also serves to limit the duration of signals on one path of the four-wire circuit from returning over the other path by reflections at the termination; these reflections may give rise to mis-operation of signalling equipment on the other path.

3.1.2 The protection against mutual interference between in-band signalling systems in international service involves limitations of the length of any part of:

3.1.2.1 the *international* signal that may be able to pass:

a) from the international signalling system into a national signalling system (protection of the national system);

b) from one international signalling system into another international signalling system, when they are switched in tandem (protection of the international systems);

c) from one international circuit into another international circuit of the same system when they are switched in tandem in the case of link-by-link signalling.

3.1.2.2 the *national* signal that may be able to pass:

a) from the national signalling system into an international signalling system (protection of the international system);

b) from one national signalling system into the national signalling system of another country via an international connection (protection of the national system).

3.2 *Protection of national and international systems against international systems*

Conditions 3.1.2.1 above are met because international signalling systems have a splitting device on each circuit. The splitting times of such systems are:

55 milliseconds for the compound signal element in system No. 4;
35 milliseconds for a signal in systems No. 5 and No. 5*bis*;
20 milliseconds for a signal in the R1 system.

3.3 *Protection of the international system against national systems*

Condition 3.1.2.2 a) above is generally covered because:

— the values given in the Specifications of the C.C.I.T.T. standard systems as the minimum recognition time of a line signal are in general greater than the splitting times of national systems (see the tables giving the basic characteristics of national signalling systems in Supplement No. 3 in the Documentary Part of this volume);

— the signalling frequencies used in the international systems are, in the majority of countries, different from those used in national systems.

It may be necessary, if the splitting time of a national signalling system is greater than the minimum signal recognition time of an international system and the signalling frequencies used in the national system and international system are the same or nearly the same, to insert a device at the international exchange which will prevent a part of the national signal from passing into the international circuit for longer than this recognition time.

3.4 *Interference between national signalling systems when they are interconnected via an international circuit*

3.4.1 To ensure protection of national signalling systems one against the other (protection defined under 3.1.2.2 b) above), it has been recommended by the C.C.I.T.T. since 1954 that new national in-band signalling systems should comply with the following two clauses:

a) not more than 35 milliseconds of a national signal should be able to pass into another country;

b) the connection between an international circuit and a national circuit should be split on the national circuit at the international exchange 30 to 50 milliseconds before that exchange sends any signal over the national signalling system.

Note. — The object of these two clauses is to avoid interference, especially in conditions that may exist on international automatic connections.

3.4.2 Clause 4.1 a) permits the signalling system used in country A to have a minimum signal recognition time based on this value of 35 milliseconds. It will then be possible to ensure, without taking any other precautions at the incoming end of an international circuit, that no fraction of a signal coming from country B, and being of the same, or nearly the same, frequency as that used in country A, will be wrongly recognized as a signal in country A.

One method of meeting clause 3.4.1 a) is to adopt a splitting time of less than 35 milliseconds for the national systems.

Another method exists which does not involve such a limitation in the splitting times of national systems, and which might be preferred when the design of the national signalling system is such that a short splitting time is not normally justified for that system alone. This second method involves the introduction, in the international exchange, of an arrangement for limiting the length of national signals which are liable to pass into the international circuit. Such an arrangement would be used only on circuits to those countries where there is a danger that interference might arise.

3.4.3 Clause 3.4.1 b) avoids the false operation of the guard circuit of a signal receiver situated at the distant end of a national circuit.

E. *Miscellaneous provisions*

RECOMMENDATION Q.26

DIRECT ACCESS TO THE INTERNATIONAL NETWORK FROM THE NATIONAL NETWORK

The choice of the method of access to an outgoing international exchange from the national network is a purely national matter. Nevertheless, if an international connection is set up by automatic switching from an exchange other than the international exchange which is the outgoing point of the international circuit used, arrangements should be made in the national network to transmit over the international circuit at least the signals required to ensure the satisfactory setting-up, control and clearing-down of the international connection.

In addition, where a group of national circuits used in the above manner carries both semi-automatic and automatic traffic, means should be provided for distinguishing between these two classes of traffic for the purposes of international accounting (see Recommendation Q.51, section 2).

RECOMMENDATION Q.27

TRANSMISSION OF THE ANSWER SIGNAL

It is essential for the answer signal to be transmitted with a minimum of interference to the transmission of speech currents, because the called subscriber may already be announcing his presence at this stage of the call.

On a connection which has been set up, the answer signal generally entails, at a certain number of points,

a) repetitions and conversions, which delay transmission, and

b) splitting of the speech path, where in-band signalling is used.

It is therefore desirable to minimize the delays and the duration of the interruption of the speech path. Minimization of the latter can be achieved by:

— short send line splitting,

— short duration of the signal, and

— fast termination of the sending and receiving splits on cessation of the signal.

RECOMMENDATION Q.28

DETERMINATION OF THE MOMENT OF THE CALLED SUBSCRIBER'S ANSWER IN THE AUTOMATIC SERVICE

1. Arrangements should be made in the national signalling system of the incoming country to determine (in the outgoing international exchange) the moment when the called subscriber replies; this information is necessary in the international service for the purposes of:

— charging the calling subscriber (see Recommendation E.204);

— measuring the call duration (see Recommendations E.280 and Q.50).

2. Where subscribers in an outgoing country have direct access to an operator's position (in a manual exchange, for instance) in an incoming country, arrangements should be made in the national network of the incoming country to ensure that—in the outgoing country—the calling subscriber is charged, and the call duration measured, only from the moment when the called subscriber replies *. These provisions are set out in detail for C.C.I.T.T. standardized systems (see Recommendation Q.102).

RECOMMENDATION Q.29

CAUSES OF NOISE AND WAYS OF REDUCING NOISE IN TELEPHONE EXCHANGES

Circuit noise may be classified as follows:

a) power supply noise,

b) noise generated in the speech path circuit,

c) noise induced in the speech path circuit.

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* This means that an answer signal is not sent when the operator in the incoming country replies.

1. *Power supply noise*

1.1 *Power sources*

The interference resulting from the harmonics, ripple and current fluctuation of machines, rectifiers and batteries.

This noise may be reduced by d.c. generators with low harmonics and good regulation and rectifiers with good regulation, effective filters, and batteries with large capacity (i.e. with low internal impedance).

1.2 *Supply leads*

The interference in the speech circuits of an exchange due to power supply equipment originates mainly in the common impedances of the supply paths of speech and switching circuits, and is caused mainly by the sudden fluctuation of the current resulting from the sudden operation and release of the different relays, magnets and contacts.

These common impedances may be reduced by:

1.2.1 the use of common power supply leads of sufficiently low resistance, the use of large capacitors fitted at apparatus ends of supply leads, or supply leads with minimum impedances, e.g. minimum distance between bus bars, or coaxial feeders. Another method employs close-spaced cables with alternate polarity;

1.2.2 the use of a common battery with separate power supply leads for speech and switching circuits. Better results may be obtained at an increased cost by independent batteries adequately separated;

1.2.3 the arrangement of the cells of the battery in a U formation.

1.3 *Earth returns*

Independent earth returns should be used for signalling-frequency supply circuits.

2. *Noise generated in the speech circuit*

2.1 *Contact noise caused by vibration*

This kind of noise is caused by contact resistance variations of the various commutator, switch and relay contacts due to mechanical vibration.

This contact noise may be reduced by:

2.1.1 the use of damping devices to reduce the generation of vibration caused in particular by relay sets, mechanical and electromagnetic clutches;

2.1.2 the use of multiple brushes, springs or resilient mountings to reduce the transmission of vibration;

2.1.3 a suitable choice of contact materials;

2.1.4 the use of the best contact shape and of twin contacts;

2.1.5 maintaining atmospheric conditions at an appropriate relative humidity and the use of air filters; use of dust covers on equipment; arranging design of columns, window sills, radiators and floor to avoid harbouring dust;

2.1.6 careful maintenance cleaning and lubrication in accordance with specifications.

2.2 *Frying noise*

In speech circuits some contact materials are liable to cause frying noise.

This noise may be reduced by the use of suitable contact materials and by keeping an appropriate relative humidity.

2.3 *Contact noise caused by wetting currents*

Speech circuits without d.c. currents are liable to fading due to contact resistance fluctuations. Fading may be reduced by wetting. However, wetting currents may introduce frying noise on the lines.

2.4 *Charge and discharge clicks*

Clicks may frequently be caused by the charging or discharging of capacities (cable capacity) by switches when rotating over occupied and non-occupied terminals.

Objectionable clicks are also likely to result from sudden battery reversals, dialling and other abrupt changes in the current flowing in the speech circuits.

These effects may be reduced:

2.4.1 by disconnecting the speech circuits from the brushes during the hunting period of the switch;

2.4.2 by the use of twisted pairs, by limiting the length of cabling and also by locating relays as close as possible to the selectors they control.

2.5 *Unsound contacts*

Objectionable noise may be due to unsound contacts on distribution frames, particularly when work is in progress such as adding or changing jumpers, etc. Such unsound contacts may be due to "dry" contacts inadequately soldered, poorly wrapped joints, or to the use of distribution frame equipment having inadequate contact pressure. It is suspected that this type of trouble is responsible for most of the "hits" and "misses" and usually for an increase in noise.

2.6 *Tapping losses*

When lines are tapped for service interception, observation, etc., the tapping circuit should be designed to give the minimum of unbalance to earth and the transmission loss introduced should be a minimum. Semi-permanent connections should be used in preference to base-metal sliding connections at the tapping point.

2.7 *Reduction of the number of switching contacts*

Circuits should be designed so that at each switching stage there is a minimum number of contacts in the speech circuit in order to reduce the risk of microphonic noise from "dry" contacts.

3. *Noise induced in the speech circuit*

3.1 Noise induced in the speech circuit may be due to:

3.1.1 speech crosstalk;

3.1.2 signalling frequency crosstalk;

3.1.3 induction from tone supplies;

3.1.4 direct current pulses;

3.1.5 clicks caused by abrupt changes in inductive and capacitive circuits.

Clicks may be reduced at the source by the use of spark quench devices or other means to reduce the steepness of the interfering wave-front concerned. In addition, noise may be reduced by balancing, by using twisted pairs and/or by screening.

3.2 *Noises due to unbalanced transmission bridge circuits*

A well-balanced circuit is necessary for the transmission bridge to avoid noise interference. This can be achieved by:

3.2.1 the use of balanced components;

3.2.2 the separation of components used for speech from those used for control and switching;

3.2.3 the separation of individual transmission bridges by screening or spacing;

3.2.4 the addition of balancing components, e.g. balancing transformers or retardation coils;

3.2.5 taking the precautions listed at the end of 3.1.

3.3 *Low-level speech circuits*

Low-level electronic speech circuits are particularly susceptible to noise induction and should therefore be screened.

3.4 *Longitudinal interference*

Such noise may be induced into the speech circuit from the line by power distribution systems and traction circuits or by earth potential differences.

These may be reduced by balancing the line or by the addition of transformers.

Note. — Interference which is sufficiently severe to cause unwanted operation of relays, etc., may be overcome by the use of loop circuits which should also reduce noise.

RECOMMENDATION Q.30

IMPROVING THE RELIABILITY OF CONTACTS IN SPEECH CIRCUITS

The following methods can be used for improving the reliability of contacts in speech circuits:

a) use of precious metals such as platinum, palladium, gold, silver, or alloys of these metals. If, for one reason or another, it is not desired to "wet" the contacts, or if enough contact pressure cannot be provided, it is preferable to use the metals or alloys mentioned above, with the exception of pure silver,

b) use of high contact pressure,

c) double contacts,

d) lubrication (with suitable oils) of certain non-precious metal contacts in the case of sliding contacts,

e) direct current "wetting" of contacts, care being taken to avoid the introduction of noise due to transients when the contacts are made or broken,

f) air filtration or other protective measures to avoid dust,

g) the maintenance of suitable humidity,

h) the use of protective covers,

i) protection against fumes, vapours and gases,

j) avoidance of the use, near contacts, of materials likely to be detrimental to the contacts.

When voice-frequency signals are sent over a transmission path, as it is not possible to use direct current wetting for the voice-frequency signal transmitting contacts, due to the surges which occur on closing and opening the contact, it is preferable to use static modulators with rectifier elements.

RECOMMENDATION Q.31

NOISE IN A NATIONAL FOUR-WIRE AUTOMATIC EXCHANGE

It is desirable that the requirements concerning noise conditions for a national four-wire automatic exchange be the same as for an international exchange (see Recommendation Q.45, paragraph 5).

RECOMMENDATION Q.32

REDUCTION OF THE RISK OF INSTABILITY BY SWITCHING MEANS

Arrangements should be made in the incoming country to reduce the risk of instability:

— during the period between the moment when the speech path is established and the moment when the called subscriber answers, and

— also the period between the moment when the called subscriber clears and the moment when the circuits are released.

This can be achieved in principle by any of the methods a), b) or c) shown in Figures 1, 2 and 3.

FIGURES 1, 2 and 3. — **Possible methods for reducing the risk of instability**

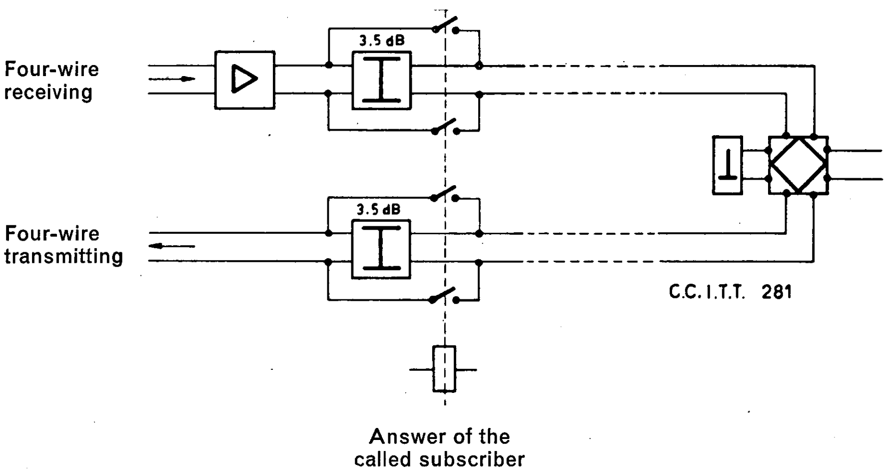

FIGURE 1. — *Method a)* **Inserting an attenuator in each channel of the four-wire chain of the connection**

In principle, the attenuators may be inserted in any of the exchanges, for example the incoming international centre.

It is recommended that, whatever method is used, the measures are taken in the incoming (in the traffic sense) country. Taking into account experience already acquired and also the stability calculations referred to in Recommendation G.131 of the *White Book*, Volume III, it is considered sufficient to arrange for the stability * of the four-wire

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* It should be noted that Recommendation Q.32 always refers to *stability* (definition 05.46 of the *List of definitions of essential telecommunication terms* published by the I.T.U., Part I) and never to singing margin (definition 05.48) which is approximately double the stability. The methods described on Figures 1, 2 and 3 are examples of possible means of increasing the stability of the four-wire chain of circuits by 3.5 dB.

chain of circuits (made up of international circuits and national extension circuits, interconnected on a four-wire basis) to be augmented by 3.5 dB.

This recommendation applies to all signalling and switching (national or international) systems which could be used on international connections.

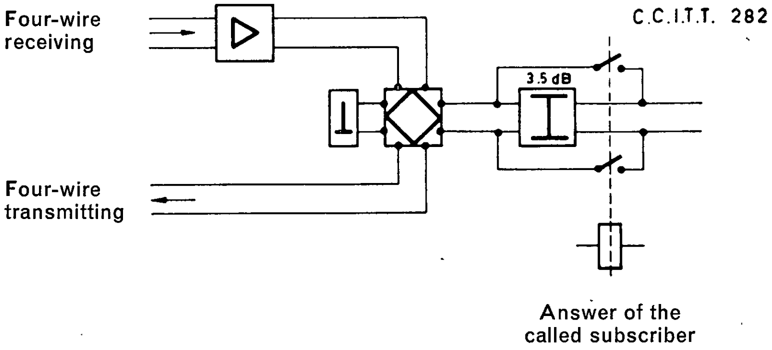

FIGURE 2. — *Method b)* **Inserting an attenuator in the two-wire extension of the connection**

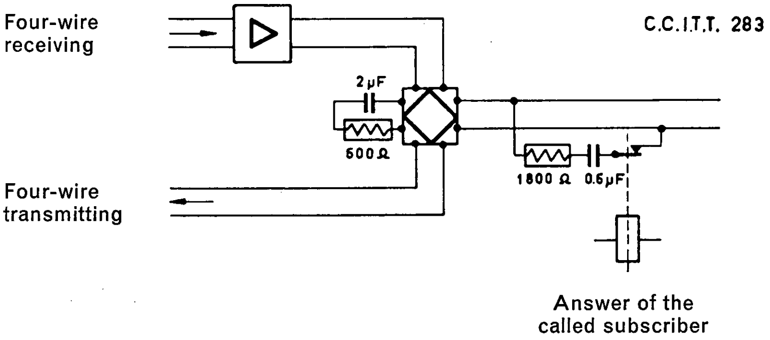

FIGURE 3. — *Method c)* **Bridging a terminating impedance across the two-wire extension of the connection**

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PART I

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PART II

CHAPTER V

TONES FOR NATIONAL SIGNALLING SYSTEMS

RECOMMENDATION E.180

RECOMMENDATION Q.35

CHARACTERISTICS OF THE RINGING TONE, THE BUSY TONE, THE CONGESTION TONE, THE SPECIAL INFORMATION TONE AND THE WARNING TONE[1]

1. *General*

Administrations are reminded of the advantages of standardizing as far as possible supervisory tones, so that subscribers and operators may quickly recognize any tone transmitted, of whatever origin.

In considering the degree of possible standardization, the C.C.I.T.T. in 1960 took account of the nature of the various tones already used in Europe, and set limits for cadence, frequency and level so that in the C.C.I.T.T. view no confusion will be caused when subscribers hear these tones. It was also considered that Administrations introducing new tones would find it helpful to know the preferred limits of cadence, frequency and level.

Limits for tone cadences and frequencies are set forth below, all working tolerances being included in the limits.

Besides the limits applying to specifications of new equipment for new exchanges, limits have been laid down for application to existing exchanges.

These latter limits are herein called " *accepted* " limits, while those for new equipment are called " *recommended* " limits.

2. *Power levels for tones*

2.1 For international purposes, the levels of the ringing tone, the busy tone, the congestion tone and the special information tone have to be defined at a zero relative level point at the incoming (in the traffic direction) end of the international circuit.

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[1] See also Supplement No. 4 to Volume VI of the *White Book* for particular values of tone cadences and frequencies in actual use.

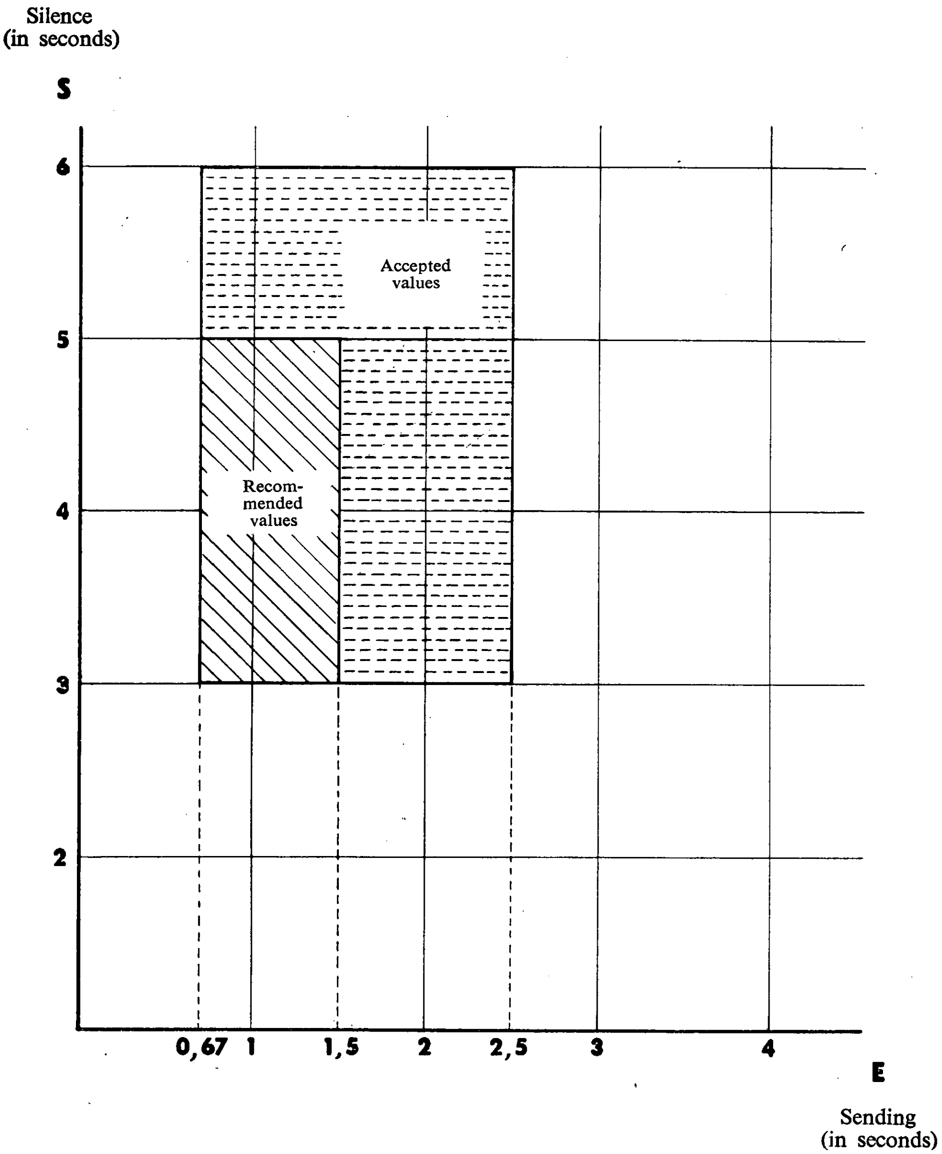

FIGURE 1. — **Ringing tone**

Frequency:

— recommended interval: 400-450 Hz

— accepted interval: 340-500 Hz

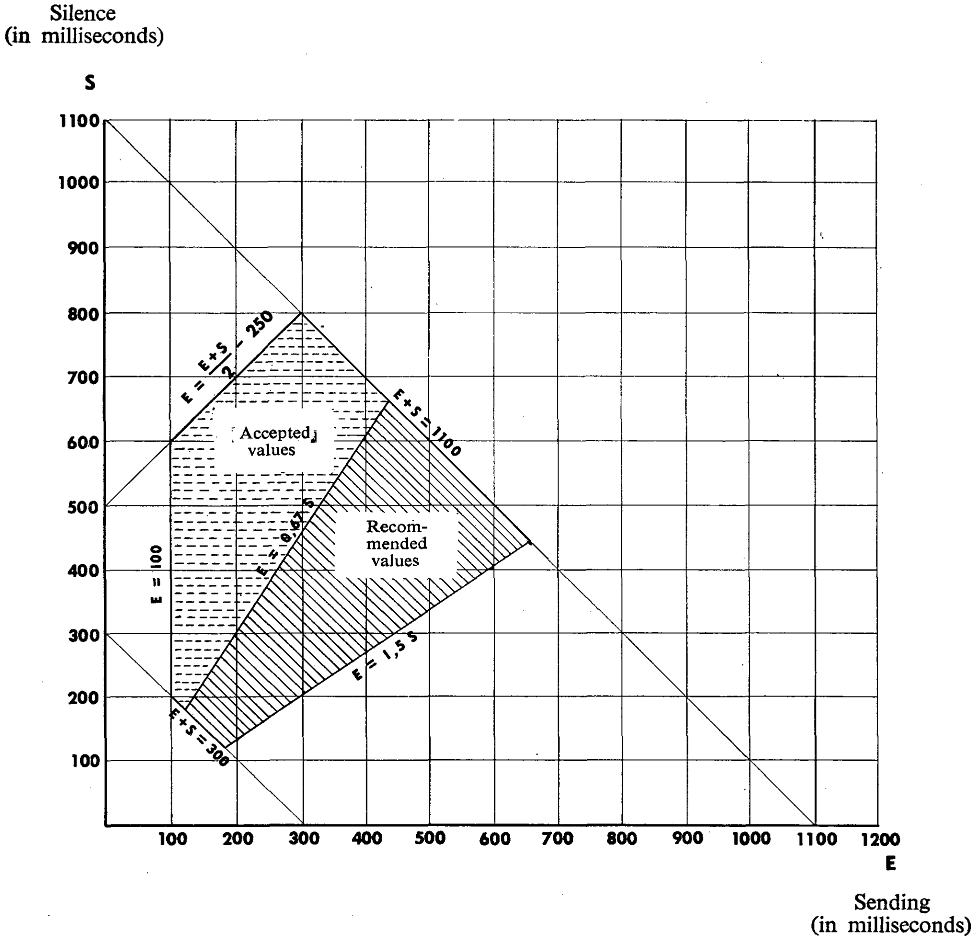

FIGURE 2. — **(Subscriber) busy tone and (equipment or circuit group) congestion tone**

Frequency:

- recommended interval: 400-450 Hz
- accepted interval: 340-500 Hz

The level of tones so defined must have a nominal value of –10 dBm0. The recommended limits should be not more than –5 dBm0 nor less than –15 dBm0 measured with continuous tone.

For the special information tone, a difference in level of 3 dB is tolerable between any two of the three frequencies which make up the tone.

2.2 The level of the " warning tone " described under 6 has to be defined at a zero relative level point at the incoming or at the outgoing end of the international circuit.

This level should not be higher than –5 dBm0 measured with continuous tone.

3. *Ringing tone*

3.1 Ringing tone is a *slow* period tone, in which the tone period is shorter than the silent period.

The *recommended* limits for the tone period (including tolerances) are from 0.67 to 1.5 second. For existing exchanges, the *accepted* upper limit for the tone period is 2.5 seconds.

The *recommended* limits for the silent period separating two tone periods are 3 to 5 seconds. For existing exchanges, the *accepted* upper limit is 6 seconds.

The first tone period should start as soon as possible after the called subscriber's line has been found.

Figure 1 shows the recommended and accepted limits for the ringing tone periods

3.2 The *recommended* frequency for the ringing tone should be between 400 and 450[1] Hz. The *accepted* frequency should not be less than 340 Hz, nor more than 500 Hz. Frequencies between 450 and 500 Hz in the accepted frequency range should, however, be avoided.

The ringing tone frequency may be modulated by a frequency between 16 and 100 Hz, but such modulation is not recommended for new equipment. If the accepted frequency is more than 475 Hz, no modulation by a lower frequency is allowed.

4. *Busy tone and congestion tone*

4.1. The (subscriber) busy tones and the (equipment or circuit group) congestion tone are *quick* period tones in which the tone period is theoretically equal to the silent period. The total duration of a complete cycle (tone period $E +$ silent period S) should be between 300 and 1100 milliseconds.

The ratio $\frac{E}{S}$ of the tone period to the silent period should be between 0.67 and 1.5 (*recommended* values).

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[1] For the frequencies used in the North American network, see Supplements Nos. 4 and 5 to Volume V of the *White Book*.

For existing exchanges, or for tones to be used in a special way, it is *accepted* that the tone period may be 250 milliseconds shorter than the theoretical value $\frac{E+S}{2}$ (which gives $E = \frac{E+S}{2} - 250$, that is to say, $E = S - 500$ milliseconds). In no circumstances should the tone period be shorter than 100 milliseconds.

Figure 2 shows the recommended and the accepted areas for the busy tone and the congestion tone periods.

4.2 The (subscriber) busy tone condition and the (equipment or circuit group) congestion condition may be indicated by one and the same audible tone, as is often the case in existing national networks.

For newer developments an Administration may wish to adopt a distinction in the tones denoting these conditions; for international uniformity it is recommended that in these circumstances:

a) the same *frequency* should be used for the busy tone and for the congestion tone,

b) the busy tone should have a slower *cadence* than the congestion tone but both cadences should be within the limits mentioned under 4.1.

4.3 The *recommended* frequency for the busy tone and for the congestion tone must be between 400 and 450 Hz[1]. The *accepted* frequency must not be less than 340 nor more than 500 Hz. Frequencies between 450 and 500 Hz in the accepted frequency range should, however, be avoided.

5. *Special information tone*

5.1 The special information tone is a *standardized international tone* universally comprehensible and designed to invite the calling subscriber, in international automatic working, to get in touch with an operator in his country when he cannot understand a message orally received.

The special information tone is provided for special cases, that is to say, all cases in which neither the busy nor the ringing tone can give the required information to the calling subscriber. There are three instances in which it may be used:

a) when the call is connected to a recorded voice machine; the tone is then given during the silent intervals between transmissions of the announcement;

b) under arrangements made at manual positions serving lines which have been abnormally routed so that by operating a key the operators may send the special information signal when, for example, the calling subscriber fails to understand the operator;

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[1] For the frequencies used in the North American network, see Supplements Nos. 4 and 5 to Volume VI of the *White Book.*

c) when in special cases no provision is made for recourse either to a recorded announcement or to an operator, the special tone must be connected by the equipment at the point which the calls have reached.

5.2 The special information tone has a tone period theoretically equal in length to the silent period.

Tone period. — The tone period consists of three successive tone signals, each lasting for 330 ±70 milliseconds. Between these tone signals there may be a gap of up to 30 milliseconds.

Silent period. — This lasts for 1000 ±250 milliseconds.

5.3 The frequencies used for the three tone signals are:

950 ±50 Hz; 1400 ±50 Hz; 1800 ±50 Hz,

sent in that order.

6. *Warning tone to indicate that a conversation is being recorded*

Where a conversation is being recorded at a subscriber's station the Administration *, if it so desires, may cause the subscriber to introduce a warning tone to indicate that the conversation is being recorded. When such a tone is applied, it is recommended that:

a) it consists of a 350-500 ms pulse every 15 ±3 seconds of recording time, and

b) the frequency of the tone is 1400 Hz ±1.5%.

7. *Machine recognition of tones*

The C.C.I.T.T. appreciates the value of machine recognition of tones for the purpose of service observations, maintenance, testing or for the collection of statistics where equivalent electrical signals do not exist. However, the C.C.I.T.T. considered, at Mar del Plata in 1968, that such machine recognition should not be a substitute for electrical signals.

Where machine recognition of audible tones is to be introduced, the tone frequencies and cadences must be within close limits of precision.

It is not envisaged that machine recognition of tones will be applied outside a national or an integrated network.

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* or recognized private operating Agency.

CHAPTER VI

General characteristics for international telephone connections and international telephone circuits

1.0 *General*

RECOMMENDATION Q.40 [*]

THE TRANSMISSION PLAN

A. *Principles*

The transmission plan of the C.C.I.T.T. established in 1964 (Geneva) was drawn up with the object of making use, in the international service, of the advantages offered by four-wire switching.

. . . .

However, the recommendations in the plan are to be considered as met if the use of technical means other than those described below gives an equivalent performance at the international exchange.

Recommendation G.122, *White Book*, Volume III, describes the conditions to be fulfilled by a national network for this transmission plan to be put into effect.

Note 1. — From the point of view of the transmission plan, no distinction is made between intercontinental circuits and other international circuits.

Note 2. — Short trans-frontier circuits are not covered by this plan and should be the subject of agreement between the Administrations concerned.

. . . .

B. *Definition of the constituent parts of a connection*

a) *The international chain and the national systems*

A complete international telephone connection consists of three parts, as shown in Figure 1.

— *An international chain* made up of one or more four-wire international circuits. These are interconnected on a four-wire basis in the international transit centres and are also connected on a four-wire basis to national systems in the international centres.

— *Two national systems*, one at each end. These may comprise one or more four-wire national trunk circuits with four-wire interconnection, as well as circuits with two-wire connection up to the terminal exchanges and to the subscribers.

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[*] This Recommendation is an extract of Recommendation G.101 in series G (Line transmission, Volume III of the *White Book*) of the C.C.I.T.T. Recommendations.

The suspensive points show where a passage in Recommendation G.101 has not been reproduced under Q.40.

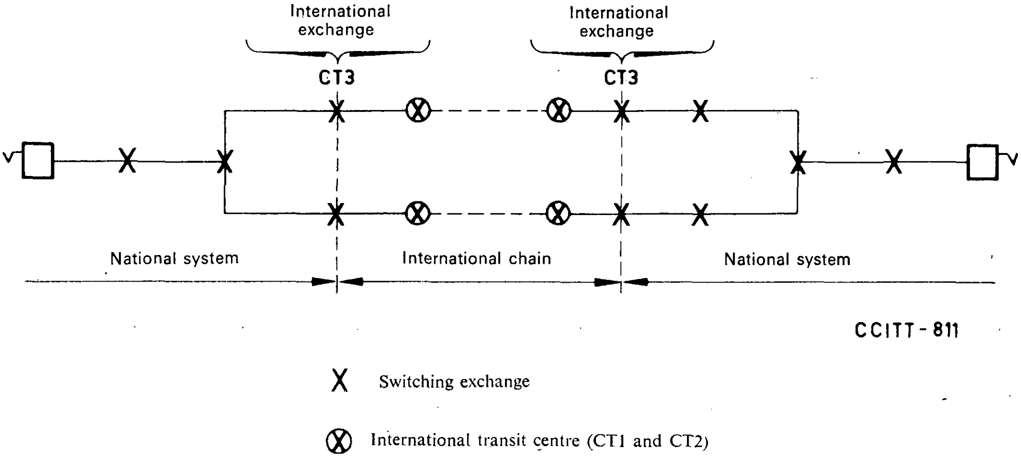


FIGURE 1. — **Definition of the constituent parts of an international connection**

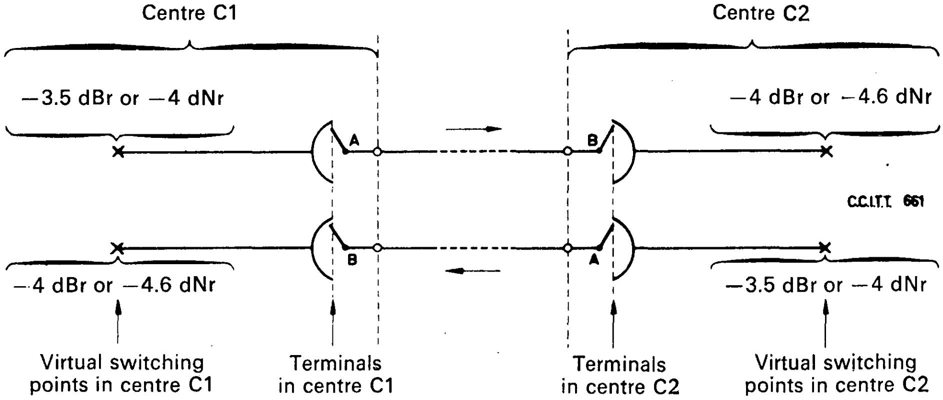


FIGURE 2. — **Definitions for an international circuit**

A four-wire circuit is defined by its *virtual switching points* in an international transit exchange or an international exchange. These are theoretical points with specified relative levels (see Figure 2; for further details see Recommendation G.141, Volume III).

The difference between the sending and receiving nominal relative levels at the reference frequency is, by definition, *the nominal transmission loss* of the four-wire circuit *between virtual switching points.*

In an international exchange, the division between the international chain and the national system is determined by the virtual switching points of the international circuit.

The virtual switching points may not be the same as the points at which the circuit terminates physically in the switching equipment. These latter points are known as the *circuit terminals*; the exact position of these terminals is decided in each case by the Administration concerned.

b) *National extension circuits: four-wire chain*

When the maximum distance between an international exchange and a subscriber who can be reached from it does not exceed about 600 miles (1000 km) or, exceptionally, 1000 miles (1500 km), the country concerned is considered as of average size. In such countries, at the most three national four-wire circuits can be interconnected on a four-wire basis between each other and to international circuits. They should comply with the recommendations of paragraph 1.4 of Recommendation G.141, *White Book*, Volume III.

In a large country, a fourth and possibly a fifth national circuit may be included in the four-wire chain, provided it has the nominal transmission loss and the characteristics recommended for international circuits used in a four-wire chain (see Recommendation Q.43 and the recommendations in paragraph 1.5 of Recommendation G.151, *White Book*, Volume III).

Note. — The abbreviation "a four-wire chain" (see Figure 3) signifies the chain composed of the international chain and the national extension circuits connected to it, either by four-wire switching or by some equivalent procedure (as understood in section A above).

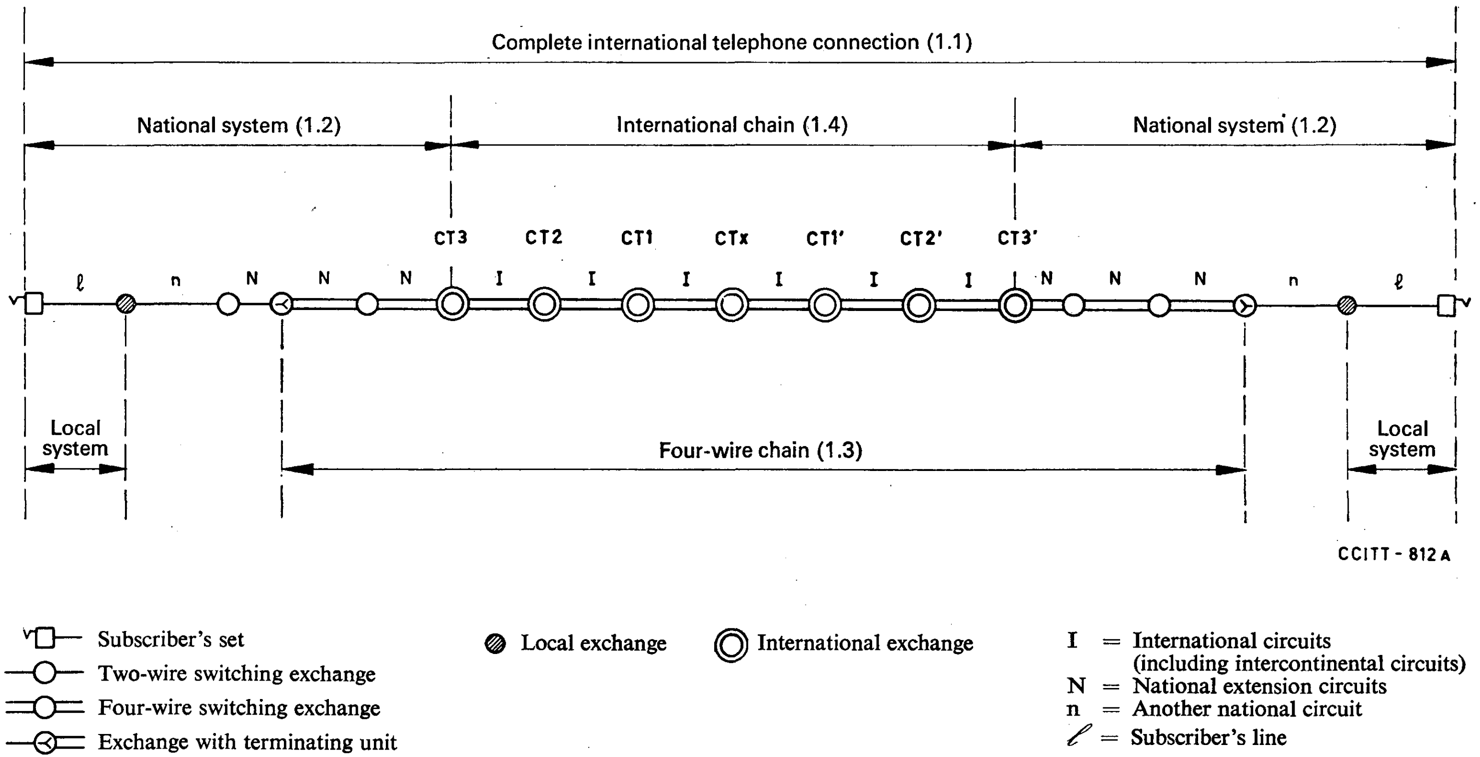
C. *Maximum number of circuits*

a) *National circuits*

It seems reasonable to assume that in most countries any *local exchange* can be connected to the international network by means of a chain of four (or less) national circuits. Five national circuits may be needed in some countries, but it is unlikely that any country may need to use more than five circuits. Hence the C.C.I.T.T. has reached the conclusion that four circuits is a representative figure to assume for the great majority of international connections.

In most modern national networks, the four circuits will probably include three four-wire amplified circuits (usually set up on carrier systems) and one two-wire circuit, probably unamplified. In some instances, however, local exchanges will be reached by four circuits, only two of which will be four-wire circuits.

The representative maximum international connection considered by the C.C.I.T.T. for the study of transmission performance (see Figure 3 of this Recommendation and



Note. — The numbers in brackets are the numbers of the sub-sections in Section 1 in which the relevant recommendations appear. In addition, the circuits making up this chain must individually meet the requirements of sub-section 1.5.

FIGURE 3. — **An international connection to illustrate the nomenclature adopted**

Figure 1 of Recommendation G.103) thus includes eight national circuits, besides the international ones. The cumulative distortion of these eight circuits is likely to be large, and close to the maximum allowable value. Consequently, the international circuits must not introduce any further appreciable deterioration. This principle has been borne in mind during the drafting of the Recommendations dealing with such circuits.

b) *International circuits*

Implementation of the routing plan for automatic and semi-automatic international telephone traffic (Recommendation Q.13, *White Book*, Volume VI) presupposes that the transmission plan is applied. In the routing plan, the C.C.I.T.T. has defined three classes of international centres, CT1, CT2 and CT3, and has arranged to restrict *the number of international circuits to five* or, exceptionally, to six or seven. The CT3s connect international and national circuits; the CT2s and CT1s interconnect international circuits. In some connections, an international centre designated CTX, as well as the CT1s, may be encountered as shown in Figure 3. Certain exceptional routings, moreover, involve a seventh international circuit.

c) *Hypothetical reference connections*

See Recommendation G.103 (*White Book*, Volume III).

1.1 *General characteristics of a complete international telephone connection*

RECOMMENDATION Q.41 *

MEAN ONE-WAY PROPAGATION TIME

A. *Limits for a connection*

It is necessary in an international telephone connection to limit the propagation time between two subscribers. As the propagation time is increased, subscriber difficulties increase, and the rate of increase of difficulty rises. Relevant evidence is given in the bibliography below, particularly with reference to paragraph b) in Recommendation G.114 (Volume III of the *White Book*).

The C.C.I.T.T. therefore *recommends* the following limitations on mean one-way propagation times ** when echo sources exist and appropriate echo suppressors are used:

a) 0 to 150 ms, acceptable.

Note. — Old-type echo suppressors may be used; they should be modified for delays above 50 ms.

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* This Recommendation is an extract of Recommendation G.114 in series G (Line transmission, Volume III of the *White Book*) of the C.C.I.T.T. Recommendations.

The suspensive points show where a passage in Recommendation G.114 has not been reproduced under Q.41.

** Mean of the times in the two directions of transmission.

b) 150 to 400 ms, acceptable, provided that increasing care is exercised on connections as the mean one-way propagation time exceeds about 300 ms, and provided that echo suppressors designed for long delay circuits are used.

c) above 400 ms, unacceptable. Connections with these delays should not be used except under the most exceptional circumstances.

. . . .

B. *Values for circuits*

In the establishment of the general interconnection plan within these limits the one-way propagation time of both the national extension circuits and the international circuits must be taken into account.

a) *National extension circuits*

. . . .

b) *International circuits*

International circuits will use high-velocity transmission system; the one-way propagation times, or velocity, that should be assumed for planning purposes are:

1. *Terrestrial lines* (land lines and submarine cables)

100 miles/ms (160 km/ms).

This propagation velocity includes an allowance for terminal and intermediate multiplex equipment likely to be associated with a transmission line.

2. *Satellite links*

The mean one-way propagation times between earth stations for two illustrative single-hop communication satellite systems are:

Satellite at 8700 miles or 14 000 km altitude	110 ms
Satellite at 22 500 miles or 36 000 km altitude	260 ms

The one-way propagation times do not include any allowance for the distance from the earth stations to locations where the satellite circuits can either be extended on other international transmission systems or switched to other national or international circuits. These additional times should be taken into account for planning purposes. The practical distances between earth stations depend not only on the altitude of the satellites but also on the orbits and positions of the satellites relative to the earth stations. Exact account should be taken of these parameters in particular applications.

The magnitude of the mean one-way propagation time for circuits on high altitude communication-satellite systems makes it desirable to impose some routing restrictions of their use. Details of these restrictions are given in Recommendation Q.13, Section 3.

Note. — The propagation time referred to above is the group delay as defined in the I.T.U. *List of Definitions of Essential Telecommunication Terms* (Definition No. 04-17); the numerical values are calculated at a frequency of about 800 Hz.

1.2 *General characteristics of national systems forming part of international connections*

(See Recommendations G.121 to G.125, Volume III, *White Book.*)

1.3 *General characteristics of the "four-wire chain" formed by the international telephone circuits and national extension circuits*

(Overall characteristics for the four-wire chain defined in Recommendation Q.40, B).

RECOMMENDATION Q.42 *

STABILITY AND ECHO **

A. *Stability of telephone transmission*

. . . .

B. *Limitation of echoes*

The main circuits of a modern telephone network providing international communications are high-velocity carrier circuits on symmetric or coaxial pairs or radio-relay systems and echo suppressors are not normally used except on connections involving very long international circuits. There is often no general need for echo suppressors in national networks but they may be required for the inland service in large countries. Echo suppressors may also be needed on loaded-cable circuits (low-velocity circuits) used for international calls.

Echoes may be controlled in one of two ways; either the overall loss of the four-wire chain of circuits may be adjusted so that echo currents are sufficiently attenuated (which tacitly assumes a particular value for the echo return loss) or an echo suppressor can be fitted.

a) *Transmission loss adjustment*

. . . .

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* This Recommendation is an extract of Recommendation G.131 in Series G (Line transmission, Volume III of the *White Book*) of the C.C.I.T.T. Recommendations.

The suspensive points show where a passage in Recommendation G.131 has not been reproduced under Q.42.

** See also Recommendation Q.115.

b) *Echo suppressors*

The preferred type of echo suppressor is a terminal, differential, half-echo suppressor operated from the far end *. There are two types of half-echo suppressors in use in the international network, one suitable only for use in connections with mean one-way propagation times not exceeding 50 ms, referred to as a short-delay echo suppressor, and the other suitable for use in connections with any mean one-way propagation time especially times well over 50 ms, referred to as a long-delay echo suppressor like those used on circuits routed on communication-satellite systems. It will quite clearly be of advantage in future to retain only a single type of echo suppressor in service throughout the whole international network. The characteristics of such an echo suppressor which can be used on connections with either short or long propagation times are given in Recommendation G.161, B and C, *White Book*, Volume III. The characteristics of the short delay echo suppressor are given in the *Blue Book*, Volume III, Recommendation G.161, B.

c) *Rules governing the use of echo suppressors*

Only telephony is considered here. Echo suppressors are an embarrassment to data and other telegraph-type transmission. Use of echo suppressors with tone disablers is recommended for data transmission (see Recommendation G.161, C, Volume III of the *White Book*.)

1. IDEAL RULES

The fundamental requirements that an *ideal* scheme should comply with are given in rules A to D below.

Rule A. — The probability that an international connection between any two subscribers will exhibit an objectionable echo should not be greater than 1%. If the probability is greater, an echo suppressor must be provided.

Rule B. — Not more than the equivalent of one full echo suppressor (i.e. two half-echo suppressors) should be included in any connection needing an echo suppressor. When there is more than one full echo suppressor the conversation is liable to be clipped; lockout can also occur.

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* Definitions of Recommendation G.161 (Volume III of the *White Book*):

A terminal echo suppressor is an echo suppressor designed for operation at either terminal of a circuit.

A differential echo suppressor is an echo suppressor in which the action is controlled by the difference in level between the signals on the two speech paths.

A half-echo suppressor is an echo suppressor in which the speech signals of one path control the attenuation introduced into the other path but in which this action is not reciprocal.

A far-end operated, terminal half-echo suppressor is a half-echo suppressor fitted at the end of a circuit and which introduces the blocking attenuation into the transmit path under the control of speech signals from the receive path.

Rule C. — Connections that do not require echo suppressors should not be fitted with them, because they increase the fault rate and are an additional maintenance burden.

Rule D. — The half-echo suppressors should be associated with the terminating sets of the four-wire chain of the complete connection. This reduces the chance of speech being mutilated by the echo suppressors because the hangover times can be very short.

2. PRACTICAL RULES

It is recognized that no practical solution to the problem could comply with rules so exclusive and inflexible as the ideal rules A to D above. Some practical rules, E to L, are suggested below in the hope that they will ease the switching, signalling and economic problems. They should not be invoked unless rules A to D cannot reasonably be complied with.

Rule E. [1] — For connections involving the longest national four-wire extensions of the two countries, a probability of encountering objectionable echo not of 1% (rule A) but of 10% can, by agreement between the Administrations concerned, be tolerated. This rule E [1] is valid only in those cases where it would otherwise be necessary, according to rule A, to use an echo suppressor solely for these connections, and where there is no need for echo suppressors on connections between the regions in the immediate neighbourhood of the two international centres concerned.

Rule F. — If, as is appreciated, rule D above cannot be complied with, the echo suppressor may be fitted at the international exchange or at an appropriate national transit centre. Should it prove impracticable to fit the echo suppressor at the international exchange (CT3) on multi-circuit connections then it may be fitted at an international transit centre (CT2 or CT1).

For either of these arrangements the hangover time should normally be 50 ms. Exceptionally it may be increased to 70 ms when there is a long chain of circuits extending the connection beyond the point where the echo suppressor is situated. The values of hangover time are provisional in respect of long-delay echo suppressors.

Rule G. — In isolated cases a full short-delay echo suppressor may be fitted at the outgoing end of a transit circuit (instead of two half-echo suppressors at the terminal centres) provided that neither of the two hangover times exceeds 70 ms. This relaxation may reduce the number of echo suppressors required and may also simplify the signalling and switching arrangements. It is emphasized that full echo suppressors must not be used indiscriminately; the preferred arrangement is two half-echo suppressors as near the terminating sets as possible. A full echo suppressor should be as near to the "time-centre" of the connection as possible, because this will require lower hangover times.

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[1] Annex 2 to Question 2/XI studied in 1965-1968 (pages 291 to 294 of the *Blue Book*, Volume VI) is a study of the application of rules A and E to the United Kingdom-European network relations.

Whether a full long-delay echo suppressor can be used in this circumstance is under study.

Rule H. — In exceptional circumstances, such as breakdown, an emergency route may be provided. The circuits of this route need not be fitted with echo suppressors if they are usable without them for a short period. However, if the emergency routing is to last more than a few hours, echo suppressors must be fitted according to rules A or E above.

Rule J. — It is accepted that a connection that does not require an echo suppressor may in fact be unnecessarily equipped with one or two half-echo suppressors, or a full echo suppressor. (The presence of an echo suppressor in good adjustment on a circuit with modest delay times can hardly be detected.)

Rule K. — On a connection that requires an echo suppressor, up to the equivalent of two full-echo suppressors (e.g. three half-echo suppressors or two half-echo suppressors and a full one) may be permitted. Every effort should be made to avoid appealing to this relaxation because the equivalent of two or more full-echo suppressors, with long hangover times, on a connection can cause severe clipping of the conversation and considerably increases the risk of lockout.

Rule L. — In general it will not be desirable to switch out (or disable) the intermediate echo suppressors when a circuit equipped with long-delay echo suppressors is connected to one with short-delay echo suppressors. However, it would be desirable to switch out (or disable) the intermediate echo suppressors if the mean one-way propagation time of that portion of the connection which would now fall between the terminal half-echo suppressors is not greater than 50 ms, since the different types are likely to be compatible.

d) *Insertion of echo suppressors in a connection*

Ways of doing this which have been considered are:

1. Provide a pool of echo suppressors common to several groups of circuits, and arrange for an echo suppressor to be associated with any circuit that requires one *.

2. Arrange for the circuits to be permanently equipped with echo suppressors but switch them out (or disable them) when they are not required **.

3. Divide the circuits of an international route into two groups, one with and one without echo suppressors and route the connection over a circuit selected from the appropriate group according to whether the connection merits an echo suppressor.

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* See Annex 2 to Question 2/XI, studied in 1965-1968 (pages 291 to 294, *Blue Book*, Volume VI).

** See Annex 3 to Question 3/XI, studied in 1965-1968 (pages 295 to 297, *Blue Book*, Volume VI).

However, it is recognized that circuits may not be used efficiently when they are divided into separate groups. This must be borne in mind.

4. It is possible to conceive schemes in which the originating country and the terminal country are divided into zones at increasing mean radial distances from the international centre and to determine the nominal lengths of the national extensions by examining routing digits and circuits-of-origin.

As far as telephone transmission is concerned there is nothing to distinguish one method from another and the economic solution to the problem may well be found in the judicious use of all these methods. The C.C.I.T.T. is not in a position to recommend one of these methods as "preferred". The nature and volume of the traffic carried by a particular connection will also influence the economics of the methods and hence the choice among them.

It should be appreciated that different continents need not use the same method although the methods must be compatible to permit intercontinental connections. There appears to be no great difficulty in arranging this.

1.4 *General characteristics of the four-wire chain of international circuits ; international transit*

RECOMMENDATION Q.43 *

TRANSMISSION LOSSES, RELATIVE LEVELS AND ATTENUATION DISTORTION

1. *Relative levels specified at the virtual switching points of international circuits*

The virtual switching points of an international four-wire telephone circuit are fixed by convention at points of the circuit where the nominal relative levels at the reference frequency are:

−3.5 dBr sending

−4.0 dBr receiving

The nominal transmission loss of this circuit at the reference frequency between virtual switching points is therefore 0.5 dB or 6 cNp.

Note 1. — See the definitions in section b. The position of the virtual switching points is shown in Figure 2 of Recommendation Q.40 and in the figure in Recommendation G.122, *White Book*, Volume III.

Note 2. — Since the four-wire terminating set forms part of national systems and since its actual attenuation may depend on the national transmission plan adopted by each administration, it is no longer possible to define the relative levels on international four-wire circuits by reference to the two-wire terminals of a terminating set. In particular, the transmission loss in terminal service of the chain created by connecting a pair of terminating sets to a four-wire international circuit cannot be fixed at a single value by C.C.I.T.T. recommendations. The virtual switching points of circuits might therefore have been chosen at points of arbitrary relative level. However, the values adopted above are such that in general they permit the passage from the old plan to the new to be made with the minimum amount of difficulties.

Note 3. — If a four-wire circuit forming part of the four-wire chain contributes negligible delay and variation of transmission loss with time, it may be operated at zero nominal transmission loss between virtual switching points. This relaxation refers particularly to short four-wire tie-circuits between switching centres—for example, circuits between a CT3 and a CT2 in the same city.

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* This Recommendation is an extract of Recommendation G.141 in Series G (Line transmission, Volume III of the *White Book*) of the C.C.I.T.T. Recommendations.

2. *Definitions*

2.1 *Transmission reference point*

A hypothetical point used as the zero relative level point in the computation of nominal relative levels. Such a point exists at the sending end of each channel of a four-wire switched circuit preceding the virtual switching point; on an international circuit it is defined as having a level + 3.5 dB above that of the virtual switching point.

With the C.C.I.T.T. transmission plan this point does not necessarily coincide with the two-wire termination point as was the case with the old plan. The level of transmitted load at this point is the subject of Recommendation G.223.

2.2 *Relative (power) level*

The expression in transmission units of the ratio $\frac{P}{P_0}$, where P represents power at the point concerned and P_0 the power at the transmission reference point.

2.3 *Circuit test-access point*

Study Group IV has defined circuit test-access points as being "four-wire test-access points so located that as much as possible of the international circuit is included between corresponding pairs of these access points at the two centres concerned". These points, and their relative level (with reference to the transmission reference point), are determined in each case by the Administration concerned. They are used in practice as points of known level to which other transmission measurements will be related. In other words, for measurement and lining-up purposes, the level at the appropriate circuit test-access point is the level with respect to which other levels are adjusted.

2.4 *Measurement frequency*

For all international circuits 800 Hz is the recommended frequency for single-frequency maintenance measurements. However, by agreement between the Administrations concerned, 1000 Hz may be used for such measurements.

A frequency of 1000 Hz is in fact now widely used for single-frequency measurements on some international circuits.

Multifrequency measurements made to determine the loss/frequency characteristic will include a measurement at 800 Hz and the frequency of the reference measurement signal for such characteristics can still be 800 Hz.

3. *Interconnectiion of international circuits in a transit centre*

In a transit centre, the virtual switching points of the two international circuits to be interconnected are considered to be connected together directly without any intermediate pad or amplifier.

In this way a chain of n international circuits has a nominal transmission loss in transit of n times 0.5 dB in each direction of transmission which contributes to the stability of the connection; see Recommendation G.131, A, Volume III of the *White Book*).

RECOMMENDATION Q.44.*

ATTENUATION DISTORTION

1. The conditions laid down for carrier terminal equipment by Recommendation G.232—A guarantee that a chain of six circuits, each equipped with a single pair of channel-translating equipments in accordance with that Recommendation, will exhibit an attenuation distortion in terminal service that will meet the limits of Figure 1 in Recommendation Q.44, including the distortion contributed by the seven international centres traversed.

Note. — To assess the attenuation distortion of the international chain, the limits indicated for international circuits in Recommendation G.151—A, *White Book*, Volume III, must not be added to the limits for international centres mentioned in Recommendation Q.45. In fact, on the one hand, some exchange equipment would be counted twice if this addition were made; on the other, the specification limits of Recommendation Q.45 apply to the worst possible connection through an international exchange, while the maintenance limits of Recommendation G.151—A apply to the poorest international circuit. The specifications of the various equipments are such that the mean performance will be appreciably better than could be estimated by the above-mentioned addition.

2. The objectives for the variation with frequency of transmission loss in terminal condition of a world-wide four-wire chain of 12 circuits (international plus national extensions), each one routed over a single group link, are shown in Figure 1, which assumes that no use is made of high-frequency radio circuits or 3-kHz channel equipment.

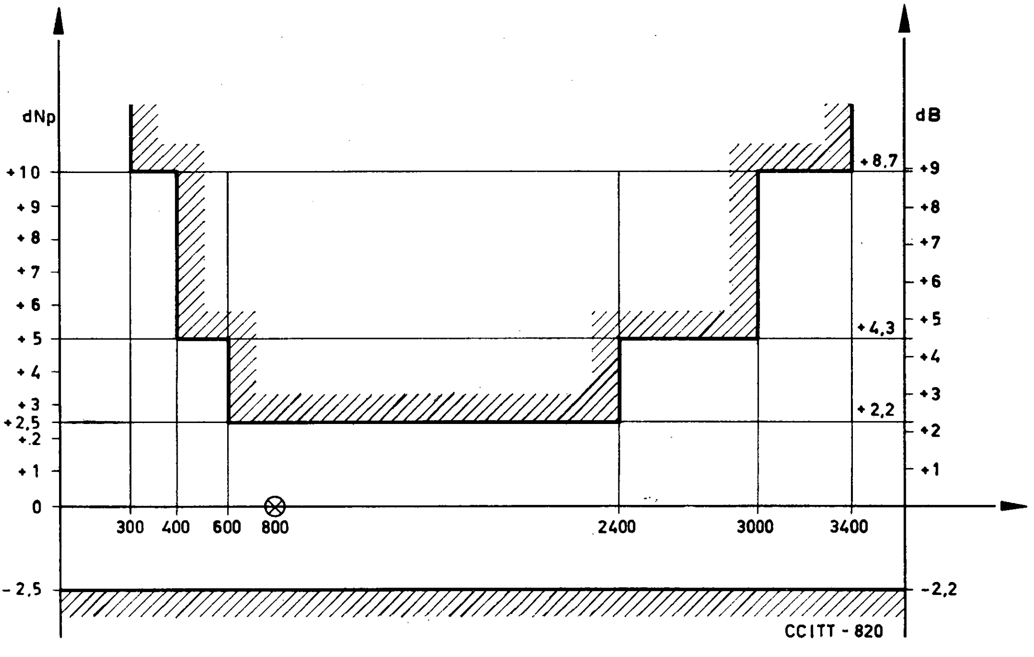

FIGURE 1. Diagram No. 1 of Volume III. — **Permissible attenuation variation with respect to its value measured at 800 Hz (objective for world-wide chain of 12 circuits in terminal service)**

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* Recommendation Q.44 is an extract of Volume III, *White Book*, Recommendations G.142 (Paragraph 1 of Q.44) and G.132 (Paragraph 2 of Q.44).

RECOMMENDATION Q.45

TRANSMISSION CHARACTERISTICS OF AN INTERNATIONAL EXCHANGE

1. *Introduction*

1.1 For the purposes of this Recommendation, an international exchange is a collection of equipment regarded as an entity by the Administration concerned. In the case of an international transit centre, it extends from the end of the incoming international line to the beginning of the outgoing international line (e.g. between such points as A and D in Figure 1 or any other suitable pair of points).

In the absence of an international agreement on the choice of the points delimiting an international exchange, it has proved impossible to draw up model specifications showing the limits to be observed for quantities measured between these points. The C.C.I.T.T. recommendations given hereafter have been issued regardless of the actual arrangement.

Automatic international exchanges should be provided with circuit test access points (see Recommendation Q.75) complying with Recommendation M.64, Part B (Volume IV). This Recommendation will ensure that circuit line-up and maintenance testing procedures are referred to points at or near the switch-clock (Points B and C of Figure 1).

1.2 The essential transmission requirements for an international exchange are:

a) The *transmission loss* through the centre should be substantially constant with time and independent of the routing through the centre.

b) *Crosstalk and noise* should be negligible.

c) The *distortions* introduced should be small. These include attenuation distortion, non-linear distortion, group delay distortion and intermodulation products.

d) *Impedance* and *balance with respect to earth* at the points in the international exchange to which the lines are connected should be closely controlled.

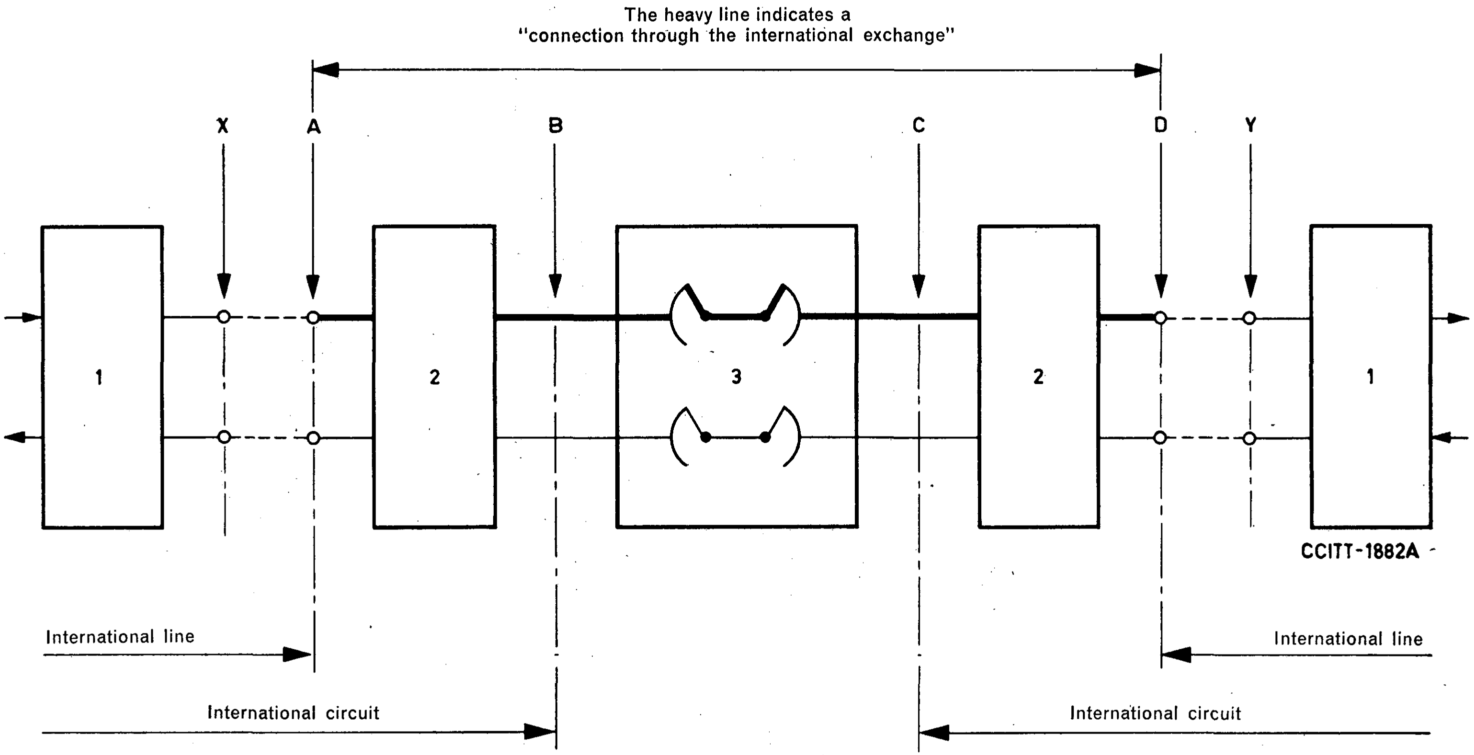
1.3 The following recommendations apply to new automatic four-wire international exchanges of the electromechanical type. It is desirable that they should apply to new national four-wire exchanges. They may also be applicable to electronic exchanges having metallic contact crosspoints.

These recommendations are intended to be used only as type tests, acceptance tests, or for special investigations. They do not constitute a complete specification. Generally the recommended tests should be conducted on a sampling basis.

2. *Definitions*

2.1 *Definition of a "connection through an exchange"*

Crosstalk and noise conditions for a four-wire international 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 one direction of transmission (GO direction or RETURN direction) and connecting the input point of one circuit incoming in the exchange and the output point of a different circuit outgoing from the exchange (these input or output points are often taken at the test-jack frame).



1 = channel translating equipment
2 = incoming and outgoing relay set
3 = automatic switching equipment

Between points X and A and points D and Y, there may be equipment such as echo suppressors, compandors, equalizers, line signal receivers, etc., in addition to the cabling.

FIGURE 1

A connection through the international exchange is shown be a heavy line in Figure 1.

2.2 *Definition of switching equipment input and output points.*

Although the virtual switching points, which are points at which the two circuits are considered to be directly connected, are theoretical points, in practice it will always be possible to choose a point considered as the *switching equipment input* for the receive channel of a circuit and a point considered as the *switching equipment output* for the transmit channel of a circuit.

The exact position of each of these points depends on national practice and it is unnecessary for the C.C.I.T.T. to define it. Only the national authority responsible for each international transit centre can fix the position of these points in each case.

The switching equipment input point associated with a receive channel may be such that the nominal relative level is different from —4.0 dBr. Let this nominal relative level be R *.

The switching equipment output point associated with a transmit channel may be such that the nominal relative level is different from —3.5 dBr. Let this nominal relative level be S *.

Consider a circuit between the switching centre concerned and the adjacent centre. Let T be the nominal transmission loss between virtual switching points at the two ends of the channel of this circuit, which is the receive channel in the centre concerned.

When a transit connection is established through a centre by connecting the receive and transmit channels of one circuit to the transmit and receive channels respectively of another circuit, in order to ensure that the virtual switching points have been connected together without additional loss or gain, the *nominal* value of the attenuation (loss) to be introduced between the switching equipment input and the switching equipment output is $R-S+T$.

2.3 *Definition of the net switching loss*

Let the actual value of the attenuation introduced between the switching equipment input and output points be A. The net switching loss is defined to be equal to the difference between this *actual* value and the *nominal* value of the attenuation. Thus:

Net switching loss = Actual loss — nominal loss = $A-(R-S+T)$.

3. *Recommendations concerning transmission loss*

3.1 *Net switching loss*

The net switching loss of an international exchange should be zero. That is, the *actual* loss (A) should equal the *nominal* loss ($R-S+T$).

Example. — The relationship between the actual switching points and the virtual switching points in a practical international exchange is illustrated in Figure 2.

In this arrangement:

$R = +7$ dBr
$S = -16$ dBr
and T is assumed to be 0.5 dB

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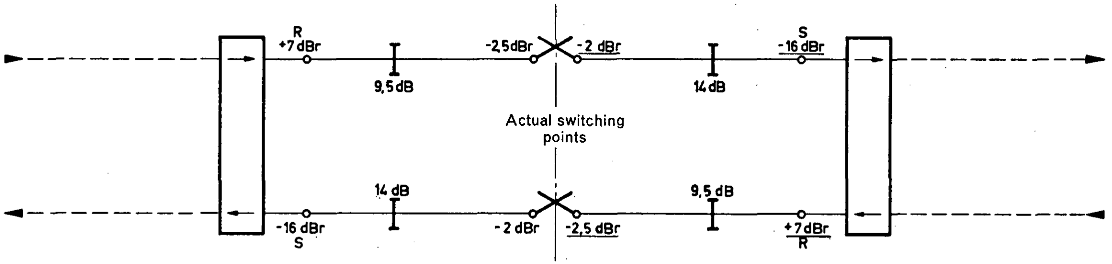
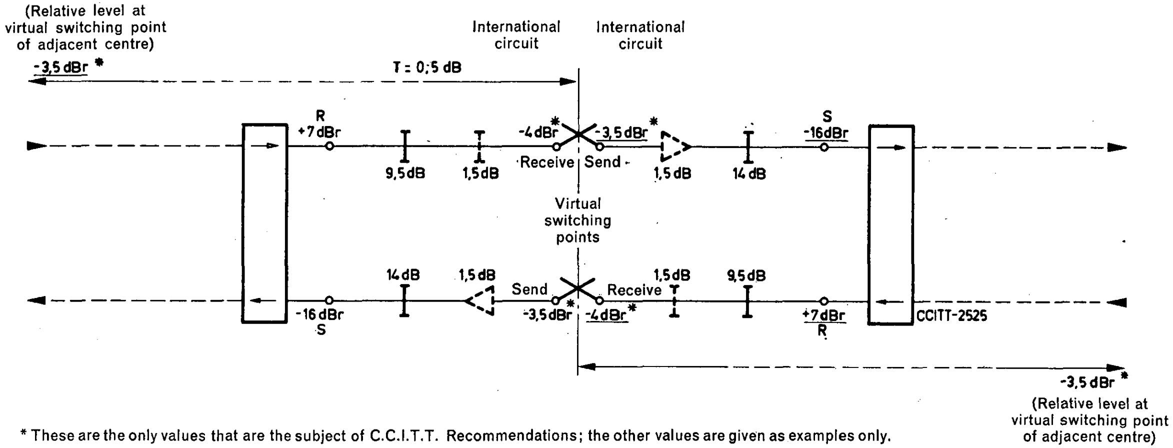
* If the value of R is chosen to be higher than the value of S, the level difference can be used to offset any inherent transmission loss in the switching equipment and the requirements of the transmission plan can be met without any need to install supplementary audio-frequency amplifiers.



a) *Actual arrangement*



* These are the only values that are the subject of C.C.I.T.T. Recommendations; the other values are given as examples only.

b) *Hypothetical arrangement indicating possible position of the virtual switching points of the two circuits*

FIGURE 2. — **Example showing a simplified representation of a transit connection in an international exchange with actual arrangement and possible location of virtual switching points**

Note. — Underlined values of relative level refer to the circuit on the right of the point concerned. Values of relative level not underlined refer to the circuit on the left of the point concerned. In an actual switching centre the virtual switching points would not physically exist.

so that the nominal transmission loss needed between the + 7 and − 16 dBr points is:

$$(+ 7) - (- 16) + (0.5) = 23.5 \text{ dB}$$

3.2 *Loss dispersion*

According to Recommendation M.64, Part B (Volume IV), circuit test access points are located at or near the switch block (points B and C of Figure 1). Moreover, the dispersion of loss is mainly due to the diversity of paths in the switchblock. It is therefore only necessary to consider the dispersion of loss between the points B and C.

The standard deviation of loss measured at 800 Hz of all possible paths between points B and C should be as small as possible and in any case not larger than 0.2 dB.

Note. — Routings through the switchblock involving more complicated paths than directly from B to C, for example used as a special means of introducing echo suppressors, are not taken into account.

3.3 *Non-linear distortion*

The transmission loss measured on any " connection through the international exchange " should not vary by more than 0.2 dB when the level of the test-tone is varied from − 40 dBm0 to + 3.5 dBm0.

3.4 *Loss-frequency distortion referred to 800 Hz*

The transmission loss measured on any "connection through the international exchange" over the frequency bands indicated below should not differ from that measured at 800 Hz * by more than the values stated:

300- 400 Hz: —0.2 dB to +0.5 dB
400-2400 Hz: —0.2 dB to +0.3 dB
2400-3400 Hz: —0.2 dB to +0.5 dB

4. *Crosstalk recommendations*

4.1 Crosstalk should be measured in exchanges at a frequency of 1100 Hz in accordance with Recommendation G.134 (Volume III).

4.2 *Crosstalk between connections established (between points A and D)*

In an international four-wire exchange the signal to crosstalk ratio measured at points A and D between any two "connections through the international exchange" (see definition in 2.1) should be 70 dB or better.

This limit of 70 dB should normally apply to the most unfavourable case, in which two "connections" have parallel paths throughout the international exchange. It should be noted that this does not occur in practice, because normal cabling layout is such that when, at one switching stage, two "connections" use adjacent switches, in the following stage, the two "connections" generally use switches which are not adjacent.

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* 1000 Hz is an acceptable alternative reference frequency.

4.3 *Go to return crosstalk of the same path (between points A and D)*

The signal to crosstalk ratio between the two "connections" which constitute the GO and RETURN channels of a four-wire path established through the international exchange should be 60 dB or better.

5. *Noise*

5.1 *Weighted noise*

In any four-wire international exchange, the busy hour *psophometric* power level on any "connection through the exchange" and measured in the appropriate direction at points A and D and referred to points of zero relative level of the circuits connected to the exchange should not exceed —67 dBm0p (200 picowatts).

5.2 *Unweighted noise*

In any four-wire international exchange, the busy-hour mean *unweighted* noise power level measured in the same conditions as in 5.1 and referred to points of zero relative level of the circuits connected to the exchange should not exceed —40 dBm0 (100 000 picowatts).

Note. — Unweighted noise should be measured with a device with a uniform response curve throughout the band 30-20 000 Hz.

5.3 *Impulse noise*

This question is under study in Study Group XI *.

6. *Other transmission recommendations*

6.1 *Intermodulation products (measured at A and D)*

The intermodulation products to be taken into account for end-to-end multi-frequency signalling and for data transmission are those of the third order, of type $(2f_1-f_2)$ and $(2f_2-f_1)$ where f_1 and f_2 are two signalling frequencies.

For a measurement of the intermodulation products, the two frequencies to be used are 900 Hz and 1020 Hz (see Recommendation G.162, Volume III). With each frequency f_1 and f_2 at a level of —6 dBm0, the difference between the level of either frequency f_1 or f_2 and the level of either of the intermodulation products at $(2f_1-f_2)$ or $(2f_2-f_1)$ should be at least 40 dB.

6.2 *Group delay distortion (measured between A and D)*

The group delay distortion measured on any "connection through the international exchange" over the band 600-3000 Hz should not exceed 100 microseconds.

6.3 *Return loss (measured at A and D, from A towards D and from D towards A)*

At any frequency from 300-600 Hz the return loss measured against 600 ohms should be not less than 15 dB. The corresponding value from 600-3400 Hz should be not less than 20 dB.

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* See Question 8/XI.

6.4 *Impedance unbalance to earth*

6.4.1 The impedance unbalance to earth measured, at points A and D, should not be worse than:

300-600 Hz: 40 dB
600-3400 Hz: 46 dB.

Note. — Some Administrations guided by their knowledge of local conditions may feel a need to specify a figure for a lower frequency, for instance, 50 Hz.

6.4.2 The degree of unbalance to earth is defined as the ratio e/E measured as shown on Figure 3a or Figure 3b and is expressed in decibels as the reciprocal of this ratio in transmission units.

The diagrams of Figures 3a and 3b used for measurement of unbalance differ only in respect of the presence or absence of an earth at the mid-point of the termination. Unbalance measurements according to Figure 3a or Figure 3b can give quite different results according to the nature of the unbalance.

6.4.3 The C.C.I.T.T. has recommended in 1968 that the set of limit values of 6.4.1 should be met for unbalance to earth measured with *both* measuring diagrams according to Figure 3a and Figure 3b.

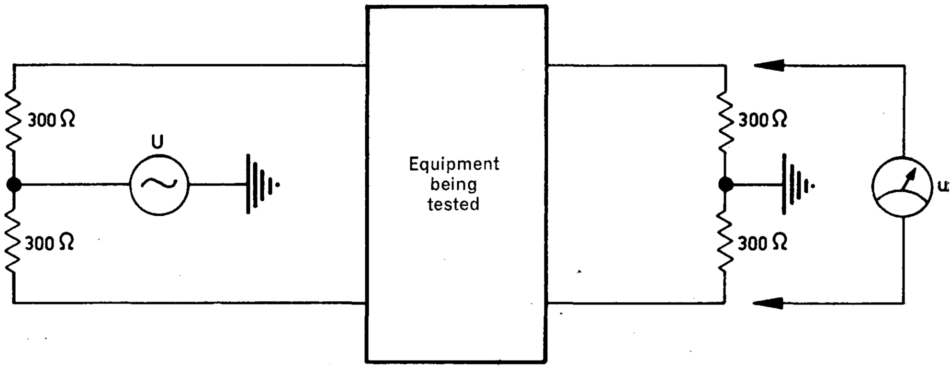

Figure 3a

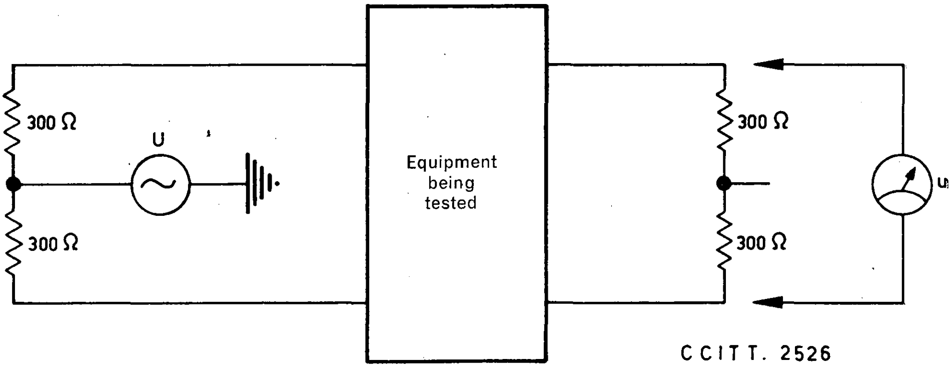

Figure 3b

Use of cables specified by the I.E.C.

The cables for telephone exchanges in accordance with I.E.C. (International Electrotechnical Commission) publication 189 will meet the electrical characteristics required by the C.C.I.T.T. (especially as regards crosstalk) for ordinary exchanges, but this may no longer hold good for larger exchanges with considerable lengths of cable.

In accordance with Recommendation G.231 (Volume III), it will be for the administrations or the contractors to check whether standard cables will be satisfactory in equipping an exchange which requires telephone cables of exceptional length.

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PART II	PART III
CHAPTER IV	CHAPTER I (cont'd)

CONTINENTAL TELEPHONE ACCOUNTING

RECOMMENDATION E.280 RECOMMENDATION Q.50

ACCOUNTING SYSTEM IN THE AUTOMATIC TELEPHONE SERVICE[1]

In the international automatic service, the charge will, in general, be automatically registered on subscribers' meters and Administrations * will no longer have tickets available for working out the distribution of charges on the basis of the chargeable duration of calls.

Although technically possible, the recording, for international accounts, of the chargeable duration of each effective call would require the installation of new equipment which does not seem justified with the sole object of establishing international accounts. The various systems used for charging subscribers would also result in different chargeable durations for the same traffic.

In these circumstances:

1. The C.C.I.T.T. recommends that accounts between Administrations * should be drawn up on the basis of the total of all call durations measured in the international exchanges in the country of origin on the appropriate meters. A charge in gold francs per minute of call duration, valid in both directions of the relation and applicable solely for international accounts relating to automatic service, will be fixed by agreement between Administrations *.

Exceptions to this general rule may occur in the following cases:

a) When the Administrations * concerned agree to dispense with accounts or to adopt lump-sum settlement,

b) When one or both of the Administrations * concerned already possess equipment capable of showing the chargeable durations incurred by the subscribers. The accounts prepared on these bases must give the same result as if the call durations had been measured.

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* or recognized private operating Agencies.

[1] This Recommendation applies to the European Continent. For the study period 1968-1972 of the C.C.I.T.T. it is the subject of a new study which might lead to an integration with the new system of international accounting described in Recommendation E.250.

c) When simplified code signalling systems are used which make it impossible to assess the call durations without excessive complications, the Administrations * shall measure the total holding time of the outgoing circuits. In that case, a correction factor shall be applied to the traffic figures so as to assess, in total call duration, the traffic which is to serve as the basis for preparing the accounts. The corrections to be applied must be determined by agreement between the Administrations * concerned.

2. International accounts for semi-automatic service shall continue to be based on the information recorded by the outgoing operators. Hence, in the international exchange of the country of origin, a distinction should be made, in the preparation of international accounts, between semi-automatic and automatic traffic.

In exceptional cases where, with simplified code signalling systems, this distinction is not possible, the Administration * of the country of origin should come to an agreement with the Administration * of the country of destination (and, where appropriate, with the Administrations * of transit countries) on the arrangements to be made.

3. To take account of the special system of charging for frontier relations (reduced charges between neighbouring frontier zones), special steps will have to be taken to discriminate between automatic calls in frontier relations and other automatic calls. This discrimination will be made every time that frontier traffic is routed wholly or partly (overflow) by international circuits having devices for measuring call duration.

This discrimination will, in general, necessitate:

a) a more complete analysis of the national (significant) number of the called subscriber than the one which is quoted in Recommendation E.161 (Q.11), and

b) the determination of the origin of the calls, since frontier charges depend on the distance between the outgoing and the incoming frontier zones.

4. Measurement of the call duration on meters shall be made according to country of destination. When the country of destination comprises several charging zones, these measurements will ordinarily be made according to the charging zone.

5. The measurement of call durations made by the international exchange in the country of origin to a given country of destination shall not distinguish between the routes involving different transit countries, provided that the traffic is transmitted over direct circuits which constitute the normal route. For accounting purposes, the total volume of traffic sent by each route is assumed to be proportional to the number of circuits in service on the 15th of each month on each route.

6. From the theoretical point of view, it might seem desirable for the Administration * of the country of origin to measure the traffic according to route and destination when a transit exchange in another country is used. However, it is left to Administrations * to decide whether:

— metering by route is much more complicated than metering by destination alone;

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* or recognized private operating Agency (or Agencies).

- metering by route is justified for obtaining the traffic data necessary, as well as for the drawing-up of international accounts;
- the complication of metering by route can be justified by the prospect of setting up automatic transit traffic.

When the Administration * of the country of origin is not in a position to assess the traffic by route and by destination, it should come to an agreement with the other Administrations * concerned as to the way in which the traffic is assumed to be split up over the various routes.

7. The following special rule shall be permissible to avoid the need for an analysis of routes actually taken by a call beyond a transit exchange when several routes passing through different countries to the destination in question are possible from the transit exchange. The distribution of transit traffic over these different routes shall be taken to be the same as the distribution of traffic originating at the transit exchange for the destination concerned. The distribution between the routes shall be assessed every six months by the Administration * of the transit exchange and communicated to the Administration * of the country of origin.

8. In international accounts the traffic expressed in minutes relating to test calls, service calls and calls terminating at wrong numbers should not be deducted, since the over-all duration of these various types of call is very small in relation to the total traffic.

Nevertheless, when the percentage of wrong numbers due to faults in the equipment in the country of destination is greatly in excess of what is regarded as a reasonable percentage in a service of good quality, the Administration in the country of origin will be entitled to make certain deductions, in agreement with the Administration of the country of destination.

When free calls are allowed, for example during international telecommunication conferences, deductions may be made in the international accounts by the Administration * of the country on whose territory the conferences are held.

9. The arrangements concerning the acceptance of international accounts as defined in the *Telephone Regulations* (Chapter XIV—Accounting) are applicable to automatic traffic.

Accounts shall be drawn up monthly but, to avoid errors which might be serious in the event of the meters being faulty, the call duration meters shall be read every day.

10. It is not essential that call duration meters be read at midnight on the last day of the month: it will suffice if they are read on the last day of the month at the most convenient time. Should the last day of the month not be a working day, these meters can be read the day before or the day after.

The monthly account forwarded to the other Administrations * shall show the day on which meters were read. It ought to be possible to arrange for all meters in an exchange to be read on the same day, since there are relatively few circuits on which call duration meters have to be read.

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* or recognized private operating Agency (or Agencies).

11. The degree of accuracy of the call duration measurement equipment shall de ± 2% with a confidence limit of 95%, on the understanding that the result is obtained for a set of measurements covering an adequate number of calls, which, in light traffic relations, may lead to acceptance of the fact that ± 2% accuracy should be obtained on the overall measurements for the year, but not for each of the partial measurements made during that year (monthly measurements, for example, if the monthly interval is retained for the establishment of international accounts).

CHAPTER II

RECOMMENDATION Q.51

BASIC TECHNICAL PROBLEMS CONCERNING THE MEASUREMENT AND RECORDING OF CALL DURATIONS

1. *Recording call duration*

1.1 Technically "call duration" is the interval that elapses between:

— the moment when the reply condition is detected at the point where the recording of call durations takes place and

— the moment when the clear-forward condition is detected at the same point.

It follows that the apparatus used to record call durations of automatic calls must be capable of detecting the two moments mentioned above and of measuring the interval between them.

1.2 When, in application of the provisions of paragraph 1 *(c)* of Recommendation Q.50, an administration using a simplified signalling system has recourse to recording holding times for the establishment of international accounts, it is necessary to have a conversion factor making it possible to obtain the call duration from the holding time. The determination of this conversion factor requires fairly close observation. The ratio of holding time to call duration may not be the same for all the circuits of a single group, so that a fairly large number of circuits must be observed in order to find a reliable conversion factor. Moreover, the holding time also depends on the availability of switching equipment in the incoming country, as well as the reaction of subscribers when they hear ringing tone, busy tone, etc.; the holding time for a given call duration may thus be extremely variable.

2. *Discrimination between automatic and semi-automatic calls*

Since different accounting procedures are used for automatic and semi-automatic calls, the recording apparatus must be capable of distinguishing between these two types of calls and must record the call duration of automatic calls only.

Discrimination can be effected by one of the following methods:

a) by connecting the measuring apparatus to a point in the exchange through which only automatic traffic is routed;

b) by recording call durations only for calls containing the "discriminating" digit 0 used in automatic working (see paragraph 1.4.2 in Recommendation Q.104).

Method b) may be particularly useful when both automatic and semi-automatic calls originate at exchanges within the national network and are routed to the outgoing international exchange over a common group of circuits.

3. *Omission of international transit traffic from the records of call durations*

All records of call durations will be taken in the outgoing country and will relate to calls originating in that country. It will therefore be necessary, in an international exchange which routes both terminal and international transit traffic, to exclude the call duration of international transit calls passing through the exchange.

It will be difficult to discriminate between originated calls and transit calls on the outgoing international circuits and it may therefore be necessary to segregate this traffic within the exchange and connect the recording apparatus at a point in the exchange where transit traffic is not encountered.

4. *Discrimination according to destination*

4.1 The records of call durations obtained by the recording apparatus must be related to particular countries of destination and, if required, to the charging areas of the country of destination; the recording apparatus should therefore be capable of identifying the destination of a call and of associating the measured call duration with this destination.

Note. — For drawing up international accounts (apart from frontier relations) it is not necessary to know the origin of the call or the charging zone from which it comes. The difference in quotas resulting from different outgoing charging zones in a given country are kept by that country.

4.2 *Incoming country constituting a single charging zone*

Where the recording apparatus is connected to a circuit group carrying only terminal traffic, no discrimination is required. Where, however, a circuit group carries traffic to more than one country, discrimination between these countries must be effected from an examination of the international code for the country and/or the type of seizing signal (terminal or transit) which is sent over the international circuits.

4.3 *Incoming country consisting of several charging zones*

If the accounting procedure agreed between two countries demands the production of separate records of call durations for calls made to each charging zone in an incoming country, the recording apparatus must be arranged to discriminate between the calls to the different charging zones according to the first one or first two digits of the called station's national (significant) number * (see Recommendation Q.11).

4.4 *Special frontier arrangements*

To take account of the special system of charging for frontier relations (reduced charges between neighbouring frontier zones), special steps will have to be taken to discriminate between automatic calls in frontier relations and other automatic calls. This

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* See the definition of the national (significant) number in Recommendation Q.10. (E.100).

discrimination will be made every time that frontier traffic is routed wholly or partly (overflow) by long-distance international circuits having devices for measuring call duration.

This discrimination will in general necessitate:

a) further analysis of the national (significant) number of the called subscriber than the one which is quoted in Recommendation Q.11 (E.161) and

b) the determination of the origin of the call, since frontier charges depend on the distance between the outgoing and the incoming frontier zones.

5. *Discrimination according to route and destination*

In general there will be little difficulty in determining the route taken by a call on leaving the outgoing international exchange. If the recording apparatus is connected to the international circuits, then of course the recordings obtained will be appropriate to the route in question. If, however, the recording apparatus is connected to a point in the exchange remote from the outgoing circuits and the call to a particular country has the choice of more than one route, then information in respect of the actual route taken by the call must be supplied to the recording apparatus.

When, in the case of transit traffic, the rule in point 6 of Recommendation Q.50 is applied, it is not necessary, at the outgoing international exchange, to provide discrimination between the different routes taken beyond a transit centre.

6. *Distribution of traffic in an international exchange for the purpose of measuring call durations*

By way of example, Figure 1 is given hereafter showing how traffic should be distributed in an international exchange so as to take account of the provisions above.

The traffic passing through the international exchange is divided into the following four groups, as shown on the figure:

i) international transit traffic,
ii) automatic traffic (originated locally),
iii) semi-automatic traffic (originated locally),
iv) combined automatic and semi-automatic traffic from provincial exchanges.

These groups would employ independent groups of link circuits and registers. Only group (ii) and possibly group (iv) would be involved in measuring call duration.

The following auxiliary equipment is envisaged:

a) for each link circuit in groups ii) and iv), a selecting device capable of dealing with every possible combination of route/country or "charging zone" destination;

b) for each link circuit in group iv), a device to take care of the discrimination between semi-automatic and automatic traffic;

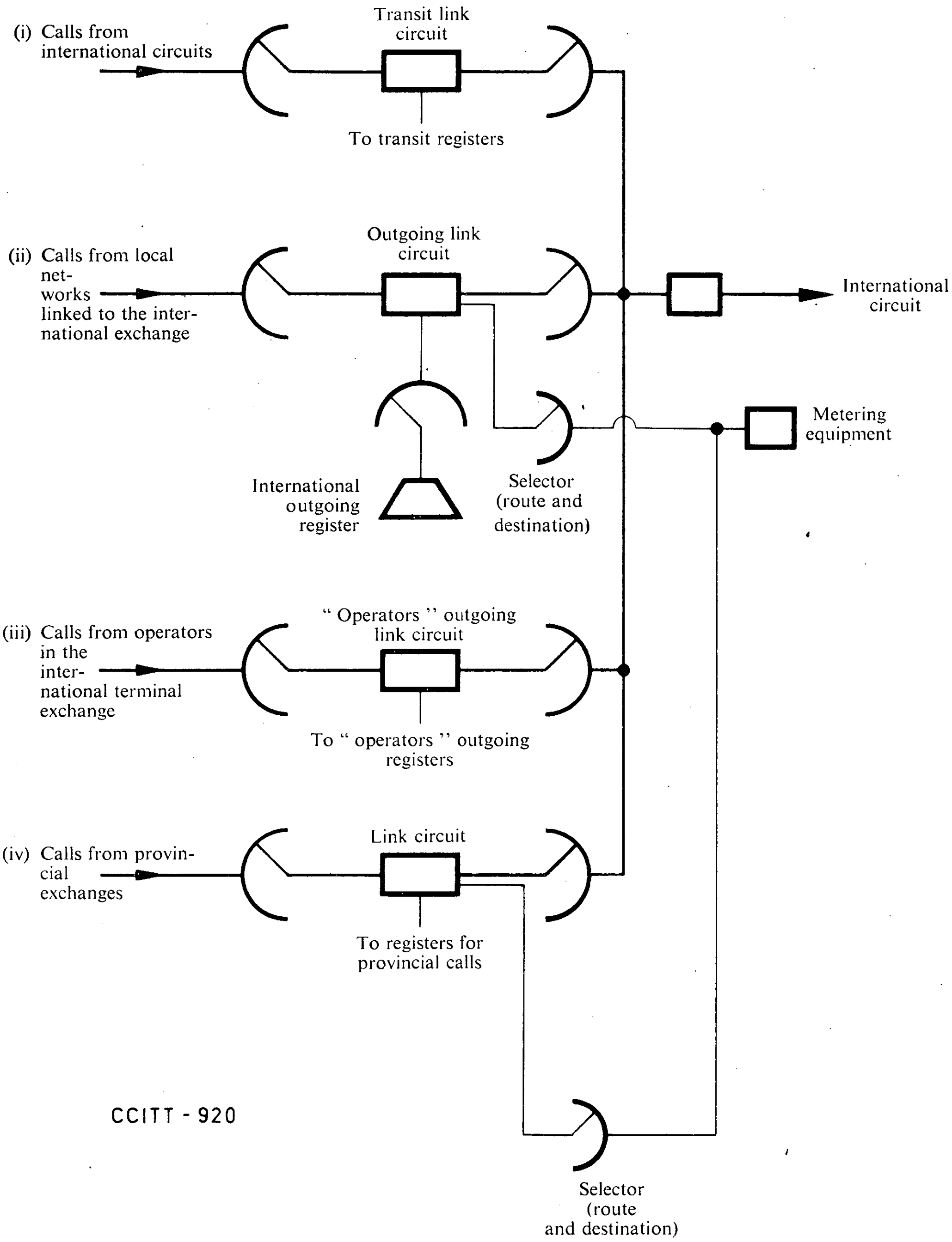

FIGURE 1. — **Diagram giving an example of traffic distribution in an international exchange**

c) for registers in groups ii) and iv), equipment for analysing country codes and if necessary an appropriate number of digits of the national (significant) number of the called subscriber in order to discriminate between charging zones (see Recommendation Q.11, item 1.2).

d) for registers in group iv), a device to recognize the "discriminating" digit 0 used for automatic working;

e) a means of recording the call duration for each combination of route/country or "charging zone" destination.

CHAPTER III

RECOMMENDATION Q.52

DEVICES FOR MEASURING AND RECORDING CALL DURATIONS

There are three main methods used for measuring call duration:

1. *Use of apparatus of the type which meters the quantity of electricity (ampere-hour meter or coulomb-meter)*

This type of meter is permanently connected to the circuits or equipment under observation; for the measurements in question, the current strength in the meter is at all times proportional to the number of circuits or units of equipment in the speech position. With this type of apparatus the accuracy of the measurements depends on:

a) errors in the meter (shunt included) itself; in any case, in the absence of special arrangements, the accuracy of the latter is not so good for intensities which are only a small fraction of the nominal intensity for which the apparatus is designed;

b) the accuracy and possibly the variations with time of the resistors inserted in the circuits to be observed;

c) the ohmic resistance of the connections between the measuring equipment and the circuits to be observed;

d) voltage variations in the supply battery used.

Obviously, the longer the period of observation, the greater are the chances that partial compensations will occur between the various causes of error. With such apparatus it seems unlikely that more than 2% accuracy of measurements can be obtained for measurements made over an adequate period of time which includes hours of varying load; measurements made only at times when there is very little traffic might involve a considerably greater error.

2. *Use of pulse-counting meters*

With this method, the circuits or equipment under observation are connected, for the duration of a call, to pulse-counting meters which receive pulses from a common timing mechanism at suitable intervals, for example every 6 seconds. The call duration is deduced from the meter readings.

3. *Use of a device for periodically scanning circuits or equipment*

These devices can be based on either the conventional type of equipment (relays, crossbar switch, etc.) or some form of electronic equipment. (See also Annex to Recommendation Q.85).

4. *Degree of accuracy of methods 2 and 3*

With the two last-named methods, the degree of accuracy of measurements depends on:

— the average call duration and the statistical distribution of call durations;

— the number of calls observed;

— the interval between the sending of pulses *(method 2)* or the scanning interval *(method 3)*.

It is also possible to assess mathematically, as a function of these factors, the anticipated degree of accuracy. Errors may also arise from the operation of the meter in *method* 3, or from accidental variations in the pulsing or scanning interval.

There is no doubt that if the number of calls observed is sufficiently high it is possible, using these methods and without reducing the pulse-sending interval or the scanning interval to such a small value that operation difficulties would arise with classic-type apparatus, to obtain greater accuracy than could be obtained with the method described in paragraph 1.

5. *Fault indication*

It is recommended that provision should be made for indicating faults in the measuring and recording device. There are two possibilities:

a) to design the measuring and recording apparatus so that there is a permanent check on its operation, with an alarm system to indicate faults;

b) to provide special equipment to make a routine check of the operation of the measuring equipment.

6. *Equipment design*

The design of equipment for measuring and recording call durations is left to administrations. Some information will be found in the Annex hereafter.

ANNEX

(to Recommendation Q.52)

Measuring call duration

1. The technique to be adopted for recording call durations of automatic traffic will depend on the accounting arrangements agreed between administrations and particularly on whether recordings are to be made:

— by country of destination alone,

— by route and country of destination,

— by route, country of destination and charging zone.

In all cases it will be necessary to discriminate between automatic and semi-automatic traffic and possibly transit traffic.

2. Assuming that it is possible to identify automatic calls on the outgoing international circuit and that the circuits carry only terminal traffic, the measurement of call durations could be effected by connecting a measuring and recording device to each international circuit. The disadvantage of this scheme is the large number of recorders to be provided and read daily.

A single recorder could be made to serve a group of international circuits by arranging for the recorder to be connected to each circuit of a group in turn, say every 6 seconds, and for the recorder to operate each time that an international circuit in the answered condition is encountered. The recorder would then show the total call duration of the circuit group.

3. Where transit routings are involved and the recordings are required on the basis of route and country of destination, separate totals of call durations will be required for each country served by the route in question. In other words, it will be necessary to determine the destination of each call and record the call duration on the appropriate recorder.

This may be found to be a complicated process and it may be more convenient to connect the recorder at a point remote from the international circuit, for example at the register access relay set, where information in respect of the destination and routing of the call can be obtained from the outgoing international register. Figure 1 illustrates an arrangement in which selector *A* is positioned under the control of the register to connect the appropriate route and destination recorder to the register access relay set.

The recorder could be an ampere-hour meter or it could consist of a meter and a selector arranged to scan all the register access relay sets which have been connected to this particular route and destination recorder.

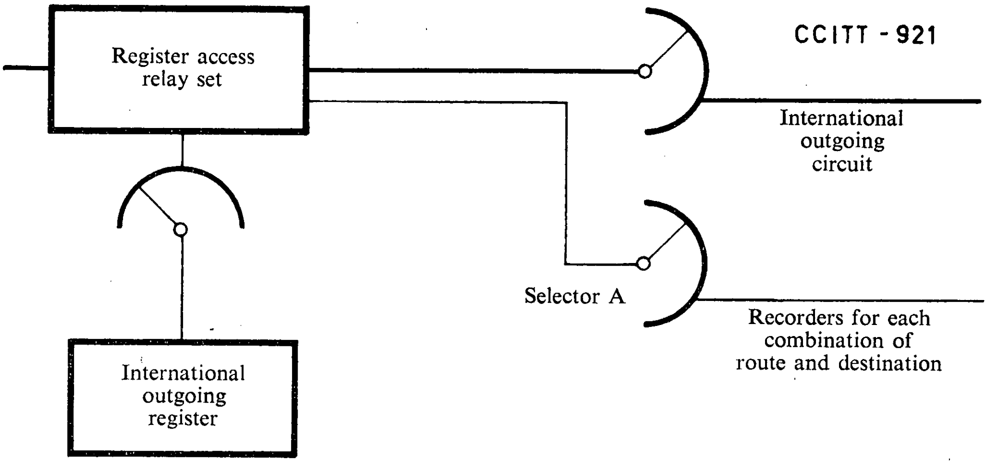

FIGURE 1

4. A similar arrangement to Figure 1 can be employed where recordings are required on the basis of route, country of destination and charging zone. The additional complications introduced in determining the charging zone mainly concern the outgoing register but it should be noted that a greater number of separate call duration recorders will then be needed.

5. The number of recorders or separate records of call durations is equal to the summation, for all destinations, of the product of number of routes by number of charging zones for each country of destination. The capacity of selector *A* in Figure 1 must be sufficient to permit access to any recorder and the economics of this scheme will be determined by the number of separate recordings required and the total volume of international traffic originated at the exchange concerned.

6. For a larger number of separate recordings, administrations might consider whether it would be cheaper to use electronic methods for recording call durations. In this connection administrations might take into account the possible future introduction of cheap rates which could double the number of separate records required.

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PART IV PART IV

CHAPTER II

CHECKING THE QUALITY OF THE INTERNATIONAL TELEPHONE SERVICE

RECOMMENDATION E.420 RECOMMENDATION Q.60

The methods of measuring the quality of service are as follows:

1. Service observations;
2. Test calls (simulated traffic);
3. Customer interviews (see note at the end of this Recommendation.)

Administrations * are recommended to draw up a programme for observations and tests designed for assessment of circuits and equipment, supervision of operators and evaluation of the quality of service given to subscribers. It would be desirable if telephone Administrations * were to exchange statistics on quality of service directly, and immediately after they have been made out, in accordance with Tables I, II and III in Recommendations Q.61, Q.62 and Q.63.

Table I in Recommendation Q.61 relates to the observations on the outgoing end on the quality of international automatic and semi-automatic service. It provides in particular a check of the percentage of unsuccessful calls due to technical faults (equipment shortages or failures).

Table II in Recommendation Q.62 relates to observations on traffic set up by operators. It provides, in manual and semi-automatic service, a means of determining the efficiency of international circuits, of assessing the work of operators and the quality of transmission.

Table III in Recommendation Q.63 is used to record the results of test calls undertaken especially when the observations shown in Table I make it clear that the percentage of faults is too high.

Note. — Customer interviews were also suggested during the study period 1964-1968 for ascertaining opinions on service quality. This question of using customer interviews will be studied during the period 1968-1972 (see Question 12/XIII).

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* or recognized private operating Agencies.

RECOMMENDATION E.421

RECOMMENDATION Q.60 *bis*

SERVICE QUALITY OBSERVATIONS

SECTION 1. — DEFINITIONS

1.1 *Service observation*

Monitoring to obtain a complete or partial assessment of the quality of telephone calls, excluding test calls.

1.2 *Manual observation*

Monitoring of telephone calls by an observer without using any automatic data-recording machine.

1.3 *Automatic observation*

Monitoring of telephone calls without an observer.

1.4 *Semi-automatic observation*

Monitoring of telephone calls using equipment which records some data automatically. For example, equipment in which information such as exchange being observed, number dialled by the subscriber, metering pulses and time of call are recorded automatically on some means suitable for data processing. The observer merely has to key in a code indicating the condition observed.

SECTION 2. — RELATIVE MERITS OF MANUAL, AUTOMATIC AND SEMI-AUTOMATIC OBSERVATIONS

2.1 The three methods mentioned above in 1.2, 1.3 and 1.4 are not exclusive, for example: automatic observations may be used to supplement observations taken by an operator. It is considered in 1968 that the need for automatic observations will increase in view of the heavy cost associated with manual or semi-automatic observations on the rapidly expanding international network. It is also considered that automatic observations will not entirely supersede observations taken by an observer within the foreseeable future.

The relative merits of the three methods can be assessed as follows:

2.2 *Manual observations*

Provides all the data required in Tables 1 and 2.

Observations can be carried out with a minimum of equipment.

Observations can permit the detection of a number of abnormalities which cannot be detected automatically, e.g. very poor speech transmission [1] or difficulty with audible tones encountered in the international service [2].

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[1] Item 3.7 of Table 1.

[2] Item 4.4 of Table 1.

2.3 *Automatic observation*

Operating cost is minimum (staff reduction).

Continuous observation is possible.

It is possible to have a larger sample.

Human error is eliminated.

Automatic processing of data is facilitated.

Conversational privacy is ensured.

Control of the time at which observations are made is facilitated.

2.4 *Semi-automatic observation*

Provides all the data required in Tables 1 and 2.

There is a saving in staffing costs compared with manual observation.

Greater accuracy compared with manual observation is possible due to the fact that there is an automatic recording of the number dialled, the time of the call, etc.

It is possible for the observer to give more attention to the more critical conditions being checked during observations of calls.

The results are produced in a form suitable for subsequent mechanized analysis.

Owing to the reduction of costs it is possible to obtain a larger sample for the same expenditure.

Semi-automatic equipment may be converted, during certain hours of the day, to automatic operation.

SECTION 3. — PERIOD DURING WHICH DATA SERVICE OBSERVATION SHOULD BE COLLECTED (BUSY HOURS, SLACK HOURS, BOTH)

The results of all observations taken over the whole day should be recorded in Table 1 under the main heading " Observations spread over the day " (including the busy hours). The results of observations taken during the *four hours* of the day which are considered to be normally the busiest period(s) for the route involved should be recorded additionally under the main heading " Observations limited to four busy hours of the day ".

It is necessary to have the two sets of results of Table 1 to reflect:

- on the one hand, the average quality of service given to subscribers and,
- on the other, the performance of the network during busy periods for assessment of circuits and equipment.

In view of the limited amount of information in Table 2, which can be used for assessment of circuits and equipment, it is not necessary to record separately the results obtained during the busy period(s).

SECTION 4. — OBSERVATION ACCESS POINTS

4.1 Observations for Table 1 should be carried out from access points as close as possible to the international exchange.

The following access points can be considered:

i) outgoing relay set of an international circuit (" exchange " side), i.e. " international circuit access point " [1];

ii) incoming relay set of a national circuit;

iii) link circuits of the international exchange.

If the observations are made at an access point other than on the outgoing international circuit, account will be taken only of calls which have actually caused the international circuit to be seized. Observations will be made only while the call is being set up, and a few seconds after the called subscriber's reply.

When the " circuit access point " [1] is used for observation of international calls it is possible that the service quality of the international exchange may not be checked by either international or national observation programmes.

It is necessary to state in Table 1 the access point where the observations have been made, as observations obtained at each one of the three access points mentioned above are not comparable.

4.2 Observations for Table 2 must be carried out from access points on the operators' positions.

SECTION 5. — NUMBER OF OBSERVATIONS

5.1 Service observing programmes should be established in such a manner that statistical results obtained be as reliable as practicable bearing in mind the cost of obtaining large samples.

5.2 According to the studies carried out by the C.C.I.T.T. in 1964-1968, the quantities shown below are considered the *minimum* quantities to provide a general indication of the quality of service.

5.2.1 *Table 1*

The minimum number of observations per outgoing circuit group for Table 1 should be 200 per month when more than 20 circuits are included in a group, 200 per quarter when there are between 10 and 20 circuits in a group and 200 per year if there are less than 10 circuits in a group.

5.2.2 *Table 2*

The minimum number of observations for Table 2 should be 200 per quarter when there are more than 20 circuits in the group, 200 per semester when there are between 10 and 20 circuits and 200 per year when there are less than 10 circuits in the group.

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[1] For definitions of test access points see Recommendation M.64 (*White Book*, Volume IV). See also Recommendation M.11 (*White Book*, Volume IV).

5.2.3 *Transit traffic*

Where an outgoing circuit group also carries transit traffic it is desirable to obtain data for each destination country reached via this circuit group. In principle, the number of observations for each destination should be obtained as indicated above. To accomplish this, one should use for each destination country its corresponding number of *erlangs* and derive from these *erlangs* a theoretical number of circuits.

However, where only a very small amount of traffic is handled, e.g. less than 5 *erlangs*, each Administration may wish either to make a smaller number of observations or (e.g. in case of no complaints) no observations at all and rely on the information obtained at the transit exchange.

5.3 The number of observations specified above will provide a general indication of results on quality of service in certain broad categories. Administrations * may desire more accurate results, especially for the individual categories in Table 1.

Attention is drawn to Table A, which gives the number of observations required to obtain a certain degree of accuracy.

TABLE A

Expected percentage rate of failure	Number of observations of a random sample required to predict with 95% confidence the true percentage of failure with an accuracy of:					
	±25%	±30%	±35%	±40%	±45%	±50%
2	3136	2178	1600	1225	1030	880
4	1536	1067	784	600	500	440
6	1003	696	512	392	330	290
8	736	511	376	288	245	215
10	576	400	294	225	195	170
12	469	326	239	183	150	132
14	393	273	201	154	128	112
16	336	233	171	131	112	98
18	292	202	149	114	95	80
20	256	178	131	100	85	70
30	149	104	76	60	50	42
40	96	67	50	38	30	24
50	64	44	33	25	20	16

ANNEX TO TABLE A

Examples of use of Table A

1. It is estimated from previous results that a particular type of failure occurs on about 4% of calls. If it is required to confirm, with 95% confidence, that the existing failure rate is between 3% and 5% (i.e. ±25% of 4%), then observations must be made on a random sample of 1536 calls.

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* or recognized private operating Agencies.

2. For an expected failure rate of 2%, observations must be made on a random sample of about 1200 calls (1225 in the table) to predict, with 95% of confidence, that the true percentage is between 1.2% and 2.8% (i.e. ±40% of 2%). This means that when 200 observations are taken over a period it is necessary to take the " rolling average " of conditions over six periods. The rate of failure for a number of categories important from the maintenance point of view is expected to be about 2%, e.g. item 3.8 of Table 1 (no tone, no answer).

3. After observations have been taken and the rate of failure in the sample has been calculated, the table may be used in a " backward " direction to give a rough indication of the accuracy of the result.

Suppose that out of a sample of 1000 observations, there were 29 failures due to cause " X " and 15 failures due to cause " Y ". The rates of failure in the sample due to X and Y, respectively, are then 2.9% and 1.5%. From the table, it is apparent from this sample of 1000 calls that the true rate of failure due to X has an accuracy of about ±35% (i.e. is between 1.9% and 3.9%), and that due to Y has an accuracy of about ±50% (i.e. is between 0.8% and 2.3%).

SECTION 6. — EXCHANGE AND ANALYSIS OF THE RESULTS OF OBSERVATIONS

6.1 *Exchange of the results of observations*

The following periodicities are proposed for the exchange of results between Administrations:

Table 1 — a monthly exchange is desirable;

Table 2 — a quarterly exchange is desirable.

Nevertheless, in the case of small groups of circuits (less than 20 circuits) the information should be exchanged after 200 observations have been made but never later than one year in any case; attention is drawn to Table A above, which shows that less than 200 observations are of little value.

Results of observations will be reported without delay:

- to the Administrations * and the I.S.C.C.[1] of the country where observations are carried out,
- to the Administrations * and the I.S.C.C.[1] of the other country (including Transit Administrations and their I.S.C.C. when involved).

The benefits to be derived from service observations tend to decrease with any increase in the time taken to make the results available to those who can take action to bring about an improvement. The results of service observations according to Tables 1 and 2 should therefore be made available to the Administration * in the countries of destination as soon as possible after completion of the observation period and in any case within 6 weeks **.

6.2 *Analysis of observation results*

An analysis of the results should be carried out in the country of origin. However, analysis may also be performed in the country of destination or on a centralized basis[2].

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* or recognized private operating Agencies.

[1] I.S.C.C. = International Service Co-ordination Centre (see Recommendation Q.72).

[2] See new Question 9/XIII: Field trials of centralized processing of service observation results.

Some Administrations have found it useful to distribute to other Administrations concerned service observation statistics in the form of graphs.

RECOMMENDATION E.422 RECOMMENDATION Q.61

OBSERVATION OF INTERNATIONAL OUTGOING TELEPHONE CIRCUITS FOR QUALITY OF SERVICE

(See Table 1)

COMMENTS CONCERNING THE USE OF TABLE 1

a) This table summarizes observations made on outgoing automatic and semi-automatic traffic.

A separate form will be used for each country of destination, and for each group of circuits.

For an explanation of the point of access, see Recommendation E.421 (Q.60 *bis*), section 4.1.

Should certain Administrations wish to observe incoming traffic, too, the outcome of such observations could be entered in a similar form [1].

b) These observations should be conducted according to Recommendation Q.60 *bis.*

c) One and the same attempt to set up a call will be entered under one category only, namely the most appropriate one. In the case of several faults on one attempt, the most significant cause of failure should be entered.

d) In completing this table, reference should be made to the following explanations:

HOW TO FILL IN TABLE 1

Observations on international outgoing telephone circuits for quality of service

Category

1. Under this category, enter calls successfully put through to a conversation without difficulty. If it is observed that the caller has dialled a wrong number, the call will be entered under 4.1. Category 1 will also include calls put through correctly to operator positions, information services, or to machines replying in place of the subscriber.

2. Enter calls which did not lead to a conversation, provided this fact was not attributable to some equipment failure or to incorrect handling by the caller.

2.1 Calls on which no answer is received after ringing tone has been received for at least 30 seconds.

2.2 Calls which encounter called subscriber busy (see 2.3).

2.3 Every effort should be made to distinguish between the " busy " circumstances under 2.2, 3.1, 3.2 and 3.3.

If no complete distinction between these categories can be made, calls encountering a busy indication will be entered here.

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* or recognized private operating Agencies.

[1] See Question 10/XIII.

TABLE 1

Observation of international outgoing telephone circuits for quality of service

Outgoing international exchange: ______________________ Point of access: ____________

Group of circuits: ______________________

Service { automatic[a]
semi-automatic[a]

Period from ____

Category	Observations spread over the day (including busy hours)				Observations limited to 4 busy hours per day			
	Number		%		Number		%	
	Sub-total	Total	Sub-total	Total	Sub total	Total	Sub-total	Total
1	2	3	4	5	9	7	8	9
1. Calls[b] successfully put through		...		...		...		...
2. Calls[b] which did not lead to a conversation (but failure not due to equipment or incorrect handling by the caller)		...		...		...		...
2.1 No answer	...		...		...		...	
2.2 Subscribers busy[c]	...		...		...		...	
2.3 Subscribers or routes occupied	...		...		...		...	
3. Unsuccessful calls[b] due to equipment		...		...		...		...
3.1 Congestion at the international transit exchange[c]	...		...		...		...	
3.2 Congestion at the incoming international exchange[c]	...		...		...		...	
3.3 Congestion in the incoming national network[c]	...		...		...		...	
3.4 Wrong number obtained	...		...		...		...	
3.5 Non-reception of answer signal on chargeable calls	...		...		...		...	
3.6 Reception of answer signal when the called party does not reply	...		...		...		...	
3.7 Very poor speech transmission	...		...		...		...	
3.8 No tone, no answer (within 30 seconds)[d]	...		...		...		...	
3.9 Other failures of a technical kind	...		...		...		...	
4. Unsuccessful calls[b] due to incorrect handling by the caller (subscriber or operator)		...		...		...		...
4.1 Wrong number dialled	...		...		...		...	
4.2 Incomplete number	...		...		...		...	
4.3 Call abandoned prematurely (within 30 seconds) before receipt of a tone[d]	...		...		...		...	
4.4 Call abandoned prematurely (within 30 seconds) after receipt of the ringing tone	...		...		...		...	
4.5 Other failures due to incorrect handling	...		...		...		...	
5. Unclassified failures		...		...		...		...
Total calls[b] monitored		...		100		...		100

---

[a] Delete whatever is inapplicable.
[b] The term " calls " throughout this table refers to circuit seizures by outgoing traffic.
[c] In so far as a distinction is possible; otherwise, 2.3 will apply.
[d] See remark in parentheses at the end of items 3.8 and 4.3 of the explanatory notes.

3. Unsuccessful calls due to equipment.

3.1, 3.2 and 3.3 Calls which encounter congestion (see 2.3).

3.4 Wrong number obtained, although the caller has dialled correctly.

3.5 Calls on which the answer signal has not arrived on the called subscriber's reply, and speech follows. Do not include calls correctly put through, on which the answer signal is not to be sent (for example, the information services in some countries).

3.6 Calls on which an answer signal has been received although the called subscriber has not answered.

3.7 Calls abandoned by the caller because of very poor speech transmission, although the answer signal has been received.

3.8 Calls on which the digital information has been correctly and completely sent, but the caller receives no tone, although he has waited for at least 30 seconds after the sending of the last digit before abandoning the call. (In certain countries post-dialling delay may exceed 30 seconds and this should therefore be taken into account in interpreting the results for this item 3.8).

3.9 This covers failures which cannot be classified under 3.1 to 3.8. It will also cover cases of poor speech transmission detected during the period of observation, even though the call was not abandoned [1].

4. Enter all unsuccessful calls due to incorrect handling by the caller. Calls under this category will be subdivided into:

4.1 Wrong number dialled [2].

4.2 Incomplete number [2].

The observer must as far as possible be aware of the number of digits to be dialled for a successful call. Note that in certain circumstances too long a period between the figures dialled may lead to an anomaly which should be included under this category.

4.3 Prematurely abandoned calls before receipt of a tone. The caller has hung up without awaiting a tone before 30 seconds have elapsed since the last digit of the called number was sent over the international circuit. (In certain countries post-dialling delay may exceed 30 seconds and this should therefore be taken into account in interpreting the results for this item.)

4.4 Call prematurely abandoned after receipt of the ringing tone. The caller has hung up less than 30 seconds after the ringing tone began.

4.5 All cases of incorrect handling by the caller which cannot be entered in 4.1 to 4.4 [1].

5. Enter anomalies which cannot be classified under 2 to 4 [1].

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* or recognized private operating Agency.

[1] The Administration * making the observation should supply all possible information about the failures observed.

[2] This applies only to observations where it is possible to determine that the caller has dialled a wrong or incomplete number.

RECOMMENDATION E.423 RECOMMENDATION Q.62

OBSERVATIONS ON TRAFFIC SET UP BY OPERATORS

(See Table 2 overleaf)

Comments concerning the use of Table 2

a) This table summarizes observations relating to manual and semi-automatic outgoing traffic originated by operators. These observations will be made, if possible, during the whole call duration.

b) Administrations * should, if possible, make a distinction between the different types of call, e.g. station-to-station, personal and collect calls; they should use a separate column for each under the heading " Type of call ".

c) For collect calls, the times to be recorded will be those observed in the country where the call request was made.

d) It is recommended that these observations be spread over the whole day.

e) Each outgoing Administration * will select the international circuit groups on which observations should be carried out.

f) In completing this table, reference should be made to the following explanations:

How to fill in Table 2

Observations on traffic set up by operators

Category

1. This category should show the mean duration of all calls observed which are successful and have been charged for (" effective " calls).

2. This category will show the mean *chargeable* duration of all effective calls observed.

3. This category will show, for each type of observed call, the average time per effective call during which the international circuit has been occupied for manœuvres or for call preparation.

This average should be based on the time during which the international circuit is held:

a) to obtain information concerning the called number;

b) to obtain information about routing and trunk codes;

c) to call operators, in the incoming international exchange;

d) to exchange information on how to set up the call;

e) to (or attempt to) obtain the called number even when it is engaged or does not reply;

f) to (or attempt to) obtain the called person (in personal calls);

g) between replacement of the receiver by the called person and release of the circuit;

h) because the operator is holding the circuit (whether she is on the line or not) and for any other reasons for which the circuit is engaged.

The times listed above, which exclude the conversation time, should be added together. This total should be divided by the number of effective calls observed during the period in question to obtain the value to be entered in Table 2.

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* or recognized private operating Agency (or Agencies).

TABLE 2

Observations on traffic set up by operator

International outgoing exchange: ____________________

Circuit group: ____________________

Service { semi-automatic [a]
manual [a]

Period from ____________________ to: ____________________

Category	Type of call [b]			
	Ordinary	Préavis or personal		
1. Mean call duration—in seconds				
2. Mean chargeable duration—in seconds				
3. Mean holding time of circuits for manœuvres and preparation of calls—in seconds				
4. Number of effective calls observed				
5. Mean number of times the international circuit was seized per effective call				
6. Mean number of " attempts " per effective call				
7. Percentage of calls set up at the first " attempt "				

8. Time-to-answer by operators	Total number of calls answered and unanswered		Calls answered						Calls unanswered (abandoned calls)			
	Num-ber	Mean waiting time in seconds	under 15 seconds		in 15 to 30 seconds		after 30 seconds		within 30 seconds		after 30 seconds	
Operators:			No.	%	No.	%	No.	%	No.	%	No.	%
— incoming operator (code 11)												
— delay operator (code 12)												
— assistance operator												
— information operator												

9. Quality of transmission from the subscriber's viewpoint:	Number	%	10. Comments
— good			
— defective			
Total		100	

---

[a] Delete whichever is inapplicable.

[b] In accordance with b) under remarks.

4. The number of effective calls observed considered in category 1.

5. The mean number of times the international circuit was seized per effective call (see category 3). This number is usually obtained by meter recordings.

6. The mean number of " attempts " (as specifically defined hereafter from the operating point of view) to set up a call. Should the operator try several times to set up a call while continuously occupied on that call, all these operations must be considered as being one attempt. Similarly, if the operator makes several tries to set up a call and each time encounters a congestion or busy condition and if, after the last try, she informs the caller, only one attempt must be entered. Calls to information services or to obtain routing particulars, and all calls not directly related to the establishment of a call or to information required by the caller, should not be considered as attempts and should not be included.

The total number of attempts during the period of observation should be divided by the number of effective calls observed in the same period to obtain the mean number of attempts per call.

The total number of attempts is usually determined from markings or notations on call tickets.

7. The data for this category will be taken from all tickets prepared for the relation concerned, during the period of observation or a comparable period.

8. The mean waiting time for outgoing operators to receive an answer will be indicated in seconds. This average will include both answered and unanswered calls.

An outgoing operator waits on the circuit (waiting time) for the period:

a) until the incoming operator answers, or

b) until she abandons the attempt, should the incoming operator not answer.

Thus while mean waiting time relates to the outgoing operator it is also a measure of the performance of the incoming operators.

9. It will be difficult to obtain absolutely comparable results from all observers for this category. However, the observer should consider the quality of transmission from the subscribers' viewpoint, taking into account comments made in this respect by subscribers and the number of requests for conversation to be repeated.

10. This category should include any comments likely to explain the probable cause of difficulties frequently noted during the observations.

RECOMMENDATION E.424 RECOMMENDATION Q.63

TEST CALLS

1. *General*

Test calls carried out manually or automatically to assess the functioning of international circuits or connections are of three types:

a) *Type 1 test call*

A test call conducted between two directly connected international centres to verify that the transmission and signalling on an international circuit of a given group are satisfactory.

b) *Type 2 test call*

A test call conducted between two international centres not directly connected to verify transit operational facilities of an intermediate international centre.

c) *Type 3 test call*

A test call from an international centre to a subscriber type number in the national network of the distant country, generally as a result of a particular kind of fault.

Types 1, 2 and 3 test calls must not interfere with customer traffic. If, however, test calls contributing a significant load on a part of a network are to be made, prior advice should be given to the other Administration(s) * concerned. Types 1 and 2 test calls for preventive maintenance should be conducted during light load periods. Types 1 and 2 test calls should be conducted as and when required for the investigation and clearance of faults.

Type 3 test calls should be conducted only after adequate testing has been done by means of type 1 or 2 test calls and after the distant Administration * has made the necessary check in its national network. Type 3 test calls should be conducted during light load period.

In order to find faults in last-choice equipment, it may be necessary for tests to be carried out at the time when the traffic load approaches the full capacity of the route under test. The agreement of the distant I.S.C.C. will be necessary before this test is carried out.

Note. — Subscriber-to-subscriber type test calls are being studied by the C.C.I.T.T. in 1968-1972 under Question 11/XIII.

2. *Results of test calls*

(See Table 3 overleaf)

COMMENTS CONCERNING THE USE OF TABLE 3

a) Table 3 summarizes tests carried out manually or automatically to assess the functioning of the international circuit or connection.

b) It is essential to indicate clearly the way in which the tests have been carried out and to give full information about the testing apparatus used.

c) Administrations * may insert additional categories in Table 3 as they see fit.

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* or recognized private operating Agency (or Agencies).

TABLE 3

Results of test calls

International outgoing exchange: ____________________

Circuit group: ____________________

Service { semi-automatic [a] / automatic [a]

Type of test call:
Type 1 [a]
Type 2 [a]
Type 3 [a]

Period from: ____________ to: ____________

Category	Number		%	
	Sub-total	Total	Sub-total	Total
1. Satisfactory tests		...		...
2. Signalling and charging faults		...		...
2.1 Wrong number	...		...	
2.2 No tone, no answer	...		...	
2.3 Absence of a backward line signal	...		...	
2.4 Other faults	...		...	
3. Transmission faults		...		...
3.1 Conversation impossible	...		...	
3.2 Call overamplified or underamplified	...		...	
3.3 Noise	...		...	
3.4 Fading	...		...	
3.5 Crosstalk	...		...	
4. Congestion		...		...
5. Other faults		...		...
	...		...	
	...		...	
	...		...	
Tests carried out		...		100

Test procedure followed (apparatus used, destination of calls, etc.)

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[a] Delete whichever is inapplicable.

Volume IV
SERIES M RECOMMENDATIONS

Volume VI
PART V

3.3 — Guiding principles for the maintenance of the international automatic service[1]

The guiding principles for the maintenance of automatic telephone circuits deal with the division of responsibility for the maintenance of international automatic or semi-automatic telephone circuits between those concerned (operating services, switching services, transmission services, etc.). These principles are found in Recommendations M.70 to M.74 and Q.70 to Q.74.

RECOMMENDATION M.70 AND Q.70

DEFINITIONS FOR THE MAINTENANCE ORGANIZATION

international line

Transmission system contained between the " line access points " of the two international transmission maintenance centres (I.T.M.C.).

Each international line has only one " line access point " at each terminal I.T.M.C. This access point is defined in Recommendations M.64 and Q.75.

international automatic circuit

The whole of the international line and the outgoing and incoming equipment (or both-way equipments) proper to the automatic circuit considered. The ends of this circuit are defined by the " circuit access points ". These points are defined in Recommendations M.64 and Q.75.

automatic switching equipment

That part of an international exchange concerned with switching operations for routing the call in the desired direction.

maintenance

The whole of the operations required for setting up and maintaining, within prescribed limits, any element entering into the setting-up of a connection.

In international automatic service, maintenance is particularly concerned with circuits and automatic switching equipment.

Circuit and automatic equipment maintenance includes:

a) the carrying out of setting-up measurements and adjustments[2];

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[1] As is mentioned in Volumes IV and VI, the expression " automatic circuit ", except where otherwise indicated, means circuits which may be used either for semi-automatic or automatic operation.

[2] It is considered that maintenance commences from the start of measurements and adjustments that precede entry into service. The results of these measurements provide reference values for subsequent maintenance, in the strict sense of the word.

b) the planning and programming of a maintenance scheme;

c) carrying out the prescribed routine preventive maintenance measurements and all other tests and measurements deemed necessary;

d) locating and clearing faults.

routine or preventive maintenance

Method involving the use of systematic operations intended to discover and clear faults before they affect service.

corrective maintenance

Method based solely on locating and clearing faults after they have affected the service.

qualitative maintenance[1]

Method based on an analysis of faults.

international connection

Whole of the means joining temporarily two subscribers and enabling them to exchange information. (See Recommendation G.101.)

measurement

The numerical assessment in suitable units of the value of a simple or complex quantity or magnitude.

test

A direct practical trial in whatever manner it may be made.

" *yes or no* " *test*

A test made to indicate whether a quantity or magnitude would fall above or below a specified limit or boundary defined to distinguish pass and fail conditions.

functional test

A " yes or no " test made to indicate whether a circuit, equipment or part of an equipment will function or not function under actual working conditions.

limit test[2]

A test made to indicate whether a quantity would fall within or outside a pair of limits or boundaries.

The required degree of precision of expression is to be achieved by extending the term to state:

- *on what the limit test is made*, for example " circuit limit test ";
- *the function or characteristic that is tested*, for example, " limit test of signalling "; and

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[1] See the *Manual on National Automatic Telephone Networks*, Chapter IX, page 10.

[2] Such a test might be made to ascertain the margin of security in actual operating conditions.

— *for what purpose the limit test is intended,* for example, " limit test for readjustment purposes ".

localization of faults

The *broad localization* of a fault consists of finding the general part of the equipment in which it exists.

Fault finding consists of determining the faulty item of the equipment.

RECOMMENDATION M.71 AND Q.71

GENERAL MAINTENANCE ORGANIZATION FOR THE INTERNATIONAL AUTOMATIC SERVICE

1. *General*

To ensure satisfactory service quality in the international automatic telephone service, it is necessary to have an organization which can use the techniques recommended for achieving this. This organization is described in paragraphs 2.1 to 2.5 below and relates to the maintenance of the different component parts of an international connection.

Administrations are requested to apply these recommendations in order to obtain satisfactory service quality.

2. *Maintenance organization for the automatic service*

2.1 Co-operation in the maintenance of the international automatic service should be based on an organization comprising three types of centre in each country, which will be responsible for:

— transmission maintenance

— switching maintenance

— analysis of international service quality

as in the organizational chart shown in Figure 1/M.71 et Q.71.

The size and complexity of the maintenance organization will depend on the particular case and the particular country concerned. In some instances it may be possible to carry out all functions from a single centre; in others each function may be carried out from separate locations or, alternatively, only some of the functions might be combined and carried out from one location. The C.C.I.T.T. limits itself to defining the functions of the separate elements, and it is left to the administration concerned to decide whether to keep these functions separate or to combine them in a manner to suit the administration.

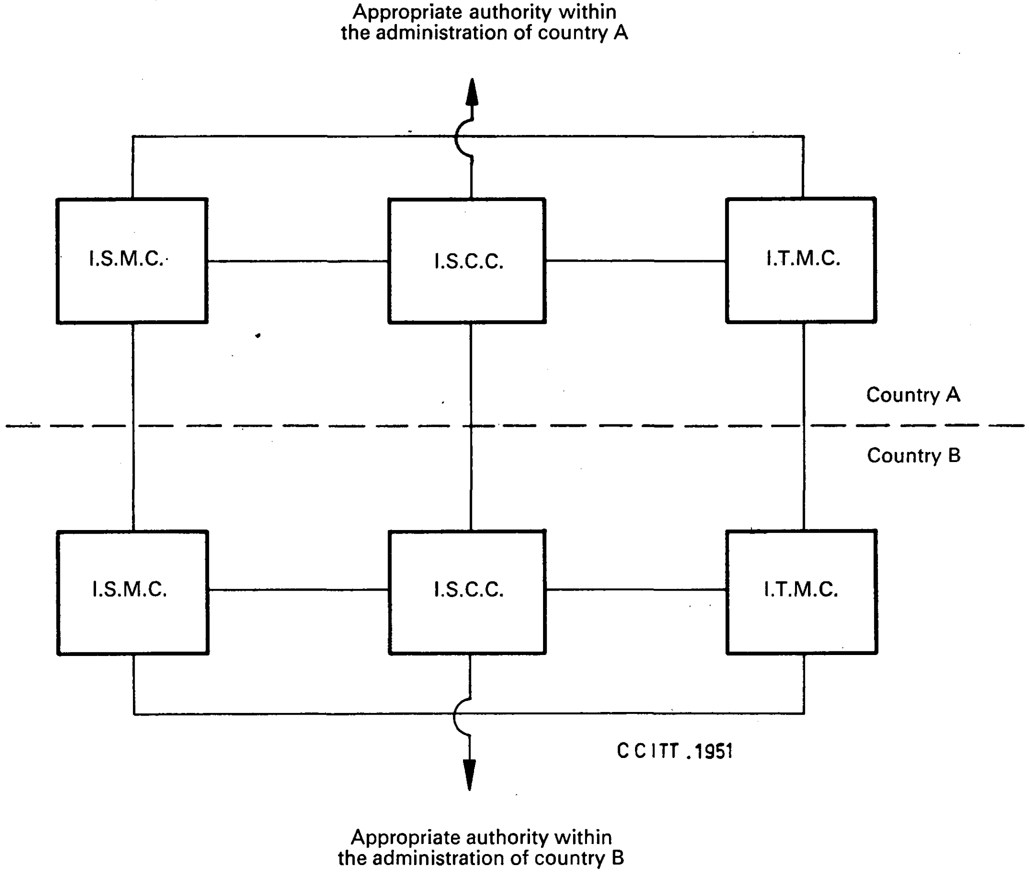
2.2 The maintenance centres for transmission and switching are those attached to the international repeater station and the international switching centre respectively. Their duties are described in the *White Book,* Volume IV (for transmission) and in Volume VI (for switching).

The international service co-ordination centre is to be responsible for supervising the quality of the service. Its duties are defined in Recommendation M.72 (Q.72). This centre should be in direct contact with the appropriate superior authority.

2.3 The three types of centre in each country should not be subordinated to one another on the international level.

The three types of centre may communicate directly with one another and with their corresponding centres in other countries.

Communication between centres of the same type in different countries may be carried out by means of telephone or telegraph service circuits (order wires) or through the switching networks, as arranged between the administrations concerned.



I.T.M.C. = International transmission maintenance centre
I.S.M.C. = International switching maintenance centre
I.S.C.C. = International service co-ordination centre

FIGURE 1/M.71 and Q.71

2.4 The attention of administrations is drawn to the benefit that may be derived from enabling staff in the international service who work in corresponding centres in different countries to meet and discuss their work.

2.5 These three centres are known in C.C.I.T.T. Recommendations as:

- International transmission maintenance centre (I.T.M.C.)
- International switching maintenance centre (I.S.M.C.)
- International service co-ordination centre (I.S.C.C.)

(see Figure 1/M.71 and Q.71).

RECOMMENDATION M.72 AND Q.72

INTERNATIONAL SERVICE CO-ORDINATION CENTRE (I.S.C.C.)

1. The appropriate service, which will analyse information from various sources in regards to international network performance at each international centre or in complex arrangements for more than one international centre, is the international service co-ordination centre (I.S.C.C.).

2. The I.S.C.C. has the authority to request assistance from:

- the international switching maintenance centres in its own country.
- the international transmission maintenance centres in its own country,
- the I.S.C.C.s in other countries.

The I.S.C.C. that refers a fault condition to any other organization must be informed of the essential action taken to clear the referred fault.

3. All events likely to affect the international service must be reported to the appropriate I.S.C.C.

4. The functions of the I.S.C.C. are as follows:

4.1 To collect and analyse information from various sources on the quality of the international service;

4.2 To initiate action, as indicated by the analysis, in conjunction either with maintenance forces within its own country or with I.S.C.C.s in other countries;

4.3 To keep a continuous watch on out-of-service times and to co-operate with the maintenance units in their efforts to reduce such times to a minimum;

4.4 To make optimum use of statistical methods[1] for determining the probable location of failure points;

4.5 To co-operate with the I.S.C.C.s of other countries in order to co-ordinate action in case of service defects and congestion existing in the part of the network depending on those I.S.C.C.s.

5. Besides having the required knowledge and experience to cater for the functions listed under 4, the I.S.C.C. staff should also possess, collectively, an adequate knowledge of switching equipment and of transmission equipment. In addition, the staff should be selected with a view to avoiding language difficulties.

6. The I.S.C.C. must also have the following information:

- routing information, diagrams or plans of the arteries relevant to the international network and the national network of the country concerned;
- general information about signalling, switching and transmission systems employed by other administrations.

7. The I.S.C.C. should also be kept up to date with:

- all relevant service observation data;
- all relevant information relating to the current state of service.

8. If considerable alterations are made to the numbering plan in a given country all the I.S.C.C.s concerned will be given prior notice. They will, moreover, be informed of the action taken to deal with calls to the old numbers.

RECOMMENDATION M.73 AND Q.73

PREVENTIVE MAINTENANCE

1. *Functional tests*

1.1 In carrying out functional tests, ordinary working conditions apply and the equipment and circuits are taken as found.

They are carried out on a systematic basis to discover faults that would influence the quality of service. The response to each signal may be tested by equipment provided for this purpose. Such tests may be applied to any part of the signalling path.

1.2 Functional tests are carried out locally, or from either end of an international circuit to the other.

1.3 The organization of the programme for carrying out functional tests locally is left to the discretion of the administration responsible for the international exchange.

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[1] These methods are intended to include what are known, in some countries, as " trouble pattern techniques " (for example, graphical analysis of series of service defects) but this term has not yet been defined by the C.C.I.T.T.

1.4 Overall functional tests on an international circuit are such that they can be made from one end of the circuit without co-operation of technical personnel at the other end of the circuit. These tests may utilize the switching equipment at each end of the circuit, but such equipment is not being tested directly, only the circuit.

The verification of satisfactory signalling operation may be done by using various types of tests:

a) Certain types of tests not requiring any special equipment, for example checking that a seizing-signal is followed by the return of a proceed-to-send signal and that a clear-forward signal is followed by the return of a release-guard signal;

b) Other types combining several tests, using special equipment at both ends. Any type which is in general use by administrations may be used if suitable and agreed between the administrations concerned.

2. *Circuit limit tests*

2.1 A circuit limit test is made to verify that the international circuit meets specified operating margins. These tests enable the performance of the whole international circuit to be checked. They will be made as required but normally at the following times:

- before putting the circuit into service;
- according to a systematic test programme which may be based on measurement results or fault (trouble) statistics or quality of service observations.

They may also be made if functional tests indicate a fault, in order to locate such a fault.

Circuit limit tests may be made with respect either to transmission or to signalling conditions.

2.2 The frequency of such tests will be determined by the administrations concerned and the test conditions to be applied will be in conformity with C.C.I.T.T. Recommendations.

2.3 The test equipment, the specifications and methods of gaining access to this equipment are described in the specifications of international signalling, switching and transmission equipment.

3. *Limit tests on the constituent parts of a circuit*

3.1 These limit tests are made to verify that the constituent parts of a circuit meet specified operating margins. They will be made as required but normally at the following times:

- at installation;
- if functional or limit tests on the circuit indicate a fault, if such tests will help in fault-location;

- systematic test programmes which may be based on measurement results or trouble statistics or quality of service observations.

3.2 The frequency of such tests will be determined by the administrations concerned and the test conditions to be applied will be in conformity with C.C.I.T.T. Recommendations.

3.3 Limit tests on constituent parts may indicate that the latter need to be readjusted; in such a case, measurements are made on those constituent parts and they are then readjusted in accordance with the relevant C.C.I.T.T. Recommendations.

3.4 The test equipment, its specification and the provision of access points will be determined by the administration concerned taking into account the relevant C.C.I.T.T. Recommendations.

4. *Maintenance measurements*

4.1 *General*

Maintenance measurements are made periodically on complete circuits as well as on their constituent parts. Their object is to indicate whether the circuits and equipments are maintained to their specified values when first put into service and, if not, to allow the necessary readjustment to be carried out.

Some maintenance measurements are made to check signalling; others are made to check transmission. They are carried out by the respective technical services responsible for signalling and transmission.

4.2 *Measurements concerning signalling*

The conditions for carrying out such measurements, the apparatus used and the periodicity of operations are determined by the relevant Recommendations of the Q series. Interventions following such measurements are determined by:

a) C.C.I.T.T. Recommendations;

b) equipment specifications when these are not given in detail by the C.C.I.T.T.

For example, for carrying out local measurements concerning signalling on circuits using C.C.I.T.T. signalling system No. 4, the C.C.I.T.T., in Recommendation Q.138, has specified a calibrated signal generator and a signal measuring set.

In Recommendation Q.164 analogous specifications are given for signalling system No. 5.

4.3 *Measurements concerning transmission*

These measurements include:

a) local measurements, for which the administrations concerned decide the conditions and periodicity;

b) circuit and line measurements for which the conditions are generally defined in the Series M Recommendations of the C.C.I.T.T. *White Book*, Volume IV.

These Series M Recommendations give, in particular, the periodicity of the measurements and the conditions for readjustment of transmission equipment.

The C.C.I.T.T. has already specified certain transmission measuring apparatus, and other apparatus specifications are being studied.

RECOMMENDATION M.74 AND Q.74

FAULT REPORTING PROCEDURE IN INTERNATIONAL MAINTENANCE

1. *General*

Within the framework of the organization indicated in Recommendation M.71 and Q.71 three categories of personnel are concerned in fault reporting procedure in international maintenance:

a) International transmission maintenance centre staff;

b) International switching maintenance centre staff;

c) International service co-ordination centre staff.

2. *Reporting service defects to the international service co-ordination centre*

As a general rule, the international service co-ordination centre should receive fault reports from the following sources:

a) operators,

b) customers,

c) service observation staff,

d) other international service co-ordination centres,

e) international transmission maintenance centres of its own country,

f) international switching maintenance centres of its own country,

g) accounting (charging) analysis service,

h) various maintenance centres regarding the quantities of equipment or circuits available following a major breakdown,

i) any other source.

The transmission and switching maintenance centres will deal directly with faults detected as a result of alarms, tests, or measurements. Details of faults found will be forwarded to the international service co-ordination centre for analysis to detect long-term trends. Reports of faults for which no cause has been found will also be forwarded to the international service co-ordination centre of their own country.

3. *Action to be taken by the international service co-ordination centre*

If, as a result of analysis, the general location of a fault is clear, the international service co-ordination centre will refer details of its findings to the appropriate service which will endeavour to locate the fault and advise the international service co-ordination centre of the results achieved.

If the analysis does not give a clear indication of the location of a fault, the international service co-ordination centre may request the service that it deems most appropriate to undertake an investigation without delay to locate the fault.

RECOMMENDATION Q.75 *

TEST ACCESS POINTS

1. The following three clear subdivisions are made for maintenance purposes:

a) the *international line*, i.e. the transmission system situated between the test jack panels of the two terminal repeater stations;

b) the *international circuit*, i.e. the whole of the international line together with the outgoing equipment and the incoming equipment or with the both-way equipments proper to the line;

c) the *automatic switching equipment*, i.e. the part of the international exchange concerned with switching the call in the desired direction.

2. Access points must be provided for testing:

— the international line,

— the outgoing equipment and the incoming equipment or the both-way equipments proper to this line,

— the switching equipment.

It must be possible to test the international line, the outgoing equipment and the incoming equipment separately or in combination with one another. The same applies to an international line with both-way equipment.
It must be possible to test the incoming equipment or the outgoing equipment or the both-way equipment in combination with the switching equipment of the exchange concerned. Each access point must enable tests to be made in parallel with the speech wires, and possibly with the signalling wires, without disconnection.

3. An equipment enabling observations to be made of all the signals exchanged on the international circuits and which can be connected via the parallel access points mentioned in 2 should be provided for international exchanges equipped for automatic switching.

4. The following arrangements should be made at these access points:

— the occupation of a circuit will be marked by a visible indication near the access points of the circuit,

— before (or as soon as) a circuit is seized from an access point, that circuit will be made inaccessible to the switching equipment (also at the other end where appropriate). When necessary the circuit will be marked engaged on the outgoing operators' positions,

— when in system No. 4 an incoming circuit is seized at an access point, a blocking signal must be sent to the outgoing exchange.

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* See also Recommendation M. 66 of Volume IV of the *Blue Book*.

CHAPTER VI

Organization of routine maintenance tests and measurements of signalling and switching

RECOMMENDATION Q.76

GENERAL CONSIDERATIONS

The object of routine maintenance tests and measurements of signalling and switching is to detect changes in the functioning of signalling and switching which are likely to cause a reduction in the quality of service provided. These changes are those which occur in relation to the values indicated in the specifications for the signalling systems concerned (see the pertinent Recommendations in series Q in this Volume). In the various sections of this Volume, limits are laid down within which:

— no action is necessary,

— action is required by the maintenance service at either of the terminal exchanges.

Routine maintenance measurements and tests have to be made at intervals as defined in Recommendation Q.77 below according to a routine maintenance programme. Administrations should agree beforehand to the appropriate terms during which the circuits and links between their respective countries shall be tested and measured. The day and the time at which the tests will be made is agreed between those responsible for switching and signalling at the international exchanges concerned.

Routine maintenance operations must normally be made at times of light traffic, where staffing arrangements permit.

RECOMMENDATION Q.77

PERIODICITY OF SIGNALLING AND SWITCHING MAINTENANCE TESTS AND MEASUREMENTS

The optimum periodicity for the testing of signalling and switching equipment has not been established and should be determined by the I.S.M.C. on the basis of available service observations.

The minimum frequency of signalling and switching maintenance tests and measurements is shown in the table below:

System	Type of test	Rapid test	Test calls	Comprehensive tests
No. 4	Manual	Daily and in accordance with Q.139, 5.7.2	Monthly and in accordance with Q.139, 5.7.3	Yearly and in accordance with the method to be specified by Study Group XIII (see Question 14/XIII)
	Automatic	Daily and to be specified in a new Recommendation		
No. 5	Manual	Daily and in accordance with Q.163, 4.3.2	Monthly and in accordance with Q.163, 4.3.3	Yearly and in accordance with Q.163, 4.3.4
	Automatic	Daily and in accordance with a new Recommentation under study.		

RECOMMENDATION Q.78

GUIDING PRINCIPLES ON THE GENERAL MAINTENANCE ORGANIZATION FOR THE INTERNATIONAL SWITCHING MAINTENANCE CENTRE (I.S.M.C.)

1. *General*

The C.C.I.T.T. recommends the following as guiding principles to Administrations on the general organization of maintenance at the international switching maintenance centre (I.S.M.C.).

1.1 Definitions relating to various maintenance functions are given in Recommendation Q.70.

1.2 The size and complexity of the maintenance organization will depend on the particular case and the particular country concerned. In some instances it may be possible to carry out all functions from a single centre; in others each function may be carried out from separate locations or alternatively only some of the functions might be combined and carried out from one location.

The exact dispositions to be taken are under the initiative of the interested Administration. The C.C.I.T.T. limits itself to defining the functions of the different elements leaving to the Administrations the manner in which these elements are grouped.

2. *Types of circuits to be catered for*

The types of telephone circuits to be catered for are as follows:

— incoming circuits,

- outgoing circuits,
- both-way circuits,
- voice grade circuits which can be used for other purposes and which utilize the switched network.

3. *Maintenance organization*

3.1 An essential feature of the maintenance organization for international telephone circuits is the international switching maintenance centre (I.S.M.C.) as referred to in Recommendation Q.71 and its associated Figure 1.

In order to co-ordinate and ensure effective maintenance and fault reporting on international telephone circuits it is desirable to set up international switching maintenance centre(s) (I.S.M.C.) at an appropriate point in international centres of the international network.

The basic elements provided by the I.S.M.C. are given in i) and ii) below and their functions are given in Annexes 1 and 2 of Question 13/XIII studied by Commission XIII in 1969-1972:

i) a "testing centre" responsible for setting-up, lining-up and subsequent maintenance of the signalling and switching equipments of the circuits for which the centre is responsible,

ii) a "fault-report point" provided with all the necessary facilities and arranged in such a way that it may receive fault reports from and make fault reports to:

- similar fault-report points of other Administrations (and recognized private operating Agencies);
- its own transmission and other services;
- the International Service Coordination Centre (I.S.C.C.).

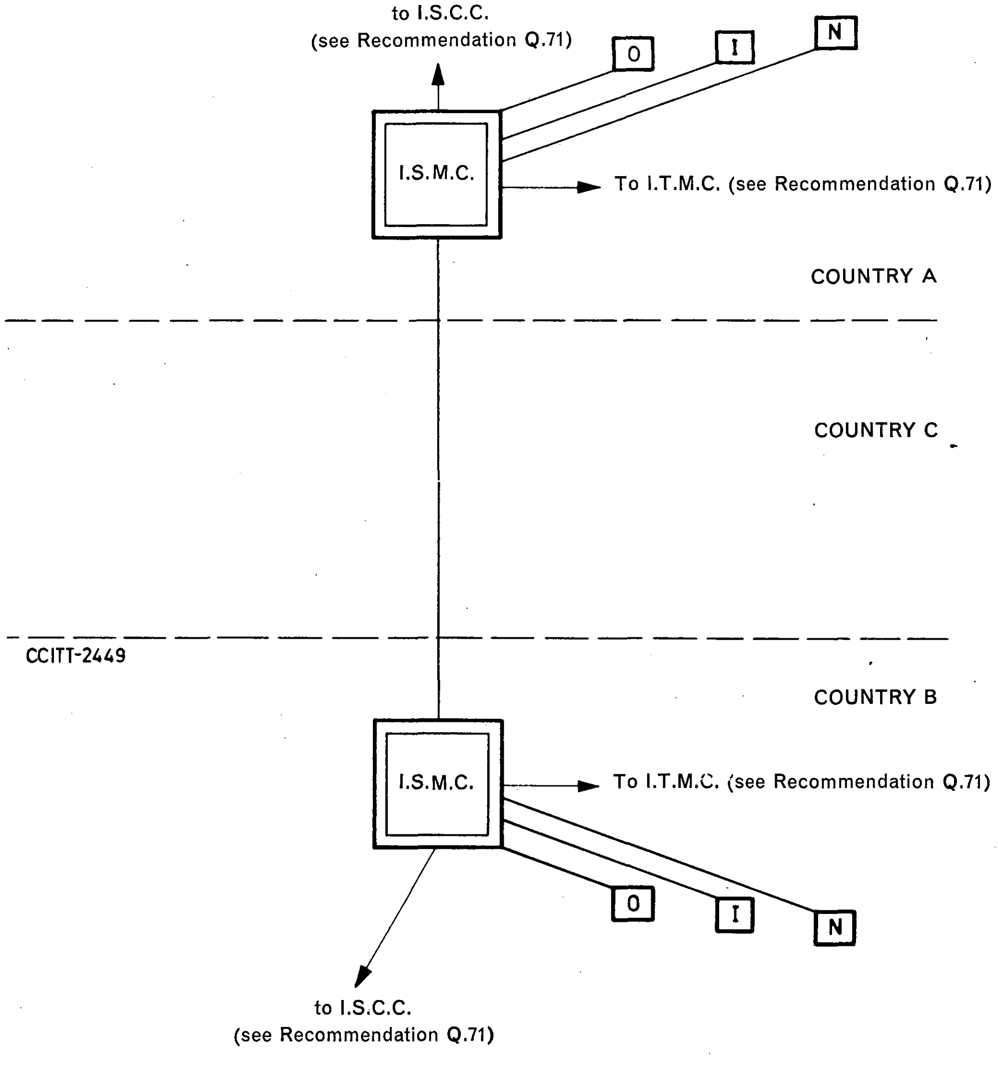
This fault-report point will also initiate the fault location and clearing operations.

3.2 In the absence of a separate I.S.M.C. a terminal switching centre in the international service may perform the functions of the I.S.M.C. because such centres can include the elements having the responsibilities mentioned in paragraph 3.1.

Small switching centres may also have these elements.

4. *Organization diagram*

Figure 1 shows the interrelations between the I.S.M.C. and other services of its country and also its relations with other countries.



Legend

I.S.M.C. = International switching maintenance centre.
I.T.M.C. = International transmission maintenance centre.
I.S.C.C. = International service co-ordination centre.
O = Operation supervisors (semi-automatic and manual).
I = The other I.S.M.C.'s of the country.
N = National extension circuits and other services concerned.

FIGURE 1 — **Interrelations of I.S.M.C. and associated services**

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PART V PART VI

TRAFFIC ENGINEERING

CHAPTER I

MEASUREMENT AND RECORDING OF TRAFFIC

RECOMMENDATION E.500 RECOMMENDATION Q.80

MEASUREMENT OF TRAFFIC FLOW [1]

1. Traffic statistics should be measured for the significant period of each day of the whole year by automatic measuring and recording equipment capable of running continuously.

The recording equipment should make a record of the *traffic flow* carried during the *mean busy hour* for at least the 30 days (not necessarily consecutive) of the previous 12 months in which the mean busy-hour traffic flow is the highest. The record should also include the date of such measurements. This method gives traffic information of relatively high accuracy. This method is suitable for circuit groups operated automatically or semi-automatically.

Note. — The traffic flow for the busiest days having been recorded in this way, processing means can be employed to calculate values for the average traffic flow for the 30 and for the 5 busiest days during periods of 12 consecutive months. Such pairs of values can be calculated for a period of 12 months terminating in December and/or periods of 12 months terminating at other times.

It is recommended that the minimum requirement is an annual series of values terminating at the same time each year.

2. A second method which yields information of a lower degree of accuracy may be used by Administrations * until they are ready to use the first, which is the preferred method. However, under certain circumstances, for manually operated groups of circuits, the second method is the only one possible.

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* or recognized private operating Agencies.

[1] See the definitions of the terms used in the Annex to Part VI (for Volume VI only).

This second method comprises a measuring period of 10 consecutive normal working days during the busiest season of the year. In the determination of the busiest season of the year it is necessary to bear in mind that a pronounced annual growth may cause a busy season at the end of the year to appear to exceed the busiest season which occurred earlier in the year. Since in most cases the busiest season is not clearly defined and varies from year to year, this method may be improved by taking a consecutive 10-day sample from the results of measurements made over a much longer period, for example 13 weeks covering the busy season(s). This extended period of measurement should provide information about the exceptionally busy days.

3. *Notification of mean busy hour traffic*

Measurements of the mean busy hour traffic, expressed in erlangs and quoting the busy hour on a G.M.T. basis, also the date of measurement or the period for which the estimate is valid, should be communicated to other Administrations* concerned in the handling of the traffic.

RECOMMENDATION E.501 RECOMMENDATION Q.81

AUTOMATIC TRAFFIC-RECORDING DEVICES

Greater use should be made of automatic methods of recording and analysing traffic data because it would appear inevitable that more information regarding the traffic will be required as the continental and intercontinental networks are expanded. Therefore automatic methods, in addition to being more efficient, may well be the only economical ones to use. It is emphasized that, whilst any automatic equipment should not be unduly complicated, it should nevertheless be able to provide output information in a form which will be readily acceptable to an automatic data-processing system.

Attention of Administrations * is drawn to the following features given in the Annex for the design of traffic-recording machines; these features cover arrangements which might be made and facilities which might be incorporated.

ANNEX

(to Recommendation E.501 and Q.81)

Features for automatic traffic-recording machines

1. *Basic automatic traffic-recording equipment*

1.1 *Purposes*

The equipment is primarily intended for ordinary traffic-engineering purposes, i.e. to collect the traffic data which are generally desired for the continuous supervision of a network and its long-term planning.

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* or recognized private operating Agencies.

It is the main purpose of the equipment that measurements may be made, sometimes over extended periods, with the minimum of maintenance attention. In consequence, it is envisaged that each measurement will be provided as the result of instructions given to the machine in advance. The results of such measurements should be printed out or recorded on tape. A typical instruction would be to measure the traffic on a group of circuits between, say, 10 a.m. and 11 a.m. and to connect an output circuit at 11 a.m. which would print out and/or record the results on a tape.

1.2 *Measurement period*

It is required that the traffic-recording equipment should be capable of making traffic comparisons either for a single busy hour or for a number of periods during a day.

Until the traffic characteristics of a group of circuits have been established it will be desirable to make daily measurements throughout the year. Such measurements will indicate the busy seasons and the distribution of the busy days. It is recognized that many of the measurements relating to slack days have no lasting value and it is therefore advantageous to consider whether the traffic-recording equipment cannot be designed with facilities such that the output is inhibited for those days on which the traffic does not exceed some predetermined minimum. As each group would need to have its own predetermined value, the machine would need to have means for storing the reference value for each group.

1.3 *Traffic data necessary to plan for a specified grade of service*

The amount of information necessary for planning will not be identical for all groups of circuits and for all relations [1], as some groups of circuits will provide for several relations whereas the traffic for some relations may be divided between different routes. It is desirable that the traffic machine should be designed to measure:

a) carried traffic flow;

b) number of call attempts (including repeated attempts and call attempts not gaining access to a group of international circuits);

c) duration of the periods during which no circuits are available;

d) number of call attempts experiencing congestion.

It is intended that the holding time when needed could be deduced from items a) and b). For groups with an adequate number of circuits any measurements under c) and d) are likely to be of little value.

As congestion increases, the b), c) and d) measurements become much more important for the following reasons:

i) Measurements of carried traffic will not include calls experiencing congestion. Repeated attempts may result from such calls.

ii) Circuits blocked by the maintenance staff may lead to much more serious congestion than might be expected from the carried-traffic flow.

iii) Although the number of calls experiencing congestion, d), provide more information than the congestion-time measurements, c), complications arise in the case of both-way circuits because the d) measurements have to take place in both terminations, and this may result in delay in obtaining access to the full statistics.

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[1] The word "relations" is used to describe the traffic from one particular country to another particular country.

1.4 *Traffic measurements for different groups of circuits*

1.4.1 The traffic-recording machine is required particularly to collect carried-traffic statistics as defined in Recommendation E.500 and Q.80. As a general rule, carried-traffic measurements will refer to the whole of a group of circuits between two centres. Such circuits may carry one-way or both-way traffic.

1.4.2 Measurement of traffic for particular relations (e.g. between two different countries):

1.4.2.1 *Direct (point-to-point) circuits*

In some cases the traffic for a particular relation will use an independent group of direct circuits (without overflow facilities) and the traffic measurement should be made according to section 1.3.

1.4.2.2 *High-usage and final routes*

Some relations will be served by direct high-usage circuits and by overflow facilities. In such cases the direct high-usage group of circuits can be measured according to section 1.3. Such measurements provide only an indication of the traffic flow because the day-to-day fluctuations will be more apparent on the overflow than on the high-usage group.

The arrangement described in the following section 3 indicates means whereby more detailed information can be collected. It should be observed that holding-time statistics are available on the high-usage group, and the traffic machine should be capable of measuring these values directly or by measuring the traffic flow and the corresponding number of calls.

1.4.2.3 *No direct or high-usage circuits*

The traffic for many relations may be combined and switched through a transit centre; in such cases the normal form of measurement cannot provide complete information and reference needs to be made to registers or markers which are aware of call destinations. The C.C.I.T.T. signalling systems do not provide facilities to enable transit or incoming calls to be identified according to their country of origin and, therefore, it is possible to make measurements only at the outgoing international exchange. Such measurements should indicate the number of offered calls and the number of calls experiencing congestion. These measurements will not indicate holding time and it does not seem justified to complicate the equipment in order to allow such measurement to be made. It is thought to be sufficient to provide facilities to measure the mean holding time on each group of circuits serving a number of relations. A check can be made of the holding time for any relation by reference to the statistics collected for international accounting. (See Recommendation E.280 and Q.50.)

It is expected that traffic measurements for particular relations can be taken on a non-continuous basis and that it will be unnecessary to provide facilities for measuring many relations simultaneously. Nevertheless, it must be recognized that the determination of the busy season for a relation may not be easy if the traffic for several relations uses the same group of circuits. Full traffic statistics for a relation can always be measured in special cases by routing the traffic through an additional switching stage at the outgoing centre so that independent measurements can be made.

In many cases the need for information about relations with a small amount of traffic will be limited to ascertaining the advisability of introducing high-usage (direct) circuits. This situation will become evident from statistics for international accounting.

1.5 *Indication of traffic congestion*

A traffic machine which runs continuously has the valuable asset of being able to indicate abnormal congestion quickly.

As a consequence it is recommended that, besides measuring traffic carried on a group of circuits, the machine should be able to recognize when there is congestion and indicate this fact so that immediate action can be taken.

1.6 *Indication of results*

In order that statistics may be collected in respect to both outgoing and incoming calls, and in order to keep the measuring equipment as flexible as possible, the indications to the measuring equipment from the circuits under measurement should be given in the same way for both types of call.

In applications in which it is desired to separate the semi-automatic and automatic call statistics separate indications must be given by the circuits to the measuring equipment.

Facilities should be provided for simultaneous measurement of the four traffic characteristics listed in section 1.3 on any specified group of circuits. It should be possible to give varying instructions to the machine indicating when to make measurements. The individual results should be printed out or recorded on tape.

It should be possible to make measurements on a specified number of routes. As a general rule, traffic carried and congestion time will always be referred to the whole of the circuit group, while the total number of calls and the number of calls experiencing congestion may also be referred to one of several relations served by a circuit group or to a relation served by a number of routes.

The indications for the traffic characteristics in section 1.3 may be given from the individual circuit equipments and/or from common equipment such as markers or registers. It is desirable that the indications follow a given standard.

The number of groups of circuits for which simultaneous measurements are required should be specified separately.

1.7 *Examples of measurements which may be provided by the automatic measuring equipment*

Examples of measurements that may be desired are shown below in section 1.8. In order to indicate the importance these different measurements may be expected to have, the different items have been given the signs I or II having the following meanings:

(I) Measurements expected to be made on all routes for supervision of the network, including its long-term planning.

(II) Measurements expected to be made occasionally on a few routes at the same time, provided that the inclusion of the facilities does not noticeably increase the cost of the equipment.

1.8 *Facilities*

1.8.1. Facilities should be provided for measuring the carried traffic flow for a group for any specified period (I).

1.8.2. Facilities should be provided for measuring the congestion time and/or the number of calls experiencing a congestion condition. It is required that the equipment should allow measurement totals to be made available daily on either a busy-hour, a 2-hour or a 24-hour basis. Facilities should be provided for giving an alarm if the congestion exceeds a specified limit (I).

1.8.3 Facilities should be provided for measuring and for printing out or recording on tape the total traffic carried during each 15-minute period, so that the mean busy hour may be determined (I).

Note. — As an example, the facilities can be provided by causing the machine to produce an output total at 15-minute intervals from any starting hour to any finishing hour.

1.8.4 Facilities should be provided for measuring both the traffic and the number of call attempts and for printing out or recording on tape the totals for a specified hour or for 24 hours (II).

Note. — The results can be used for the calculation of holding times.

1.8.5 Facilities should be provided for counting call attempts in common circuits (such as registers, markers, etc.) for the following purposes:

i) to identify the sample busy hour by periodically printing out or recording on tape the totals as in 1.8.3 (II).

ii) to determine the number of call attempts to a specified country during the sample busy hour (I).

iii) to determine the number of call attempts switched over a direct route to a specified country (I or II).

iv) to determine the number of call attempts switched over one or more overflow routes to a specified country (I or II).

v) to determine the number of call attempts to a specified country which are ineffective due to equipment or signalling failures. Such failures might upset the accuracy of traffic measurement in a similar way to congestion (I or II).

vi) to determine the number of call attempts to a specified country which are ineffective due to all direct and overflow circuits being in use (I).

vii) to determine the number of operator-handled call attempts on a given route (II).

viii) to determine the number of subscriber-dialled call attempts on a given route (II).

1.9 *Control*

It is intended that in principle the recording equipment should be operated in response to processed instructions, for example a message on tape. It is desirable that the arrangement should be of such a form that remote control can easily be arranged.

2. *Supplementary traffic-recording equipment*

2.1 *Purpose*

The equipment is primarily intended for ordinary traffic-engineering purposes, i.e. to collect the traffic data which are generally desired for the continuous supervision of a network and its long-term planning.

Whereas the features listed in section 1 are generally needed for this equipment also, there is a basic difference. For the supplementary equipment a typical instruction will be to measure whether the traffic characteristics on a group of circuits between, say, 10 a.m. and 11 a.m. exceeds a predetermined value. If there should be an excess, it is required that an output equipment should be connected at 11 a.m. and that this equipment shall then print out and/or record the resulting information.

2.2 *Traffic characteristics to be recorded*

These requirements are similar to those in section 1 but differ because an average traffic-flow value is not required for every sample period but the value should be passed to output equipment when it exceeds a predetermined figure.

2.3 *Output-recording equipment*

This equipment forms the subject of section 3. If a common output is used, then the route must be recorded. It is sufficient to insert the date only once per day.

2.4 *Measurement period*

Traffic-recording equipment should be capable of making traffic comparisons either for a single busy hour or for a number of periods during a day.

3. *Central analysing equipment*

3.1 Central analysing equipment is required to examine the traffic records which have been accumulated. It is assumed that the necessary measurement statistics have been recorded on some medium which can be read by machine (e.g. paper tape).

For these purposes it is desirable that the analysing equipment should be capable of identifying the busiest season, the traffic flow at the busiest season, the annual growth of the traffic flow, and the extent to which the busiest season exceeds other seasons.

Furthermore the equipment should be capable of receiving data in respect to both the present number of circuits in operation and the dates on which it is planned that the present facilities will be extended. With this information it should be possible for the machine to estimate when the amount of disturbed traffic may be expected to exceed a specified grade of service.

3.2 It is expected that, in addition to the analysis which will be needed when planning an extension period, reviews will be advisable to check the rate of growth; such checks may be satisfied by extracting the busiest season and the mean busy-hour traffic for the 5 and 30 highest days. For a more complete analysis it would be interesting to extract such averages for each month and to establish any relationship between these averages.

It may prove to be more economical to design the recording equipment to record all days during which the busy-hour traffic exceeds some predetermined value than to design it to ascertain, as a continuous process, which are the 30 highest days. In either case the recording equipment must measure the busy-hour traffic each day, and it is likely to be simpler to make a record of all days which exceed a predetermined value than to have to ascertain whether the value for a particular day will be needed or not.

CHAPTER II

DETERMINATION OF THE NUMBER OF CIRCUITS IN MANUAL OPERATION

RECOMMENDATION E.510 [1]

RECOMMENDATION Q.85

DETERMINATION OF THE NUMBER OF CIRCUITS IN MANUAL OPERATION

1. The quality of an international manual demand service should be defined as the percentage of call requests which, during the average busy hour (as defined later under 3), cannot be satisfied immediately because no circuit is free in the relation considered.

By "call requests satisfied immediately" are meant those for which the call is established by the same operator who received the call, and within a period of two minutes from receipt of that call, whether the operator (when she does not immediately find a free circuit) continues observation of the group of circuits, or whether she makes several attempts in the course of this period.

Ultimately, it will be desirable to evolve a corresponding definition based on the " average speed " of establishing calls in the busy hour, that is to say the average time which elapses between the moment when the operator has completed the recording of the call request and the moment when the called subscriber is on the line, or the caller receives the advice " subscriber engaged ", " no reply ", etc. But for the moment, in the absence of information about the operating time in the European international service, such a definition cannot be established.

2. The number of circuits it is necessary to allocate to an international relation, in order to obtain a given grade of service, should be determined as a function of the " total holding time " of the group in the busy hour.

The total holding time [2] is the product of the number of calls in the busy hour and a factor which is the sum of the average call duration and the average operating time.

These durations will be obtained by means of a large number of observations made during the busy hours, by agreement between the Administrations * concerned. If necessary, the particulars entered on the tickets could also serve to determine the average duration of the calls.

The average call duration will be obtained by dividing the total number of minutes of conversation recorded by the recorded number of effective calls.

The average operating time will be obtained by dividing the total number of minutes given to operating (including ineffective calls) by the number of effective calls recorded.

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* or recognized private operating Agencies.

[1] This Recommendation dates from the XIIIth Plenary Assembly of the C.C.I.F. (London, 1946) and has not been fundamentally revised since. It will be studied under Question 13/II in the 1969-1972 C.C.I.T.T. study period.

[2] It should be noted that the determination of the total holding time in this Recommendation is not consistent with the measurement of traffic flow as described in Recommendation Q.50.

3. The number of calls in the busy hour will be determined from the average of returns taken during the busy hours on a certain number of busy days in the year.

Exceptionally busy days, such as those which occur around certain holidays, etc., will be eliminated from these returns. The Administrations * concerned should plan, whenever possible, to put additional circuits into service for these days.

In principle, these returns will be taken during the working days of two consecutive weeks, or during ten consecutive working days. If the monthly traffic curve shows only small variations, they will be repeated twice a year only. They will be taken three or four times a year or more if there are material seasonal variations, so that the average established is in accordance with all the characteristic periods of traffic flow.

4. The total occupied time thus determined should be increased by a certain amount determined by agreement between the Administrations * concerned according to the statistics of traffic growth during earlier years, to take account of the probable growth in traffic and the fact that putting new circuits into service takes place some time after they are first found to be necessary.

5. The total holding time of the circuits thus obtained, in conjunction with a suitable table (see below), will enable the required number of circuits to be ascertained.

6. In the international manual telephone service, the following Tables A and B should be used as a basis of minimum allocation:

Table A corresponds to about 30% of calls failing at the first attempt because of all circuits being engaged and to about 20% of the calls being deferred.

Table B, corresponding to about 7% of calls deferred, will be used whenever possible.

These tables do not take account of the fact that the possibility of using secondary routes permits, particularly for small groups, an increase in the permissible occupation time.

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* or recognized private operating Agencies.

Capacity tables of circuit groups

Number of circuits	Table A		Table B	
	Percentage of circuit usage	Minutes of circuit usage possible in the busy hour	Percentage of circuit usage	Minutes of circuit usage possible in the busy hour
1	65.0	39	—	—
2	76.7	92	46.6	56
3	83.3	150	56.7	102
4	86.7	208	63.3	152
5	88.6	266	68.3	205
6	90.0	324	72.0	259
7	91.0	382	74.5	313
8	91.7	440	76.5	367
9	92.2	498	78.0	421
10	92.6	556	79.2	475
11	93.0	614	80.1	529
12	93.4	672	81.0	583
13	93.6	730	81.7	637
14	93.9	788	82.3	691
15	94.1	846	82.8	745
16	94.2	904	83.2	799
17	94.3	962	83.6	853
18	94.4	1020	83.9	907
19	94.5	1078	84.2	961
20	94.6	1136	84.6	1015

Remark. — Tables A and B can be extended for groups comprising more than 20 circuits by using the values given for 20 circuits.

CHAPTER III

DETERMINATION OF THE NUMBER OF CIRCUITS IN AUTOMATIC AND SEMI-AUTOMATIC OPERATION

RECOMMENDATION E.520 RECOMMENDATION Q.87

NUMBER OF CIRCUITS TO BE PROVIDED IN AUTOMATIC AND/OR SEMI-AUTOMATIC OPERATION, WITHOUT OVERFLOW FACILITIES

This Recommendation refers to groups of circuits used:

— in automatic operation;
— in semi-automatic operation;
— in both automatic and semi-automatic operations on the same group of circuits.

1. *General method*

1.1 The C.C.I.T.T. recommends that the number of circuits needed for a group should be read from tables or curves based on the classical Erlang B formula (see *White Book*, Volume VI, Documentary part, Supplements No. 8 and No. 9), which refers to full availability groups. Recommended methods for traffic determination are indicated in Recommendation E.500 and Q.80.

For *semi-automatic operation* the loss probability p should be based on 3% during the mean busy hour.

For *automatic operation* the loss probability p should be based on 1% during the mean busy hour.

Semi-automatic traffic using the same circuits as automatic traffic is to be added to the automatic traffic and the same parameter value of $p = 1\%$ should be used for the total traffic.

The values of 3% and 1% quoted above refer to the Erlang B formula and derived tables and curves. The 3% value should not be considered as determining a grade of service because with semi-automatic operation there will be some smoothing of the traffic peaks; it is quoted here only to determine the value of the parameter p (loss probability) to use in the Erlang B tables and curves.

1.2 In order to provide a satisfactory grade of service both for the mean busy-hour traffic and for the traffic on exceptionally busy days, it is recommended that the proposed number of circuits should, if necessary, be increased to ensure that the loss probability shall not exceed 7% during the mean busy hour for the average traffic estimated for *the five busiest days* as specified in Recommendation E.500 (Q.80).

1.3 For *small groups of long intercontinental circuits* with automatic operation some relaxation could be made in respect to loss probability. It is envisaged that such circuits would be operated on a both-way basis and that a reasonable minimum for automatic service would be a group of six circuits. A table providing relaxation is annexed to this Recommendation and is based on a loss probability of 3% for six circuits, with a smooth progression to 1% for 20 circuits. The general provision for exceptional days remains unchanged.

For exceptional circumstances in which very small groups (less than six intercontinental circuits) are used for automatic operation, dimensioning of the group should be based on the loss probability of 3%.

2. *Time differences*

Time differences at the two terminations of intercontinental circuits are likely to be much more pronounced than those on continental circuits. In order to allow for differences on groups containing both-way circuits it will be desirable to acquire information in respect to traffic flow both during the mean busy hour for both directions and during the mean busy hour for each direction.

It is possible that in some cases overflow traffic can be accepted without any necessity to increase the number of circuits, in spite of the fact that this overflow traffic is of a peaky nature. Such circumstances may arise if there is no traffic overflowing from high-usage groups during the mean busy hour of the final group.

3. *Both-way circuits*

3.1 With the use of both-way circuits there is a danger of simultaneous seizure at both ends; this is particularly the case on circuits with a long propagation time. It is advisable to arrange the sequence of selection at the two ends so that such double seizure can only occur when a single circuit remains free.

When all the circuits of a group are operated on a both-way basis, time differences in the directional mean busy hours may result in a total mean busy hour traffic flow for the group which is not the sum of the mean busy hour traffic loads in each direction. Furthermore, such differences in directional mean busy hour may vary with seasons of the year. However, the available methods of traffic measurement can determine the traffic flow during mean busy hour for this total traffic.

5.2 Some intercontinental groups may include one-way as well as both-way operated circuits. It is recommended that in all cases the one-way circuits should be used, when free, in preference to the both-way circuits. The number of circuits to be provided will depend upon the one-way and total traffic.

The total traffic will need to be determined for:

a) each direction of traffic;
b) both-way traffic.

This determination is to be made for the busy hour or the busy hours corresponding to the two cases a) and b) above.

In the cases where the number of one-way circuits is approximately equal for each direction, no special procedure is necessary, and the calculation can be treated as for a simple two-group grading [1].

If the number of one-way circuits is quite different for the two directions, some correction may be needed for the difference in randomness of the flow of calls from the two one-way circuit groups to the both-way circuit group. The general techniques for handling cases of this type are quoted in Recommendation E.521 (Q.88).

ANNEX

(to Recommendation E.520 (Q.87))

The following table may be applied to small groups of long intercontinental circuits. The values in column 2 are suitable for a random offered traffic with full availability access.

Number of circuits	Traffic flow (in erlangs)		
	Offered	Carried	Encountering congestion
(1)	(2)	(3)	(4)
6	2.54	2.47	0.08
7	3.13	3.05	0.09
8	3.73	3.65	0.09
9	4.35	4.26	0.09
10	4.99	4.90	0.09
11	5.64	5.55	0.10
12	6.31	6.21	0.10
13	6.99	6.88	0.10
14	7.67	7.57	0.10
15	8.37	8.27	0.11
16	9.08	8.96	0.11
17	9.81	9.69	0.11
18	10.54	10.42	0.11
19	11.28	11.16	0.12
20	12.03	11.91	0.12

The table is based on 1% loss probability for 20 circuits and increases progressively to a loss probability of 2% at 9 circuits and 3% at 6 circuits (loss probabilities for these three values being based on the Erlang loss formula: see Supplement No. 8 to Volume VI or Supplement No. 1 in Volume II-A). The traffic flow values obtained from a smoothing curve coincide very nearly with those determined by equal marginal utility theory, i.e. an improvement factor of 0.05 erlang for an additional circuit.

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[1] See article by I. TÅNGE: " Optimal use of both-way circuits in cases of unlimited availability ", *TELE,* English Edition No. 1, 1956.

For groups requiring more than 20 circuits the table quoted in Recommendation E.520 (Q.87) for loss probability of 1% should be used (see Supplement No. 8 to Volume VI or Supplement No. 1 in Volume II-A).

RECOMMENDATION E.521 RECOMMENDATION Q.88

CALCULATION OF THE NUMBER OF CIRCUITS IN A GROUP CARRYING OVERFLOW TRAFFIC

A calculation of the number of circuits in groups carrying overflow traffic should be based on this Recommendation and Recommendation E.522 (Q.89) dealing with high-usage circuits. An annex to this Recommendation describes two simplified methods with appropriate examples. These two methods should give substantially the same results.

A still simpler method for determining the number of circuits required on overflow systems could be based on increasing the overflow traffic values by 2% to 4% and then using Recommendation E.520 (Q.87).

Yet another method consists in applying a modified traffic table which gives the number of final circuits increased by 7% compared with the Erlang loss formula. This procedure may result in considerable over-provision of circuits but it compensates for traffic underestimates and provides safeguards for traffic surges [1].

ANNEX

(to Recommendation E.521 (Q.88)

Simplified methods of determining the number of circuits in a group carrying overflow traffic

The following two methods are applicable when *computational* facilities are limited and an approximate value for the number of circuits is sufficient:

Method 1 — Simplified weighted choice method

Method 2 — Maximum variance method

Method 1 — Simplified weighted choice method

The peakedness of the constituent parts of the overflow traffic is described by the *choice factor*, e.g. 0.41 erlangs, overflowing from 12 circuits is described as 0.41 × 13, i.e. 0.41 erlangs offered to a 13th choice circuit. The sum of the products of these two values (i.e. 0.41 × 13 in the above example) for each constituent part is divided by the total of the overflow traffic to obtain a weighted description of the overflow traffic.

The number of circuits required for 1% congestion is obtained by taking the total traffic offered and the weighted choice and then reading the number of circuits from Table 4.

An illustration of the use of this method is given in Table 1 below:

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[1] See " Processing by computers for network planning and design " by Kenzo FUKUI; *N.T.T.* Technical Publication D—No. 8 and *J.T.R.* 1967, Volume 9, No. 4.

TABLE 1

Example of the determination of the weighted choice

Constituent parts (1)	Traffic offered to the overflow group of circuits and choice factor (2)	Choice × erlangs (3)
a	0.41 × 13	5.33
b	0.16 × 3	0.48
c	0.42 × 4	1.68
d	0.51 × 7	3.57
e	0.35 × 3	1.05
f	0.69 × 8	5.52
g	0.50 × 2	1.00
h	2.95 × 7	20.65
	approx. 6	approx. 40

Therefore the weighted choice is $\frac{40}{6} = 7$ and the number of circuits is 15.

Notes. — Column (2) is determined from overflow tables or curves, column (3) is product of the two values in column (2).

The first column " constituent parts " may include a traffic parcel which is not overflow traffic; for such an item the entry in column (2) should be $A \times 1$ where A is the offered traffic value and 1 indicates that the traffic is offered to the overflow group as a first choice item of traffic.

Method 2 — Maximum variance method

The overflow traffic is described by two parameters, the mean value, β, and a " peakedness factor ", z.

The peakedness factor indicates the degree to which the variability of the calls deviates from pure chance traffic, and in statistical terms is the variance-to-mean ratio of the distribution of simultaneous overflow calls.

The mean overflow traffic, β, from a high-usage group is found by employing the standard Erlang loss formula $E_1\, n\,(A)$

$$\beta = A \cdot E_1, n\,(A)$$

where A is the offered load in erlangs to n high-usage circuits.

Peakedness factors of overflow traffic depend principally upon the number of circuits over which random traffic has limited access. In most practical cases, the actual peakedness of the traffic overflowing from a high-usage group will be only slightly below the maximum peakedness values [1,2]. The maximum peakedness values are given in Table 2 and are assumed to be sufficiently accurate for use with this method.

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[1] Tables giving:
— the exact mean of the overflow traffic and
— the difference between variance and mean of the overflow traffic have been computed and are set out in " Tabellen für die Planung von Fernsprecheinrichtungen, Siemens u. Halske, München 1961 ".

[2] Curves giving the exact mean and variance of overflow traffic are given in Figures 12 and 13 of "Theories for Toll Traffic Engineering in the U.S.A.", by R. I. WILKINSON, *Bell System Technical Journal*, Volume 35, March 1956. See also by the same author a more detailed description of the method in " Simplified Engineering of Single Stage Alternate Routing Systems ", Fourth International Teletraffic Congress, London, 1964.

TABLE 2

Maximum peakedness factors, z

Number of circuits (n)	Peakedness factor (z)	Number of circuits (n)	Peakedness factor (z)
1	1.17	16	2.44
2	1.31	17	2.49
3	1.43	18	2.55
4	1.54	19	2.61
5	1.64	20	2.66
6	1.73	21	2.71
7	1.82	22	2.76
8	1.90	23	2.81
9	1.98	24	2.86
10	2.05	25	2.91
11	2.12	26	2.96
12	2.19	27	3.00
13	2.26	28	3.05
14	2.32	29	3.09
15	2.38	30	3.14

The weighted mean peakedness factor, z, is then calculated from

$$z = \frac{\sum_{i=1}^{h} \beta_i z_i}{\sum_{i=1}^{h} \beta_i}$$

for the h parcels of traffic being offered to the final circuits. As an example, the calculations for the weighted mean peakedness factor are as shown in Table 3 below for the case of the parcels of traffic quoted in Table 1.

The number of circuits required is then determined from Table 5 using the column heading nearest to the weighted peakedness factor, z. In the example above it is found that the overflow load of 5.99 erlangs can be served at a loss probability $p = 1\%$ by 15 circuits.

TABLE 3

Example of the determination of the weighted mean peakedness factor

High-usage group number	Traffic offered to HU group	Number of HU circuits	Mean value of overflow traffic β	Peakedness factor z	$z \times \beta$
(1)	(2)	(3)	(4)	(5)	(6) = (4) × (5)
a	8.0	12	0.41	2.19	0.90
b	0.9	2	0.16	1.31	0.21
c	2.0	3	0.42	1.43	0.60
d	4.1	6	0.51	1.73	0.88
e	1.3	2	0.35	1.31	0.46
f	5.2	7	0.69	1.82	1.26
g	1.0	1	0.50	1.17	0.59
h	7.8	6	2.95	1.73	5.10
Totals	30.3		5.99		10.00

The weighted mean peakedness factor is therefore $= \frac{10.00}{5.99} = 1.67$

TABLE 4

Number of circuits for a loss probability p = *0.01, for overflow traffic, using the simplified weighted choice method*

Required number of circuits	Weighted choice											
	1.0	1.5	2.0	2.5	3.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0
	Overflow traffic in erlangs											
1	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.15	0.05	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.46	0.35	0.24	0.13	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.87	0.75	0.62	0.53	0.4	0.23	0.0	0.0	0.0	0.0	0.0	0.0
5	1.36	1.23	1.11	0.99	0.88	0.67	0.33	0.0	0.0	0.0	0.0	0.0
6	1.91	1.77	1.64	1.52	1.39	1.18	0.82	0.51	0.20	0.0	0.0	0.0
7	2.50	2.35	2.13	2.09	1.96	1.72	1.34	1.02	0.74	0.47	0.14	0.0
8	3.13	2.97	2.83	2.69	2.56	2.30	1.90	1.58	1.28	1.02	0.76	0.52
9	3.78	3.61	3.46	3.32	3.20	2.91	2.50	2.14	1.84	1.57	1.32	1.08
10	4.46	4.29	4.13	3.98	3.85	3.55	3.11	2.75	2.43	2.15	1.89	1.65
11	5.16	4.98	4.81	4.66	4.52	4.21	3.75	3.37	3.04	2.75	2.48	2.24
12	5.88	5.69	5.51	5.34	5.21	4.89	4.40	4.01	3.67	3.36	3.09	2.84
13	6.61	6.41	6.22	6.05	5.91	5.58	5.08	4.68	4.32	4.00	3.72	3.46
14	7.35	7.15	6.96	6.78	6.64	6.29	5.77	5.34	4.98	4.66	4.36	4.09
15	8.11	7.91	7.71	7.52	7.37	7.02	6.48	6.04	5.66	5.32	5.02	4.74
16	8.88	8.66	8.46	8.27	8.12	7.75	7.20	6.74	6.35	6.00	5.69	5.40
17	9.65	9.44	9.24	9.04	8.87	8.50	7.93	7.46	7.06	6.69	6.37	6.07
18	10.44	10.22	10.00	9.80	9.63	9.26	8.66	8.18	7.77	7.39	7.07	6.76
19	11.23	11.01	10.79	10.57	10.39	10.02	9.41	8.92	8.50	8.11	7.77	7.45
20	12.03	11.80	11.57	11.35	11.17	10.80	10.17	9.66	9.23	8.83	8.48	8.16
21	12.84	12.61	12.38	12.15	11.96	11.58	10.94	10.43	9.98	9.56	9.21	8.87
22	13.65	13.42	13.19	12.96	12.75	12.37	11.72	11.19	10.73	10.31	9.94	9.59
23	14.47	14.23	14.00	13.77	13.56	13.16	12.49	11.95	11.49	11.05	10.68	10.33
24	15.29	15.05	14.81	14.58	14.37	13.97	13.28	12.73	12.26	11.81	11.42	11.07
25	16.12	15.88	15.64	15.40	15.19	14.78	14.08	13.52	13.03	12.57	12.18	11.81

TABLE 4 (continued)

Required number of circuits	Weighted choice											
	1.0	1.5	2.0	2.5	3.0	4.0	6.0	8.0	10.0	12.0	14.0	16.0
	Overflow traffic in erlangs											
26	16.96	16.72	16.48	16.24	16.03	15.60	14.88	14.30	13.81	13.34	12.94	12.56
27	17.80	17.55	17.31	17.07	16.85	16.42	15.69	15.11	14.60	14.11	13.71	13.32
28	18.64	18.39	18.14	17.90	17.68	17.24	16.50	15.90	15.39	14.90	14.47	14.09
29	19.49	19.23	18.98	18.74	18.52	18.07	17.32	16.71	16.19	15.68	15.25	14.85
30	20.34	20.09	19.84	19.59	19.36	18.90	18.14	17.52	16.99	16.48	16.04	15.63
31	21.19	20.93	20.68	20.44	20.20	19.74	18.97	18.34	17.80	17.27	16.82	16.41
32	22.05	21.79	21.54	21.29	21.06	20.59	19.80	19.16	18.61	18.07	17.62	17.20
33	22.91	22.65	22.40	22.15	21.92	21.43	20.63	19.99	19.43	18.88	18.42	17.99
34	23.77	23.52	23.27	23.02	22.78	22.29	21.47	20.82	20.25	19.70	19.22	18.78
35	24.64	24.38	24.13	23.88	23.64	23.14	22.31	21.66	21.08	20.50	20.03	19.58
36	25.51	25.24	24.99	24.75	24.50	24.00	23.16	22.49	21.90	21.33	20.84	20.38
37	26.38	26.12	25.87	25.62	25.37	24.86	24.01	23.33	22.74	22.15	21.65	21.19
38	27.25	26.99	26.74	26.49	26.24	25.72	24.86	24.18	23.58	22.98	22.47	22.00
39	28.13	27.86	27.61	27.36	27.11	26.59	25.72	25.03	24.42	23.81	23.29	22.81
40	29.01	28.74	28.48	28.23	27.99	27.45	26.57	25.88	25.26	24.64	24.11	23.63
41	29.89	29.62	29.36	29.11	28.86	28.33	27.44	26.74	26.11	25.48	24.94	24.45
42	30.77	30.51	30.24	29.99	29.74	29.20	28.30	27.60	26.96	26.32	25.77	25.27
43	31.66	31.39	31.13	30.88	30.63	30.09	29.17	28.46	27.81	27.17	26.61	26.10
44	32.54	32.28	32.02	31.77	31.51	30.97	30.04	29.32	28.68	28.01	27.44	26.93
45	33.43	33.17	32.91	32.66	32.40	31.85	30.91	30.19	29.53	28.86	28.29	27.76
46	34.32	34.06	33.80	33.55	33.29	32.73	31.79	31.06	30.40	29.72	29.14	28.60
47	35.21	34.95	34.69	34.43	34.18	33.61	32.66	31.93	31.26	30.57	29.98	29.43
48	36.11	35.84	35.58	35.32	35.07	34.51	33.55	32.80	32.13	31.43	30.83	30.28
49	37.00	36.74	35.48	36.22	35.96	35.40	34.43	33.69	33.01	32.29	31.68	31.12
50	37.90	37.64	37.38	37.12	36.86	36.29	35.32	34.57	33.87	33.15	32.53	31.97

TABLE 4 (continued)

Required number of circuits	Weighted choice											
	18.0	20.0	22.0	24.0	26.0	28.0	30.0	35.0	40.0	45.0	50.0	52.0
	Overflow traffic in erlangs											
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	0.26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	0.85	0.62	0.28	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	1.43	1.21	0.99	0.79	0.56	0.35	0.19	0.0	0.0	0.0	0.0	0.0
11	2.00	1.78	1.57	1.36	1.16	0.97	0.77	0.25	0.0	0.0	0.0	0.0
12	2.60	2.37	2.15	1.94	1.75	1.56	1.37	0.93	0.35	0.0	0.0	0.0
13	3.21	2.97	2.75	2.53	2.33	2.13	1.95	1.52	1.11	0.67	0.26	0.13
14	3.83	3.59	3.36	3.14	2.93	2.73	2.54	2.10	1.70	1.32	0.93	0.77
15	4.47	4.22	3.99	3.75	3.54	3.33	3.13	2.69	2.29	1.92	1.55	1.41
16	5.12	4.86	4.62	4.39	4.16	3.94	3.74	3.29	2.89	2.51	2.15	2.01
17	5.79	5.52	5.27	5.03	4.80	4.57	4.36	3.90	3.49	3.11	2.75	2.61
18	6.46	6.19	5.94	5.68	5.44	5.21	4.99	4.52	4.10	3.71	3.35	3.21
19	7.15	6.87	6.61	6.34	6.10	5.86	5.63	5.14	4.71	4.32	3.95	3.81
20	7.85	7.56	7.29	7.02	6.76	6.51	6.28	5.78	5.34	4.94	4.57	4.43
21	8.55	8.26	7.97	7.69	7.43	7.18	6.94	6.43	5.97	5.56	5.19	5.05
22	9.27	8.95	8.67	8.38	8.11	7.85	7.61	7.09	6.62	6.20	5.82	5.67
23	9.99	9.67	9.37	9.08	8.81	8.54	8.29	7.75	7.27	6.85	6.46	6.31
24	10.72	10.39	10.09	9.79	9.51	9.23	8.97	8.42	7.93	7.50	7.10	6.95
25	11.45	11.12	10.81	10.50	10.22	9.93	9.66	9.09	8.60	8.16	7.75	7.60

TABLE 4 (continued)

Required number of circuits	Weighted choice											
	18.0	20.0	22.0	24.0	26.0	28.0	30.0	35.0	40.0	45.0	50.0	52.0
	Overflow traffic in erlangs											
26	12.20	11.86	11.54	11.22	10.92	10.63	10.36	9.78	9.27	8.83	8.41	8.26
27	12.95	12.60	12.27	11.94	11.64	11.34	11.06	10.47	9.95	9.49	9.07	8.91
28	13.70	13.35	13.01	12.68	12.37	12.06	11.77	11.17	10.63	10.17	9.75	9.59
29	14.46	14.10	13.76	13.41	13.10	12.79	12.49	11.87	11.32	10.86	10.42	10.26
30	15.23	14.85	14.51	14.16	13.84	13.52	13.21	12.58	12.01	11.54	11.10	10.94
31	16.01	15.61	15.27	14.91	14.59	14.26	13.95	13.29	12.72	12.24	11.79	11.62
32	16.78	16.38	16.02	15.66	15.33	15.00	14.68	14.01	13.42	12.93	12.48	12.31
33	17.56	17.16	16.80	16.42	16.09	15.74	15.42	14.74	14.14	13.64	13.18	13.01
34	18.35	17.94	17.57	17.19	16.85	16.50	16.16	15.47	14.85	14.35	13.88	13.71
35	19.14	18.73	18.34	17.96	17.61	17.25	16.91	16.20	15.58	15.06	14.59	14.41
36	19.93	19.51	19.12	18.73	18.38	18.02	17.67	16.94	16.30	15.78	15.31	15.13
37	20.74	20.30	19.91	19.51	19.15	18.78	18.43	17.69	17.03	16.51	16.02	15.84
38	21.53	21.10	20.70	20.29	19.92	19.56	19.19	18.43	17.77	17.24	16.74	16.56
39	22.35	21.89	21.49	21.08	20.71	20.33	19.96	19.18	18.50	17.96	17.46	17.28
40	23.15	22.69	22.28	21.86	21.49	21.11	20.73	19.94	19.25	18.70	18.19	18.00
41	23.96	23.50	23.09	22.66	22.27	21.88	21.50	20.70	19.99	19.44	18.93	18.74
42	24.78	24.31	23.88	23.45	23.06	22.67	22.28	21.47	20.74	20.18	19.66	19.47
43	25.60	25.12	24.69	24.25	23.86	23.46	23.07	22.23	21.50	20.93	20.40	20.20
44	26.43	25.93	25.50	25.05	24.66	24.25	23.85	23.00	22.25	21.67	21.14	20.94
45	27.25	26.75	26.31	25.86	25.46	25.05	24.64	23.78	23.01	22.43	21.89	21.68
46	28.08	27.57	27.13	26.67	26.26	25.85	25.43	24.55	23.77	23.18	22.64	22.43
47	28.92	28.40	27.94	27.48	27.07	26.65	26.23	25.33	24.54	23.94	23.39	23.18
48	29.74	29.22	28.76	28.29	27.88	27.45	27.03	26.11	25.30	24.70	24.15	23.94
49	30.59	30.05	29.59	29.11	28.69	28.26	27.83	26.90	26.08	25.46	24.90	24.69
50	31.42	30.89	30.41	29.93	29.51	29.08	28.64	27.69	26.85	26.23	25.67	25.45

TABLE 5

Number of circuits for a loss probability p = *0.01 for overflow traffic, using the maximum variance method*

Required number of circuits	Weighted mean peakedness factor										
	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
	Overflow traffic in erlangs										
1	0.01	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.15	0.03	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.46	0.32	0.19	0.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.87	0.72	0.57	0.42	0.28	0.11	0.0	0.0	0.0	0.0	0.0
5	1.36	1.20	1.03	0.87	0.71	0.55	0.39	0.22	0.0	0.0	0.0
6	1.91	1.73	1.55	1.38	1.20	1.04	0.87	0.70	0.53	0.35	0.15
7	2.50	2.30	2.11	1.92	1.74	1.56	1.38	1.21	1.03	0.86	0.68
8	3.13	2.91	2.71	2.50	2.31	2.12	1.93	1.75	1.57	1.38	1.21
9	3.78	3.55	3.33	3.12	2.91	2.71	2.51	2.32	2.12	1.94	1.75
10	4.46	4.22	3.98	3.76	3.54	3.32	3.11	2.91	2.71	2.51	2.32
11	5.16	4.90	4.65	4.42	4.18	3.96	3.74	3.53	3.32	3.11	2.91
12	5.88	5.60	5.34	5.09	4.85	4.61	4.38	4.16	3.94	3.73	3.52
13	6.61	6.32	6.05	5.78	5.53	5.28	5.05	4.81	4.59	4.36	4.15
14	7.35	7.05	6.77	6.49	6.23	5.97	5.72	5.48	5.24	5.01	4.79
15	8.11	7.80	7.50	7.21	6.94	6.67	6.41	6.16	5.92	5.68	5.44
16	8.88	8.55	8.24	7.95	7.66	7.38	7.12	6.85	6.60	6.35	6.11
17	9.65	9.32	9.00	8.69	8.39	8.11	7.83	7.56	7.30	7.04	6.79
18	10.44	10.09	9.76	9.44	9.13	8.84	8.55	8.27	8.00	7.24	7.48
19	11.23	10.87	10.53	10.20	9.88	9.58	9.28	9.00	8.72	8.45	8.18
20	12.03	11.66	11.31	10.97	10.64	10.33	10.02	9.73	9.44	9.16	8.89
21	12.84	12.46	12.09	11.75	11.41	11.09	10.77	10.47	10.18	9.89	9.61
22	13.65	13.26	12.89	12.53	12.18	11.85	11.53	11.22	10.92	10.62	10.34
23	14.47	14.07	13.68	13.32	12.96	12.62	12.29	11.97	11.66	11.36	11.07
24	15.29	14.88	14.49	14.11	13.75	13.40	13.06	12.73	12.42	12.11	11.81
25	16.12	15.70	15.30	14.91	14.54	14.18	13.84	13.50	13.18	12.86	12.56

TABLE 5 (continued)

Required number of circuits	Weighted mean peakedness factor										
	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
	Overflow traffic in erlangs										
26	16.96	16.53	16.11	15.72	15.34	14.97	14.62	14.28	13.94	13.62	13.31
27	17.80	17.35	16.93	16.53	16.14	15.77	15.41	15.06	14.72	14.39	14.07
28	18.64	18.19	17.76	17.34	16.95	16.57	16.20	15.84	15.49	15.16	14.83
29	19.49	19.02	18.58	18.16	17.76	17.37	16.99	16.63	16.28	15.93	15.60
30	20.34	19.87	19.42	18.99	18.57	18.18	17.79	17.42	17.06	16.71	16.37
31	21.19	20.71	20.25	19.81	19.39	18.99	18.60	18.22	17.85	17.50	17.15
32	22.05	21.56	21.09	20.65	20.22	19.80	19.41	19.02	18.65	18.29	17.93
33	22.91	22.41	21.93	21.48	21.04	20.63	20.22	19.83	19.45	19.08	18.72
34	23.77	23.27	22.78	22.32	21.88	21.45	21.04	20.64	20.25	19.88	19.51
35	24.64	24.12	23.63	23.16	22.71	22.28	21.86	21.45	21.06	20.68	20.31
36	25.51	24.98	24.48	24.01	23.55	23.11	22.68	22.27	21.87	21.48	21.10
37	26.38	25.85	25.34	24.85	24.39	23.94	23.51	23.09	22.68	22.29	21.91
38	27.25	26.71	26.20	25.70	25.23	24.78	24.34	23.91	23.50	23.10	22.71
39	28.13	22.58	27.06	26.56	26.08	25.61	25.17	24.74	24.32	23.91	23.52
40	29.01	28.45	27.92	27.41	26.92	26.46	26.00	25.57	25.14	24.73	24.33
41	29.89	29.32	28.79	28.27	27.78	27.30	26.84	26.40	25.97	25.55	25.15
42	30.77	30.20	29.65	29.13	28.63	28.15	27.68	27.23	26.80	26.37	25.96
43	31.66	31.08	30.52	30.00	29.49	29.00	28.53	28.07	27.63	27.20	26.78
44	32.54	31.96	31.40	30.86	30.35	29.85	29.37	28.91	28.46	28.03	27.61
45	33.43	32.84	32.27	31.73	31.21	30.70	30.22	29.75	29.30	28.86	28.43
46	34.32	33.72	33.14	32.60	32.07	31.56	31.07	30.60	30.14	29.69	29.26
47	35.21	34.61	34.02	33.47	32.93	32.42	31.92	31.44	30.98	30.53	30.09
48	36.11	35.49	34.90	34.34	33.80	33.28	32.78	32.29	31.82	31.37	30.92
49	37.00	36.38	35.78	35.21	34.67	34.14	33.63	33.14	32.67	32.21	31.26
50	37.90	37.27	36.67	36.09	35.54	35.01	34.49	34.00	33.52	33.05	32.59

TABLE 5 (continued)

Required number of circuits	Weighted mean peakedness factor												
	2.1	2.2	2.3	2.4	2.5	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
	Overflow traffic in erlangs												
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.50	0.31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	1.03	0.84	0.66	0.46	0.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	1.57	1.38	1.20	1.01	0.82	0.63	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	2.13	1.94	1.75	1.56	1.38	1.19	0.80	0.35	0.0	0.0	0.0	0.0	0.0
11	2.71	2.52	2.32	2.13	1.94	1.75	1.36	0.97	0.54	0.0	0.0	0.0	0.0
12	3.31	3.11	2.91	2.71	2.52	2.32	1.93	1.55	1.15	0.73	0.0	0.0	0.0
13	3.93	3.72	3.52	3.31	3.11	2.91	2.51	2.12	1.73	1.33	0.91	0.39	0.0
14	4.57	4.35	4.13	3.92	3.72	3.51	3.11	2.71	2.31	1.91	1.51	1.09	0.61
15	5.21	4.99	4.77	4.55	4.34	4.13	3.71	3.30	2.90	2.50	2.10	1.70	1.27
16	5.88	5.64	5.42	5.19	4.97	4.75	4.33	3.91	3.50	3.10	2.69	2.29	1.88
17	6.55	6.31	6.07	5.84	5.62	5.39	4.96	4.53	4.11	3.70	3.29	2.89	2.48
18	7.23	6.99	6.74	6.51	6.27	6.05	5.60	5.16	4.73	4.31	3.90	3.49	3.08
19	7.93	7.67	7.42	7.18	6.94	6.71	6.25	5.80	5.36	4.93	4.51	4.09	3.68
20	8.63	8.37	8.11	7.86	7.62	7.38	6.91	6.45	6.00	5.56	5.13	4.71	4.29
21	9.34	9.07	8.81	8.55	8.30	8.06	7.57	7.11	6.65	6.20	5.76	5.33	4.91
22	10.06	9.78	9.52	9.25	9.00	8.74	8.25	7.77	7.31	6.85	6.40	5.97	5.53
23	10.78	10.50	10.23	9.96	9.70	9.44	8.93	8.45	7.97	7.51	7.05	6.61	6.17
24	11.52	11.23	10.95	10.68	10.41	10.14	9.63	9.13	8.64	8.17	7.71	7.25	6.81
25	12.26	11.96	11.68	11.40	11.12	10.85	10.33	9.82	9.32	8.84	8.37	7.91	7.45

TABLE 5 (continued)

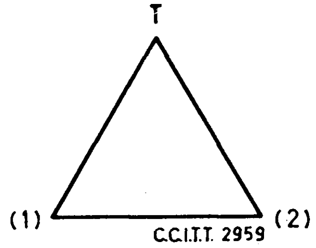
Required number of circuits	Weighted mean peakedness factor												
	2.1	2.2	2.3	2.4	2.5	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
	Overflow traffic in erlangs												
26	13.00	12.70	12.41	12.12	11.84	11.57	11.03	10.51	10.01	9.51	9.04	8.57	8.11
27	13.75	13.45	13.15	12.86	12.57	12.29	11.74	11.21	10.70	10.20	9.71	9.23	8.76
28	14.51	14.20	13.89	13.60	13.30	13.02	12.46	11.92	11.40	10.89	10.39	9.91	9.43
29	15.27	14.96	14.64	14.34	14.04	13.75	13.18	12.63	12.10	11.58	11.08	10.59	10.10
30	16.04	15.72	15.40	15.09	14.79	14.49	13.91	13.35	12.81	12.28	11.77	11.27	10.78
31	16.81	16.48	16.16	15.85	15.54	15.23	14.65	14.08	13.53	12.99	12.47	11.96	11.46
32	17.59	17.25	16.93	16.61	16.29	15.98	15.38	14.81	14.25	13.70	13.17	12.65	12.15
33	18.37	18.03	17.70	17.37	17.05	16.74	16.13	15.54	14.97	14.42	13.88	13.36	12.84
34	19.16	18.81	18.47	18.14	17.81	17.50	16.88	16.28	15.70	15.14	14.59	14.06	13.54
35	19.94	19.59	19.25	18.91	18.58	18.26	17.63	17.02	16.43	15.87	15.31	14.77	14.24
36	20.74	20.38	20.03	19.69	19.35	19.02	18.39	17.77	17.17	16.59	16.03	15.49	14.95
37	21.53	21.17	20.81	20.47	20.13	19.79	19.15	18.52	17.92	17.33	16.76	16.20	15.66
38	22.33	21.96	21.60	21.25	20.90	20.57	19.91	19.28	18.66	18.07	17.49	16.93	16.38
39	23.14	22.76	22.40	22.04	21.69	21.34	20.68	20.04	19.41	18.81	18.22	17.65	17.10
40	23.94	23.56	23.19	22.83	22.47	22.12	21.45	20.80	20.17	19.56	18.96	18.38	17.82
41	24.75	24.36	23.99	23.62	23.26	22.91	22.23	21.56	20.92	20.31	19.70	19.12	18.55
42	25.56	25.17	24.79	24.42	24.05	23.70	23.00	22.33	21.69	21.06	20.45	19.86	19.28
43	26.38	25.98	25.60	25.22	24.85	24.49	23.78	23.11	22.45	21.82	21.20	20.60	20.01
44	27.19	26.79	26.40	26.02	25.65	25.28	24.57	23.88	23.22	22.57	21.95	21.34	20.75
45	28.01	27.61	27.21	26.82	26.45	26.07	25.36	24.66	23.99	23.34	22.71	22.09	21.49
46	28.84	28.43	28.03	27.63	27.25	26.87	26.15	25.44	24.76	24.10	23.47	22.84	22.24
47	29.66	29.25	28.84	28.44	28.06	27.68	26.94	26.23	25.54	24.87	24.23	23.60	22.98
48	30.49	30.07	29.66	29.26	28.86	28.48	27.23	27.01	26.32	25.64	24.99	24.36	23.74
49	31.32	30.89	30.48	30.07	29.68	29.29	28.53	27.80	27.10	26.42	25.76	25.11	24.49
50	32.15	31.72	31.30	30.89	30.49	30.10	29.33	28.60	27.89	27.20	26.53	25.88	25.25

RECOMMENDATION E.522 RECOMMENDATION Q.89

NUMBER OF CIRCUITS IN A HIGH-USAGE GROUP

1. *Introduction*

For the economic planning of an alternate routing network the number of circuits in a high-usage group should be determined so that the annual charges for the whole network arrangement is a minimum. This is done under the constraint that given requirements for the grade of service are fulfilled. In the optimum arrangement, the cost per erlang of carrying a marginal amount of traffic over the high-usage route or over the alternative route is the same.



The optimum number of high-usage circuits, *n*, from one exchange (1) to another exchange (2) is therefore obtained from the following expression when the overflow traffic is routed over a transit exchange *T* (route 1-*T*-2).

$$F_n(A) = A\{E_1n(A) - E_1(n+1)(A)\} = M \cdot \frac{\text{annual charge (1-2)}}{\text{annual charge (1-}T\text{-2)}}$$

A is the traffic flow offered, for the relation " 1-2 ", in the Erlang loss formula for a full availability group. The expression $F_n(A)$ gives the marginal occupancy (improvement function[1]) for the high-usage group, if one more circuit were added *M* is the *marginal utilization factor for the final route* " 1-*T*-2 " (which has nothing to do with cost ratio), if one additional circuit were provided. The annual charges are marginal charges for adding one additional circuit to route " 1-2 " and likewise to route " 1-*T*-2 ".

Planning of an alternate routing network is described in the literature (see, *inter alia*, the bibliography contained in Annex 1).

2. *Recommended practical method*

2.1 *Field of application*

It must be recognized that the conditions applying to alternative routing will vary widely between the continental network and the intercontinental network. Significant differences between the two cases apply to the length and cost of circuits, the traffic flow and the different times at which the busy hours occur. The method described attempts to take account of these factors in so far as it is practicable to do so in any simplified procedure.

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[1] The values $F_n(A)$ are tabulated in A. Jensen, *Moe's Principle*, Copenhagen, 1950.

2.2 *Traffic statistics*

The importance of reliable traffic estimates should be emphasized. Traffic estimates are required for each of the relations in question, for both the busy hour of the relation and for the busy hour of each link of the routes to which the traffic overflows. Since this may be affected by the high-usage arrangements finally adopted, it will be necessary to have traffic estimates for each relation covering most of the significant hours of the day. This applies particularly to the intercontinental network where the final routes carry traffic components with widely differing busy hours.

2.3 *Basis of the recommended method*

The method is based on a simplification of the economic dimensioning equations described under 1. Introduction. The simplifying assumptions are:

i) the ratios of the alternative/high-usage annual charges are grouped in classes and a single ratio selected as representative for each class. This is acceptable because total network costs are known to be relatively insensitive to changes in the annual charges ratio;

ii) the marginal utilization factor M applicable to the overflow routes is regarded as constant within a range of circuit group sizes;

Size of group (number of circuits)	Value of M
for less than 10	0.6
for 10 or more	0.8

iii) each high-usage group will be dimensioned against the cheapest alternative route to which traffic overflows. (That is, the effect of parallel alternative routes is ignored.)

Where greater precision is required in either network or individual route dimensioning, more sophisticated methods may be employed. The utility of computers in this work is recognized[1].

2.4 *Determination of cost ratio*

In continental and intercontinental working, the number of circuits to be provided in high-usage circuit groups depends upon the ratio of the annual charges estimated by the Administrations * involved. The annual charge ratio (see Table 1 at the end of the Recommendation) is defined as:

$$R = \frac{\text{annual charge of one additional circuit on the alternative route}}{\text{annual charge of one additional circuit on the high-usage route}}$$

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* or recognized private operating agencies.

[1] See Question 18/XIII.

The " annual charge of one additional circuit on the alternative route " is calculated by summing:

— the annual charge per circuit of each link comprising the alternative route and

— the annual charge of switching one circuit at each intermediate switching centre.

The traffic value used should be the value of traffic offered to the high-usage route during the busy hour of the final route. It is likely that some of the busy hours of the circuit groups or links forming an alternative route will not coincide with the busy hour of the relation. Some of these links may therefore receive no overflow necessitating additional circuits and there will be no annual charges for this link of the alternative route. Several hours must be examined to determine the ratio between the annual charges for the alternative and the high-usage route. It is possible that the ratio is less than unity but this case is not shown in the table because the provision of high-usage circuits would then be used for grade of service reasons. Cases of this type can introduce valuable economies but the calculation of the appropriate number of circuits to be provided is best handled by a computer.

The value determined for R should then be employed to select in Table 1 the precise (or next higher) value of annual charges ratio for use in traffic tables. The value of annual charges ratios may be grouped in the following general sets:

a) within a single continent or other smaller closely connected land mass involving distances up to 1000 miles, high traffic and frequently one-way operation:

Annual charges ratio: $R = 1.5; \underline{\underline{2.0}}; 3.0$ and 4

b) intercontinental working involving long distances, small traffic and usually two-way operation:

Annual charges ratio: $R = 1.1; \underline{\underline{1.3}}$ and 1.5

2.5 *Use of method*

High-usage circuit groups carrying random traffic can be dimensioned from Table 1.

Step 1. — Estimate the annual charges ratio R as described under 2.4. (There is little difference between adjacent ratios.) If this ratio is difficult to estimate, the values underlined in a) and b), section 2.4, should be used.

Step 2. — Consult Table 1 to determine the number of high-usage circuits N.

Note. — When two values of N are given the right-hand figure applies to alternative routes of more than 10 circuits, the left-hand figure applies to smaller groups. The left-hand figure is omitted when it is no longer possible for the alternative route to be small.

3. *Service considerations*

On intercontinental circuits, where both-way operation is employed, a minimum of two circuits may be economical. Service considerations may also favour an increase in the number of direct circuits provided, particularly where the annual charges ratio approaches unity.

Although the dimensioning of high-usage groups is normally determined by traffic flows and annual charges ratios, it is recognized that such groups form part of a network having service requirements relative to the subscriber. The ability to handle the offered traffic with acceptable traffic efficiency should be tempered by the overall network considerations on quality of service.

The quality of service feature, which is of primary importance in a system of high-usage and final circuit groups, is the advantage derived from direct circuits versus multi-link connections. A liberal use of direct high-usage circuit groups, taking into account the economic factors, favours a high quality of service to the subscriber. It is recommended that new high-usage groups should be provided whenever the traffic flow and cost ratios are not conclusive. This practice may result in direct high-usage groups of two circuits or more.

The introduction of high-usage groups improves the overall grade of service and provides better opportunities of handling traffic during surges and breakdown conditions. When high-usage links bypass the main backbone final routes the introduction of high-usage routes can assist in avoiding expenses which might otherwise be incurred in keeping below the maximum number of long-distance links in series. In the future, more measurements of traffic flows may be necessary for international accounting purposes and high-usage circuits should make this easier.

TABLE 1

Number of high-usage circuits for different values of offered traffic, annual charges ratios and sizes of overflow groups

Traffic offered during network busy hour (erlangs)	Annual charges ratios						Number of circuits if there is no overflow route, for $p = 0.01$
	1.1	1.3	1.5	2.0	3.0	4.0	
	Minimum circuit occupancies for high-usage traffic						
	0.545/0.727	0.46/0.615	0.4/0.53	0.3/0.4	0.2/0.26	0.15/0.2	
	N, number of high-usage circuits A/B, where A is for less than 10 circuits in the overflow group ($M = 0.6$). B is for 10 or more circuits in the overflow group ($M = 0.8$).						
1.5	1/0	1/0	2/1	2/2	3/2	3/3	6
1.75	1/0	2/1	2/1	3/2	3/3	4/3	6
2.0	1/0	2/1	2/2	3/2	4/3	4/4	7
2.25	2/0	2/1	3/2	3/3	4/4	5/4	7
2.5	2/0	3/1	3/2	4/3	5/4	5/5	7
2.75	2/1	3/2	3/2	4/3	5/4	5/5	8
3	3/1	3/2	4/3	4/4	5/5	6/5	8
3.5	3/1	4/2	4/3	5/4	6/5	7/6	9
4.0	4/2	4/3	5/4	6/5	7/6	7/7	10
4.5	4/2	5/3	6/4	6/6	7/7	8/7	10
5.0	5/3	6/4	6/5	7/6	8/7	9/8	11
5.5	5/3	6/5	7/5	8/7	9/8	9/9	12
6.0	6/3	7/5	7/6	8/7	9/9	10/9	13
7.0	7/4	8/6	8/7	10/8	11/10	11/11	14
8.0	8/5	9/7	10/8	11/10	12/11	13/12	15
9.0	/6	/8	/9	/11	/12	/13	17
10.0	/7	/9	/10	/12	/14	/15	18
12.0	/9	/11	/12	/14	/16	/17	20
15.0	/12	/14	/16	/18	/20	/21	24
20.0	/16	/19	/21	/23	/25	/27	30
25.0	/21	/24	/26	/29	/31	/33	36
30.0	/26	/29	/31	/34	/37	/38	42

ANNEX

(to Recommendation E.522 (Q.89))

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CHAPTER IV

GRADE OF SERVICE

RECOMMENDATION E.540 RECOMMENDATION Q.95

OVERALL GRADE OF SERVICE OF THE INTERNATIONAL PART OF AN INTERNATIONAL CONNECTION[1]

1. The International Routing Plan envisages that international traffic relations may be served by any of the following routing arrangements:

a) direct circuits;

b) transit operation involving one or more transit centres for all connections,

c) direct high-usage circuits with overflow via one or more transit centres.

In principle there would be merit in dimensioning international facilities to provide the same grade of service for all relations, however served. Practical considerations make it advisable to depart from one universal value.

2. Direct circuit groups are dimensioned, according to Recommendation E.520 (Q.87) on the basis of $p = 1\%$ loss probability during the mean busy hour. An exception is permitted for small groups of very long international circuits for which $p = 3\%$ loss probability is accepted for six or fewer circuits. As the traffic increases the grade of service improves progressively until $p = 1\%$ loss value is reached for 20 circuits.

3. For the relations served exclusively by transit operation the grade of service will deteriorate with the number of transit centres in the connection. Measurements made on congestion in such circumstances suggest that the overall grade of service for up to six links in tandem is less than twice the congestion of any of the six links in the chain. Hence, for a series of routes, each dimensioned for $p = 1\%$, the overall grade of service should seldom exceed 2%. An East-West type of connection would have the advantage of different busy hours on the various links. Corresponding advantage would not apply to North-South circuits.

In the case of relations served by high-usage circuits the overflow traffic will route over at least two links and, hence, will be subject to the same deterioration of service as in the case for transit traffic. However, a substantial part of the traffic will be connected over the high-usage circuits and the overall grade of service will approximate that of the relations served solely by direct circuits.

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[1] See also Question 17/XIII: Overall grade of service for international connections (subscriber to subscriber).

It is desirable that at least one high-usage circuit should always be provided between a CT3 and its homing CT1, even though the circuit may not be wholly justified on economic considerations alone. The provision of such circuits would improve the transmission as well as the grade of service; these considerations should encourage an increase both in traffic and in the revenue-earning capacity of the circuits provided.

The overall grade of service for the international part of a connection is a contributory factor to the overall grade of service from the calling party in one country to the called party in another.

However, such a circuit should not be provided unless there is a measurable amount of traffic which exists, or can be foreseen in the busy hour.

RECOMMENDATION E.541 RECOMMENDATION Q.96

ACCEPTABLE REDUCTION IN THE NUMBER OF CIRCUITS OF A FINAL ROUTE IN THE EVENT OF A BREAKDOWN

1. *Maximum traffic loading*

1.1 It is the experience of Administrations that an acceptable automatic service on a final circuit group cannot be maintained if the traffic loading on the group exceeds a level corresponding to a calculated Erlang grade of service of 10%. Beyond this traffic loading, and especially owing to the cumulative effect of repeat attempt calls, the service rapidly deteriorates.

1.2 It is recommended, therefore, that this traffic loading be adopted as a criterion to determine whether special corrective measures, described in section 3 of this Recommendation, should be introduced in those cases where it is expected that the abnormal conditions will persist for more than fifteen minutes.

2. *Tolerated proportionate reduction in circuits*

2.1 The following curve indicates the proportionate reduction in circuits that may be tolerated for a short period, 15 minutes for example, under normal busy-hour conditions, on a full availability circuit group dimensioned for 1% Erlang loss, in accordance with the above traffic overload criterion. Table 1 gives the figures used to plot the curve.

2.2 This curve is intended merely as a guide. If the breakdown occurs during an exceptionally busy hour, the permissible proportionate reduction will be less. Conversely, if the breakdown occurs during an hour of light traffic a higher proportionate reduction in circuits could be tolerated. A higher reduction might also be acceptable after an appropriate oral announcement has been introduced. In the general case, a knowledge of the circuit occupancy will enable an estimate to be made of the prevailing Erlang loss figure, with the reduced number of circuits.

The permissible reduction in the case of large groups should not be exceeded, otherwise very serious congestion can result from repeated attempts.

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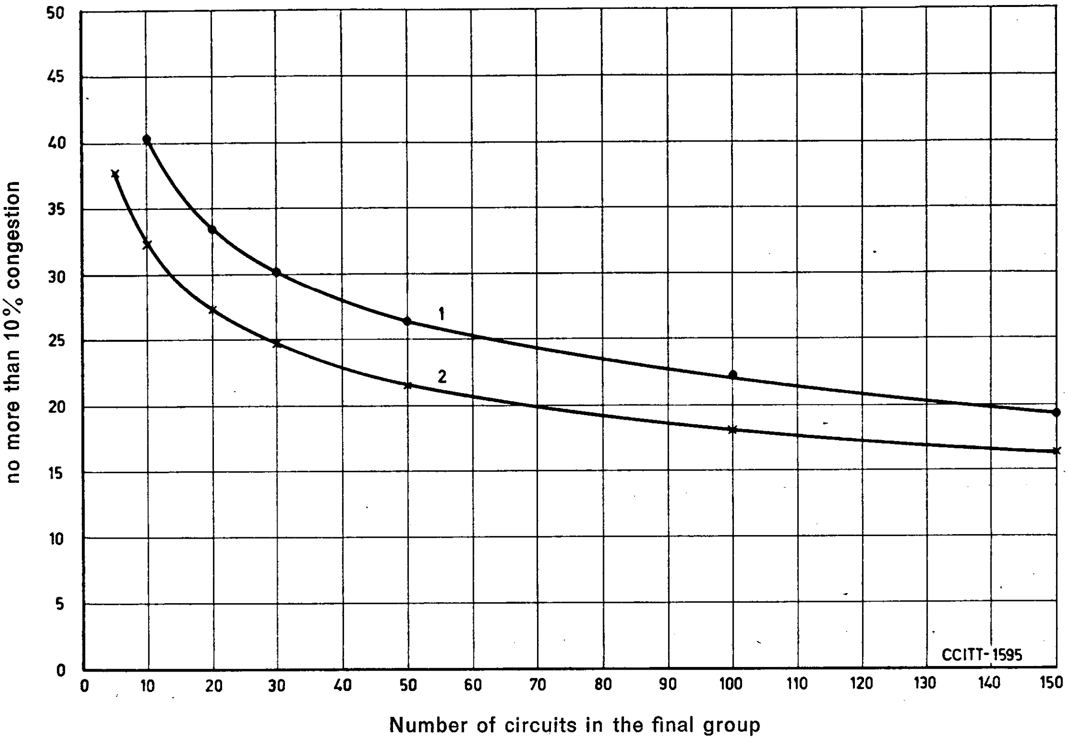
* or recognized private operating Agencies.



1: Peakedness factor = 2.5
2: Random traffic (peakedness factor = 1.0)

Acceptable reduction in the number of circuits in a final group in the event of a breakdown

TABLE 1

Acceptable % reduction in the number of circuits

Number of circuits	If originally operating at 1% congestion, % reduction in circuits allowed to yield 10% congestion	
	Random traffic (peakedness factor = 1.0)	Peakedness factor = 2.5
5	37.7	—
10	32.3	40.2
20	27.2	33.3
30	24.8	30.1
50	21.7	26.5
100	18.3	22.4
150	16.7	19.7

3. *Corrective measures*

3.1 In order to minimize the effect of a breakdown the following procedures should be adopted:

3.1.1 Administrations * should prepare plans for dealing with breakdowns on major routes. Such plans should include dispersal of traffic and prearranged alternatives for emergency use.

3.1.2 Alternative auxiliary routes, not normally economic for the relations affected, should be opened up. In such cases recourse should first be had to supplementary routing indicated in the International Routing Plan but other routings may need to be used. Adequate precautions should be taken to ensure that in no case a call will be routed through a CT previously traversed.

3.1.3 Where TASI systems are used, the number of TASI circuits on the affected route should be expanded but not to exceed a 20% increase.

3.2 The traffic which would normally be offered to the final route affected by breakdown could be reduced in the following ways:

3.2.1 Calls encountering congestion are connected, via overflow, which are normally engaged, to suitable recorded announcements. These announcements could state that a breakdown had occurred and give appropriate instructions to the callers.

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* or recognized private operating Agencies.

3.2.2 In order to reduce the risk of spreading congestion, reports indicating breakdown should be sent by network management signals, as an example, to other centres in order that traffic may be re-routed away from the affected route when this is possible. Reports made for example by network management signals [1] should be used to enable this announcement to be made at the originating centre.

Note. — This Recommendation refers to breakdowns on a final route; however, some of the procedures outlined above could be applied when a breakdown occurs on a high-usage route.

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[1] See Question 4/XIII.

ANNEX

(to Volume VI, Part VI)

Definitions relating to traffic engineering appearing in Recommendation E.100

(see Volume II of the *White Book*)

. . . .

DEFINITION 18. — Traffic carried (by a group of circuits or a group of switches)

18.1 *Amount of traffic carried*

The amount of traffic carried (by a group of circuits or a group of switches) during any period is the sum of the holding times expressed in hours.

18.2 *Traffic flow*

The traffic flow (on a group of circuits or a group of switches) equals the amount of traffic divided by the duration of the observation, provided that the period of observation and the holding times are expressed in the same time units. Traffic flow calculated in this way is expressed in erlangs.

DEFINITION 19. — Traffic offered (to a group of circuits or a group of switches)

It is necessary to distinguish between traffic offered and traffic carried. The traffic carried is only equal to the traffic offered if all calls are immediately handled (by the group of circuits or group of switches being measured) without any call being lost or delayed on account of congestion.

The flow of traffic offered, and of traffic carried, is expressed in erlangs. The amount of traffic offered and of traffic carried is expressed in erlang hours.

DEFINITION 20. — Measurement of busy hour traffic

20.1 *Busy hour (of a group of circuits, a group of switches or an exchange, etc.)*

The busy hour is the uninterrupted period of 60 minutes for which the traffic is the maximum.

Note. — It is usual for the period of the busy hour and the amount of traffic in the busy hour to vary from day to day. In order to obtain a representative traffic estimate, it is recommended that an average value should be calculated from the measurement of a sample, as described later.

It is possible to calculate an average traffic flow which is the mean for the busy hours of the different days in the sample. An alternative method is to find the continuous 60-minute period when the average of the sample is the maximum and to obtain from this period the representative traffic flow. The following recommendations relating to the determination of the sample period and of the mean busy hour (sometimes called " time-consistent " busy hour) apply particularly to the second method.

20.2 *Mean busy hour (of a group of circuits, a group of switches, or an exchange, etc.)*

The mean busy hour is the uninterrupted period of 60 minutes for which the total traffic of a sample is the maximum.

Note. — If it is not known which 60-minute period constitutes the mean busy hour, a sample measurement taken over 10 days should be sufficient to enable the position of the mean busy hour to be determined. As it is desirable to have a uniform method of analysing the statistics thus obtained, the following method is recommended for adoption in the international service, the observations being made over quarter-hourly periods:

- for a number of consecutive days the values observed for the same quarter of an hour each day are added together;
- the mean busy hour is then determined as being the four consecutive quarters which together give the largest sum of observed values.

DEFINITION 21. — **Circuit usage for a group of international circuits (or an international circuit)**

The percentage ratio between the sum of the holding times during a specified period equal to 60 consecutive minutes at least and the total length of that specified period.

In the case of a group of circuits, the circuit usage corresponds to the average traffic density *per circuit* during the specified period.

Note. — Unless otherwise indicated, circuit usage is based on the busy hour.

SPECIFICATIONS FOR STANDARDIZED INTERNATIONAL SIGNALLING AND SWITCHING EQUIPMENT

INTRODUCTION

The strict observance of the clauses of these specifications is of the utmost importance in the manufacture and operation of the equipment. Hence these clauses are obligatory except where it is explicitly stipulated to the contrary.

The values given below are imperative and must be met under normal service conditions.

PART VII

CLAUSES APPLICABLE TO C.C.I.T.T. STANDARD SYSTEMS

CHAPTER I

General. — Clauses applicable to all C.C.I.T.T. standard systems

RECOMMENDATION Q.101

1.1 FACILITIES PROVIDED IN INTERNATIONAL SEMI-AUTOMATIC WORKING

1.1.1 The operating methods used in the semi-automatic international service are described in the *Instructions for the International Telephone Service.* These operating methods assume the existence of equipment (operators' positions and automatic switching equipment) involving the following categories of operators:

a) *outgoing* operators,
b) *incoming* operators,
c) *delay* operators
d) *assistance* operators,
e) information or special service operators.

1.1.2 The outgoing operator controls the setting-up of calls at the outgoing exchange. (From the operating point of view she is, in general, the controlling operator and is sometimes so referred to in the Instructions.)

She must be able to set up calls to any one of the following points in the called country:

a) subscribers;
b) incoming operators at the incoming international exchange;
c) delay operators, especially a particular delay operator at the incoming international exchange;
d) incoming operators at a local manual exchange in the called country;
e) information or special service operators.

The outgoing operator should be able to recall incoming and delay operators on calls set up via these operators, by sending a forward-transfer signal as defined in the relevant system specifications.

1.1.3 The *incoming operator* at the incoming international exchange is obtained by using a special code-11 signal or a special number. The code-11 signal is a particular combination provided by the signal code. This operator performs the functions of an incoming operator in ordinary manual service, for those calls which cannot be routed automatically at the incoming international exchange.

1.1.4 The *delay operator* is obtained by using a special code-12 signal, or a special number. The code-12 signal is a particular combination provided by the signal code. The delay operator may be:

- any of the operators of this category;
- or a particular operator, or one of those operating a particular group of positions; her position or her group of positions is then indicated by a number which follows the code-12 signal or is indicated by the special number.

With respect to the direction in which a required call is set up, the delay operator may be at the outgoing international exchange and may be called by an operator at the incoming international exchange. From the technical point of view and as far as signalling is concerned, however, the delay operator at the outgoing international exchange called back by an operator at an incoming international exchange must be regarded as being at the incoming end of the international circuit over which she has been called back.

1.1.5 Notes on incoming and delay operators:

a) Incoming and delay operators must be able to speak the *service language* used for the route concerned, and hence may have to belong to a particular language group. A *language* (or information) *digit*, from 1 to 8, sent on all semi-automatic calls, is used to obtain operators of a particular language group (see Recommendation Q.104)*.

b) It may be the same operator who acts as an incoming and as a delay operator, and even as an assistance operator. She enters a circuit in any of these capacities in response to the appropriate signal.

c) While an incoming or delay operator is being called, the national ringing tone of the incoming country must be sent back over the international circuit.

1.1.6 The *assistance operator* at the incoming international exchange enters a semi-automatic circuit on a call already set up, when requested by the outgoing operator, because of language difficulties or, for instance, when she is required to interpret a national tone. Access to an assistance operator at an international transit exchange is not possible.

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* The language digit may not be used on some intraregional circuits.

The assistance operator is called by a forward-transfer signal, sent by the outgoing operator when, for example, she operates a key on the outgoing position. An assistance operator in a required language group is obtained in conjunction with the forward-transfer signal by the language digit (or information) sent previously during the setting-up of the call. Hence the incoming relay set must store the language digit (or information).

The outgoing operator receives no indication to show that the assistance operator is being called, or to show when she answers or withdraws from the circuit, but if necessary the outgoing operator can send the forward-transfer signal several times on the same call.

The assistance operator must be able:

a) to break into the call as a third party (this she would do, for example, when the language spoken in the country of arrival is other than the service language used in that relation, and the operator intervenes as an interpreter);

b) to enter a circuit on one side only after having isolated the other. She does this, in particular, when she translates a verbal announcement or interprets an audible tone returned from the incoming end.

In no circumstances will the assistance operator be able to block the international circuit.

Note. — It should be noted that the term "assistance operator" has a very definite meaning in C.C.I.T.T. documents. It stands for an operator who breaks in, as required, as a third party in a circuit already set up. Hence this operator must not be confused with any other operator in the incoming country who may help *to set up* the call in conjunction with the international outgoing operator. Assistance operators may not be available on intraregional circuits.

1.1.7 The information or special service operator of the country of destination is obtained by using a special number. This operator is responsible for giving details concerning subscriber number and miscellaneous inquiries.

RECOMMENDATION Q.102

1.2 FACILITIES PROVIDED IN INTERNATIONAL AUTOMATIC WORKING

In international automatic working, the calling subscriber can obtain only such subscriber numbers as are made up of the numerical digits appearing on his dial or push-button set. Hence, he cannot obtain operators reached by code-11 or code-12 signal, or an assistance operator reached by a forward-transfer signal. In principle, he should not obtain access to incoming, delay or information* operators reached by special numbers.

He can have direct dialling access to manual exchanges in the incoming country only subject to certain conditions (these conditions are defined in Recommendation Q.28, paragraph 2, and in Recommendation Q.120, paragraph 1.8, and are applicable to all C.C.I.T.T. standard systems).

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* For information operators, see Recommendation E.122 reproduced hereafter in the Annex. Technical arrangements of the same nature as the ones described in paragraph 3 of the Annex could be considered for barring access, in the incoming country, to incoming or delay operators when they are reached not by codes 11 or 12 but by special numbers.

It is pointless to send a language digit (or information) over an international circuit since the calling subscriber does not have to obtain operators speaking a particular language at the incoming international exchange. On automatic calls, a discriminating digit (or discriminating information) replaces the language digit (or information) sent on semi-automatic calls. This

- enables the equipment in the outgoing international exchange to make a distinction between semi-automatic and automatic calls as is required when drawing up international accounts, as described in section 2 of Recommendation Q.51;
- enables, therefore, incoming equipment to serve both automatic and semi-automatic service;
- in systems No. 4, No. 5 *bis* and No. 6, informs the equipment in the international incoming exchange that it has not to rely on an end-of-pulsing signal (see Recommendation Q.106);
- enables the equipment in the incoming international exchange to prevent automatic calls from having access to certain destinations (special services, for example).

ANNEX

(to Recommendation Q.102)

Access to a telephone information operator in a foreign country *

1. In the international *automatic* service:

1.1 A subscriber desiring to inquire about a subscriber's number, or to make any general telephone inquiry in another country, must appeal to a special service in his own country, which will obtain the information for him if it is not to hand.

1.2 Technical arrangements should, so far as practicable, bar access by a subscriber in a foreign country to an operator of the telephone information service of another country.

Note. — If it is impossible to prevent subscribers having free access to information operators in a foreign country, there would generally be timing to clear down the call when no answer signal is forthcoming, and the access time to the information service would thus be automatically limited.

1.3 On no account should the numbers or codes giving access to the telephone information services in other countries be included in published dialling code information.

2. In *semi-automatic* international service:

Outgoing operators should be able to get in touch with the information services of foreign countries. It was considered advantageous, and even essential, where big countries were concerned, that an operator should be able to obtain information about subscriber numbers from the source, that is to say, from any decentralized services that might happen to be in the foreign country, and not just from some single information bureau in that country.

Provision should be made for access to a centralized service in the country of destination for the purpose of acquiring information about subscriber numbers, even when direct access

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* This text appears in Volume II-A of the *White Book* as Recommendation E.122.

to decentralized information services is possible, since the outgoing operator might fear language difficulties, or may not know the number to dial to obtain the regional information service.

3. There are various possible ways whereby operators could be ensured access to the information operators in other countries, and whereby such access could be prohibited to subscribers.

3.1 Automatic calls might be distinguished from semi-automatic ones on arrival. Automatic calls to information services, characterized by the few number of the digits in their call numbers, could be blocked.

3.2 Outgoing operators might be told to get in touch with information operators in a foreign country via incoming operators (so-called code-11 operators). Access to information services would then be blocked for all calls coming from international circuits.

RECOMMENDATION Q.103

1.3 NUMBERING USED

1.3.1 *International prefix*

The international prefix (see definition 1 in Recommendation Q.10) which gives subscribers access to the international automatic network is used only in automatic working and is not used in semi-automatic working.

The international prefix is not included in the numerical signals sent out from the international outgoing exchange.

1.3.2 *Country code* *

Information about country codes will be found under 7.2 in Recommendation Q.11. In the international outgoing exchange, the country code is used:

a) in automatic working for the purpose of giving access to outgoing circuits;

b) in semi-automatic working when it is required to give outgoing operators in the outgoing international exchange access to the circuit by means of selectors.

The country code is sent on the international circuit or signalling channel in the case of transit calls (in system No. 5 *bis* on terminal and transit calls).

RECOMMENDATION Q.104

1.4 LANGUAGE DIGIT OR DISCRIMINATING DIGIT

1.4.1 *Language digit* (or language information)

1.4.1.1 The language digit defined under 1.1.5 indicates the *service language* to be used between operators in the international service, that is to say, the language to be spoken in the incoming international exchange by the incoming, delay and assistance operators

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* The country code may not be used on some intraregional calls.

when they come on the circuit. The language digit (or information) must be sent on *all* semi-automatic calls.

1.4.1.2 The digit (or indicator) to be used to select the appropriate language is as follows:

1 = French
2 = English
3 = German
4 = Russian
5 = Spanish
6, 7, 8 } available to Administrations for selecting a particular language provided by mutual agreement (in systems No. 5 and No. 5 *bis*, however, digit 7 is used on calls requiring access to test equipment)
9 = reserve (see 1.4.2.2)

1.4.1.3 The language digit (or information) is either:

— sent by the operator to the outgoing equipment; in this case the operator must send it immediately before the national (significant) number* of the called subscriber;

or:

— sent automatically by the outgoing equipment.

1.4.2 *Discriminating digit* (or discriminating information)

1.4.2.1 In all automatic calls, the position in the sequence of numerical signals occupied by the discriminating digit (or information) is that occupied by the language digit (or information) in semi-automatic calls (see Recommendations Q.102 and Q.107).

1.4.2.2 The digit 9 (or its equivalent) in the list of language digits (or calling party's categories) has been kept in reserve for use as extra discriminating information if required. Such use should be for a call with special characteristics, but the digit 9 (or the equivalent information) must not be used merely to take the place of the digit 0 (or its equivalent) in an automatic call**.

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* See definition in Recommendation Q.10 (E.160).

** For example, it might be thought useful to have an additional discriminating digit (or information) when a distinction has to be made between:

a) automatic calls and

b) semi-automatic calls set up in the outgoing country directly by ordinary operators, in national exchanges and not by international operators in the international exchange, and arriving by the same group of national circuits as calls mentioned in a).

Such a distinction might be necessary because:

— in international accounts, calls mentioned in b) are to be dealt with as semi-automatic calls and are not to be metered by the international equipment,

— for signalling, calls mentioned in b) are not accompanied by an end-of-pulsing signal.

1.4.2.3 Combination 13 in the signal code of system No. 4 and system R2 and its equivalent in system No. 6, as well as combination 7 in the signal code of system No. 5 and system No. 5 *bis* serve as a discriminating digit (or information) on calls to automatic testing equipment.

1.4.2.4 Combination 11 and combination 12 in the signal code of system No. 5 *bis* or its equivalent in system No. 6 may be used as a discriminating digit (or calling party's category indicator) on calls originated by a subscriber with priority (combination 11) or on data calls (combination 12).

1.4.2.5 On all automatic calls the discriminating digit must be sent over the international circuit or signalling channel by the country of origin of the call, and this country has to arrange for the automatic insertion of the discriminating digit (or information).

RECOMMENDATION Q.105

1.5 NATIONAL (SIGNIFICANT) NUMBER

1.5.1 In automatic working, the subscriber sends the called subscriber's national (significant) number* by means of a dial, push-button set, or automatic dialling device.

1.5.2 In semi-automatic working, the operator sends the national (significant) number* of the called subscriber by means of a keyset for example.

1.5.3 The outgoing equipment must be designed to cater for a sufficient number of digits in the national (significant) number* as specified in Recommendation E.161 (Q.11), paragraphs 2.2 and 3.

RECOMMENDATION Q.106

1.6 THE SENDING-FINISHED SIGNAL

In semi-automatic working, when the international outgoing operator has finished keying or dialling, she operates a special button on her keyboard or a key so that, after the number, a local signal which is called a "sending-finished" signal is sent to the outgoing equipment to show that there are no more digits to follow. In automatic working, subscribers cannot show when they have finished dialling the number, and so this signal does not apply.

Note. — In semi-automatic working, local sending of the sending-finished signal will cause an "end-of-pulsing" signal to be sent on the international circuit** or signalling channel. This has the same function and shows the incoming equipment that there are no more digits to be received. In some cases also in automatic working, when the outgoing equipment decides that there are no more digits to follow, an end-of-pulsing signal is sent on the international circuit or signalling channel, for example in the ST condition of system No. 5 (see Recommendation Q.152),

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* See the definitions in Recommendation Q.10 (E.160).

** In system R2 the sending of "end-of-pulsing" signal (code 15) may not occur if a "number-received" indication has already been received.

RECOMMENDATION Q.107

1.7 SENDING SEQUENCE OF NUMERICAL (OR ADDRESS) SIGNALS

The sequence of numerical (or address) signals sent from the operator, calling subscriber or test equipment to the outgoing equipment is usually as shown on Table 1. This sequence corresponds in general to the sequence of signals sent over the international circuit or signalling channel. For complete details, see the specifications of the signalling systems concerned.

Notes to Table 1:

[1] The terminal or transit indication is contained in the seizure signals.

[2] KP1 for terminal calls, KP2 for transit calls.

[3] Calling party's category information may be sent on request.

[4] In some cases the country code will be preceded by a KP signal.

[5] The operator may not have to send this information.

[6] For a call to a subscriber connected to a manual exchange obtained by automatic switching via the incoming international exchange, the national (significant) number consists of:

- the code of the required manual exchange in the national numbering plan,
- possibly the called subscriber's number if, in the incoming country, this number is required for routing the call to the manual exchange.

[7] When a country has more than one incoming international exchange, code 11 or code 12 may be preceded by one extra digit designating the incoming exchange. However, it is recognized that existing design of some present-day equipments does not permit the insertion of the extra digit N1. In this situation, agreement will be required between the relevant countries concerned that this insertion of N1 would not be provided for at a particular outgoing international exchange as long as the equipment limitation applied.

[8] For a call to an incoming or to any delay operator, code 11 and code 12 respectively will be followed by the "sending finished" signal.

For a call to a specific delay operator or to a specific group of delay operators, code 12 will be followed by numerical information designating the desired delay operator or group of delay operators.

For a call to an information operator, special service operator or, in general, for calls to incoming and delay operators in countries not equipped to receive code 11 or code 12 signals, special numbers will be used to designate the operator or group of operators desired.

[9] The country code is not sent to the incoming (terminal) international exchange.

[10] The trunk code (area code) is not sent to the called numbering area (NPA) of a country in an integrated numbering plan.

[11] The transit indication (= code 12) and the country code are not sent to the incoming (terminal) international exchange.

[12] On bilateral agreement, the L- or D-digit will not be sent to the incoming (terminal) international exchange.

[13] Code 15 is not sent if the incoming international exchange does not request it.

[14] On automatic calls code 15 or the ST-signal *may* be sent when available.

[15] For traffic within an integrated numbering area, the discriminating or language digit (or equivalent information) and the country code may not always be sent.

[16] For traffic within an integrated numbering area, the international prefix and the country code may not always be sent.

The following abbreviations are used throughout the table:

L = Language digit or information.
D = Discriminating digit or information.
Nat. No. = National (significant) number.
CP category ind. = Calling party's category indicator.
Routing inf. = Routing information in system No. 6 (terminal or transit indicator, nature of circuit indicator and echo-suppressor indicator).

TABLE 1. — **Sequence of numerical (address) signals**

Type of call	Information sent by the user	Numerical (or address) and routing information sent over the circuit or signalling channel in C.C.I.T.T. system					
		No. 4[1]	No. 5[2]	No. 5 *bis*	No. 6	R1	R2[3]
Semi-automatic call to a subscriber	— Country code[4, 5] L-digit[5] Nat. No.[6] Sending finished	— Country code[9] L-digit Nat. No. Code 15	KP1 or KP2 Country code[9] L-digit Nat. No. ST	X-digit Country code Z-digit (L) Nat. No. ST	Routing inf. CP category ind. (L) Country code[9] — Nat. No. ST	KP Country code[15] L-digit[15] Nat. No.[10] ST	Trans. indication[11] Country code[11] L-digit[12] Nat. No. Code 15[13]
Semi-automatic call to an incoming, delay, information or special service operator	— Country code[4, 5] L-digit[5] Code 11, code 12 or a special No.[7,8] Sending finished	— Country code[9] L-digit Code 11, code 12 or special No. Code 15	KP1 or KP2 — Country code[9] L-digit Code 11, code 12 or special No. ST	X-digit Country code Z-digit (L) Code 11, code 12 or special No. ST	Routing inf. CP category ind. (L) Country code[9] — Code 11, code 12 or special No. ST	KP Country code[15] L-digit[15] Special No.[10] ST	Trans. indicat.[11] Country code[11] L-digit[12] Code 11, code 12 or special No. Code 15[13]
Automatic call to a subscriber	— Internat. prefix[16] Country code[16] — Nat. No. —	— — Country code[9] D = 0 Nat. No. Code 15[14]	KP1 or KP2 — Country code[9] D = 0 Nat. No. ST	X-digit — Country code[9] Z-digit (D) Nat. No. ST[14]	Routing inf. C.P. category ind. (D) Country code[9] Nat. No. ST[14]	KP — — Country code[15] D = 0[15] Nat. No.[10] ST	Trans. ind.[11] — Country code[11] D = 0 Nat. No. —
Test call		— — D = Code 13 Code 12 Digit 0 2 digits Code 15	KP1 — D = Code 7 Code 12 Digit 0 2 digits ST	X-digit Country code Z-digit (D = 7) Code 12 Digit 0 2 digits ST	Routing inf. — C.P. category ind. (test) — — X ($^{1, 2}$ or ^{3}) ST	KP — — — — Digits to be agreed ST	— — Code 13 — Code 13 2 digits Code 15[13]

RECOMMENDATION Q.108

1.8 ONE-WAY OR BOTH-WAY OPERATION OF INTERNATIONAL CIRCUITS

1.8.1 *One-way operation*

In order to have as simple as possible equipment in international exchanges and to avoid double seizures, systems No. 3 and No. 4 have been designed in 1949-1954 for one-way operation of international circuits in semi-automatic and automatic working.

1.8.2 *Both-way operation*

1.8.2.1 These advantages of one-way operation naturally hold good in the case of long international (intercontinental) circuits. However, for these circuits the following considerations have been determining factors in providing both-way circuit operation:

a) When a group of circuits is composed of a small number of circuits, the increase in efficiency due to both-way operation is obviously very important. Moreover, long international (intercontinental) circuits are very costly. Finally, the increase in the cost of terminal equipment which results from both-way operation is small compared with the considerable economic advantage derived from this mode of operation.

b) The two ends of a long international (intercontinental) group of circuits may belong to two time-zones which are very far apart and, depending on the difference in time, this is likely to result in important and variable differences between the traffic in the two directions.

1.8.2.2 All circuits in systems No. 5 and No. 5 *bis*, and the speech circuits in system No. 6 should be *equipped* to work in both-way operation. Nevertheless, the both-way method of operation would be applied only if it offered a considerable economic advantage. Hence in the case of large groups (for example, more than 40 circuits in each direction), the possibility of maintaining *one-way operation* might be considered, because of the extra reliability of this type of operation. If, in circumstances necessitating the use of large groups, there are great differences between the busy hours at each end, it would be advisable, if it were desired to maintain one-way operation, to arrange that the circuits be used successively in one or the other direction according to the time of day. This availability of the circuits for routing traffic from country A to country B or vice versa would be arranged by a convenient method.

In certain cases another solution is worthy of consideration. This consists of setting up three groups of circuits, two operated one-way and the third both-way, it being understood that the latter would be used as an overflow route for calls which could not be routed on the first two groups.

1.8.2.3 Attention is drawn to the conditions which should be introduced to avoid double seizing and false blocking on both-way international circuits. In addition, attention is drawn to the fact that in semi-automatic working, as in automatic working, access to the circuits at both ends should be automatic.

In semi-automatic operation, in the event of double seizing, automatic selection of a new circuit should be preferred to the operator's setting up the call again, so that the operator does not become aware of the double seizing. In automatic operation, automatic selection of a new circuit should naturally be the rule.

The necessary arrangements have been made in the specifications of the systems concerning simultaneous seizing in both-way operation.

1.8.2.4 The circuits in systems R1 and R2 may be equipped to work in both-way operation.

RECOMMENDATION Q.109

1.9 TRANSMISSION OF THE ANSWER SIGNAL IN INTERNATIONAL EXCHANGES

For the reasons given in Recommendation Q.27, it is necessary to reduce to a minimum the delays resulting from:

- the conversion of the national answer signal into the international answer signal and vice versa, and
- the transmission of the international answer signal over the international part of the connection,

these delays being additional to any delays due to conversions and repetitions of the answer signal within the national systems of the incoming and outgoing countries.

CHAPTER II

Transmission clauses for signalling

CLAUSES COMMON TO SIGNAL RECEIVERS (AND SENDERS) FOR SIGNALLING SYSTEMS No. 4, No. 5, No. 5*bis*, R1 AND R2 *

RECOMMENDATION Q.112

2.1 SIGNAL LEVELS AND SIGNAL RECEIVER SENSITIVITY

2.1.1 *Standardized transmitted power*

The values of the standardized transmitted power for the different line and inter-register signals are defined in the relevant parts of the Specifications for the C.C.I.T.T. systems No. 4, No. 5, No. 5 *bis*, R.1 and R.2. They correspond with the " maximum permissible power " for the signalling frequencies (see Recommendation Q.16).

Note. — The level of leak current which might be transmitted to line, for example, when static modulators are used for signal transmission, should be considerably below signal-level, as specified.

2.1.2 *Variations of the absolute power level of received signals*

The standardized absolute power level of the signalling current to be transmitted is fixed at the maximum value compatible with circuit transmission requirements and the extreme values of absolute power level, between which received signalling currents may lie, depend on three factors:

1. the overall loss and the variation with time of this loss of the international circuit (link-by-link signalling) or of the chain of international circuits (end-to-end signalling) at 800 Hz;
2. the variation with frequency of the overall loss of these circuits, in relation to the nominal value at 800 Hz;
3. the tolerance on the transmitted absolute power level in relation to the nominal value.

The operate level range of the signal receivers about a nominal value should take account of these three factors. In system No. 4, the operate range (± 9 dB) is appropriate for end-to-end signalling. The maximum number of circuits in the end-to-end signalling situation is normally three but more may be possible depending upon the actual conditions. In systems No. 5 and No. 5*bis* the operate range (± 7 dB) for line signals and for register

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* For signalling system No. 6, see Part XIV of this Volume.

signals is appropriate for each circuit in link-by-link signalling. For the other C.C.I.T.T. systems see the relevant parts of their specifications.

2.1.3 *Maximum sensitivity of the signal receiver*

It is desirable to limit the maximum sensitivity of the signal receiver, particularly on account of crosstalk between the GO and RETURN paths of a four-wire circuit, leak currents, etc.

RECOMMENDATION Q.113

2.2 CONNECTION OF SIGNAL RECEIVERS IN THE CIRCUIT

2.2.1 The line signal receivers are permanently connected to the four-wire side of the circuit. The register signal receivers in system No. 5 are connected to the four-wire side of the circuit when the register is associated with the circuit for the setting-up of the call; the same is valid for the register signal receivers in system No. 5 *bis* and (in the international exchanges) for the register signal receivers in systems R.1 and R.2.

2.2.2 An in-band line signal receiver should be protected against disturbing currents (voice currents or possibly noise), coming from the near end of the circuit, by a buffer amplifier or other arrangement. The arrangement used should introduce an appropriate supplementary attenuation in such a manner that, at the point where the line signal receiver is connected, these disturbing currents are of such a level that they cannot:

— operate the line signal receiver,

— interfere with the reception of signals by operating the guard circuit of the line signal receiver.

The additional attenuation introduced should in consequence take account of:

a) the relative level n at the point where the signal receiver is connected (this relative level is obtained by assuming a zero relative level at the distant origin of the circuit);

b) the minimum permissible signal level at the input to the signal receiver, for example:

$-18 + n$ dBm in the case of system No. 4 (see 3.2.1 in Recommendation Q.123)
$-16 + n$ dBm in the case of system No. 5 (see 2.4.1 in Recommendation Q.144);

c) the maximum permissible level for disturbing currents (voice currents and switching noise) coming from the near end of the circuit. The maximum level of voice currents might be assumed to be, for example, + 10 dBm0 in the direction *opposite* to that of the signals. The nature of the switching noises depends on the national systems used;

d) any attenuation (terminating set and possibly pads) between the point where the signal receiver is connected and the point where the near-end disturbing currents are considered;

e) a safety margin to give an appreciable reduction of the level of disturbing currents coming from the near end (as defined in c)) compared to the minimum level of the signal as defined in paragraph b).

2.2.3 When a register-signal receiver is connected to the circuit, the exchange side of the circuit is disconnected and hence the receiver is not subject to near-end disturbances.

2.2.4 The recommendations of Volume III of the *White Book* concerning international circuits must still be met after the connection of a signal sender and a signal receiver and of the switching equipment. In consequence, it is necessary to fix the limits of input and output impedance, insertion loss, attenuation distortion, non-linear distortion, balance, and crosstalk of line signal senders and receivers; an example of specification clauses concerning these conditions is given in Recommendation Q.114 below.

RECOMMENDATION Q.114

2.3 TYPICAL TRANSMISSION REQUIREMENTS FOR SIGNAL SENDERS AND RECEIVERS

2.3.1 The following clauses 2.3.2 to 2.3.7 concerning in-band line signal receivers (including the buffer amplifier or equivalent device) apply only in the case where the signal receiver is a four-terminal device ("quadripole") and where the nominal circuit impedance is 600 ohms.

2.3.2 *Input and output impedance*

The nominal value of the input and ouput impedances of the signal receiver is 600 ohms.

Z_E and Z_S, which are respectively the measured values of the input and output impedances of the signal receiver, should meet the following condition throughout the 300- to 3400-Hz frequency band:

$$\left|\frac{Z_E-600}{Z_E+600}\right| \leqslant 0.35 \text{ and } \left|\frac{Z_S-600}{Z_S+600}\right| \leqslant 0.35$$

In making these measurements the free terminals should be looped by a resistance of 600 ohms and the voltage applied must not overload the equipment.

2.3.3 *Attenuation*

At 800 Hz, the insertion loss of the signal receiver, measured with a generator and a receiver of internal resistance of 600 ohms, must be between the limits:

$A \pm 0.5$ decibel

The value A is to be determined from the level diagram of the circuit according to the point of the circuit at which the signal receiver should be connected.

The measurement is made with a 1-mW generator having an internal impedance equal to a pure resistance of 600 ohms and having an e.m.f. of 2 × 0.775 volt (so-called "standard generator"). The e.m.f. of the generator will be adjusted to take into account the relative level of the point of the circuit at which the signal receiver is connected.

If n is the relative level at the signal receiver input, the e.m.f. of the generator will therefore be:

$$1.55 \cdot 10^{\frac{n}{20}} \text{ volts, if } n \text{ is expressed in decibels.}$$

2:3.4 *Attenuation distortion*

The variation in insertion loss of the signal receiver in the 300-3400-Hz frequency band, measured under the conditions of paragraph 2.3.3, should not exceed the limits shown in Figure 1.

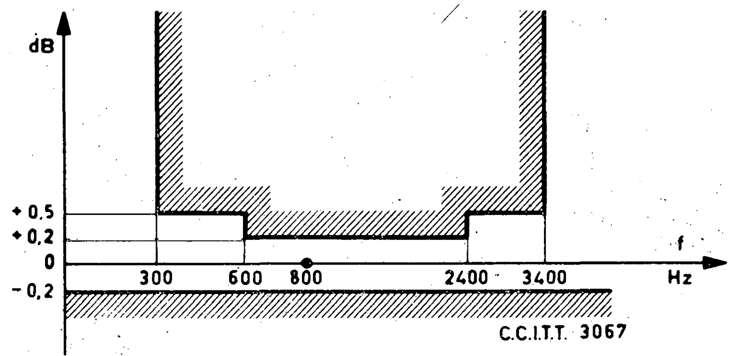

FIGURE 1

As in certain cases systems No. 5 and No. 5 *bis* may be applied to circuits in transmission systems with a channel spacing of less than 4 kHz, the 300-Hz lower limit shown above may be replaced by 200 Hz for system No. 5.

2.3.5 *Non-linear distortion*

The curve representing the variation (as a function of power) of the output level of the signal receiver, with reference to the nominal value of the output level, should be within the limits shown in Figure 2 over the relevant frequency range.

2.3.6 *Balance*

The input and output of the signal receiver should have a high degree of balance to earth, the admittance of each terminal to earth being very low.

The same clause should apply to the signal sender.

2.3.7 *Crosstalk between adjacent signal receivers*

The crosstalk ratio between two adjacent signal receivers should not be less than 74 dB in the relevant frequency band.

2.3.8 During the register signalling period no speech transmission takes place. It is not essential therefore for the register signalling equipment of systems having separate equipment for that purpose to take account of clauses 2.3.2 to 2.3.7 but it is desirable to adopt appropriate clauses for efficient signalling performance.

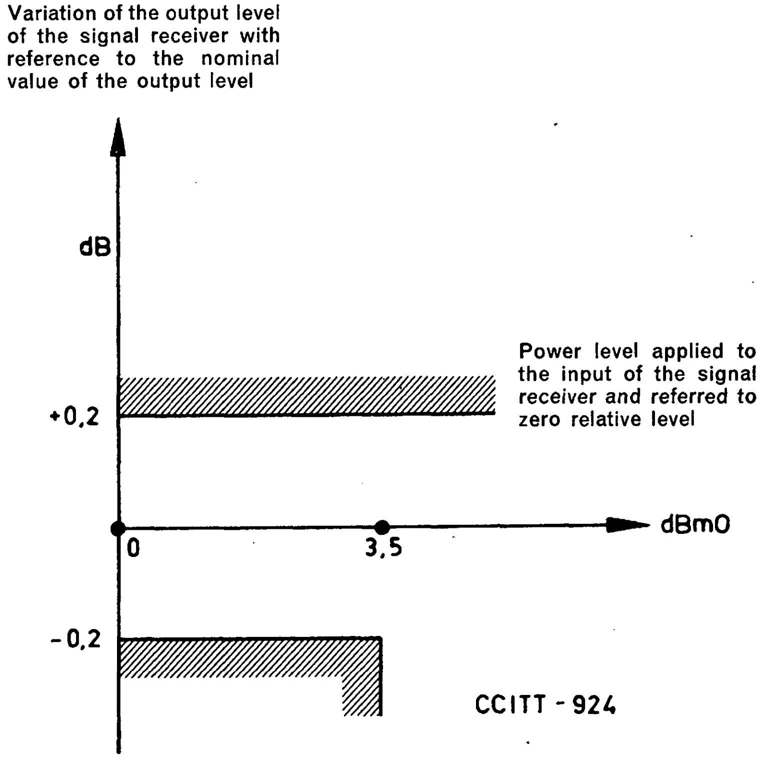

FIGURE 2. — **Limits for non-linear distortion due to the insertion of the signal receiver**

CHAPTER III

Control of echo suppressors

RECOMMENDATION Q.115

3. CONTROL OF ECHO SUPPRESSORS

a) Arrangements should be incorporated in the switching equipment to prevent echo suppressor action from disturbing simultaneous forward and backward signalling via the speech paths. For this case typical arrangements are:

i) Locating the echo suppressors on the switching side of the signalling equipment;

ii) Inhibiting the action of echo suppressors located on the line side of the signalling equipment by means of an appropriate condition extended from the signalling equipment to the echo suppressor while signalling is in progress.

b) Arrangements should be incorporated in the system No. 6 equipment to prevent echo suppressor action from disturbing the procedure for making the continuity check of the speech path.

c) Arrangements should be incorporated at a transit exchange to disconnect, for the duration of a call, the incoming and outgoing half echo suppressors should these be present on the two circuits switched in tandem.

This echo-suppressor disconnect feature shall not apply when the two circuits switched in tandem have:

i) an incoming or an outgoing half echo suppressor only,

ii) an incoming or an outgoing full echo suppressor only, or

iii) a half echo suppressor on one circuit and a full echo suppressor on the other.

CHAPTER IV

Abnormal conditions

RECOMMENDATION Q.116

4.1 INDICATION GIVEN TO THE OUTGOING OPERATOR OR CALLING SUBSCRIBER IN CASE OF AN ABNORMAL CONDITION

In general, when an abnormal condition occurs in the setting-up of a call, the outgoing operator in semi-automatic operation and the calling subscriber in automatic operation should receive an indication to show that it is necessary to make a new attempt to set up the call or to take other appropriate action.

The tables in the specifications of the signalling systems give details of the signals that are received at the outgoing exchange when abnormal conditions occur in setting up a call. Each Administration will decide how these signals are to be translated into appropriate indications for outgoing operators or calling subscribers.

RECOMMENDATION Q.117

4.2 ALARMS FOR TECHNICAL STAFF AND ARRANGEMENTS IN CASE OF FAULTS

4.2.1 In general, when an abnormal condition is recognized as being possibly due to a fault, an alarm must be given to indicate this condition and, if possible, any other necessary operation must be carried out to avoid circuits being put out of service unnecessarily and to facilitate fault tracing.

4.2.2 There will be the usual alarm and fault indication arrangements for such items as blown fuses, disconnected heat coils, faulty signalling equipment, failures of power supplies, failures of common control equipment, etc., as provided under the specifications of each Administration.

4.2.3 The occupation of each item of equipment such as line circuit equipment, link circuit, operators' calling equipment, selectors, registers, etc., can be indicated by the lighting of a lamp near to the equipment concerned, or by other suitable means, as may be available, e.g., in exchanges with stored programme control.

4.2.4 It can be arranged for the progress of a call to be followed, in particular the sending or reception of digits or successive numerical signals. In this respect, each Administration will decide the arrangements it desires to install, taking account of the practice which it normally follows in this matter.

RECOMMENDATION Q.118

4.3 SPECIAL RELEASE ARRANGEMENTS

4.3.1 *Answer signal not received by an outgoing exchange after receiving a number-received signal or number-received information (systems No. 4, No. 5 bis and R2) or after receiving an address complete signal (system No. 6) or after transmitting the ST signal (system No. 5).*

It is recommended that arrangements should be made either in the national network of the outgoing country or at the outgoing international exchange, for the connection to be released if an answer signal is not received within a delay period of 2 to 4 minutes as soon as it is known, or can be assumed, that the called subscriber's line has been reached.

If an Administration adopts a shorter delay period for this forced release condition, there will be a risk that the international connection will be released prematurely on calls not returning an answer signal. If the maximum delay of 4 minutes is exceeded, it will of course involve an unnecessary occupation of international circuits.

4.3.2 *Delay in clearing by the calling subscriber in automatic service* (arrangements made in the outgoing country)

In automatic working, errangements must be made to clear international connection and stop the charging if, between one and two minutes after receipt of the clear-back signal *, the calling subscriber has not cleared. Clearing of the international connection should preferably be controlled from the point wher athe charging of the calling subscriber is carried out.

4.3.3 *Clear-forward signal not received by the incoming exchange after sending a clear-back signal* **

The incoming circuits at the incoming international exchange should include an arrangement for releasing the national part of the connection if, after sending a clear-back signal, a clear-forward signal is not received within 2 to 3 minutes (provided that a similar arrangement is not already made in the national network of the incoming country). This arrangement avoids indefinite blocking of the national circuits of the country of destination or of the subscriber's line in the case of interruptions of the line or equipment faults.

4.4 INDICATION OF CONGESTION CONDITIONS AT TRANSIT EXCHANGES

In the case of congestion at a transit exchange, the following conditions apply:

4.4.1 The busy flash signal or an equivalent signal shall be returned to indicate that there is equipment congestion in the exchange or that no free outgoing circuit is available. This signal shall be returned within the periods specified.

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* In the North American network the corresponding time-out is 13 to 32 seconds.

** These release arrangements may not be used within some regional networks.

In semi-automatic and in automatic working, the receipt of this signal by the outgoing exchange will cause the clear-forward signal to be sent so as to release the international connection and will give a suitable indication to the calling subscriber or operator, unless an automatic repeat attempt is made.

4.4.2 In addition, in a transit exchange, when reached by a circuit with system No. 4, connection should be made to a recorded announcement to advise the outgoing operator of the place where the congestion occurred.

In this case the busy-flash signal and the recorded announcement will be used at the outgoing exchange in the manner judged most suitable by the Administration of the country concerned.

PART VIII

RECOMMENDATION Q.119

C.C.I.T.T. SYSTEM No. 3

C.C.I.T.T. system No. 3 was studied between 1946 and 1949, subject to field trials from 1949 to 1954, and standardized by the C.C.I.F. in 1954 as the "one-frequency system". Detailed specifications for this system were drawn up in 1955 and underwent minor amendments during the revisions made in 1956 and 1960. The study of the system, which is applicable in semi-automatic and automatic working, was not carried beyond the stage of terminal traffic operation. It is used only for that purpose on the European continent, and the C.C.I.T.T. therefore decided in 1964 that, in principle, it should not be used in new international connections.

The system uses the frequency 2280 Hz for transmitting line and register signals and provides for one-way circuits only.

The specification of signalling system No. 3 is described in Part 5 of Volume VI of the *Red Book* (New Delhi, 1960). The clauses which relate specifically to this system (Recommendations Q.76 to Q.79) appear in Chapter V (pages 116 to 125) of the *Red Book*.

Section 5.2.3 (Efficiency of the guard circuit) (page 117 in Volume VI of the *Red Book)* should, however, be amended according to a decision of the IIIrd C.C.I.T.T. Plenary Assembly (Geneva, 1964) by inserting the following text between the first and second paragraphs:

"To minimize signal imitation by speech currents it is advisable that the guard circuit be tuned.

To minimize signal interference by low frequency noise it is advisable that the response of the guard circuit falls off towards the lower frequencies and that the sensitivity of the guard circuit at 200 Hz be at least 10 dB less than that at 1000 Hz."

PART IX

SIGNALLING SYSTEM No. 4

CHAPTER I

Definition and function of signals

RECOMMENDATION Q.120

1. DEFINITION AND FUNCTION OF SIGNALS

1.1 Seizing signal (sent in the forward direction)

This signal is transmitted at the beginning of a call to initiate circuit operation at the incoming end of an international circuit.

The seizing signal can also perform switching functions and two different types of seizing signal are provided for this purpose, viz:

a) the *terminal seizing* signal, which can be used at the incoming international exchange, to seize equipment used exclusively for switching the call to the national network of the incoming country;

b) the *transit seizing* signal, which can be used in the exchange at the incoming end of the international circuit to seize equipment used exclusively for switching the call to another international exchange.

1.2 Proceed-to-send signal (sent in the backward direction)

This signal is sent from the incoming end of an international circuit, following the receipt of a seizing signal, to indicate that the equipment is ready to receive the numerical signals.

In system No. 4 two different proceed-to-send signals are provided:

a) the *terminal* proceed-to-send signal, used to invite the sending of the language digit * (or the discriminating digit *) plus the national (significant) number *;

b) the *transit* proceed-to-send signal, used to invite the sending of only those numerical signals (beginning with the first digit of the country code *) necessary for routing the call through the international transit exchange towards the incoming international exchange or to another international transit exchange.

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* For definitions, see Recommendations E.160 (Q.10) and Q.104.

1.3 **Numerical signal** (sent in the forward direction)

This signal provides an element of information necessary to effect the switching of the call in the desired direction. There is always a succession of numerical signals sent.

1.4 **End-of-pulsing signal,** also called for system No. 4 code 15 (sent in the forward direction)

This numerical type signal is sent from the international outgoing exchange to show that there are no more numerical signals to follow. In semi-automatic working this signal is always sent. In automatic working this signal *may* be sent, viz., when, in the outgoing international exchange, it is known that there are no more digits to follow.

1.5 **Number-received signal** (sent in the backward direction)

1.5.1 This signal is sent from the incoming international exchange to the outgoing international exchange when the incoming register has recognized that all the digits required for routing the call to the called subscriber have been received.

Purpose of the signal

1.5.2 In semi-automatic working, the number-received signal may be used to inform the outgoing operator that the international switching operations have been completed.

1.5.3 In automatic working, this signal is essential to show the outgoing register at the outgoing international exchange that it can release and to set up speech conditions at this exchange. Hence, it is desirable that the signal be sent as soon as possible.

Generation of the signal

1.5.4 In semi-automatic working, the incoming register (or associated equipment) sends back the number-received signal after reception of the end-of-pulsing signal.

1.5.5 In automatic working, the incoming register (or associated equipment) recognizes that all the digits of a national (significant) number * have been received **:

1.5.5.1 by the receipt of the end-of-pulsing signal; or

1.5.5.2 a) by checking the number of digits received, in countries where the national (significant) number * is always made up of the same number of digits; or

b) in countries where this is not so:

i) by the receipt of the maximum number of digits, used in the numbering plan of the country; or

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* See definition in Recommendation E.160 (Q.10).

** See Recommendation Q.180 for the case of interworking between systems No. 4 and No. 5 and Recommendation Q.232 for the case of interworking between systems No. 4 and No. 5 *bis*.

ii) by analysing the first digits in the national (significant) number * to decide how many digits there are in the subscribers' numbers in the particular national numbering zone; or

iii) by using a national end-of-selection signal or national "electrical" ringing-tone signal; or

iv) exceptionally, by observing that 4 to 10 (for new equipment 4 to 6) seconds have elapsed since the last digit was received, and that no fresh information has been received; in such circumstances, retransmission to the national network of the last digit received must be prevented until the end of the waiting period which causes the number-received signal to be sent over the international circuit. In this way, it is ensured that no national answer signal can arrive before the number-received signal has been sent.

1.6 **Busy-flash signal** (sent in the backward direction)

This signal is sent to the outgoing international exchange to show that either the route or the called subscriber is busy. The conditions of use of this signal are as follows:

a) An international transit exchange *must* send this signal to indicate that there is congestion at that exchange or on the appropriate outgoing routes.

b) An incoming international exchange *must* send this signal if there is congestion at that exchange or on the outgoing routes directly connected to it, but sending the signal is *optional* when there is congestion beyond that exchange (when there is congestion at a point in the national network of the incoming country or when the called subscriber's line is busy). This signal is optional because there are several countries that do not send it from their national networks.

Note. — The receipt of the busy-flash signal at the outgoing exchange will cause:

- an appropriate indication to be given to the outgoing operator or to the calling subscriber; and
- in automatic working, the sending of the clear-forward by the outgoing exchange to release the international connection (except when otherwise arranged, for example, in the case of observations on circuits).

1.7 **Answer signal** (sent in the backward direction)

This signal is sent to the outgoing international exchange to show that the called party has answered the call *.

In semi-automatic working, the signal has a supervisory function.

In automatic working, it is used:

- to start metering the charge to the calling subscriber,
- to start the measurement of call duration for international accounting purposes.

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* See Recommendation Q.27 for the action to be taken to ensure that answer signals both national and international, are transmitted as quickly as possible.

1.8 **Clear-back signal** (sent in the backward direction)

This is sent to the outgoing international exchange to indicate that the called party has cleared. In the semi-automatic service, it performs a supervisory function. It must not permanently open the speech path at the outgoing international exchange.

In automatic working, arrangements must be made to clear the international connection, stop the charging and stop the measurements of call duration if, between one and two minutes after receipt of the clear-back signal, the calling subscriber has not cleared. Clearing of the international connection should preferably be controlled from the point where the charging of the calling subscriber is carried out.

Notes on the answer and clear-back signals

1.8.1 NOTE 1. — In general, the sequence of answer and clear-back signals that will be sent when the called subscriber depresses and releases the switch-hook of his telephone will not always be able to follow the frequency of this operation of the switch-hook, but correct indication of the *final* position of the switch-hook must *always* be given;

— to the outgoing international operator in semi-automatic operation;

— to the outgoing international equipment in automatic operation.

1.8.2 NOTE 2. — The "called party" referred to in the definitions of the answer and clear-back signals may be:

— the called subscriber,

— in semi-automatic working, the operator who puts the call through in her own country and who sends an answer signal when she answers the call.

1.8.3 NOTE 3. — The following is a detailed description of the various possible circumstances in which the answer and clear-back signals are sent.

A. *Called subscriber obtained automatically by the international outgoing operator*

The answer and clear-back signals are sent every time the called subscriber answers or clears.

B. *Called subscriber not obtained automatically by the international outgoing operator*

a) *Only one operator involved in the incoming country, without through-supervision via her position.*

— (This operator can be an incoming or a delay operator or a manual exchange operator obtained automatically from the outgoing international exchange.)

The answer signal is sent when the operator enters the circuit.

The clear-back signal is sent when the operator clears the connection.

b) *Only one operator involved in the incoming country, with through-supervision via her position.*

— (The operator can be the same as for a) above.)

(Through-supervision can be effected:

— via the cord circuits, the incoming operator intervening to clear down the connection at the end of the call,

— via cordless positions, in which case the connection is released automatically without the intervention of an operator when the called subscriber clears and when the outgoing operator causes the clear-forward signal to be sent.)

The answer signal is sent when the operator enters the circuit.

A clear-back signal is sent when the operator goes out of circuit. This can happen, for example, when the operator hears the ringing tone but does not wait for the called subscriber to reply.

A second answer signal is sent when the called subscriber answers or when the incoming operator again enters the circuit.

The clear-back signal is also sent when the called subscriber clears or when the incoming operator, by mistake, clears the connection before the called subscriber has cleared.

The same signal (answer signal or clear-back signal) must not be sent twice in succession.

c) *Two operators involved in the incoming country.*

These can be:

- an incoming or a delay operator at the international exchange, and
- an operator at a national manual exchange.

c.1) There is no through-supervision via the operators' positions at the international exchange. The answer and clear-back signals are sent as described in a) above.

c.2) The international operator's position is normally able to provide through-supervision. There are still two cases to consider:

c.2.1) If the whole of the national chain, including the operators' positions, gives through-supervision from the called subscriber, the operating conditions can be as described in b) above. An operator intervenes to send an answer signal; her withdrawal causes the sending of a clear-back signal, an answer signal is sent when the called subscriber answers, and a clear-back signal is sent when the called subscriber clears. If an operator clears down the connection in error, before the called party clears, a clear-back signal is sent.

c.2.2) If the whole of the national chain does not give through-supervision from the called subscriber, supervision is extended from the point at which through-supervision ceases.

* * *

In a), b) and c) above, it is recommended that the incoming or the delay operator should have facilities to recall the outgoing operator by sending a succession of clear-back and answer signals, by means of a special key, for example.

If *automatic service requirements* necessitate the action described under C below, it will inevitably follow that in *semi-automatic working* correct supervision cannot be given, so that the sequence of answer and clear-back signals described above cannot be guaranteed.

C. *Automatic calls*

When direct access by a subscriber to an operator's position in the incoming country cannot be barred, it is essential, to avoid mistakes in charging, not to give the answer signal at the moment this operator replies. Arrangements must be made to ensure that the answer signal is sent when the called subscriber, or paid special service, answers. The answer signal is sent:

- either by an operator (using a key), or
- automatically, by through-supervision.

1.9 **Clear-forward signal** (sent in the forward direction)

1.9.1 This signal is sent in the forward direction at the end of a call when:

a) in semi-automatic working, the operator at the outgoing international exchange withdraws her plug from the jack, or when an equivalent operation is performed;

b) in automatic working, when the calling subscriber hangs up or otherwise clears (as in the case of a subscriber's installation with extension telephones).

In automatic working, this signal is also sent after receipt of a busy-flash signal by the outgoing international exchange, and when there is forced release of the connection; see paragraphs 4.3.1 and 4.3.2 in Recommendation Q.118 and Recommendation Q.131.

In semi-automatic working there may be forced release in the case of paragraph 4.3.1 of Recommendation Q.118.

1.9.2 At the end of the clear-forward signal, all switching units held on the call must release at the outgoing, incoming, and transit international exchanges. (The clear-forward signal must therefore be recognized at an international transit exchange.) Each international circuit, however, is guarded against subsequent seizure until the release-guard signal has been received from the incoming end of the international circuit concerned.

1.9.3 In a transit exchange, the following arrangements must be made on disconnection:

a) the GO channel must not be split until the clear-forward signal has completely ceased;

b) the RETURN channel must be split as soon as possible after recognition of the clear-forward signal;

c) a clear-forward signal received at the moment a call is established, but before speech conditions have been set up, must be repeated over the outgoing circuit that has been seized.

1.10 **Release-guard signal** (sent in the backward direction)

This signal is sent in the backward direction in response to the clear-forward signal, to indicate that the latter has been fully effective in bringing about the release of the switching equipment at the incoming end of an international circuit. It serves to protect an international circuit against subsequent seizure as long as the disconnection operations controlled by reception of the clear-forward signal have not been completed at its incoming end.

1.11 **Blocking signal** (sent in the backward direction)

This signal is sent, when required, to the outgoing end of the circuit to cause engaged conditions to be applied to the outgoing end of the international circuit.

The design of the signalling equipment at the outgoing end of international circuits should be such that the receipt of a blocking signal over a free circuit will cause that circuit to be engaged to operators or automatic equipment which would otherwise have access to it.

1.12 **Forward-transfer signal** (sent in the forward direction)

This signal is sent to the incoming international exchange when the outgoing international exchange operator wants the help of an operator at the incoming international exchange.

The signal will normally serve to bring an assistance operator * into the circuit if the call is automatically set up at that exchange. When a call is completed via an operator (incoming operator or delay operator) at the incoming international exchange, the signal will cause this operator to be recalled.

1.13 **Diagrams showing signal sequence**

The sequence of signals in semi-automatic and automatic working is shown in Tables 1 and 2 of Annex 1 to Part IX. Tables of Annex 2 to Part IX give a description of the operations corresponding to the various normal and abnormal conditions which may arise in setting up a call.

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* See the definition of assistance operator in paragraph 1.1.6 of Recommendation Q.101.

CHAPTER II

Signal code

RECOMMENDATION Q.121

2. SIGNAL CODE

2.1 General

The signals of system No. 4 are:

- signals called "line signals" for the so-called supervisory functions,
- signals (binary code signals and their acknowledgement signals) used for the transmission of numerical information.

2.2 Transit working

In transit operation, the line equipment at the transit exchange shall keep memory that the condition is transit; this will facilitate, in particular, the parallel reception of the clear-forward signal at the transit and incoming international exchanges. (See Recommendation Q.120, item 1.9.)

2.3 Line signals

2.3.1 *Line signal code*

The line signal code is given in Table 1.

The use of two frequencies in this code makes it possible to form a characteristic *compound signal,* in which both frequencies are transmitted simultaneously and which can be used as a preparatory signal element (called a *prefix*) to the control signal element (called a *suffix*) having a single frequency.

The compound signal prefix element is much less likely to be imitated by speech currents than a single-frequency element of the same duration and serves to prepare a switching circuit for the reception of the suffix element which follows. The prefix signal element also serves to bring about the splitting of the line at the receiving end to prevent the remaining part of the signal from passing out of the section in which it is intended to be operative.

The symbols used in Table 1 have the following significance:

Prefix signal element	P	prefix signal constituted by two frequencies x and y compounded
Control signal elements or "suffixes"	X	short signal element of the single frequency x
	Y	short signal element of the single frequency y
	XX	long signal element of the single frequency x
	YY	long signal element of the single frequency y.

SIGNAL CODE

TABLE 1

Code for signalling system No. 4

List No.	Name of signal	Code
(See Rec. Q.120)	FORWARD SIGNALS	
1	a) Terminal seizing — *Prise terminale*	PX
	b) Transit seizing — *Prise pour transit international*	PY
3	Numerical signals — *Signaux de numérotation*	Binary code (see Table 2)
4	End-of-pulsing signal — *Signal de fin de numérotation* . . .	
9	Clear-forward — *Signal de fin*	PXX
12	Forward transfer — *Signal d'intervention*	PYY
	BACKWARD SIGNALS	
2	Proceed-to-send *Invitation à transmettre* a) Terminal — *Terminale*	X
	b) International transit — *de transit international*	Y
5	Number-received — *Numéro reçu*	P
6	Busy-flash — *Occupation*	PX
7	Answer — *Réponse*	PY
8	Clear-back — *Raccrochage du demandé*	PX
10	Release-guard — *Libération de garde*	PYY
11	Blocking * — *Blocage*	PX
—	(Unblocking) *(Déblocage)* = use of signal 10 of the list . .	PYY

* In addition to the blocking which results from the reception of a blocking signal at the outgoing end of a circuit, the outgoing equipment should be such that a *temporary* condition of "circuit busied" should result at the outgoing end on receiving, on a free circuit, one or other of the frequencies *x* or *y* or both these frequencies. This condition should be maintained for as long as the frequency or frequencies are received. The maintenance instructions given to the maintenance staff stipulate that such an occupation of a circuit should be as short as possible and in any case less than 5 minutes.

2.3.2 *Sending duration of line signal elements*

The elements of each of the voice-frequency line signals shown in Table 1 have a duration of:

P	150±30 ms
X and Y	100±20 ms
XX and YY	350±70 ms

(The durations of the signal elements P, X and Y, XX and YY are multiples of 50 ms with a tolerance of ± 10 ms.)

Once the sending of a signal has begun it must be sent completely. If two signals have to be sent one immediately after the other in the same direction, a silent interval must separate the two successive signals. The duration of this interval must not be less than 100 milliseconds but it must not be so long as to cause an unreasonable delay in signalling.

This 100-ms interval must also occur between the sending of a numerical signal including the acknowledgement signal and a subsequent line signal.

Sending of the proceed-to-send or busy-flash signal by an incoming or transit exchange should not take place until 50 ms after the end of the receipt of the corresponding seizing signal. Such a delay will normally result from the operation of equipment (operating times of relays, time of hunting for register).

On sending, there will be no intentional interval of silence between the prefix element and the suffix element of a signal but where such an interval exists its duration at the sending end must not exceed 5 ms.

It can happen, when sending the P prefix element, that the two frequencies will not be sent simultaneously. The interval of time between the instants when each of the two frequencies is sent must not, in this case, exceed 1 ms. In the same way, if the suffix element does not immediately follow the prefix but is separated from it by an interval of silence as explained in the paragraph above, the interval of time between the two instants when the sending of each of the two frequencies ceases shall not exceed 1 ms.

2.3.3 *Recognition time * of line-signal elements at the receiving end*

At the output of the signal receiver, the duration of the direct current signal elements produced by the line signals is determined in terms of the sending duration of the voice-frequency signal elements and the distortion due to the line and to the signal receiver.

This over-all distortion due to the line and the signal receiver is taken to be 10 ms maximum for a prefix-signal element and 15 ms for a suffix-signal element. (The distortion of the suffix-signal element may be greater than that of the prefix-signal element because it depends not only on the distortion of the pulse consisting of a single frequency which is sent as a suffix element, but also on the moment when the other frequency used for the prefix element ceases.)

The incoming switching equipment must recognize a signal only after a certain time, called the recognition time, from the beginning of the receipt of the direct current signal, so that the risk of recognizing false signals is reduced and so that signals of different length can be distinguished.

The recognition times of the line signal elements are:

P	80±20 ms
X and Y	40±10 ms
XX and YY	200±40 ms

The incoming switching equipment shall be able to recognize a signal correctly when the prefix and the suffix of this signal are separated by an interval of silence of 15 ms or less.

2.4 Numerical signals

2.4.1 *Binary numerical signal code*

The numerical signal code is given in Table 2. This code is a binary code of four elements each separated from the next by a short interval of silence *s*; each element consists of the sending of one or other of the signalling frequencies.

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* See definition of recognition time in 2.5 hereafter.

The symbols used in Table 2 and in Figure 2 have the following significance:

x short element of the single frequency *x*
y short element of the single frequency *y*

TABLE 2

Binary code of system No. 4

Signal	Combination				
	Number	Elements			
		1	2	3	4
Digit 1	1	y	y	y	x
” 2	2	y	y	x	y
” 3	3	y	y	x	x
” 4	4	y	x	y	y
” 5	5	y	x	y	x
” 6	6	y	x	x	y
” 7	7	y	x	x	x
” 8	8	x	y	y	y
” 9	9	x	y	y	x
” 0	10	x	y	x	y
Call operator code 11	11	x	y	x	x
Call operator code 12	12	x	x	y	y
Spare code (except case envisaged under 1.4.2.3 of Q.104)	13	x	x	y	x
Spare code	14	x	x	x	y
End-of-pulsing	15	x	x	x	x
Spare code	16	y	y	y	y

The relation between the transmitted digits and the different combinations of the binary code is arrived at by giving the value 8, 4, 2 or 1 to the presence of an element *x* depending on whether this element *x* constitutes the 1st, 2nd, 3rd or 4th element of the numerical code.

2.4.2 *Sending duration of the signal elements x and y*

The sending duration of the signal elements *x* and *y* to line, as voice-frequency signals, shall be:

35±7 ms

The sending duration of the interval of silence *s* between signal elements of the same digit shall have the same value of 35±7 ms.

(The maximum duration of the signal elements and intervals of silence is not a critical factor in the design of the system but is specified in order that the speed of signalling is not unduly slow.)

2.4.3 *Recognition time * of the x, y and s elements at the receiving end*

The recognition time by the incoming switching equipment:

a) of the direct-current signal elements *x* and *y*,
b) of intervals of silence *s*

received from the output of the signal receiver is: 10±5 ms.

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* See definition of the "recognition time" in 2.5 under d).

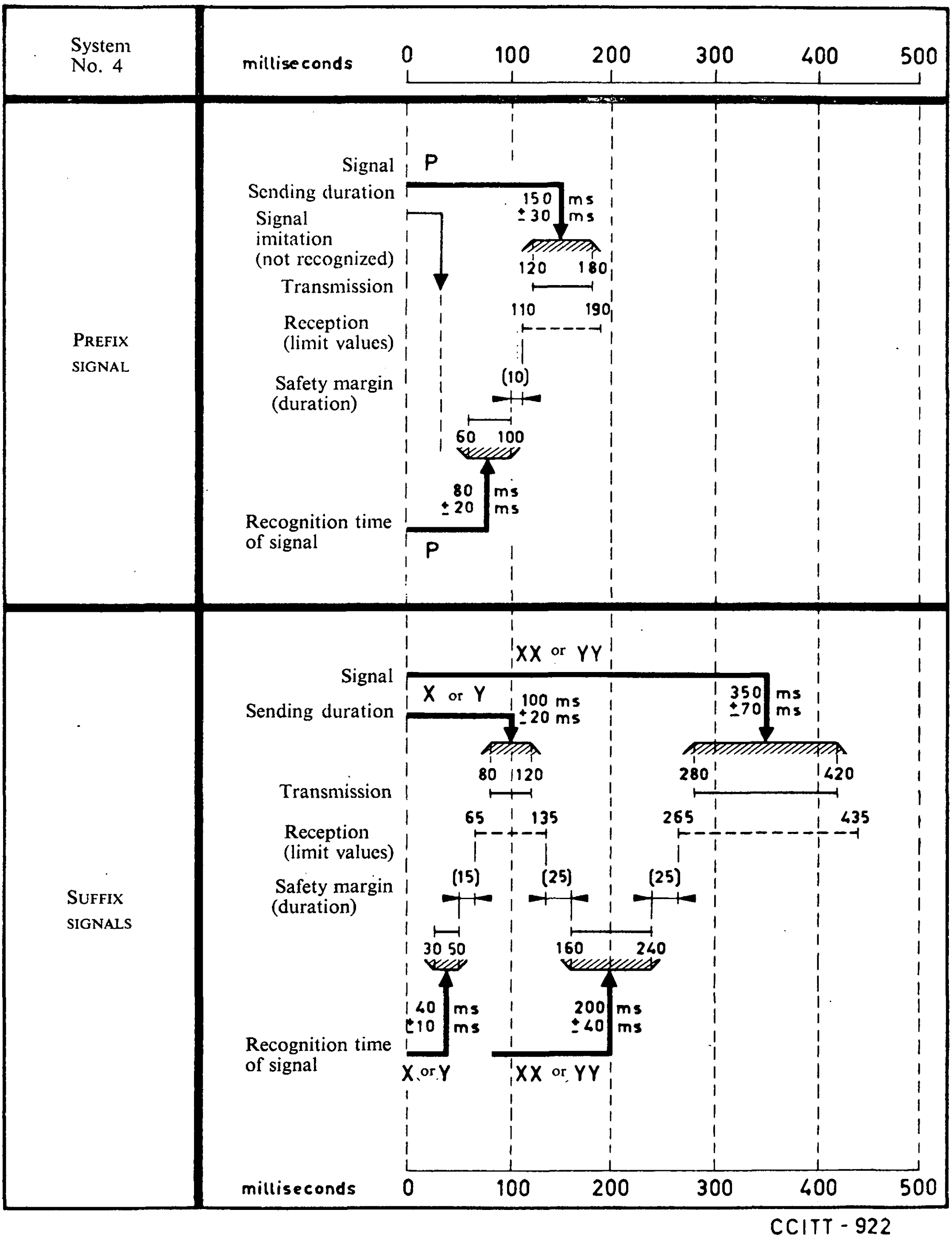

FIGURE 1. — **Duration of line signal elements**

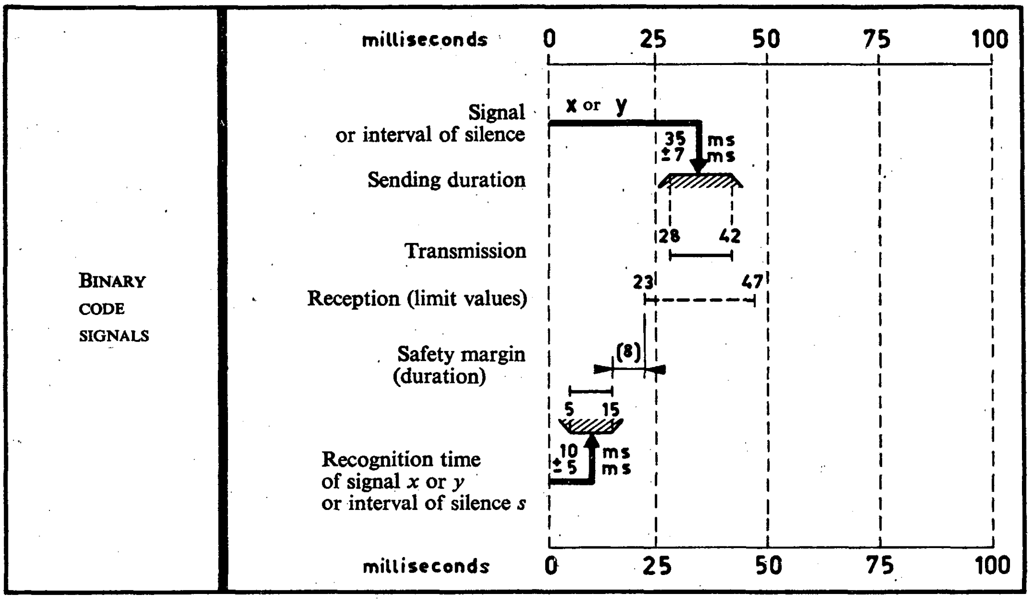

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FIGURE 2. — **Numerical signal elements**

Legend to Figures 1 and 2

Signalling timing diagrams

Figures 1 and 2 give diagrams showing for line signal elements (Figure 1) and for numerical signal elements x and y (Figure 2):

— the sending duration (transmission at voice-frequency over the line);

— the received duration (direct current signals at the signal receiver output);

— the safety margins that allow for equipment not being in adjustment, etc.;

— the recognition time (which assumes an operating margin) of the receiving switching equipment; this margin is defined between a lower limit t and an upper limit T. The switching equipment must *not* recognize a signal element *before t* but must *certainly* have recognized it *at the end of time T.*

2.4.4 *Acknowledgement signals*

Incoming international and international transit exchanges shall return an acknowledgement signal to the outgoing international exchange *at the end of the reception* of the 4th element of a numerical signal.

At the outgoing international exchange a numerical signal will be sent only if a signal is received from the incoming end acknowledging the receipt of the preceding numerical signal. However, to avoid this procedure delaying the transmission of numerical signals the sending of numerical signals may begin *as soon as the acknowledgement signal is recognized.*

Two types of acknowledgement signals are provided, one constituted by the signal element x defined above and the other constituted by the signal element y defined above.

The acknowledgement signal x has two meanings:

- after a terminal proceed-to-send signal has been received by the outgoing register: "digit received; send next digit"
- after a transit proceed-to-send signal, but before a terminal proceed-to-send signal has been received: "digit received; stop the sending of digits".

The acknowledgement signal y has one meaning only, i.e. after a transit proceed-to-send signal has been received: "digit received; send next digit".

2.5 Signalling timing diagrams

Figures 1 and 2 give diagrams showing for line signal elements (Figure 1) and for numerical signal elements x and y (Figure 2):

a) the sending duration (transmission at voice-frequency over the line);

b) the received duration (direct current signals at the signal receiver output);

c) the safety margins that allow for equipment not being in adjustment, etc.;

d) the recognition time of the receiving switching equipment; this time assumes an operating margin and is defined between a lower limit t and an upper limit T. The switching equipment must *not* recognize a signal element *before* t but must *certainly* have recognized it *at the end of time* T.

2.6 General note on the operation of signalling and switching equipment

The tolerances defined in sections 2.3 and 2.4 concerning the sending duration of signals and their recognition times at the receiving end must be strictly observed in all circumstances and especially under all conditions of battery voltage variation likely to arise in working conditions.

CHAPTER III

Signal sender and signal receiver

RECOMMENDATION Q.122

3.1 SIGNAL SENDER *

3.1.1 *Signalling frequencies*

The signalling frequencies shall be:

2040±6 Hz ("*x*" frequency) and
2400±6 Hz ("*y*" frequency),

these frequencies being applied separately or in combination.

3.1.2 *Absolute power level transmitted*

The absolute power level of the unmodulated signal frequencies at a zero relative level point shall be −9 dBm with a tolerance of ± 1 dB.

These levels also apply to each signal frequency in a signal element made up of a combination of the two frequencies (compound signal element) but the two signalling frequencies making up such a signal must not differ in level by more than 0.5 dB.

Note 1. — The noise as measured at the output of the line signal sender shall be as low as practicable, but in any event, at least 40 dB below signal level. This noise includes all extraneous power in the frequency band between 300 Hz and 3400 Hz including power resulting from non-linear distortion of the signal.

Note 2. — The level of the leak current which might be transmitted to line, for example when static modulators are used for signal transmission, should be at least 50 dB below signal level per frequency.

RECOMMENDATION Q.123

3.2 SIGNAL RECEIVER *

3.2.1 *Operating limits of the signal receiver*

The signal receiver shall operate in the conditions specified under 3.2.5 to received signals that meet the following three conditions.

a) The signal frequencies shall be within the following limits:

"*x*" frequency: 2040±15 Hz
"*y*" frequency: 2400±15 Hz

b) The absolute power level N of each unmodulated received signal frequency shall be within the limits

$$-18 + n \leqslant N \leqslant n \text{ dBm}$$

where n is the relative power level at the signal receiver input.

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* See also Recommendation Q.112.

These limits give a margin * of ± 9 dB on the nominal absolute level of each received signal at the input to the signal receiver.

c) The absolute level of the two unmodulated signal frequencies may differ from each other, but the received level of the 2400-Hz signal shall not be more than 3 dB above, nor more than 6 dB below the received level of the 2040-Hz signal.

The tolerances given in paragraphs a), b) and c) above are to allow for variations at the sending end and for variations in line transmission.

3.2.2 *Non-operate conditions for the signal receiver*

a) *Selectivity*

The signal receiver shall not operate to a signal having an absolute power level at the receiving end within the limits specified in paragraph 3.2.1 when the frequency differs by more than 150 Hz from the nominal value of 2040 Hz or of 2400 Hz.

b) *Maximum sensitivity of the signal receiver*

The signal receiver shall not operate to a signal of 2040 ± 15 Hz or 2400 ± 15 Hz whose absolute power level at the point of connection of the receiver is $(-26-9+n)$ dBm, n being the relative power level at this point.

This limit is 26 decibels below the nominal absolute level of the signal current at the input to the signal receiver.

3.2.3 *Efficiency of the guard circuit*

The signal receiver must be protected by a guard circuit against false operation due to speech currents, circuit noise or other currents of miscellaneous origin circulating in the line.

The purpose of the guard circuit is to prevent:

a) signal imitation (signals are imitated if the duration of the resulting direct current pulses at the output of the signal receiver is long enough to be recognized as signals by the switching equipment),

b) operation of the splitting device from interfering with speech.

To minimize signal imitation by speech currents it is advisable that the guard circuit be tuned.

To minimize signal interference by low-frequency noise, it is advisable that the response of the guard circuit falls off towards the lower frequencies and that the sensitivity of the guard circuit at 200 Hz be at least 10 dB less than that at 1000 Hz.

An indication of the efficiency of the guard circuit is given by the following:

a) during 10 hours of speech, normal speech currents should not, on the average, cause more than one simultaneous operation of the receiver relays for each of the two

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* See 2.1.2 of Recommendation Q.112.

signalling frequencies lasting more than 55 ms (the minimum recognition time of a compound signal element is 60 ms),

b) the number of false splits of the speech path caused by speech currents should not cause an appreciable reduction in transmission quality of the circuit.

3.2.4 *Guard circuit limits*

A. *Steady noise*

Considering

a) that when there is noise on a circuit an over-sensitive guard circuit might give rise to signalling difficulties and, in particular, inhibit the response of the signal receiver,

b) that unweighted noise of a level −40 dBm0 (100 000 pW) and uniform spectrum energy may arise during end-to-end signalling over a multilink chain of system No. 4 circuits,

it is recommended that, for either one or two signalling currents (each being within the limits of level specified in paragraph 3.2.1) the signal receiver should satisfy the conditions indicated in paragraph 3.2.5 for the distortion of signals in the presence of noise of a level of −40 dBm0 and uniform spectrum energy over the frequency range 300 to 3400 Hz.

B. *Surges*

A guard circuit with an excessive hangover time may cause difficulties in receiving a signal, for example when it has been immediately preceded by surges, and it is therefore recommended that the following condition should be fulfilled:

If a disturbing current of a frequency corresponding to the maximum sensitivity of the guard circuit and having an absolute power level of $(-10 + n)$ dBm at the relative level point n where the receiver is connected, ceases 30 ms before the application of a signal satisfying the limits defined in paragraph 3.2.1, the lengths of the received signals must remain within the limits specified in paragraph 3.2.5.

3.2.5 *Distortion of received signals*

When the signal frequencies and levels are within the limits specified in paragraph 3.2.1, the following conditions should be met:

1. a) the delay in the start of a received pulse consisting of one of the two signalling frequencies should be less than 20 ms;

b) the delay in reproducing the beginning of a signal consisting of a combination of the two frequencies x and y (compound signal) should be less than 20 ms; this delay is defined as the interval between the moment when the beginning of the compound signal arrives at the signal receiver input and the moment of beginning the reproduction of the two frequencies x and y as a direct current signal output of the signal receiver;

2. the change of signal length in the presence of the noise defined in paragraph 3.2.4 should be less than:

a) 5 ms when the signal receiver receives an *isolated pulse at one frequency only*, with a minimum duration of 25 ms;

b) 8 ms when the signal receiver receives a *compound pulse* of the two frequencies with a minimum duration of 50 ms; this change is defined as the difference between the simultaneous reception of the two received frequencies at the input to the receiver and the simultaneous reproduction of the two components as a direct current signal at the output of the signal receiver;

c) 6 ms when the signal receiver receives a pulse of current of a *single frequency* with a minimum duration of 80 ms, *preceded by a compound signal element* (separated or not by an interval of silence of 5 ms maximum). Consequently the change in the duration of a signal suffix *, measured from the moment when the prefix ends to the moment when the suffix ends, and taking account of the change in the duration of the prefix signal mentioned under b), will be less than 6 + 8 = 14 ms.

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* See the definition of prefix and suffix signals under paragraph 2.3.1 of Recommendation Q.121.

CHAPTER IV

Switching conditions

RECOMMENDATION Q.124

4.1 SPLITTING ARRANGEMENTS *

Sending line split

4.1.1 According to Recommendation Q.25, section B, sending split arrangements have to be provided.

4.1.2 The exchange side of the international circuit shall be disconnected 30 to 50 ms before a voice-frequency signal is sent over the circuit.

4.1.3 The exchange side of the international circuit will not be reconnected for 30 to 50 ms following the end of the sending of a voice-frequency signal over the circuit.

Receiving line split

4.1.4 The international circuit should be split (completely cut) at outgoing and incoming international exchanges when a compound signal is received, to ensure that no fraction of the combination of the two frequencies exceeding 55 ms duration may pass out of the international circuit.

The splitting time of 55 ms may be reduced by each Administration concerned, in order to help to protect its national network against the effect of signals coming from the international circuit. It should be noted, however, that a shorter splitting time can lead to an increase in the number of false operations of the splitting device by speech currents, and impair speech transmission.

4.1.5 The split must be maintained for the duration of the signal, but must cease within 25 ms of the end of the direct current signal which caused the splitting device to operate.

For the correct operation of the splitting device, it is necessary to take into account the delay in the reproduction of the compound signal caused by the signal receiver for which the conditions are as described in paragraph 3.2.5.1 b).

4.1.6 The splitting of the line must not give rise to surges which might cause interference with signalling over the international circuit or with other signalling systems associated with it for setting up an international call.

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* See Recommendation Q.25.

RECOMMENDATION Q.125

4.2 SPEED OF SWITCHING IN INTERNATIONAL EXCHANGES

4.2.1 It is recommended that the equipment in international exchanges (terminal or transit) shall have a high switching speed so that the switching time may be as short as possible.

4.2.2 It is also recommended that the incoming register at the incoming international exchange should begin to set up the national part of the connection as soon as the register has received a sufficient number of digits and without waiting to receive the complete number of the called subscriber.

4.2.3 At the outgoing international exchange:

- with semi-automatic operation it may be desirable for the outgoing register to start sending numerical signals to line without waiting to receive all the digits of the called subscriber's number. However, this may depend on national conditions.
- with automatic operation, it is evident that the sending of numerical signals must begin without waiting for the receipt of all the digits of the called subscriber's number because the outgoing register will not generally know how many digits there are going to be.

4.2.4 At international exchanges, use may be made of the advantages of continuous hunting (of circuits or common equipment), i.e. economy in the number of outgoing circuits to be provided or improvement in the quality of service for a given number of circuits. However, at incoming and transit exchanges, the return of a busy-flash signal must take place within the following delay times, specified in particular so that the release conditions of registers can be laid down:

- a maximum delay of 5 seconds following recognition of a seizing signal at an incoming or transit exchange if a free register and/or link circuit is not found;
- a maximum delay of 10 seconds following receipt, at an incoming exchange, of the information necessary for determining the required route, if congestion is encountered;
- a maximum delay of 10 seconds following receipt of the digits necessary to determine the routing at a transit exchange, if congestion is encountered.

RECOMMENDATION Q.126

4.3 ANALYSIS AND TRANSFER OF DIGITAL INFORMATION

4.3.1 *General requirements for the transit exchange*

In an international transit exchange an analysis of some of the digits is required to determine the routing * to the desired international incoming exchange or to another

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* See Recommendation E.161 (Q.11), paragraph 1.2.

international transit exchange. As a general rule the country code of the destination country is subject to this analysis. In some cases an analysis of more or fewer digits may be required (see Annex hereafter).

The transit exchange decides how many digits it needs for this analysis and asks for the sending of these digits from the outgoing register by means of the acknowledgement signals as indicated in paragraph 4.3.5 and in the Annex to this Recommendation.

The transit exchange ensures that the transit register does not request the signal code 15, e.g. by evaluating the signals code 11 or code 12.

4.3.2 *Maximum number of digits transmitted to an international transit exchange*

1. The *maximum* number of digits which has to be transmitted to a transit exchange to determine the routing at this exchange is as follows:

$I_1 \quad Z \quad N_1 \quad N_2 \quad N_3$

$I_1 \quad I_2 \quad Z \quad N_1 \quad N_2$

$I_1 \quad I_2 \quad I_3 \quad Z \quad N_1 \quad N_2$

where I_1, I_2, I_3 = digits of the country code

Z = characteristic digit, i.e. discriminating digit (D) or language digit (L), and

N_1, – – –, N_n = digits of the national (significant) number.

Note. — In the case of countries with more than one incoming international exchange where code 11 or code 12 traffic requires for routing in the transit exchange a digit analysis beyond the country code, N_1 is the extra-digit designating the incoming international exchange.

2. Accordingly, the *maximum* number of digits that has to be analysed at an international transit exchange is six, which number includes the language or the discriminating digit.

4.3.3 *Digital analysis for routing at the outgoing international exchange*

The *maximum* number of digits which has to be analysed in the outgoing international exchange to determine the routing is also six, as in paragraph 4.3.2.2 above for the transit exchange. This number of six digits includes the language or the discriminating digit.

4.3.4 *Digital analysis for inserting (or detecting) the language or the discriminating digit*

1. In semi-automatic working in the case where the language digit is not sent by the operator and in automatic working, it is necessary to determine in the outgoing international exchange the position where the language or discriminating digit should be automatically inserted (immediately after the country code). This position is determined by an analysis of the first or the first two digits of the country code.

2. In an international transit exchange an analysis, effective on the first or the first two digits of the country code, determines the number of digits in the country code. The position of the language or the discriminating digit which in the sequence of numerical information follows immediately the country code is thus determined.

4.3.5 *Use of acknowledgement signals x and y for controlling the transfer of digits*

In order to reduce the digit transfer to the minimum, the transit register shall decide how many digits it needs for routing a call. Thus the translator intelligence with regard to routing which has to be available in any one exchange will only have to include those routes directly accessible by this exchange.

The transfer of digits to a transit or to a terminal exchange is controlled by backward signals. The interpretation of these backward signals is as follows:

Backward signal	Name of the signal	Interpretation at the outgoing exchange
X	Terminal proceed-to-send	Send discriminating (or language) digit (Z)
Y	Transit proceed-to-send	Send first digit (I_1) of country code
x	Acknowledgement *x*	Acknowledgement of digit received with the alternative meaning according to the type of the last proceed-to-send signal received : a) after signal X, "send next digit", b) after signal Y, "stop the sending of digits"
y	Acknowledgement *y* (used only after a transit proceed-to-send signal Y)	Acknowledgement of digit received; send the next digit

Remark. — According to the design of the transit register the acknowledgement signal *y* can be sent back by the register:
— either after a digit-by-digit consultation of the routing translator by the register, or
— immediately after reception of each digit, and this until a sufficient number of digits has been received.

ANNEX

(to Recommendation Q.126)

Examples of digit transfer control by a transit exchange

A list of possible cases for the digit transfer control by a transit exchange is the following (the letters given to the international exchanges correspond to the figure and the letters given to the digits correspond to paragraph 4.3.2 of this Recommendation):

1. Transit traffic via C in one country routed to two exchanges M or R in another country according to the first digit (s) of the national (significant) number.

a) Automatic and semi-automatic calls with normal national numbers.

Example: $I_1\ I_2\ Z\ N_1\ N_2$

b) * Semi-automatic calls to code 11 or code 12 operators.

Examples: $\underbrace{I_1\ I_2\ L\ N_1\ C_{11}}_{\text{analysed}}$ or $\underbrace{I_1\ I_2\ L\ N_1\ C_{12}}_{\text{analysed}}$

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* The existing design of some present-day equipments does not permit the insertion of the extra digit N_1.

In this situation, agreement will be required between the relevant countries concerned that this insertion of N_1 would not be provided for at a particular outgoing international exchange as long as the equipment limitation applied.

2. Transit traffic via C in one country routed to G or S in another country with semi-automatic traffic to S and automatic traffic to G according to the presence of the language digit (L) or the presence of the discriminating digit (D).

Examples: $I_1\ I_2\ D$ or $I_1\ I_2\ L$

3.* Terminal traffic incoming to an international exchange C in a country and which is to be routed to code 11 or code 12 operators in another international exchange A in the same country according to the extra digit N_1.

Examples: $\underbrace{L\ N_1\ C_{11}}_{\text{analysed}}\ C_{15}$ or $\underbrace{L\ N_1\ C_{12}}_{\text{analysed}}\ X\ X\ C_{15}$

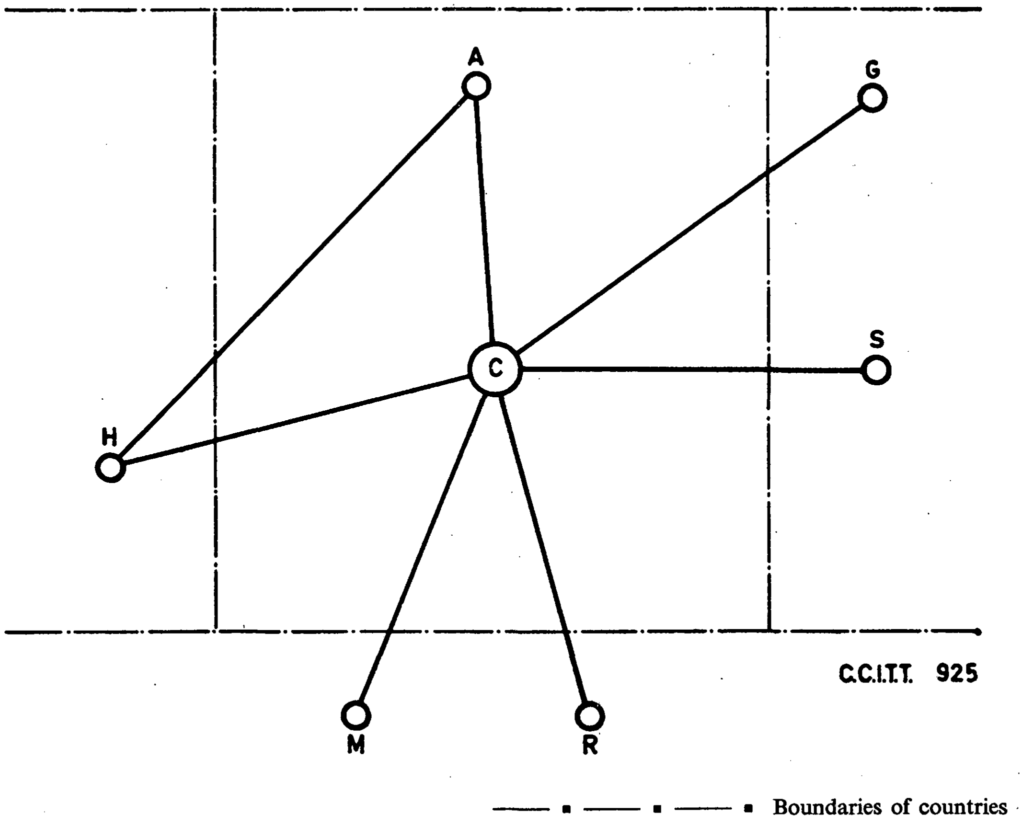

FIGURE 3. — **Examples of digit transfer control by a transit exchange**

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* It is recognized that existing design of some present-day equipments does not permit the insertion of the extra digit N_1.

In this situation, agreement will be required between the relevant countries concerned that this insertion of N_1 would not be provided for at a particular outgoing international exchange as long as the equipment limitation applied.

RECOMMENDATION Q.127

4.4 RELEASE OF REGISTERS

4.4.1 Outgoing register

4.4.1 (1) *Normal release conditions*

The outgoing register shall release in either of the following two cases:

Case 1. — The register has sent forward all the numerical signals *and* has received a local sending-finished signal from the outgoing operator indicating that there are no more digits to follow.

Case 2. — The register has received:

- either a number-received signal from the incoming international exchange indicating that all the digits comprising the complete national number have been received,
- or a busy-flash signal (this assumes that a busy-flash signal does not initiate re-routing *).

4.4.1 (2) *Abnormal release conditions*

Arrangements should be made at the outgoing exchange for the possibility of releasing the outgoing register when any one of the following conditions arises:

a_1) With semi-automatic operation if, after a delay of 10-20 seconds from the seizure of the register or the receipt of the last digit, no further digit or local sending-finished signal is received.

a_2) With automatic operation if, after a delay of 15-30 seconds from the seizure of the register or the receipt of the last digit, the register is in one of the following conditions:

- seized, but no further digit received from the calling subscriber,
- not all the digits necessary to determine the routing received,
- correct number of digits to determine the routing received, but no further digit from the calling subscriber,
- no busy-flash or a number received signal has been received although the complete national (significant) number or part of it has been sent.

In the first two cases, a shorter delay may nevertheless be adopted by certain Administrations.

In the last two cases, release of the outgoing register is made to accompany release of the international circuit by sending the clear-forward signal.

The method of indicating the above abnormal conditions to the calling subscriber will depend on the practice followed in the various countries: a tone may be sent or, better, a recorded announcement will ask the caller to recommence his call after having checked the number to be dialled. (See also Recommendations Q.116 and Q.118.)

The delay of 15-30 seconds provided for in the above conditions is considered sufficient to cover the maximum period for receiving a number-received signal under the most unfavourable conditions.

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* See definition of "re-routing" in Recommendation E.170 (Q.12).

b) Numerical information received for which no routing has been provided.

c) Proceed-to-send signal or busy-flash signal not received within:

— 10 to 30 seconds following the sending of a seizing signal,

— 15 to 30 seconds following the sending to a transit centre of the digits necessary to determine the routing,

d) An acknowledgement signal not received within 5 to 10 seconds following the sending of a digit.

e) More than the appropriate number of transit proceed-to-send signals is received (see 2.1.2.3, Recommendation Q.112 for the maximum number of circuits switched in tandem).

In the various cases mentioned above, an appropriate indication should be given to the operator or calling subscriber.

4.4.2 Transit register

4.4.2 (1) *Normal release conditions*

The transit register shall release as soon as it has selected an outgoing circuit and sent forward a seizing signal on the circuit.

However, a different procedure may be used, in which release of the register is delayed until either a proceed-to-send signal or a busy-flash signal is received from the next exchange. It may be judged more convenient to make use of the transit register when it is desired to give an alarm to show that a proceed-to-send signal has not been received. In this case, the circuit should be switched to the speech condition in both directions of transmission immediately following the operations mentioned above so as to allow the proceed-to-send signal and the following numerical signals to pass through the transit exchange.

If there is outgoing congestion from the transit exchange, the register will release after it has returned a busy-flash signal, and made connection to a recorded announcement.

4.4.2 (2) *Abnormal release conditions*

The transit register will release *without returning any signal* under either of the following conditions:

a) the digits necessary for determining the routing not received within 5 to 10 seconds following the sending of a proceed-to-send signal to the outgoing exchange:

b) numerical information received for which no routing has been provided.

On the other hand, if release of the transit register is deferred until a proceed-to-send signal is received, in accordance with the alternative method mentioned in paragraph 4.4.2 (1), it will release if a proceed-to-send signal or busy-flash signal is not received within 10 to 30 seconds following the sending of a seizing signal to the next exchange.

4.4.3 Incoming register

4.4.3 (1) *Normal release conditions*

The incoming register will release when all the numerical information necessary to set up the connection in the incoming country has been sent and after a number-received signal has been returned over the international circuit. The register will determine when the complete national (significant) number has been received under the conditions defined in Recommendation Q.120, paragraph 1.5.5.

If the incoming register finds that there is congestion within or outgoing from the incoming international exchange, it will release after returning a busy-flash signal.

4.4.3 (2) *Abnormal release conditions*

The incoming register will release if any one of the following three conditions occurs:

a) No further digit is received after a delay of 30 to 60 seconds from receipt of the last digit and it is not possible to determine by one of the methods described in paragraph 1.5 of Recommendation Q.120 that the number which is received is a complete number.

b) No digit is received within 5 to 10 seconds following the return of a proceed-to-send signal.

c) A number is received for which no routing exists, or an incomplete number is received followed by an end-of-pulsing signal (code 15).

In cases a) and b) no signal is returned because the outgoing register remains in circuit and can itself detect any abnormal condition in the establishment of the call.

In case c), before the incoming register releases, a number-received signal will be returned, followed, if possible, by a recorded announcement, a number-unobtainable tone or by the intervention of an interception operator.

RECOMMENDATION Q.128

4.5 SWITCHING TO THE SPEECH POSITION

4.5.1 *Outgoing international exchange*

The circuit shall be switched to the speech position when the outgoing register releases (see 4.4.1).

4.5.2 *International transit exchange*

The circuit shall be switched to the speech position immediately the transit register has sent the seizing signal (see 4.4.2).

4.5.3 *Incoming international exchange*

The circuit shall be switched to the speech condition immediately the incoming register:

- has sent back the number-received signal and sent forward the numerical information to the national network equipment,
- or has sent back the busy-flash signal.

or, if these signals are not sent, when the register releases under abnormal conditions (see 4.4.3 (2)).

RECOMMENDATION Q.129

4.6 MAXIMUM DURATION OF A BLOCKING SIGNAL

When a blocking signal is sent on a circuit, an alarm should be given at the outgoing end of the circuit if the blocking condition persists for more than about 5 minutes.

RECOMMENDATION Q.130

4.7 SPECIAL ARRANGEMENTS IN CASE OF FAILURES IN THE SEQUENCE OF SIGNALS

4.7.1 *Blocking an outgoing circuit*

Installations should provide the following facilities for blocking outgoing circuits. These facilities will be used or not according to the maintenance instructions which will be promulgated.

1. If, after sending a seizing signal, a proceed-to-send signal or a busy-flash signal is not received within 10 to 30 seconds, the outgoing circuit should be blocked and an alarm given *.
2. The outgoing circuit should be blocked and an alarm given * if a proceed-to-send signal or a busy-flash signal is not received within 15 to 30 seconds of the sending to a transit exchange of the digits necessary to determine the routing.
3. If, after sending a clear-forward signal, a release-guard signal is not received within 5 to 10 seconds, the outgoing end of the circuit should be blocked and an alarm given *.

At the incoming end of the circuit the clear-forward signal should be recognized at any time even if the circuit is in the idle state; the incoming line circuit must therefore be able to recognize a clear-forward signal and to return a release-guard signal even if the clear-forward signal has not been preceded by a seizing signal.

4.7.2 *Abnormal recognition of a release-guard signal at an international transit exchange*

In the case where a release-guard signal is recognized at an international transit exchange without a clear-forward signal having been recognized, arrangements should be made at the transit exchange to:

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* The alarm may be immediate or delayed depending upon the desire of the Administration concerned.

- send a blocking signal in the backward direction, to busy the outgoing end of the incoming circuit at the transit exchange,
- immediately release the circuit outgoing from the transit exchange.

This prevents the receipt of the release-guard signal from giving a wrong indication that the circuit to the transit exchange is cleared.

RECOMMENDATION Q.131

4.8 ABNORMAL RELEASE CONDITIONS OF THE OUTGOING REGISTER CAUSING RELEASE OF THE INTERNATIONAL CIRCUIT

In automatic operation the international circuit should be released when the following abnormal conditions arise:

a) if, after receiving the digits necessary to determine the routing, the outgoing register receives no further digit within a period of 15 to 30 seconds;

b) if no busy-flash or number-received signal is received by the outgoing register within a period of 15 to 30 seconds although the national (significant) number (or part of it) has been sent.

The release of the outgoing register under these abnormal conditions is dealt with in paragraph 4.4.1 (2) of Recommendation Q.127.

CHAPTER V

Testing arrangements

RECOMMENDATION Q.133

5.1 NUMBERING FOR ACCESS TO AUTOMATIC MEASURING AND TESTING DEVICES

5.1.1 Automatic measuring and testing devices situated in the I.T.M.C.s and the I.S.M.C.s of other countries will be obtainable from the access point defined in Recommendation Q.75 by means of the following digit sequences:

a) terminal seizing signal;
b) code 13 replacing the language digit;
c) code 12;
d) digit 0;
e) two digits which will be associated with the type of testing or measuring device required;
f) end-of-pulsing signal (code 15).

Note. — The allocation of the digits in e) above will enable access to be given to a number of different types of measuring or testing equipment. Combination 51 to combination 59 are allocated to automatic transmission measuring devices standardized by the C.C.I.T.T. for A.T.M.E. No. 1. Combination 00 is used for access to the automatic testing device specified in Recommendation Q.137. Combinations 01 to 03 are allocated to the automatic transmission measuring and signalling testing equipment No. 2 *.

RECOMMENDATION Q.134

5.2 ROUTINE TESTING OF EQUIPMENT (LOCAL MAINTENANCE)

5.2.1 Routine testers for testing individual items of equipment such as circuit equipment, connecting circuits, operator's line calling equipment, selectors, registers, etc., must be provided in every international exchange equipped for automatic switching. These routine testers will be provided in accordance with the practice followed in each country for the local maintenance of the switching equipment.

5.2.2 The testing equipment must conform to the following principles:

a) An item of equipment must not be taken for test until it is free; a signal will show the exchange staff that a piece of apparatus has not been taken for test because it was engaged on a call; it will then be possible to test this piece of apparatus later;

b) An item of equipment taken for test will be marked engaged for the duration of the test. When an incoming circuit equipment is taken for test, a blocking signal will be sent to the outgoing exchange (see Recommendation Q.129).

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* See Question 11/IV.

RECOMMENDATION Q.135

5.3 PRINCIPLES OF RAPID TRANSMISSION TESTING EQUIPMENT

Rapid transmission tests can be made by two methods:

a) The first method consists of a loop measurement of the GO and RETURN paths of an international circuit, these paths being looped at the incoming end of a circuit when it is free.

b) The second method consists of sending a special code on the international circuit to be tested so as to obtain access to an automatic testing equipment in the incoming exchange.

The first method requires that the incoming end of all circuits should be equipped as described later in Recommendation Q.136.

The second method assumes the existence of rapid transmission testing equipment in all exchanges between which this method is used. This testing equipment must be designed in accordance with Recommendation Q.137.

Note. — The first method provides over-all testing on the GO and RETURN paths without being able to differentiate between the conditions of each of the two directions of transmission. The second method enables separate transmission tests in the two directions. (A situation can occur, however, when it is not possible to determine whether a transmission fault is on the GO path or on the RETURN path of the circuit.) Since the second method requires that for access to the incoming testing apparatus signals must be passed over the circuit, there is some check of good signalling conditions.

RECOMMENDATION Q.136

5.4 LOOP TRANSMISSION MEASUREMENTS

A permanent loop will be connected between the GO and RETURN paths of an international circuit at its incoming end when the circuit is free, so that transmission tests can be made independently of the signalling conditions.

The loop between the GO and RETURN paths shall be connected in such a manner that the level diagrams of each of the two paths will be respected when the circuit is free (loop established); the loop may therefore include an attenuation pad of the required value.

The loop at the incoming end of the international circuit should be disconnected when a seizing signal is received. The loop must be disconnected within 35 ms so as to ensure that the part of a seizing signal which passes round the loop and which is returned to the outgoing end cannot be recognized as a signal.

RECOMMENDATION Q.137

5.5 AUTOMATIC TESTING EQUIPMENT

The second method for rapid transmission tests consists of extending the international circuit, by means of a special code, to an automatic testing equipment at the incoming exchange. For this method, there must be incoming testing equipment at the incoming international exchange and outgoing testing equipment at the outgoing international exchange. This equipment should be designed in accordance with the following conditions:

5.5.1 *Incoming testing equipment*

(1) Connection to incoming testing equipment:

The incoming testing equipment will normally be connected in the four-wire part of the circuit.

Access to this equipment from an outgoing international exchange will be obtained by sending successively on the international circuit, according to Recommendation Q.133:

a) terminal seizing signal,

b) code 13 replacing the language digit,

c) code 12,

d) three digits 000, the last two being the combination for access to the automatic testing equipment,

e) end-of-pulsing signal (code 15).

If the incoming testing equipment is free, the answer signal will be sent 800 to 1200 ms after it is connected.

If the incoming testing apparatus is occupied, a busy-flash signal will be returned.

(2) Measuring condition:

When the answer signal has been sent, the incoming testing equipment will pass to the measuring condition, in which the level of the test signal sent by the outgoing testing apparatus will be measured. The passage to the measuring condition will be effected after a period of 600 to 900 ms calculated from the moment when the testing equipment prompts the sending of the answer signal. This delay is necessary to ensure that the noise which may be produced at the moment of the passage of the circuit to the speech conditions will not influence the measuring arrangement.

The measurement of the received signal will be made with an accuracy of ± 1 dB.

To provide time for the test signal to become stabilized, there should be a delay of 100 to 150 ms after the operation of the detector circuit, before indications on the level of the test signal are given.

The incoming testing equipment will determine whether the level of the test signal is within the prescribed limits; these limits will be predetermined by an adjustment of the equipment to specified values. These limits will provisionally be ± 4 dB with respect to the nominal level at which the test tone should be received.

(3) Passage to the sending condition:

If the received test signal is within the prescribed limits (deviation of ± 4 dB from the nominal value) the incoming testing equipment will send a test signal on the RETURN path of the circuit.

This test signal will have a frequency of 800 Hz which is the same as the test frequency sent on the GO path of the circuit by the outgoing testing equipment. The frequency sent should be controlled within ± 3%. The test signal sent by the incoming testing equipment will give a power of 1 milliwatt at a zero relative level point of the circuit. The sending level must be maintained to ± 0.5 dB.

If, due to the non-reception of a clear-forward signal, the test signal is transmitted for a period of 1-2 minutes, the incoming testing equipment will stop transmitting this test signal and a clear-back signal will be sent. The release of the incoming testing equipment will then be carried out in accordance with the provisions of Recommendation Q.118, paragraph 4.3.3.

(4) Indication of unsatisfactory transmission on the GO path of the circuit:

If the level of the received test signal is outside the prescribed limits or if the incoming testing equipment does not receive the test signal, a clear-back signal will be returned to the outgoing end. This clear-back signal will be sent 5 seconds after passing to the measuring position and will indicate to the testing officer at the outgoing exchange that the transmission quality of the GO path of the circuit is not up to standard.

5.5.2 *Outgoing testing equipment*

(1) Connection to the outgoing testing equipment:

The outgoing testing equipment will be designed to automatically send the numerical information mentioned under (1) in paragraph 5.5.1 above.

(2) Sending condition:

The receipt of an answer signal sent by the incoming testing equipment will cause the sending of the test signal by the outgoing testing equipment. This test signal will be sent for a period of 500 to 800 ms. To allow the incoming testing equipment to pass into the measuring condition, this test signal should not be sent immediately after the answer signal but should be delayed for a period of at least 700 ms.

The test signal will be sent automatically or under the control of the officer making the tests. If the test signal is sent automatically, the delay in sending the test signal following the end of the receipt of the answer signal should be between 700 and 900 ms. If the test signal is sent under the control of the operator, the latter should operate quickly, because the clear-back signal can be returned by the incoming testing apparatus after a delay of 5 seconds.

The frequency of the test signal will be 800 Hz ± 3%.

The level of the sent test signal will be adjusted to give a power of 1 milliwatt at a zero relative level point of the circuit. The sent level will be accurate to ± 0.5 dB.

(3) Passage to the measuring condition:

As soon as the outgoing testing equipment has sent the test signal, it will pass automatically from the sending condition to the measuring condition. In this condition, the level measuring equipment will measure the level of the test signal received from the incoming end. The operator or the automatic device at the outgoing end will check that the level of the received signal is within the prescribed limits.

RECOMMENDATION Q.138

5.6 INSTRUMENTS FOR CHECKING EQUIPMENT AND MEASURING SIGNALS

5.6.1 *General*

For local checks of correct equipment operation and for readjusting the equipment, international exchanges should have available instruments of the following two types:

a) calibrated signal generator,

b) signal measuring apparatus.

These instruments should have the following characteristics:

5.6.2 *Calibrated signal generator*

Duration of sent signals to be adjustable between the extreme limits given in the equipment Specifications, i.e.: 3 to 500 ms.

The accuracy required in the duration of sent signals should be the higher of the following two values:

± 1 ms or ± 1% of the nominal value of the sent signal.

Frequency:

The sent frequency shall not differ by more than ± 5 Hz from the nominal value and shall not vary during the time required for testing.

Level of the sent signals to be variable between the extreme limits given in the equipment Specifications and able to be set to a particular fixed value equal to the nominal value as defined in these Specifications.

Tolerances on the reading of the level of the sent signalling frequencies to be ± 0.2 dB.

5.6.3 *Signal-measuring equipment*

Duration of signals to be measured to be between the extreme limits given in the equipment Specifications, i.e.: 3 to 500 ms.

The accuracy required in the duration of the measured signals should be the higher of the following two values:

± 1 ms or ± 1% of the nominal value of the received signal.

Signal frequency to be measured to be between the extreme limits set by the Specifications, the reading being made with an accuracy of ± 1 Hz.

Level of the signalling frequencies to be measured to be adjustable between the extreme limits set by the Specifications, the reading being made with an accuracy of ± 0.2 dB.

RECOMMENDATION Q.139

5.7 MANUAL TESTING

5.7.1 Functional testing of signalling arrangements

Functional tests from one end of the circuit to the other can be made in the following three ways:

a) The first method consists of a rapid verification of satisfactory signal transmission by ensuring that a seizing signal is followed by the return of a proceed-to-send signal, that a clear-forward signal is followed by the return of a release-guard signal and that the circuit is clear.

b) The second method consists of verification of satisfactory signal transmission by initiating a test call:

  1) to technical personnel at the distant-end international exchange, or

  2) to a test call signal testing and answering device, if such equipment is available at the distant-end international exchange.

c) The third method will consist of complete verification of satisfactory line and register signal transmission [*]. The verification consists of a check of ability to:

  1) generate and receive line and register signals,

  2) transmit the appropriate acknowledgement signals,

  3) complete terminal and transit [**] calls.

5.7.2 First method: rapid test

1. Verification of satisfactory signal transmission:

  a) Initiate a seizing signal and verify the receipt and recognition of the proceed-to-send signal from the distant end;

  b) Initiate a clear-forward signal and verify the receipt and recognition of the release-guard signal from the distant end.

2. In the event of a failure appropriate steps should be taken to locate and correct the trouble.

3. The above tests are short, simple and should be made daily.

5.7.3 Second method: test calls

1. Verification of satisfactory transmission of signals involved in completion of test calls (manual method):

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[*] See Question 14/XIII.

[**] Transit test calls are not intended to check the performance or the quality of the circuit beyond the transit exchange, this being entirely the responsibility of the Administration concerned. However, it is important that in principle the transit operations can be checked.

a) Place a call to the technical personnel at the distant international exchange.

b) On completion of connection:

   1. the audible ringing tone should be heard,
   2. the answer signal should be received when the call is answered at the distant end.

c) Request distant end to initiate a clear-back signal, followed by an answer signal.

d) A clear-back signal should be received and recognized when the distant end hangs up and a second answer signal should be received and recognized when the distant end re-answers the call.

e) Initiate a forward-transfer signal which should result in bringing in the assistance operator at the distant end.

f) Terminate the call and observe that the circuit restores to the idle condition.

2. Verification of satisfactory transmission of signals involved in completion of test calls (semi-automatic method).

If test call signal testing and answering devices are available at the distant international exchange, the signal verification tests should be made using this equipment to the extent that the applicable features indicated in 1 above are available.

3. The tests should be made monthly when the manual testing methods prescribed in 1 are used.

They may be made daily when semi-automatic test arrangements are available.

ANNEXES TO SIGNALLING SYSTEM No. 4 SPECIFICATIONS

ANNEX 1

SIGNALLING SEQUENCES

Table 1. — Signalling sequences in terminal traffic

Table 2. — Signalling sequences in transit traffic

In these tables the arrows have the following meanings:

——▶ transmission of a signalling frequency (permanent or pulse emission).

– – –▶ end of transmission of the signalling frequency in the case of its permanent transmission.

· · ·▶ transmission of an audible tone.

ANNEX 2

DESCRIPTION OF THE OPERATIONS CORRESPONDING TO THE VARIOUS NORMAL AND ABNORMAL CONDITIONS WHICH MAY ARISE IN SETTING UP A CALL

Table 1. — Outgoing exchange — Normal conditions

Table 2. — Outgoing exchange — Abnormal conditions

Table 3. — Incoming exchange — Normal conditions

Table 4. — Incoming exchange — Abnormal conditions

Table 5. — Transit exchange — Normal conditions

Table 6. — Transit exchange — Abnormal conditions

ANNEX 1

TABLE 1. — SEMI-AUTOMATIC (SA) AND AUTOMATIC (A) TERMINAL TRAFFIC

Outgoing international exchange		Incoming international exchange
	CALL TO A FREE SUBSCRIBER	
Terminal seizing signal is sent forward.	PX →	The receipt of this signal causes an incoming terminal register to be connected and when this is ready to receive the digital information a proceed-to-send (terminal) signal is returned.
The receipt of a proceed-to-send signal causes the whole of the digital information to be sent forward SA: Language digit, national (significant) number of the called party followed by the end-of-pulsing signal.	← X	
A: Discriminating digit, national (significant) number of the called party.	Binary code →	The digital information is received in the incoming register. This register then controls the setting-up of the connection within the incoming country to the called party or, on code 11 or code 12 calls in semi-automatic operations, routes the call to an operator.
The register will then release and establish the speech path at the outgoing end of the circuit: SA: after an end-of-pulsing signal is sent	x = acknowledgement of the reception of a digit ←	
A: after the receipt of the number-received signal SA: an indication is given to the operator that the international selection operations have been accomplished.	← P	A number-received signal is returned as soon as the incoming register has determined that it has received a complete number. As soon as the register has sent forward all the information received, it releases and establishes speech conditions at the incoming end of the circuit.
The operator (SA) or the calling subscriber (A) } hears the ringing tone	←……	The called subscriber, found free, is rung. The ringing tone of the incoming country is sent back.
SA: An answer supervisory signal is given to the controlling operator. A: The charging of the subscriber and the measurement of call duration start.	← PY	Called party answers; answer signal is returned.

ANNEX 1. — TABLE 1 *(continued)*

Outgoing international exchange		Incoming international exchange
SA: A clearing supervisory signal is given to the controlling operator. A: After 1-2 min. in the absence of a clear-forward signal, the international connection will be released, the charging of the subscriber and the measurement of call duration will be ceased.	← PX	Called party clears; clear-back signal is returned.
SA: An answer supervisory signal is given to the controlling operator. A: The measuring of the delay of 1-2 min. will be ceased.	← PY	Called party re-answers; answer signal is returned.
SA: Controlling operator clears down the connection. A: The calling subscriber clears: Clear-forward signal is sent.	PXX →	Releases the connection at the incoming exchange and when release is fully effective a release-guard signal is returned.
This signal removes the guard from the outgoing end and frees the circuit for further traffic.	← PYY	

CALL TO A BUSY SUBSCRIBER (OR CONGESTION)

The succession of signals is the same as for a call to a free subscriber up to the point of sending the number-received signal.

SA: An indication can be given to the outgoing operator that the international selection operations have been completed.	← P	Transmission of the number-received signal and establishment of speech conditions at the incoming end.
		1st case. — The national network of the incoming country can give the busy-flash signal.
SA: A "busy" indication is given to the outgoing operator.	← PX	The national busy-flash signal is detected by the international incoming equipment. The busy-flash signal is sent back.
The operator hears the busy tone. The outgoing operator releases the connection (see above).	←⋯⋯	The busy tone of the incoming country if present is sent back.
A: The international connection will be released automatically. The calling subscriber hears the busy tone from the (national or international) outgoing exchange.		

ANNEX 1. — TABLE 1 *(concluded)*

Outgoing international exchange		Incoming international exchange
The operator and/or the calling subscriber hears the busy tone, and releases the connection (see above).	◄··········	*2nd case.* — The national network of the incoming country cannot give the busy-flash signal. The busy tone of the incoming country is sent back.
	SPECIAL CONDITIONS	
SA: Following a call switched automatically to a subscriber, the controlling operator wishes to bring about the intervention of an assistance operator at the incoming international terminal exchange; a forward-transfer signal is sent.	PYY ──────►	Causes an assistance operator to intervene at the incoming terminal exchange on an established connection completed automatically.
SA: Following a call via code 11 or code 12, the controlling operator wishes to recall the incoming operator at the incoming international terminal exchange; a forward-transfer signal is sent.	PYY ──────►	Recalls the incoming operator on calls completed via an operator at this exchange.
This signal causes a guarding condition to be applied to block further traffic.	◄────── PX (or continuous frequency)	Engineering personnel wish to busy the international circuit at the outgoing end; a blocking signal is sent.
Guarding condition removed on cessation of continuous frequency.	◄··········	Following the continuous frequency, the guarding condition is removed when this signal is disconnected.
This signal removes the guarding condition at the outgoing end.	◄────── PYY	Following the PX-signal, a release guard signal is sent when the blocking condition is disconnected at the incoming end.

TABLE 2. — SEMI-AUTOMATIC (SA) AND AUTOMATIC (A) TRANSIT TRAFFIC

Outgoing international exchange	International transit exchange	International transit exchange	Incoming international exchange
CALL TO FREE SUBSCRIBER			
Transit seizing signal sent forward. PY →	Causes transit register to be connected.		
← Y	Transit proceed-to-send signal is returned.		
Causes the necessary digits to determine the routing to be sent forward. Binary code →	Received in the transit register.		
y = acknowledgement of a digit x = acknowledgement after last digit required ←			
	A circuit in the desired direction is taken. If an indirect route is taken a transit seizing signal is sent forward. PY →	Causes transit register to be connected.	
	Transit register releases and speech path through the transit exchange is established.		
←	←	Y Transit proceed-to-send signal is returned.	
Causes the necessary digits to determine the routing to be sent forward. →	Binary code →	Received in the transit register.	
←	y = acknowledgement of a digit x = acknowledgement after last digit required ←		

ANNEX 1. — TABLE 2 *(continued)*

Outgoing international exchange	International transit exchange	International transit exchange	Incoming international exchange
		A circuit in the desired direction is taken. If a direct route is taken a terminal seizing signal is sent forward. PX →	Causes terminal register to be connected.
		Transit register releases and speech path through the transit exchange is established.	
Causes the following digital information to be sent: ←			X Terminal proceed-to-send signal is returned.
SA: Language digit, national (significant) number of the called party followed by the end-of-pulsing signal. A: Discriminating digit, national (significant) number of the called party. →	Binary code		Received in the incoming register.
SA: The register then releases and establishes the speech path. ←		*x* = acknowledgement of a digit	This register controls the setting up of the connection within the incoming country to the called party or, on code 11 or code 12 calls, to an operator.
SA: An indication is given to the operator that the international selection operations have been accomplished. ←			P Number-received signal returned when the incoming register has completely received the national (significant) number.
A: Outgoing register releases and establishes speech conditions.			

ANNEX 1. — TABLE 2 *(continued)*

Outgoing international exchange	International transit exchange	International transit exchange	Incoming international exchange
			When it has passed forward all the received digits, the register releases and establishes speech conditions at the incoming end of the circuit. The called subscriber, found free, is rung.
The operator (SA) or the subscriber (A) hears the ringing tone. ◀	………	………	……… The ringing tone of the incoming country is sent back.
SA: An answer supervisory signal is given to the controlling operator. ◀ A: The charging of the subscriber and the measurement of call duration start.	———	———	PY Called party answers: answer signal returned.
SA: A clearing supervisory signal is given to the controlling operator. ◀ A: After 1-2 min. in the absence of a clear-forward signal the international connection will be released, the charging of the subscriber and the measurement of call duration ceased.	———	———	PX Called party clears: clear-back signal returned.
Controlling operator (SA) or the calling subscriber (A) clears. Clear-forward signal sent. PXX	———	———	▶ Clears the connection and when this has been completed sends back a release-guard signal.
	↓ Clears the connection on the cessation of the clear-forward signal. When fully released sends back a release-guard signal. PYY	↓ Clears the connection on the cessation of the clear-forward signal. When fully released sends back a release-guard signal. PYY	
Removes the guard from the outgoing circuit. ◀	Removes guard conditions from the outgoing circuit. ◀	Removes guard conditions from the outgoing circuit. ◀	PYY

ANNEX 1. — TABLE 2 *(concluded)*

Outgoing international exchange	International transit exchange	International transit exchange	Incoming international exchange
CALL TO A BUSY SUBSCRIBER (OR CONGESTION) The conditions are the same as those described on page 2 SPECIAL CONDITIONS			
SA: Visual or audible indication given to controlling operator. A: Audible indication given to the calling subscriber. Automatic release of the international connection.	◀—— PX Congestion of links, registers or outgoing circuits. Busy-flash signal returned followed by a verbal announcement.	Congestion of links, registers or outgoing circuits. Busy-flash signal returned followed by a verbal announcement.	
◀	———	—— PX	
◀	———	———	—— PX Congestion of links, registers or immediate outlets. Busy-flash signal returned. *Note.* — Congestion conditions in the national network may be indicated by audible tones or verbal announcements, or by a national busy-flash signal.
SA: Following a call switched automatically to a subscriber, the controlling operator wishes to bring about the intervention of an assistance operator at the incoming terminal exchange. Forward-transfer signal sent. PYY ——	———	———	▶ Causes an assistance operator to intervene on a connection established automatically at this centre.
SA: Following a call via code 11 or code 12, the controlling operator wishes to recall the incoming operator. Forward-transfer signal sent. PYY ——	———	———	▶ Recalls the incoming operator on calls completed via an operator at this exchange.

ANNEX 2

TABLE 1. — OUTGOING EXCHANGE — NORMAL CONDITIONS

Conditions		Subscriber free	Subscriber busy or national congestion		Congestion outgoing from the incoming exchange	Congestion of common equipment at the exchange			Congestion outgoing from the transit exchange **
			The busy-flash signal			Incoming exchange		1st transit exchange	
			is not provided	is provided		Terminal traffic	Transit traffic		
Operations effected	Release of register	SA - after sending code 15			SA - after sending code 15 or after reception of busy-flash signal	After reception of busy-flash signal		After reception of busy-flash signal *	
		A - after reception of number-received signal		A - after reception of number-received or busy-flash signal					
	Speech position	After release of register		SA - after release of register					
	Action on the international circuit			A - Release of the circuit after reception of busy-flash signal				Possibly automatic re-routing	
	SA - Local signals given to the operator ***	End of international selection operations		End of selections, then busy	Busy			Busy or re-routing	
	A - Transmission of an appropriate indication to the calling subscriber			Busy tone				Busy tone (possibly *)	
Information received from the international circuit	Signals received	Number received		Busy-flash preceded or not by number-received	Terminal proceed-to-send, then:		Transit proceed-to-send, then:		Transit proceed-to-send, then:
					Busy-flash signal				
	Audible indication received	Ringing tone	Busy tone					Name of transit exchange	
References		1.5 4.4.1 (1)		1.6 4.4.1 (1)				Q.12, Q.119; 1.6 4.4.1 (1)	

SA — Semi-automatic service
A — Automatic service
} When there is no specific indication, the clause is applicable to both services.

* — Not applicable if automatic re-routing is provided.

** — Similarly for congestion of the common equipment of a 2nd or subsequent transit exchange.

*** The indications to be given to operators in situations quoted on this line will be determined by each Administration, as this question is a purely national matter.

ANNEX 2

TABLE 2. — OUTGOING EXCHANGE — ABNORMAL CONDITIONS

Conditions		The outgoing register receives no more digits	Registration of unused numerical information	Non-receipt of a backward signal after sending the seizing signal	Non-receipt of an acknowledgement signal after sending a digit	The outgoing register not having detected an abnormality, the incoming register receives		Non-receipt of a backward signal after sending the routing-digits to a transit exchange	Receipt of too many transit proceed-to-send signals
						an incomplete number followed by code 15 (SA)	a non-existing national number (SA and A)		
Operations effected	Release of register	SA 10-20 seconds, A 15-30 seconds after seizure or the receipt of the last digit	Immediately the anomaly is recognized	10-30 seconds after sending the seizing signal	5-10 seconds after sending the digit	After sending code 15 (SA) or after receipt of the number-received signal A)		15-30 seconds after sending the required digits	After receipt of the third signal
	Speech position					After release of the register			
	Action on the international circuit	A - Release (if a circuit has been seized)		Possible blocking of the circuit				Possible blocking of the circuit	
	SA-Local signals given to the operator *	Faulty call	Wrong number	Fault	Fault	End of international selection operations		Fault	Busy
	A - Indication given to the subscriber	Appropriate audible indication							
Information received from the international circuit	Signals received					Number received			
	Tone received					If possible, national number-unobtainable tone, or verbal announcement			
References		4.4.1 (2) a	4.4.1 (2) b	4.7.1 4.4.1 (2) c	4.4.1 (2) d	4.4.3 (2) c		4.7.1 4.4.1 (2) c	4.4.1 (2) e

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* The indications to be given to operators in situations quoted on this line will be determined by each Administration as this question is a purely national matter.

ANNEX 2

TABLE 3. — INCOMING EXCHANGE — NORMAL CONDITIONS

Conditions / Operations effected	Called subscriber free	Subscriber busy or national congestion		Congestion immediately outgoing from the incoming exchange	Congestion of common equipment at the incoming exchange
		The incoming exchange cannot recognize the busy condition	The incoming exchange can recognize the busy condition		
Release of register	After sending the number-received back and sending the numerical information to the national network equipment			After sending the busy-flash signal	
Speech position				After sending the busy-flash signal	
Sending of number-received signal	After recognition of the complete national number			After recognition of the complete national number as the case may be	
Sending of busy-flash signal			After sending number-received signal	0-10 seconds after receipt of the information necessary for determining the route	0-5 seconds after receipt of the seizing signal
Sending of an audible indication	National ringing tone	National busy tone	National busy tone		
References	1.5 4.4.3 (1)	1.5 1.6 b	1.5 1.6.b	1.6.b 4.2.4, 4.4.3 (1)	4.2.4

ANNEX 2

TABLE 4. — INCOMING EXCHANGE — ABNORMAL CONDITIONS

Conditions Operations effected	Non-receipt of first digit	Break in the receipt of digits	Receipt of an unused number	Receipt of an incomplete number followed by code 15
Release of register	5-10 seconds after sending the proceed-to-send signal	30-60 seconds after receipt of the last digit	After sending the number-received signal	
Speech position	After release of the register			
Sending of number-received signal			After recognition of the anomaly	
Sending of national number-unobtainable tone or a verbal announcement			If possible (after sending number-received signal)	
References	4.4.3 (2) b	4.4.3 (2) a	4.4.3 (2) c	

ANNEX 2

TABLE 5. — TRANSIT EXCHANGE — NORMAL CONDITIONS

Conditions / Operations effected	Successful attempt (so far as transit exchange is concerned)	Congestion on switches or on international circuits outgoing from the transit exchange	Congestion on common equipment at the transit exchange
Release of register	After sending seizing signal or after receipt of proceed-to-send signal or busy-flash signal	After sending busy-flash signal	
Speech position	After sending the seizing signal	After sending busy-flash signal	
Sending of busy-flash signal		0-10 seconds after receipt of the digits necessary to determine the routing	0-5 seconds after receipt of the seizing signal
Sending of a recorded announcement (name of transit exchange)		After sending the busy-flash signal	
References	4.4.2 (1)	1.6.a 4.2.4, 4.4.2 (1), 4.6	1.6.a 4.2.4, 4.6

ANNEX 2

TABLE 6. — TRANSIT EXCHANGE — ABNORMAL CONDITIONS

Conditions Operations effected	Non-receipt of the digits necessary to determine the routing	Receipt of an unused numerical information	Non-receipt of a proceed-to-send or a busy-flash signal
Release of register	5-10 seconds after sending the proceed-to-send signal	After recognition of the anomaly	10-30 seconds after sending the seizing signal, if the register is still connected
Speech position			After sending the seizing signal
Action on the outgoing international circuit			Possible blocking of the outgoing circuit
References	4.4.2 (2) a	4.4.2 (2) b	4.4.2 (2) 4.7.1 (1)

PART X

SIGNALLING SYSTEM No. 5

INTRODUCTION

PRINCIPLES OF No. 5 SIGNALLING SYSTEM

General

System No. 5 is compatible with both TASI- * and non-TASI-equipped circuits and may be applied for automatic and semi-automatic operation and both-way working. It requires four-wire signalling and automatic access to the outgoing circuits.

The signalling equipment is in two parts:

a) line signalling—for the so-called supervisory signals, and

b) register signalling—for the numerical signals.

a) *Line signalling*

This is a link-by-link system using two in-band signalling frequencies 2400 Hz and 2600 Hz, two frequencies, instead of one frequency, being adopted for the following reasons:

i) Automatic detection of double seizing on both-way working;

ii) Frequency discrimination between signals, no time discrimination being incorporated.

Automatic detection of double seizing requires that the frequency of the proceed-to-send signal (2600 Hz) be different from that of the seizing signal (2400 Hz). The detection is achieved when one end transmits the outgoing seizing signal (2400 Hz) and at the same time receives the seizing signal (2400 Hz) from the other end and not the 2600-Hz proceed-to-send signal expected.

All signal recognition times are the same (125 ms) except for the seizing and proceed-to-send signals (40 ms). These two signals are not subject to signal imitation by speech and fast signalling is desired in particular to minimize double seizings.

To avoid, with this signalling system, relatively slow signalling in non-TASI applications and in lightly loaded conditions (the more usual) of TASI applications, all signals

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* See Supplement No. 2 in this volume.

are continuous compelled * type except the forward transfer signal. Continuous signals ensure TASI trunk/channel association during the actual time this function requires. (The alternative of TASI-prefixed pulse type signals would, due to the 500-ms TASI prefix, introduce a slight risk of failure to associate a trunk with a channel, and would slow the signalling in terms of restoration of the transmission path after the signalling line splits under the more usual conditions of TASI loading and in non-TASI applications). Only the forward-transfer signal is a TASI-prefixed pulse since for this signal a slight risk of failure can be accepted because it is operator-controlled and may be repeated at will.

Except for the answer signal, all the compelled signals are normal compelled ** type. For reasons of fast speed, the answer signal is overlap-compelled ** at transit points. Fast answer signalling is desirable to minimize the risk of an abandoned call by either the called or calling party, should the verbal answer be lost due to the line splitting on answer signalling.

b) *Register signalling*

This is a link-by-link 2/6 multifrequency (m.f.) in-band en bloc *** pulse signalling system, forward signalling only. The alternative, continuous compelled signalling, would be slow due to the long circuit propagation times in certain applications. The frequencies (700 Hz... 1700 Hz) are outside of the line signalling frequencies. The numerical information signalling is preceded by a KP signal (start-of-pulsing) and terminated by an ST signal (end-of-pulsing). En bloc non-overlap sending *** applies at the outgoing international register, the seizing signal being sent, and thus the international circuit being taken as late as possible, namely when the ST condition is available in the outgoing international register. When sending, the outgoing register pulses out in a continuous sequence. The prior GO trunk/channel association due to the seizing signal is maintained by the TASI speech detector hangover during the interval between cessation of the seizing signal (on receipt of the proceed-to-send signal) and the start of the register pulse out, and during the intervals between successive m.f. signals.

En bloc overlap register signalling *** applies at the international transit registers and at the incoming international register to minimize the post-dialling delay.

Compandors affect signalling, particularly short-pulse compound signalling (e.g. register signalling), due to distortion and the production of intermodulation frequencies. By virtue of the link-by-link signalling and the adopted duration of the m.f. pulses, system No. 5 functions correctly in the presence of compandors.

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* See for this term Recommendation Q.141, section 2.1.6.

** See for these terms Recommendation Q.141, section 2.1.7.

*** See for these terms the footnote to Recommendation Q.151, section 3.1.1.

CHAPTER I

Definition and function of signals

RECOMMENDATION Q.140

1. DEFINITION AND FUNCTION OF SIGNALS

1.1 **Seizing signal** (sent in the forward direction)

This signal is transmitted at the beginning of a call to initiate circuit operation at the incoming end of an international circuit and to seize equipment for switching the call either to the national network of the incoming country or to another international exchange.

1.2 **Proceed-to-send signal** (sent in the backward direction)

This signal is sent from the incoming end of an international circuit, following the receipt of a seizing signal, to indicate that the equipment is ready to receive the numerical signals.

1.3 **Start-of-pulsing signal, also called for system No. 5 "KP signal"** (sent in the forward direction)

This numerical type signal is sent on receipt of a proceed-to-send signal and may be used to prepare the incoming international register for the receipt of the subsequent numerical signals.

Two different KP signals are provided to discriminate between terminal and transit calls:

a) KP1, terminal and

b) KP2, transit.

1.4 **Numerical signal** (sent in the forward direction)

This signal provides an element of information necessary to effect the switching of the call in the desired direction. There is always a succession of numerical signals sent.

1.5 **End-of-pulsing signal, also called for system No. 5 "ST signal"** (sent in the forward direction)

This numerical type signal is sent to show that there are no more numerical signals to follow. The signal is always sent in semi-automatic as well as in automatic working.

1.6 **Busy-flash signal** (sent in the backward direction)

This signal, which is sent only after the proceed-to-send signal, is sent to the outgoing international exchange to show that either the route, or the called subscriber, is busy. The conditions of use of this signal are as follows:

a) An international transit exchange *must* send this signal, after register association, to indicate that there is congestion at that exchange or on the appropriate outgoing routes.

b) An incoming international exchange *must* send this signal, after register association, if there is congestion at that exchange or on the outgoing routes directly connected to it, but sending the signal is *optional* when there is congestion beyond that exchange (when there is congestion at a point in the national network of the incoming country or when the called subscriber's line is busy). This signal is optional because there are several countries that do not send it from their national networks.

Note. — The receipt of the busy-flash signal at the outgoing exchange will cause:

- an appropriate indication to be given to the outgoing operator or to the calling subscriber, and
- the sending of the clear-forward by the outgoing exchange to release the international connection (except when otherwise arranged, for example, in the case of observations on circuits).

1.7 **Answer signal** (sent in the backward direction)

This signal is sent to the outgoing international exchange to show that the called party has answered the call *.

In semi-automatic working, the signal has a supervisory function.

In automatic working, it is used:

- to start metering the charge to the calling subscriber,
- to start the measurement of call duration for international accounting purposes.

1.8 **Clear-back signal** (sent in the backward direction)

This signal is sent to the outgoing international exchange to indicate that the called party has cleared. In the semi-automatic service, it performs a supervisory function. It must not permanently open the speech path at the outgoing international exchange.

In automatic working, arrangements must be made to clear the international connection, stop the charging and stop the measurement of call duration if, between 1 and 2 minutes after receipt of the clear-back signal, the calling subscriber has not cleared. Clearing of the international connection should preferably be controlled from the point where the charging of the calling subscriber is carried out.

Notes on the answer and clear-back signals. — See the corresponding Notes in Recommendation Q.120.

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* See Recommendation Q.27 for the action to be taken to ensure that answer signals, both national and international, are transmitted as quickly as possible.

1.9 **Clear-forward signal** (sent in the forward direction)

This signal is sent in the forward direction at the end of a call when:

a) in semi-automatic working, the operator at the outgoing international exchange withdraws her plug from the jack, or when an equivalent operation is performed:

b) in automatic working, when the calling subscriber hangs up or otherwise clears (as in the case of a subscriber's installation with extension telephones).

This signal is also sent after receipt of a busy-flash signal by the outgoing international exchange, and when there is forced release of the connection (see Recommendation Q.118, paragraphs 4.3.1 and 4.3.2 for automatic working and 4.3.1 for semi-automatic working). This signal may also be sent after an abnormal release of an outgoing register in the case indicated in Recommendation Q.156 under 3.6.2.a) 1.

1.10 **Release-guard signal** (sent in the backward direction)

This signal is sent in the backward direction in response to the clear-forward signal. It serves to protect an international circuit against subsequent seizure as long as the disconnection operations controlled by reception of the clear-forward signal have not been completed at its incoming end.

1.11 **Forward-transfer signal** (sent in the forward direction)

This signal is sent to the incoming international exchange when the outgoing international exchange operator wants the help of an operator at the incoming international exchange.

The signal will normally serve to bring an assistance operator * into the circuit if the call is automatically set up at that exchange. When a call is completed via an operator (incoming or delay operator) at the incoming international exchange, the signal should preferably cause this operator to be recalled.

1.12 **Diagrams showing signal sequence**

The sequence of signals in semi-automatic and automatic working is shown in Tables 1 and 2 of Annex 1 to Part X:

A description of the various operations corresponding to the various normal and abnormal conditions which may arise in setting up a call are given in the tables of Annex 2 to Part X.

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* See the definition of assistance operator in paragraph 1.1.6 of Recommendation Q.101.

CHAPTER II

Line signalling

RECOMMENDATION Q.141

2.1 SIGNAL CODE FOR LINE SIGNALLING

2.1.1 General

The line-signal coding arrangement is based on the use of two frequencies *f*1 (2400 Hz) and *f*2 (2600 Hz) transmitted individually or in combination as shown in Table 1. The use of compound signalling for the clear-forward/release-guard sequence increases the immunity to false release by signal imitation.

By taking advantage of the fixed order of occurrence of specific signals, signals of the same frequency content are used to characterize different functions. For example, in the backward direction *f*2 is used to indicate proceed-to-send, busy-flash and clear-back without conflict. The signalling equipment must operate in a sequential manner retaining memory of the preceding signalling states and the direction of signalling in order to differentiate between signals of the same frequency content. All signals except the forward-transfer signal are acknowledged in the compelled-type manner as indicated in Table 1. The order of transmission of backward signals is subject to the following restrictions:

a) busy-flash signal: never after an answer signal and only after a proceed-to-send signal;

b) answer signal: never after a busy-flash signal;

c) clear-back signal: only after an answer signal.

Note. — The receipt of the answer signal (*f*1) permits discrimination between the busy-flash and the clear-back signals (both *f*2).

A clear-forward signal, which must be acknowledged by a release-guard signal under all conditions of the equipment including the idle condition, may be sent from an outgoing end at any time to initiate the release of the circuit. The clear-forward signal is completely overriding and may break into any other signal sequence.

2.1.2 Transit working

In transit operation, the line equipment at the transit exchange shall be informed (e.g. by the register) that the condition is transit. This will facilitate the link-by-link transmission of line signals through the transit exchange without bringing about consequences appropriate to the terminal exchanges.

2.1.3 Sending duration of line signalling

2.1.3.1 The sending durations of the line signals are shown in Table 1. Additional requirements are:

a) in the event of double seizing (due to both-way operation), the seizing signal transmitted from the end having detected double seizing should persist for at least 850 ± 200 ms to permit also the other end to detect the double seizing;

b) should the called party flash his switch-hook at a faster rate than the equipment can transmit a succession of clear-back and answer signals, the correct indication of the final position of the switch-hook must always be given by the appropriate signal;

c) once the sending of a signal (pulse or compelled) has begun it should be completed (but see paragraph 2.1.1 in regard to the clear-forward signal releasing the circuit at any stage and paragraph 2.1.7 in regard to the overlap answer signal at transit points). If two signals have to be sent one immediately after the other in the same direction, a silent interval of not less than 100 ms should separate the two successive signals. The silent interval should not be so long as to cause unreasonable delay in signalling;

Exceptionally: 1) the intervals between successive signals may be less than 100 ms. However, the technique of complete signals with intervals of at least 100 ms is the preferred arrangement;

2) the forward-transfer signal may be ceased immediately if a backward signal is received. The acknowledgement of the backward signal is then sent.

d) when sending a compound signal, the interval of time between the moments when each of the two frequencies is sent must not exceed 5 ms. The interval of time between the moments when each of the two frequencies ceases must not exceed 5 ms;

e) *Time-out and alarm procedures*

i) Should the transmission of any seize, busy-flash, answer, clear-back or clear-forward signal persist beyond a maximum of 10 to 20 seconds, the signal shall be terminated.

Note. — 10 to 20 seconds time-out for the seizing signal allows reasonable time for association of a register in a distant centre.

ii) Should the transmission of any proceed-to-send, release-guard or other acknowledgement signal persist beyond a maximum of 4 to 9 seconds, the signal shall be terminated.

Note. — The shorter time-out periods for secondary signals enable, under many conditions, detection of a fault at both ends of a circuit on a single call.

iii) Upon the occurrence of a time-out under the above two conditions, the attention of the maintenance personnel should be drawn to the fact that time-out has occurred.

iv) Upon the occurrence of a time-out, the circuit should automatically be removed from service. However, time-out of a seize signal may be excluded from this provision if time-out of that signal is followed by a clear-forward attempt *.

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* An Administration may decide that on the time-out of an acknowledgement signal at the incoming end of the connection, when an automatic repeat attempt is provided, no indication is given to the maintenance personnel, neither is the circuit taken out of service.

v) As a test procedure, Administrations may make repeated signalling attempts and restore the circuit to service if it is found to perform in a normal manner.

vi) Each Administration shall make appropriate arrangements to ensure that a single fault will not cause removal from service of more than one circuit or of more than one register.

2.1.3.2 The duration of the forward-transfer signal is based on the possibility that TASI may clip a signal by up to 500 ms on rare occasions during heavy traffic periods, and on the need for establishing a recognition time that minimizes signal imitation.

2.1.4 Recognition times of line signals

Recognition time is defined as the minimum duration a direct-current signal, at the output of the signal receiver, must have in order to be recognized as a valid condition by the switching equipment. The recognition times are given in Table 1.

For equal immunity against signal imitation, the recognition time of compound signals such as the clear-forward/release-guard sequence could be less than that of the single-frequency signals liable to signal imitation. However, for convenient design arrangements, and to improve the immunity of the clear-forward/release-guard sequence, the recognition time of the compound signals is the same (125 ± 25 ms) as that of the single-frequency signals liable to signal imitation.

After signal recognition, interruptions of up to 15 ms in the primary or acknowledgement signals shall be ignored in the compelled signalling sequences. Interruptions of more than 40 ms must be recognized as the end of the appropriate signal in the compelled signalling sequences.

2.1.5 Line signal code of system No. 5

The line signal code is given in Table 1.

2.1.6 Further specification clauses relative to the line signalling code

a) The seizing signal continues until acknowledged by the proceed-to-send signal. The proceed-to-send signal is transmitted when an incoming register is associated and continues until acknowledged by the stopping of the seizing signal *.

b) The clear-forward signal continues until acknowledged by the release-guard signal, which may be sent as described under 1) or 2) below:

1) The release-guard signal is sent on recognition of the clear-forward signal and continues until acknowledged by the cessation of the clear-forward signal or until the relevant incoming equipment at the international exchange is released, whichever occurs later *.

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* This type of signalling is called "*continuous compelled*".

TABLE 1

Line signal code

Signal	Direction (1)	Frequency (2)	Sending duration	Recognition time
Seizing — *Prise*	→	$f1$	continuous	40 ± 10 ms
Proceed-to-send — *Invitation à transmettre*	←	$f2$	continuous	40 ± 10 ms
Busy-flash — *Occupation*	←	$f2$	continuous	125 ± 25 ms
Acknowledgement — *Accusé de réception*	→	$f1$	continuous	125 ± 25 ms
Answer — *Réponse*	←	$f1$	continuous	125 ± 25 ms
Acknowledgement — *Accusé de réception*	→	$f1$	continuous	125 ± 25 ms
Clear-back — *Raccrochage du demandé*	←	$f2$	continuous	125 ± 25 ms
Acknowledgement — *Accusé de réception*	→	$f1$	continuous	125 ± 25 ms
Forward-transfer — *Signal d'intervention*	→	$f2$	850 ± 200 ms	125 ± 25 ms
Clear-forward — *Signal de fin*	→	$f1 + f2$ (compound)	continuous	125 ± 25 ms
Release-guard — *Libération de garde*	←	$f1 + f2$ (compound)	continuous	125 ± 25 ms

Notes to Table 1

(1) → forward signals
← backward signals

(2) $f1 = 2400$ Hz $f2 = 2600$ Hz

2) The release-guard signal is sent in response to the clear-forward signal to indicate that the latter has brought about the release of the relevant incoming equipment at the international exchange. The release-guard signal continues until cessation of the clear-forward signal is recognized *.

The outgoing access of the incoming end of the both-way circuit shall be maintained busy for 200 to 300 ms after the end of the transmission of the release-guard signal.

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* This type of signalling is called "*continuous compelled*".

c) With respect to the busy-flash, answer and clear-back signals the acknowledgement signal shall not be transmitted before the signal recognition time (125 ± 25 ms) of the primary signal has elapsed. The primary signal shall not be ceased until the signal recognition time (125 ± 25 ms) of the acknowledgement signal has elapsed * (see section 2.1.7 with respect to the transmission of the answer signal at a transit point).

d) The busy-flash signal will be transmitted if the call cannot be completed for any of the following reasons:

1) congestion at an incoming international exchange,
2) congestion at a transit international exchange,
3) error detected in the receipt of the register signals,
4) busy-flash (if received) from a subsequent international system (e.g. system No. 4) or from the national network,
5) time-out of an incoming international register.

e) Receipt of busy-flash at the outgoing international exchange will cause

— after signal recognition time (125 ± 25):

1) the acknowledgement signal to be sent, and
2) an appropriate audible indication to be transmitted to the operator or to the subscriber. When the preceding circuit provides for the transmission of busy-flash, this signal should be transmitted to that preceding circuit;

— after the end of the compelled sequence, i.e. 100 ms after termination of the acknowledgement signal (see paragraph 2.1.3 c):

3) a clear-forward signal to be transmitted from that exchange and the international circuit or chain of circuits to be released by the clear-forward/release-guard sequence.

f) Receipt of busy-flash at a transit exchange will cause after signal recognition time:

1) the acknowledgement signal to be sent, and
2) the busy-flash signal to be sent on the preceding incoming circuit.

Note. — The release of the chain of circuits is initiated from the outgoing (originating) international exchange only. This permits the possibility for maintenance and observation purposes to hold the connection from the outgoing (originating) exchange.

2.1.7 Backward signals on multilink connections

(consider as an example a connection A-T-B)

a) *Normal compelled signalling for busy-flash and clear-back signals*

With *normal compelled signalling* (see 2.1.6 c) above) at a transit point T, the transmission of the primary signal from T to A does not commence until the signal recognition time of the primary signal sent from B to T has elapsed. This technique is applied for the transmission of busy-flash and clear-back signals.

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* This type of signalling is called "*continuous compelled*".

b) *Overlap compelled signalling for the answer signal*

With *overlap compelled signalling* at a transit point T, the process of transmitting the primary signal from T to A is initiated as soon as the signal receiver response has caused at T the receiving end line split of BT. The normal signal recognition of the primary signal is still required at each transit point. The acknowledgement signal on a particular link should not be transmitted until signal recognition time of the primary signal has elapsed. To speed up the transmission of the answer signal, the overlap compelled technique is applied for this signal at a transit exchange when two No. 5 circuits are switched in tandem.

More details of the overlap compelled technique are given below:

If the primary signal from B to T lasts less than the signal recognition time, transmission of a primary signal already initiated at a transit point T from T to A will be stopped.

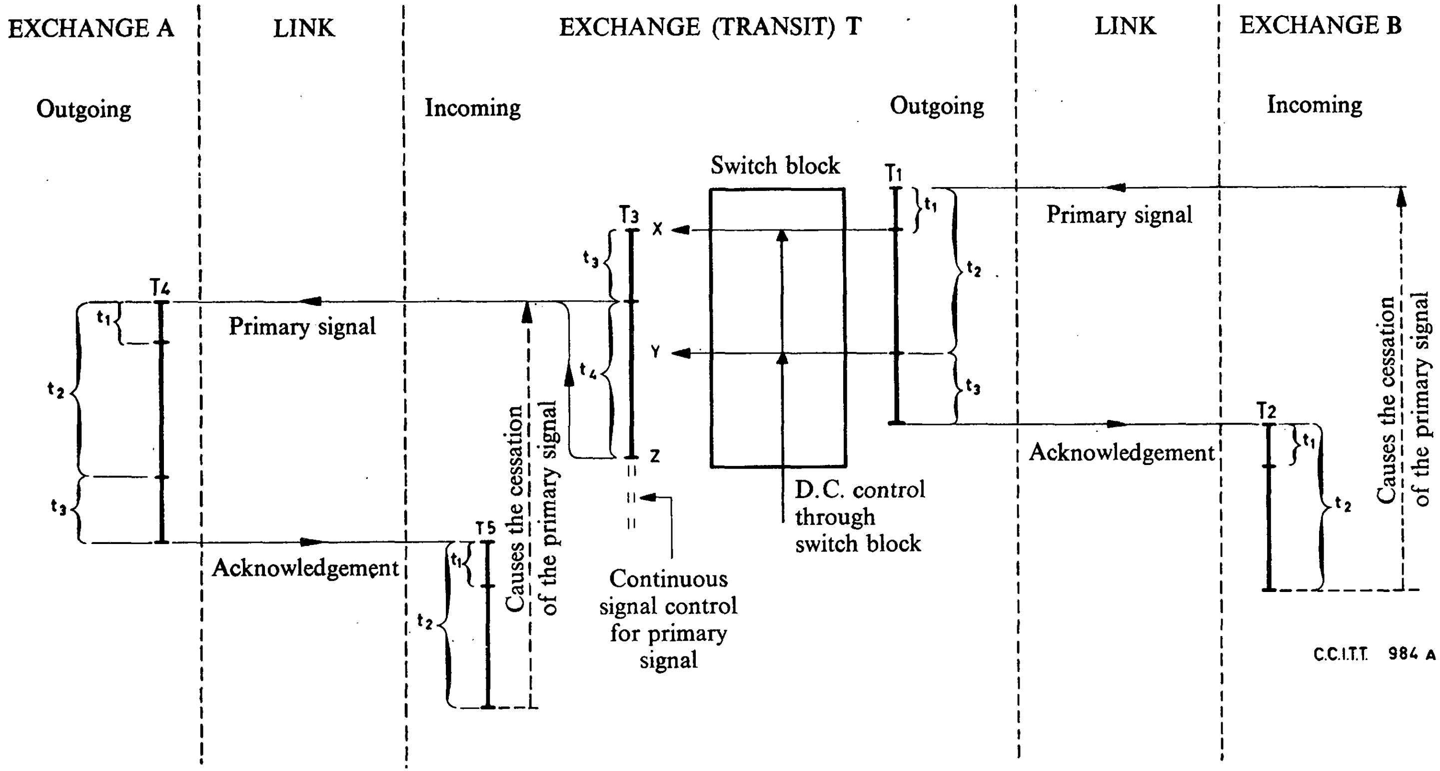
After the recognition time at T of a primary signal from B to T has elapsed, there shall be no control at T of the primary signal sent from T to A by the primary signal sent from B to T. In this case the primary signal on each link is ceased by its acknowledgement signal on that link (as in 2.1.6 c) above).

Figure 1 illustrates a typical arrangement and is included to illustrate the principle of overlap compelled signalling at transit points. Other design arrangements may be adopted as preferred by Administrations.

Transmission of the primary signal from T to A is initiated (by a "start to send" control condition X through the switch block at the transit point) as soon as the signal receiver response on the primary signal from B to T has caused the receiving-end line split (t_1 of T_1). The primary signal is transmitted from T to A after the sending-end line split (t_3 of T_3). Signal recognition of the primary signal is required at the transit point and the acknowledgement signal on a particular link should not be transmitted until the signal recognition time (t_2 of T_1, t_2 of T_4) has elapsed. The primary signal is ceased after the signal recognition time (t_2 of T_2, t_2 of T_5) of the relevant acknowledgement signal.

To prevent imitations of the primary signal on link BT lasting less than the signal recognition time from giving rise to an effective compelled signalling sequence on link TA, transmission of the primary signal on link TA is first under the "start to send" control X of a time base T_3 followed, without break at the termination of the time base (at time Z), by the continuous signal control required for compelled signalling. Should the duration of the primary signal on link BT be less than the signal recognition time (t_2 of T_1), the "start to send" control (X control) is interrupted. This stops transmission of a primary signal on link TA (should this have commenced) within the period X-Z of T_3 and hence before the continuous signal control can be applied.

After the signal recognition time of the primary signal on link BT has elapsed, there shall be no control of the transmission of the primary signal on link TA by the primary signal on link BT at the transit point. To achieve this, a condition is applied to the Y control to inhibit the X control, which should ensure that transmission of the primary signal on link TA cannot be stopped during the period X-Y of T_3 and that the continuous signal control of the primary signal is applied without break at time Y (or at time Z depending upon the particular design). In these circumstances the primary signal on each link is ceased by its relevant acknowledgement signal.



T_1, etc. = Time base
t_1 = Receiving end line split (35 ms max.)
t_2 = Signal recognition time (125 ± 25 ms)
t_3 = Sending end line split (40 ± 10 ms)
t_4 = 125 ± 25 ms typically

FIGURE 1. — **Typical arrangement to illustrate the principle of overlap compelled signalling for the answer signal at transit points**

RECOMMENDATION Q.142

2.2 DOUBLE SEIZING WITH BOTH-WAY OPERATION

2.2.1 Unguarded interval

Considering that on long international (intercontinental) circuits:

a) the sending end splitting time may be 50 ms prior to signal transmission;

b) TASI may occasionally clip the initial 500 ms of seizing signals;

c) circuit propagation time may be relatively long;

d) the signal receiver response time must be taken into account;

e) the recognition time of seizing signals is 40 ± 10 ms,

the unguarded interval relative to double seizing in the extreme case approaches 600 ms plus the circuit propagation time and the signal receiver response time. The signalling system should therefore detect double seizing and take action as defined in section 2.2.2.

2.2.2 Detection of double seizing

In the event of double seizing, the same frequency (*f*1) is received as is being transmitted at each terminal. This condition shall be detected by the signalling equipment and shall cause stoppage of the outgoing seizing signal at each end. An end having detected double seizing, and terminated the outgoing seizing signal 850 ± 200 ms after this signal has been transmitted, will maintain the circuit in the busy condition until the stoppage of the incoming seizing signal from the distant end. Each outgoing seizing signal maintained for at least 850 ± 200 ms will ensure that both ends of the circuit will detect the double seizing.

The signalling equipment will be released on termination of both the outgoing and incoming seizing signals and a clear-forward signal shall not be sent.

Either of the following arrangements may apply on detection of double seizing:

a) an automatic repeat attempt to set up the call, or

b) a re-order indication is given to the operator or to the subscriber and no automatic repeat attempt is made.

Method a) is the preferred arrangement (see Recommendation Q.108).

Method a) does not require the repeat attempt to be limited to the circuit used at the first attempt, but should the first circuit be seized again at the second attempt on the second search over the circuits, a minimum time of 100 ms shall elapse between the termination of the first attempt outgoing seizing signal (or the recognition of the cessation of the incoming seizing signal, whichever occurs later) and the commencement of the second attempt seizing signal.

To minimize the probability of double seizing, the circuit selection at the two ends should be such that, as far as possible, double seizing can occur only when a single circuit remains free (e.g. by selection of circuits in opposite order at the two ends).

RECOMMENDATION Q.143

2.3 LINE SIGNAL SENDER *

2.3.1 Signalling frequencies

2400 ± 6 Hz ($f1$) and 2600 ± 6 Hz ($f2$).

These frequencies are applied separately or in combination.

2.3.2 Transmitted signal level

−9 ± 1 dBm0 per frequency.

For compound signals the difference in transmitted level between $f1$ and $f2$ shall not exceed 1 dB.

Note 1. — The noise as measured at the output of the line signal sender shall be as low as practicable but, in any event, at least 40 dB below signal level. This noise includes all extraneous power in the frequency band between 300 Hz and 3400 Hz including power resulting from non-linear distortion of the signal.

Note 2. — The level of the leak current transmitted to line should be at least 50 dB below signal level per frequency.

RECOMMENDATION Q.144

2.4 LINE SIGNAL RECEIVER *

2.4.1 Operating limits

The line signal receiver shall operate in the conditions specified under section 2.4.5 for the distortion of received signals that meet the following conditions:

a) $f1$: 2400 ± 15Hz; $f2$: 2600 ± 15 Hz.

b) The absolute power level N of each unmodulated signal received shall be within the limits:

$$(-16 + n) \leqslant N \leqslant (-2 + n) \text{ dBm}$$

where n is the relative power level at the signal receiver input.

These limits give a margin of ± 7 dB on the nominal absolute level of each received signal at the input to the signal receiver.

c) The absolute level of the two unmodulated signal frequencies in a compound signal may differ from each other by not more than 5 dB.

The tolerances given in a), b) and c) are to allow for variations at the sending end and for variations in line transmission.

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* See also Recommendation Q.112.

2.4.2 Non-operate conditions of line signal receiver

a) *Selectivity*

The signal receiver shall not operate on a signal having an absolute power level at the receiving end within the limits specified in section 2.4.1 when the frequency is outside:

$2400 {}^{+\,100}_{-\,150}$ Hz for the $f1$ signal circuit or

$2600 {}^{+\,150}_{-\,100}$ Hz for the $f2$ signal circuit.

b) *Maximum sensitivity of line signal receiver*

The signal receiver shall not operate on a signal of 2400 ± 15 Hz or 2600 ± 15 Hz whose absolute power level at the point of connection of the receiver is $(-17\ -9 + n)$ dBm, n being the relative power level at this point. This limit is 17 dB below the nominal absolute level of the signal current at the input to the signal receiver.

2.4.3 Efficiency of the guard circuit

The signal receiver must be protected by a guard circuit against false operation due to speech currents, circuit noise, or other currents of miscellaneous origin circulating in the line.

The purpose of the guard circuit is to prevent:

a) signal imitation. (Signals are imitated if the duration of the resulting direct-current pulses at the output of the signal receiver is long enough to be recognized as signals by the switching equipment);

b) operation of the splitting device from interfering with speech.

To minimize signal imitation by speech currents it is advisable that the guard circuit be tuned.

To minimize signal interference by low-frequency noise it is advisable that the response of the guard circuit falls off towards the lower frequencies and that the sensitivity of the guard circuit at 200 Hz be at least 10 dB less than that at 1000 Hz.

An indication of the efficiency of the guard circuit is given by the following:

a) during 10 hours of speech, normal speech currents should not, on the average, cause more than one false operation of the $f1$ or the $f2$ signal circuit lasting more than 90 ms (the minimum recognition time of a signal liable to imitation is 100 ms);

b) the number of false splits of the speech path caused by speech currents should not cause an appreciable reduction in the transmission quality of the circuit.

2.4.4 Guard circuit limits

A. *Steady noise*

Considering:

a) that when there is noise on a telephone circuit an over-sensitive guard circuit might give rise to signalling difficulties and, in particular, inhibit the response of the signal receiver;

b) that unweighted noise of a level −40 dBm0 (100 000 pW) and uniform spectrum energy may arise on the longest international, i.e. intercontinental, circuit,

it is recommended that, for either one or two signalling currents (each being within the limits specified in section 2.4.1), the signal receiver should satisfy the conditions indicated in section 2.4.5 for the distortion of signals in the presence of noise of a level of −40 dBm0 and uniform spectrum energy over the frequency range 300 to 3400 Hz.

B. *Surges*

A guard circuit with an excessive hang-over time may cause difficulties in receiving a signal, for example, when it has been immediately preceded by surges, and it is therefore recommended that the following condition should be fulfilled:

If a disturbing current of a frequency corresponding to the maximum sensitivity of the guard circuit and having an absolute power level of $(-10 + n)$ dBm at the relative level point n where the receiver is connected ceases 30 ms before the application of a signal satisfying the limits defined in section 2.4.1, the lengths of the received signals must remain within the limits specified in section 2.4.5.

2.4.5 Distortion of received signals

When the signal frequencies and levels are within the limits specified in section 2.4.1, the change in signal length in the presence of noise as defined in section 2.4.4, A should not exceed:

a) 15 ms when the signal receiver receives a pulse of one frequency $f1$ or $f2$ with a minimum duration of 150 ms;

b) 25 ms when the signal receiver receives a compound pulse of the two frequencies $f1$ and $f2$ with a minimum duration of 150 ms, the change being defined as the difference between the simultaneous reception of the two frequencies at the input to the receiver and the simultaneous production of the two components as a direct-current signal at the output of the signal receiver.

In general, the response time of the signal receiver should be as short as practicable to minimize the time required for signalling purposes.

Except for the forward transfer pulse signal, the above pulse distortion requirements are of minor importance for the remaining line signals, which are all of the continuous compelled * type. Nevertheless the limits are specified for receiver design and test purposes.

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* See Recommendation Q.141, section 2.1.6., explaining the term "continuous compelled".

RECOMMENDATION Q.145

2.5 SPLITTING ARRANGEMENTS

Sending line split

2.5.1 According to Recommendation Q.25, section B, sending split arrangements have to be provided.

2.5.2 The exchange side of the international circuit shall be disconnected 30 to 50 ms before a voice-frequency signal is sent over the circuit.

2.5.3 The exchange side of the international circuit will not be reconnected for 30 to 50 ms following the end of the sending of a voice-frequency signal over the circuit.

2.5.4 Exceptionally, the values quoted in 2.5.2 and 2.5.3 above may be 0 to 50 ms as the values are of minor importance with respect to compelled-type signals.

Receiving line split

2.5.5 The international circuit should be split at the international exchange when either a single-frequency or a compound-frequency signal is received, to ensure that no fraction of the signal exceeding 35 ms duration may pass out of the international circuit.

The splitting time of 35 ms may be reduced by each Administration concerned in order to help to protect its national network against the effect of signals coming from the international circuit. It should be noted, however, that a shorter splitting time can lead to an increase in the number of false operations of the splitting device by speech currents and impair speech transmission.

2.5.6 The split must be maintained for the duration of the signal but must cease within 25 ms of the end of the direct-current signal which caused the splitting device to operate.

2.5.7 The splitting of the line must not give rise to surges which might cause interference with signalling over the international circuit or with other signalling systems associated with it for setting up an international call.

2.5.8 The splitting device may be any suitable arrangement—for example, physical line disconnection, high impedance electronic device, insertion of signalling frequency band stop filter, etc. The level of leak current transmitted to the subsequent circuit from the splitting device in the split condition should be at least 40 dB below the received signal level. Exceptionally, the level of the leak current may be 25 dB below the received signal level if this causes no interference with the relevant networks.

RECOMMENDATION Q.146

2.6 SPEED OF SWITCHING IN INTERNATIONAL EXCHANGES

2.6.1 It is recommended that the equipment in the international exchanges shall have a high switching speed so that the switching time may be as short as possible.

2.6.2 At the outgoing international exchange the seizing of the circuit and the setting-up of the connection should take place as soon as the ST end-of-pulsing condition is available (see Recommendation Q.152). In automatic operation advantage should be taken of all cases in which the ST condition can be reasonably determined at once, i.e. with avoidance of the 4-6 seconds time-out.

At an international transit exchange the setting-up of the connection on the outgoing circuit should take place as soon as the digits necessary to determine the routing are received and analysed.

At the incoming international exchange the setting-up of the national part of the connection should start as soon as the register has received a sufficient number of digits.

2.6.3 At international exchanges the return of a proceed-to-send signal should be as fast as possible but in any case the return should normally be guaranteed before the time-out (minimum 10 seconds) of the seizing signal.

Furthermore, in the case of congestion on the circuits outgoing from a transit or an incoming exchange, a busy-flash signal should be returned as soon as practicable, but in any case within a maximum delay of 10 seconds following the receipt of the information necessary to determine the routing.

CHAPTER III

Register signalling

RECOMMENDATION Q.151

3.1 SIGNAL CODE FOR REGISTER SIGNALLING

3.1.1 General

1) Automatic access to the international circuits must be used for outgoing traffic and the numerical signals from the operator or subscriber are stored in an outgoing international register before an international circuit is seized. As soon as the ST (end-of-pulsing) condition is available to the outgoing register, a free international circuit is selected and a seizing line signal transmitted. On receipt of a proceed-to-send line signal the seizing signal is terminated and a KP ("start of pulsing") pulse, followed by the numerical signals, is transmitted by the register. The final register signal transmitted is an end-of-pulsing (ST) pulse. The register signalling is not required to be TASI-prefixed.

2) Link-by-link register signalling applies. The register signals are always sent en bloc *. En bloc non-overlap * applies at the outgoing international register. En bloc overlap * applies at the transit and incoming international registers.

3) On a particular link, the KP signal sent by the international register (outgoing or transit register) on receipt of a proceed-to-send signal may be used to prepare the distant international register on this link for the receipt of the subsequent numerical signals. This signal may also serve to discriminate between terminal and transit traffic:

a) Terminal KP (KP1). Used to create conditions at the next exchange so that equipment (or techniques) used exclusively for switching the call to the national network of the incoming country is brought into circuit.

b) Transit KP (KP2). Used to bring into circuit, at the next exchange, equipment (or techniques) required to switch the call to another international exchange.

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* *En bloc register signalling* is the transmission, by a register, of all the call information as a whole in a regular timed sequence of signals.

The technique requires that, in one register on the connection, all the relevant call information from a subscriber or operator shall be completely stored before output en bloc signal transmission takes place from that register.

At registers subsequent to the one where all the call information from a subscriber or operator is completely stored, the output signal transmission may commence before the complete reception of the input information; thus overlap (to any desired degree) of the output signal transmission with the input signal reception may occur and this may be understood as being *en bloc overlap.* Alternatively, the output signal transmission may be delayed until all the call information is received and stored. This may be understood as being *en bloc non-overlap.*

4) The register signalling is a 2-out-of-6 multifrequency code, forward signalling only, as shown in Table 2.

TABLE 2

Register signal code of system No. 5

Signal	*Frequencies (compound)* Hz	*Remarks*
KP1	1100 + 1700	Terminal traffic
KP2	1300 + 1700	Transit traffic
1	700 + 900	
2	700 + 1100	
3	900 + 1100	
4	700 + 1300	
5	900 + 1300	
6	1100 + 1300	
7	700 + 1500	
8	900 + 1500	
9	1100 + 1500	
0	1300 + 1500	
Code 11	700 + 1700	Code 11 operator
Code 12	900 + 1700	Code 12 operator
ST	1500 + 1700	End-of-pulsing

3.1.2 Sending sequence of register signals

The sequence of the register signals shall conform to the sequence indicated in Recommendation Q.107, noting the following:

a) a KP start-of-pulsing signal shall precede the sequence of numerical signals in all the cases indicated;

b) the ST end-of-pulsing signal will be transmitted from the register in automatic as well as in semi-automatic operation;

c) exceptionally, special numbers for giving access to incoming operators or delay operators may be dialled by outgoing operators and transmitted by outgoing international registers instead of code 11 and code 12 signals.

RECOMMENDATION Q.152

3.2 END-OF-PULSING CONDITIONS—REGISTER ARRANGEMENTS CONCERNING ST (END-OF-PULSING) SIGNAL

3.2.1 The register signalling arrangements provide for the sending of a ST signal for both semi-automatic and automatic operation; the arrangements in the outgoing international register for recognizing the ST end-of-pulsing condition will vary as follows:

a) *Semi-automatic operation*

The ST condition is determined by the receipt of the "sending-finished" signal from the operator (see Recommendation Q.106).

b) *Automatic operation*

(1) Where the ST condition is determined by the originating national network and an ST signal is produced and transmitted to the outgoing international register, no further arrangements are necessary in that register for this purpose.

(2) Where the ST condition is not received from the originating national network, the outgoing international register will be required to determine the ST condition. This ST condition is determined when the cessation of the numerical information input to the register exceeds a period of 4 seconds (5 ± 1 seconds) in either of the following two circumstances, as preferred by the Administration:

  i) after the minimum number of digits in the world numbering plan, or
  ii) after the minimum number of digits of the destination country numbering plan.

In (i) and (ii), prolonged cessation of the numerical information input before the minimum number of digits should result in time-out release of the register without the production of the ST condition.

An immediate ST condition may be produced by a digit count to avoid the 4-second delay ST condition in the following circumstances:

  i) when the destination country numbering plan has a fixed number of digits,
  ii) when the maximum number of digits in the numbering plan of the destination country has been received.

3.2.2 Under all conditions, the outgoing international circuit should not be seized until the ST end-of-pulsing condition is available in the outgoing international register.

RECOMMENDATION Q.153

3.3 MULTIFREQUENCY SIGNAL SENDER

3.3.1 Signalling frequencies

700, 900, 1100, 1300, 1500 and 1700 Hz.

A signal shall consist of a combination of any two of these six frequencies. The frequency variation shall not exceed ± 6 Hz of each nominal frequency.

3.3.2 Transmitted signal level

−7 ± 1 dBm0 per frequency.

The difference in transmitted level between the two frequencies comprising a signal shall not exceed 1 dB.

Note. — The level of the leak current transmitted to line should be at least:

a) 50 dB below the single-frequency level when a multifrequency signal is not being transmitted;

b) 30 dB below the transmitted signal level of either of the two frequencies when a multifrequency signal is being transmitted.

3.3.3 Signal duration

KP1 and KP2 signals: 100 ± 10 ms
All other signals: 55 ± 5 ms
Interval between all signals: 55 ± 5 ms

Interval between cessation of the seizing line signal and transmission of the register KP signal: 80 ± 20 ms.

3.3.4 Compound signal tolerance

The interval of time between the moments when each of the two frequencies comprising a signal is sent must not exceed 1 ms. The interval of time between the moments when each of the two frequencies ceases must not exceed 1 ms.

RECOMMENDATION Q.154

3.4 MULTIFREQUENCY SIGNAL RECEIVER

3.4.1 Operating limits

The signal receiver must ensure a separate output signal for each of the six voice-frequency signals received, and must operate satisfactorily for any combination of two of the frequencies, received as a single pulse or in a train of pulses, satisfying the following conditions:

a) the frequency of the received signal is within ± 15 Hz of the nominal signalling frequency;

b) the absolute power level N of each unmodulated signal shall be within the limits $(-14 + n \leqslant N \leqslant n)$ dBm where n is the relative power level at the signal receiver input. These limits give a margin of ± 7 dB on the nominal absolute level of each received signal at the input to the signal receiver;

c) the absolute levels of the two unmodulated frequencies comprising a signal must not differ from each other by more than 4 dB;

d) when the signal frequencies and levels are within the limits specified in a), b) and c) above, and in the presence of noise as defined in section 3.4.3:

(1) at the input of a signal receiver, the minimum duration of an MF signal necessary to ensure correct registration of the digit shall not exceed 30 ms; this includes the operate time of the signal receiver and the two-and-two only check feature;

(2) furthermore, at the input of the signal receiver, the minimum duration of an interval necessary to ensure the correct functioning of the registration device shall not exceed 30 ms; this includes the release time of the signal receiver and the restoration time of the two-and-two only check feature.

Notes

1. The tolerances given in a), b), and c) are to allow for variations at the sending end and in line transmission.

2. The test values indicated in d) are less than the working values. The difference between the test and working values will allow for pulse distortion, difference in time of the receipt of the two frequencies comprising a signal, etc.

3.4.2 Non-operating conditions

a) *Maximum sensitivity*

The signal receiver shall not operate under the effect of a signal as indicated in paragraph 3.4.1 a) whose absolute power level at the point of connection of the receiver is (—17 —7 + *n*) dBm, *n* being the relative power level at this point.

This limit is 17 dB below the nominal absolute power level of the signal current at the input to the signal receiver.

b) *Transient response*

Operation of the signal receiver shall be delayed for a minimum period necessary to guard against false operation due to spurious signals generated within the receiver on reception of any signal.

c) *Short signal response*

The signal receiver should not operate to a pulse signal of 10 ms or less. This signal may be of single frequency or two frequencies received simultaneously.

Likewise the signal receiver should ignore short intervals.

3.4.3 Steady noise

Considering that unweighted noise of a level —40 dBm0 (100 000 pW) and uniform spectrum energy may arise on the longest international circuit, the multifrequency receiver should satisfy the condition indicated in paragraph 3.4.1 d) for minimum signal and interval durations in the presence of noise of level —40 dBm0 and uniform spectrum energy over the frequency range 300 to 3400 Hz.

3.4.4 Input impedance

The input impedance should be such that the return loss over a frequency range 300 to 3400 Hz against a 600-ohm non-inductive resistor is greater than 20 dB.

RECOMMENDATION Q.155

3.5 ANALYSIS OF DIGITAL INFORMATION FOR ROUTING

3.5.1 General requirements for the transit exchange

In an international transit exchange an analysis of some of the digits is required to determine the routing * to the desired international incoming exchange or to another international transit exchange. As a general rule the country code of the destination country is subject to this analysis. In some cases an analysis of more or fewer digits may be required (see Annex hereafter).

The transit exchange decides how many of the received digits it needs for this analysis.

3.5.2 Maximum number of digits to be analysed in an international transit exchange

(1) The *maximum* number of digits * which has to be analysed in a transit exchange to determine the routing at this exchange is as follows:

$I_1 \ Z \ N_1 \ N_2 \ N_3$
$I_1 \ I_2 \ Z \ N_1 \ N_2$
$I_1 \ I_2 \ I_3 \ Z \ N_1 \ N_2$

where I_1, I_2, I_3 = digits of the country code
Z = characteristic digit, i.e. discriminating digit (D) or language digit (L)
N_1, - - -, N_n = digits of the national (significant) number

Note. — In the case of countries with more than one incoming international exchange where code 11 or code 12 traffic requires for routing in the transit exchange a digit analysis beyond the country code, N_1 is the extra digit designating the incoming international exchange (see the Annex below, examples 1*b* and 3).

(2) Accordingly the maximum number of digits that have to be analysed at an international transit exchange is six, which number includes the language or the discriminating digit.

3.5.3 Digital analysis for routing at the outgoing international exchange

The *maximum* number of digits which have to be analysed in the outgoing international exchange to determine the routing is also six, as in section 3.5.2 for the transit exchange. This number of six digits includes the language or the discriminating digit.

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* See Recommendation E.161 (Q.11), paragraph 1.2.

3.5.4 Digital analysis for inserting (or detecting) the language or discriminating digit

(1) In semi-automatic working in the case when the language digit is not sent by the operator and in automatic working it is necessary to determine in the outgoing international exchange the position where the language or the discriminating digit should be automatically inserted (immediately after the country code). This position is determined by an analysis of the first or the first two digits of the country code.

(2) In an international transit exchange an analysis, effective on the first or the first two digits of the country code, determines the number of digits in the country code. The position of the language or the discriminating digit which, in the sequence of numerical information, follows immediately the country code, is therefore determined.

ANNEX

(To Recommendation Q.155)

Example of the digit analysis in a transit exchange

A list of possible cases for the digit analysis in a transit exchange is the following (the letters given to the international exchanges correspond to the figure and the letters given to the digits correspond to section 3.5.2 of this Recommendation):

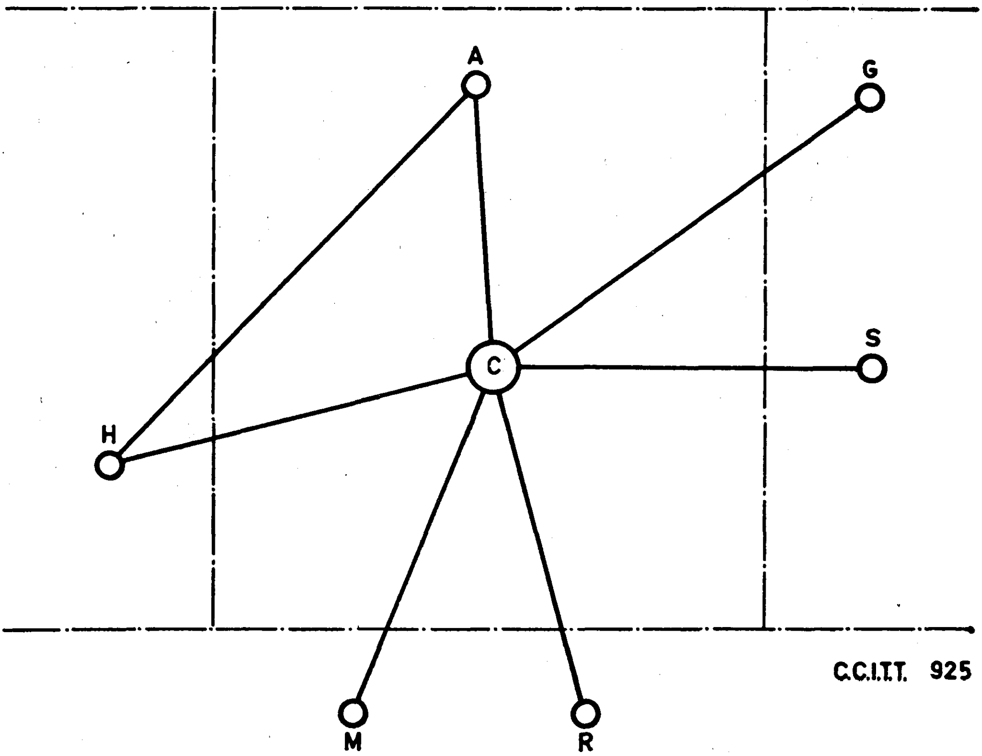

FIGURE 2. — **Example of the digit analysis in a transit exchange**

1. Transit traffic via C in one country routed to exchanges M or R in another country according to the first digit(s) of the national (significant) number.

a) Automatic and semi-automatic calls with normal national numbers.

Example: $\underbrace{I_1\ I_2\ Z\ N_1\ N_2}_{\text{Analysed}}$ - - - -

b) * Semi-automatic calls to code 11 or code 12 operators.

Examples: $\underbrace{I_1\ I_2\ L\ N_1\ C_{11}}_{\text{Analysed}}$ or $\underbrace{I_1\ I_2\ L\ N_1\ C_{12}}_{\text{Analysed}}$

2. Transit traffic via C in one country routed to G or S in another country with semi-automatic traffic to S and automatic traffic to G according to the presence of the language digit (L) or the presence of the discriminating digit (D).

Examples: $\underbrace{I_1\ I_2\ D}_{\text{Analysed}}$ - - - or $\underbrace{I_1\ I_2\ L}_{\text{Analysed}}$ - - -

3.* Terminal traffic incoming to an international exchange C in a country and which is to be routed to code 11 or code 12 operators in another international exchange A in the same country according to the extra digit N_1.

Examples: $\underbrace{L\ N_1\ C_{11}}_{\text{Analysed}}\ C_{15}$ or $\underbrace{L\ N_1\ C_{12}}_{\text{Analysed}}\ X\ X\ C_{15}$

RECOMMENDATION Q.156

3.6 RELEASE OF INTERNATIONAL REGISTERS

3.6.1 Normal release conditions

a) An outgoing international register shall be released when it has transmitted the ST signal.

b) An incoming international register shall be released in either one of the following two cases:

1. Depending on the arrangements adopted by the Administration concerned at the incoming international exchange. For example, release on transmission of the ST signal, release on receipt of a number-received condition from the national network, etc.

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* It is recognized that existing design of some present-day equipments does not permit the insertion of the extra digit N_1.

In this situation, agreement will be required between the relevant countries concerned that this insertion of N_1, would not be provided for at a particular outgoing international exchange as long as the equipment limitation applied.

2. When the busy-flash signal is returned. The return of the busy-flash signal in the case of congestion at the incoming exchange should take place as soon as practicable, but in any case within a maximum delay of 10 seconds following the receipt, at the incoming exchange, of the digits necessary to determine the routing.

c) A transit international register shall be released in either one of the following two cases:

1. When it has transmitted the ST signal.

2. When the busy-flash signal is returned. The return of the busy-flash signal in the case of congestion at the transit exchange should take place as soon as practicable, but in any case within a maximum delay of 10 seconds following the receipt, at the transit exchange, of the digits necessary to determine the routing.

3.6.2 Abnormal release conditions

a) An outgoing international register shall be released in either one of the following two cases:

1. Proceed-to-send signal not received.

To release after the maximum delay of 10 to 20 seconds indicated by the time-out of the seizing signal. Register release after this delay will depend upon the arrangements preferred by the Administrations concerned, but release should preferably take place as quickly as possible after the time-out of the seizing line signal.

2. Proceed-to-send signal received.

This case assumes that the proceed-to-send signal has ceased at the incoming end in the normal way but owing to a fault condition the outgoing register has not pulsed out. The outgoing register will be released by the clear-forward/release-guard sequence prompted by the busy-flash signal sent from the incoming end on non-receipt of register signals within a certain time. This assumes that the busy-flash signal is received at the outgoing end before the termination of any forced release delay that Administrations may wish to incorporate in the outgoing register.

b) An incoming international register shall be released in either one of the following two cases:

1. The ST signal not received within a certain time after commencement of the transmission of the proceed-to-send signal from the incoming end.

2. On return of the busy-flash signal, transmitted from the incoming end when an error is detected in the receipt of the register multifrequency signals.

c) A transit international register shall be released in any one of the cases stated for the release of the outgoing and incoming registers in paragraphs a) and b) above.

RECOMMENDATION Q.157

3.7 SWITCHING TO THE SPEECH POSITION

At the outgoing and transit international exchanges, the circuit shall be switched to the speech position when the register (outgoing or transit) is released after sending the ST signal.

At the incoming international exchange, the circuit will be switched to the speech position when the register is released (see section 3.6.1 of Recommendation Q.156)

CHAPTER IV

Manual testing arrangements for signalling system No. 5 *

RECOMMENDATION Q.161

4.1 GENERAL ARRANGEMENTS FOR MANUAL TESTING *

4.1.1 The guiding principles for the maintenance of the international automatic services, as covered by Recommendations Q.70 to Q.74, and the organization of routine maintenance tests and measurements of signalling and switching, as covered by Recommendations Q.76 to Q.78, are applicable to manual testing arrangements for system No. 5 with the following remarks:

a) Functional tests from the I.T.M.C. and the I.S.M.C. may require co-operation of personnel at the distant end.

b) These manual testing arrangements do not fully provide for the circuit limit tests specified in Recommendation Q.73.

c) The distant I.S.C.C. (see Recommendation Q.72) should be informed of any out-of-service situations and action to remove a circuit from service should be taken at both terminals.

Note. — The out-of-service situation includes intervention of maintenance personnel which causes or has caused interference with service on a circuit.

d) The procedure described in Recommendation Q.75 under item 4 may be modified if a like item of equipment, known to be properly adjusted, is switched in to take the place of equipment under test (see 4.2.2 c) of Recommendation Q.162 below).

4.1.2 The transmission tests on system No. 5 will be made by manual methods or by using test call transmission devices existing at the terminal international exchange.

RECOMMENDATION Q.162

4.2 ROUTINE TESTING OF EQUIPMENT (LOCAL MAINTENANCE)

4.2.1 Routine tests for testing individual items of equipment such as circuit equipment, connecting circuits, operator's line calling equipment, selectors, registers, etc., must be provided for in every international exchange equipped for automatic switching. These routine tests will be made in accordance with the practice followed in each country for the local maintenance of the switching equipment.

4.2.2 The testing equipment must conform to the following principles:

a) an item of equipment must not be taken for test until it is free;

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* See Question 11/IV for the automatic transmission measuring and signalling testing equipment No. 2. (A.T.M.E. No.2)

b) an item of equipment taken for test will be marked "engaged" for the duration of the test. Before a circuit equipment is taken for test, the circuit will be withdrawn from service at both international exchanges;

c) as an alternative to b), a like item of equipment, known to be properly adjusted, may be switched in, and the item of equipment to be tested is switched out during the test.

4.2.3 Testing of the circuit and signalling equipment should include a check that the specifications of system No. 5 are met in regard to the following:

a) *Line signalling system*

Signalling frequencies
Transmitted signal levels
Signal frequency leak
Receiver operate and non-operate limits
Receiving-end line split
Sending-end line split
Line signal codes
Sending duration of signals
Recognition time of signals
Overlap transmission of answer signal on transit calls
Double seizing
Time-out and alarm features

b) *Register signalling system*

Signalling frequencies
Transmitted signal levels
Signal frequency leak
Sending duration of signals
Receiver operate and non-operate limits
Operation of the receiver to a series of pulses
Error-checking features

4.2.4 *Simulated end-to-end tests*

It is desirable that a means be provided whereby end-to-end testing can be simulated on a local basis. A local loop-around arrangement permitting an outgoing test call to be routed directly on a four-wire basis into incoming equipment should be provided. The loop-around arrangement replaces the international line and is connected to the circuit equipment under test on the one side and on the other side to similar working spare both-way circuit equipment and signalling equipment having access to the switching system.

RECOMMENDATION Q.163

4.3 MANUAL TESTING

4.3.1 Functional testing of signalling arrangements

Functional tests from one end of the circuit to the other can be made in the following three ways:

a) The first method consists of a rapid verification of satisfactory signal transmission by ensuring that a seizing signal is followed by the return of a proceed-to-send signal, that a clear-forward signal is followed by the return of a release-guard signal.

b) The second method consists of verification of satisfactory signal transmission by initiating a test call:

1. to technical personnel at the distant-end international exchange, or
2. to a test call signal testing and answering device, if such equipment is available at the distant-end international exchange.

c) The third method consists of complete verification of satisfactory line and register signal transmission. The verification consists of a check of ability to:

1. generate and receive line and register signals,
2. transmit the appropriate acknowledgement signals,
3. provide required duration and spacing of MF signals,
4. complete terminal and transit * calls.

4.3.2 First method: rapid test

1. Verification of satisfactory signal transmission:

a) Initiate a seizing signal and verify the receipt and recognition of the proceed-to-send signal from the distant end;

Note. — Absence of numerical information following termination of the seizing signal may result in receipt of a busy-flash signal provided by some Administrations from the distant-end equipment.

b) Initiate a clear-forward signal and verify the receipt and recognition of the release-guard signal from the distant end.

2. Failure to complete the seizing/proceed-to-send signalling sequence or the clear-forward/release-guard signalling sequence should result in the automatic termination of the frequencies being transmitted within 10-20 seconds/4-9 seconds (see Recommendation Q.141, paragraph 2.1.3.1. e)).

3. In the event of a failure appropriate steps should be taken to locate and correct the trouble.

4. The above tests are short, simple and should be made daily, from each end of the circuit.

4.3.3 Second method: test calls

1. Verification of satisfactory transmission of signals involved in completion of test calls (manual method):

a) Place a call to the technical personnel at the distant international exchange.

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* See the note to paragraph 4.3.4.3.

b) On completion of connection:
  i) the audible ringing tone should be heard,
  ii) the answer signal should be received when the call is answered at the distant end.

c) Request distant end to initiate a clear-back signal, followed by an answer signal.

d) A clear-back signal should be received and recognized when the distant end hangs up and a second answer signal should be received and recognized when the distant end re-answers the call.

e) Initiate a forward-transfer signal which should result in bringing in the assistance operator at the distant end.

f) Terminate the call and observe that the circuit restores to the idle condition.

2. Verification of satisfactory transmission of signals involved in completion of test calls (semi-automatic method).

If test call signal testing and answering devices are available at the distant international exchange, the signal verification tests should be made using this equipment to the extent that the applicable features indicated in 1 above are available.

3. The above tests should be made from each end of the circuit. They should be made monthly when the manual testing methods prescribed in 1 are used.

They may be made daily when semi-automatic test arrangements are available.

4.3.4 Third method: comprehensive tests; terminal and transit test calls

1. Verification of satisfactory signal transmission (frequency, level, duration, etc.) involved in terminal and transit calls.

a) These tests are made in conjunction with:
  — verification and location of faults,
  — ensuring that new circuits are satisfactory in operation before being brought into service.

b) When establishing new circuits all of the tests outlined in 4.2.3 should have been completed at both terminals. New circuits assigned to Time Assignment Speech Interpolation (TASI) equipment should be patched as non-TASI for the duration of these tests.

2. Terminal calls

Initiate a call to the distant end test centre. Co-ordinate this test with the distant end so that appropriate test equipment is connected prior to establishing the call. Check the following:

a) At the originating end check that a seizing signal is followed by the receipt and recognition of the proceed-to-send signal from the distant end. Check that the proceed-to-send signal persists until the seizing signal ceases.

b) At the distant end check the following:

	Duration of transmitted signal
1. Interval between termination of seizing signal and start of KP signal	80 ± 20 ms
2. KP signal duration	100 ± 10 ms
3. Digital and ST signal duration	55 ± 5 ms
4. Interval between all signals	55 ± 5 ms

c) Check that the audible ringing tone is heard at the originating end.

d) At the originating end check that the answer signal is received, recognized and acknowledged. Check that the acknowledgement signal persists until the answer signal ceases.

e) At the distant end initiate a clear-back signal.

f) At the originating end check that a clear-back signal is received, recognized and acknowledged. Check that the acknowledgement signal persists until the clear-back signal ceases.

g) At the originating end initiate a forward-transfer signal.

h) At the distant end check the receipt of the forward-transfer signal. The transmitted duration of this signal should be 850 ± 200 ms. This signal may be subject to TASI clipping.

i) At the distant end arrange to transmit a succession of clear-back and answer signals; first at a slow rate, then at a rate which is faster than the system is capable of following.

j) At the originating end check during the slow transmission of the switch-hook flashes that each clear-back and answer signal is received and properly recognized. Verify that after the fast transmission of switch-hook flashes the equipment indicates the final position of the switch-hook.

k) At the originating end release the circuit and check that the clear-forward signal is followed by the receipt and recognition of the release-guard signal from the distant end. Check that the release-guard signal ceases after the clear-forward signal ceases. Check that the circuit restores to the idle condition.

l) At the originating end check that the clear-forward signal sent to the incoming equipment in the idle condition results in the return of the release-guard signal and that the equipment restores to the idle condition.

m) At the originating end check that the busy-flash signal is received, recognized and acknowledged. Check that the acknowledgement ceases after the busy-flash signal ceases. (Some Administrations at the incoming end may find it convenient to provide a test call device which prompts the return of a busy-flash signal.)

In normal service the receipt of a busy-flash signal causes (after the acknowledgement) a clear-forward signal to be sent automatically from the international exchange originating the call. On a test call procedure some Administrations may prefer to avoid this process. In this case, the release of the connection is controlled by the personnel at the terminal originating the test call.

Note on items a) *to* m). — As part of the comprehensive tests it may, in certain circumstances such as fault localization, be desirable to test the frequency, level, and duration of received signals. Normally, however, it may be assumed that each Administration has verified the accuracy of its signal transmission locally as covered in paragraph 4.2.3.

3. Transit calls *

   a) After securing the co-operation of a third international exchange initiate a transit call to this exchange through the international exchange covered in 2 above.

   b) With the assistance of technical personnel at the third international exchange repeat steps 2 c) to 2 k) except that in step 2 h) measurement of the duration of the forward-transfer signal need not be made.

Note. — Detailed tests of certain transit features such as that of the transmission of the answer signal on an overlap basis at the transit point should be performed locally.

RECOMMENDATION Q.164

4.4 TEST EQUIPMENT FOR CHECKING EQUIPMENT AND SIGNALS

4.4.1 General

For local checks of correct equipment operation and for readjusting the equipment, international exchanges should have test equipment available which includes:

a) Line and register signal generators.

b) Signal-measuring apparatus.

c) Loop-around equipment (see 4.4.4).

4.4.2 Signal generators

The signal generators should be able to simulate all line and register signals. The generators may be part of test equipment which cycles the equipment to be tested through actual signalling sequences, in a manner which enables rapid complete testing to determine

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* When making transit test calls it is not the intention to check the performance or the quality of the circuit beyond the transit exchange, this being completely the responsibility of the Administration concerned. However, it is important that in principle the transit operations can be checked.

whether the equipment meets the system specifications. The generators should have the following characteristics:

a) *Line signal generator*

1. Signal frequencies should be within ± 5 Hz of the nominal signalling frequency or frequencies and shall not vary during the time required for testing.
2. Signal levels should be variable between the limits given in the specification and be able to be set within ± 0.2 dB.
3. Signal durations should be long enough so that the signals can be recognized and long enough in the case of compelled signals to complete the acknowledgement process.

b) *Register signal generator*

1. Signal frequencies should be within ± 5 Hz of the nominal signalling frequency or frequencies and shall not vary during the time required for testing.
2. Signal levels should be variable between the limits given in the specification and be able to be set within ± 0.2 dB.
3. Signal durations and intervals between signals shall be within the limits given in the specification in Recommendation Q.153, paragraph 3.3.3, for normal operate values and in Recommendation Q.154, paragraph 3.4.1 d), for test operate values.

4.4.3 Signal-measuring equipement

Equipment capable or measuring signal frequencies, signal levels, signal durations and other significant signal time intervals may be part of the test equipment referred to in section 4.4.2, or separate instruments. In either case the characteristics of the measuring equipment should be as follows:

a) *Line signal-measuring equipment*

1. Signal frequency or frequencies to be measured to be between the extreme limits given in the specification, the reading being made with an accuracy of ± 1 Hz.
2. Level of the signal frequency or frequencies measured over the range given in the specification to be measured with an accuracy of ± 0.2 dB.
3. Signal durations, signal recognition times and other significant time intervals as given in the specification should be measured within an accuracy of 1 ms or ± 1% of the nominal duration, whichever yields the higher value. The range of time intervals to be measured is approximately 5 to 1050 ms. Time-out intervals of 10 to 20 seconds and of 4 to 9 seconds should be determinable within an accuracy of ± 1 second.

b) *Register signal-measuring equipment*

1. Signal frequency or frequencies to be measured to be between the extreme limits given in the specification, the reading being made with an accuracy of ± 1 Hz.
2. Level of the signal frequency or frequencies measured over the range given in the specification to be measured with an accuracy of ± 0.2 dB.
3. Signal duration and intervals between signals as given in the specification should be measured with an accuracy within 1 ms.

c) In regard to measuring time intervals a recorder having a minimum of two input channels may be useful. The recorded characteristic should conform with the accuracy quoted in a) and b) above and be easily connected to the circuit under test. The recorder input characteristic should be such as to have a negligible effect on circuit performance.

4.4.4 Loop-around equipment

Local four-wire loop-around equipment should simulate line facilities without introducing signalling degradation. The gain of the loop-around equipment should be set to provide proper transmission levels. Alternatively, if the testing of the individual items of equipment is on a limit test basis it would not be essential to set the gain of the loop to provide the exact transmission levels. In this event a straight patch would be adequate.

ANNEXES TO SIGNALLING SYSTEM No. 5 SPECIFICATIONS

ANNEX 1

SIGNALLING SEQUENCES

Table 1: Semi-automatic (SA) and automatic (A) terminal traffic.

Table 2: Semi-automatic (SA) and automatic (A) transit traffic.

In these tables the arrow have the following meanings:

——▶ transmission of a signalling frequency (permanent or pulse emission).

– – –▶ end of transmission of the signalling frequency in the case of its permanent transmission.

• • •▶ transmission of an audible tone.

ANNEX 2

DESCRIPTION OF THE OPERATIONS CORRESPONDING TO THE VARIOUS NORMAL AND ABNORMAL CONDITIONS WHICH MAY ARISE IN SETTING UP A CALL

Table 1: Outgoing exchange — Normal conditions

Table 2: Outgoing exchange — Abnormal conditions

Table 3: Incoming exchange — Normal conditions

Table 4: Incoming exchange — Abnormal conditions

Table 5: Transit exchange — Normal conditions

Table 6: Transit exchange — Abnormal conditions

ANNEX 1

TABLE 1. — SEMI-AUTOMATIC (SA) AND AUTOMATIC (A) TERMINAL TRAFFIC

Outgoing international exchange		Incoming international exchange
	CALL TO A FREE SUBSCRIBER	
The seizing signal is sent forward when the ST end-of-pulsing condition is recognized in the outgoing register (the speech path is open as long as the register is connected).	2400 ——→	Receipt of the seizing signal causes a register at the incoming exchange to be connected; when the latter is ready to receive the digital information a proceed-to-send signal is sent back (the speech path is open as long as the incoming register is connected).
Receipt of the proceed-to-send signal causes the seizing signal to cease.	←—— 2600	
It is followed by the sending *en bloc* in multifrequency code of: the KP1 signal, the language or the discriminating digit, the national (significant) number, the ST signal.	2400 – – – →	The end of reception of the seizing signal causes the proceed-to-send signal to cease.
	← – – – 2600	
The outgoing register releases after the ST signal has been sent. The speech path through the outgoing exchange is established.	MF 2/6 code ——→	The numerical signals are received in the incoming register. This register starts the setting-up of the call in the incoming country when enough digits have been received to determine the routing. The incoming register carries out the appropriate operations according to the language (or discriminating) digit. In SA operation for code 11 or 12 calls, the register directs the call to the operators' positions. The incoming register releases, and sets up the speech path in the incoming exchange as soon as it has sent forward all the information received.
SA: The operator or A: the calling subscriber hears the ringing tone.	← · · · · · · · · · · · · · ·	The ringing tone of the country of destination is sent back.
SA: An "answer" indication is given to the controlling operator. A: Charging and measurement of the call duration begin.	←—— 2400	*The called subscriber answers.* An answer signal is sent back.

ANNEX 1. — TABLE 1 *(continued)*

Outgoing international exchange		Incoming international exchange
Receipt of the answer signal causes an acknowledgement signal to be sent.	2400 ——→	Receipt of the acknowledgement ceases the answer signal.
The end of reception of the answer signal ceases the acknowledgement signal.	← – – – – 2400 2400 – – – – →	
SA: A clearing supervisory signal is given to the controlling operator. A: After 1-2 min., if there is no clear-forward signal, the international connection is released and charging and measurement of the call duration are ceased.	←—— 2600	*The called subscriber clears.* The clear-back signal is sent back.
The clear-back signal causes acknowledgement to be sent.	2400 ——→	Receipt of the acknowledgement ceases the clear-back signal.
The end of reception of the clear-back signal ceases the acknowledgement signal.	← – – – – 2600 2400 – – – – →	
The outgoing operator (SA) *or the calling subscriber* (A) *clears* A clear-forward signal is sent.	2400 + 2600 ——→	The clear-forward signal causes a release-guard signal to be sent back: a) on receipt of the clear-forward signal, or b) when the incoming equipment has been released.
The receipt of the release-guard signal ceases the clear-forward signal.	←—— 2400 + 2600 2400 + 2600 – – – – →	The clear-forward signal is sent in the country of destination. The release-guard signal is ceased: a) subject to the two conditions that the incoming equipment has been released and that the clear-forward signal is no longer received; or
The end of the release-guard signal terminates the guard condition at the outgoing end.	← – – – – 2400 + 2600	b) subject to the single condition that the clear-forward signal is no longer received. The outgoing access of the incoming end is maintained busy for 200 to 300 ms after the cessation of the release-guard signal.

ANNEX 1. — TABLE 1 *(continued)*

Outgoing international exchange		Incoming international exchange
CALL TO A BUSY SUBSCRIBER (OR CONGESTION) The signal sequence is the same as for a call to a free subscriber, up to the point where the incoming register releases.		
		1st Case
SA: A "busy" indication is given to the operator. A: The calling subscriber hears the busy tone of the outgoing (national or international) exchange. The busy-flash signal causes the acknowledgement signal to be sent.	← 2600	The national network of the incoming country can give a busy-flash signal. This signal is detected by the incoming international equipment, which sends a busy-flash signal back.
	2400 →	The acknowledgement signal ceases the busy-flash signal.
The end of reception of the busy-flash signal ceases the acknowledgement signal.	⇠ 2600	
	2400 ⇢	
The cessation of the acknowledgement signal is followed automatically by the sending of the clear-forward signal which releases the international connection.		
		2nd Case
SA: The operator, or A: the calling subscriber hears the busy tone and clears and the clear-forward signal is sent.	← · · · · · · · · · · · · · ·	The national network of the incoming country cannot give the busy-flash signal. The busy tone of the incoming country is sent back.
SPECIAL CONDITIONS		
1. FORWARD TRANSFER *1st Case* SA: Following a call switched automatically to a subscriber, or following a call established via a special number incoming or delay operator, the controlling operator wishes to call in an assistance operator at the incoming international exchange. A forward-transfer signal is sent.	2600 →	The forward-transfer signal causes an assistance operator to intervene at the incoming international exchange.

ANNEX 1. — TABLE 1 *(concluded)*

Outgoing international exchange	Incoming international exchange
2nd Case SA: Following a call via code 11 or 12, the controlling operator wishes to recall the incoming operator at the incoming international exchange. A forward-transfer signal is sent. 2600 →	Recalls the incoming operator on calls completed via the operator positions of this exchange.
2. DOUBLE SEIZING The outgoing end sends the seizing signal. 2400 →	
← 2400	The incoming end also sends the seizing signal.

The two ends of the circuit send and receive the seizing signal for a sufficiently long time to ensure that the signal can be recognized at both ends. The two ends recognize the double seizing by this condition.

The equipment is cleared at each end without the sending of a clear-forward signal; then:

a) either a second automatic attempt to set up the connection takes place, or

b) { SA: a re-order indication is given to the operator;
   A: a busy tone is sent to the subscriber.

ANNEX 1

TABLE 2. — SEMI-AUTOMATIC AND AUTOMATIC TRANSIT TRAFFIC

Outgoing international exchange	International transit exchange	Incoming international exchange
	CALL TO A FREE SUBSCRIBER	
A seizing signal is sent forward when the ST end-of-pulsing condition is recognized in the outgoing register (the speech path is open as long as outgoing register is connected). 2400 →	Receipt of the seizing signal causes a register at the transit exchange to be connected. The proceed-to-send signal is sent back when the register is connected. (The speech path is open as long as the register is connected.)	
Receipt of the proceed-to-send signal ← 2600 ceases the seizing signal.		
It is followed by the sending *en bloc* 2400 – – →	The end of reception of the seizing signal ceases the proceed-to-send signal.	
in multifrequency code of: ← – – 2600 – – — the KP2 signal — the country code — the language or the discriminating digit — the national (significant) number MF 2/6 code — the ST signal. →	The numerical signals are received in the register at the transit exchange.	
The outgoing register releases after the ST signal has been sent. The speech path through the outgoing exchange is established.		
	When enough digits have been received to determine the routing, a circuit is taken. A seizing signal is sent forward. 2400 →	Receipt of the seizing signal causes a register to be connected at the incoming exchange and, when this register is connected, the proceed-to-send signal is sent back (the speech path is open as long as the register is connected).
	Receipt of the proceed-to-send signal ← 2600 ceases the seizing signal. 2400 – – →	

ANNEX 1. — TABLE 2 *(continued)*

Outgoing international exchange	International transit exchange	Incoming international exchange
	It is followed by the sending *en bloc* overlap in multifrequency code of: — the KP1 signal — the language or the discriminating digit — the national (significant) number — the ST signal.	◀— 2600 The end of reception of the seizing signal ceases the proceed-to-send signal.
	MF 2/6 code ——▶	The numerical signals are received in the incoming register. This register starts the setting up of the call in the incoming country when enough digits have been received to determine the routing. The incoming register carries out the appropriate operations according to the language (or discriminating) digit. In SA operation for code 11 or 12 calls, the register routes the call to the operators' positions. The incoming register releases and establishes the speech path at the incoming exchange as soon as it has sent forward all the information received.
	The transit register releases after the ST signal has been sent. The speech path through the transit exchange is established.	
SA: The operator A: the calling subscriber hears the ringing tone.	◀ •	The ringing tone of the incoming country is sent back.
	Receipt of the answer signal:	◀—— 2400 *The called subscriber answers.* An answer signal is sent back.
◀—— 2400	— causes an answer signal to be sent back in "overlap compelled" manner. — causes an acknowledgement signal to be sent forward. 2400 ——▶	

ANNEX 1. — TABLE 2 *(continued)*

Outgoing international exchange	International transit exchange	Incoming international exchange
	←	2400 — — Receipt of the acknowledgement signal ceases the answer signal.
SA: An answer indication is given to the controlling operator. Receipt of the answer signal causes an acknowledgement signal to be sent forward. 2400 →	→ Receipt of the acknowledgement signal ceases the answer signal. 2400 — — The end of reception of the answer signal ceases the acknowledgement signal. 2400 — —	→
A: Charging and measurement of the call duration begin. The end of reception of the answer signal ceases the acknowledgement signal. ← — — 2400 — —	→	
	Receipt of the clear-back signal: ←	2600 *The called subscriber clears.* The clear-back signal is sent back.
SA: A clearing supervisory signal is given to the controlling operator. Receipt of the clear-back signal causes an acknowledgement signal to be sent forward. ←	2600 — causes a clear-back signal to be sent back. — causes an acknowledgement signal to be sent forward. 2400 →	→ Receipt of the acknowledgement signal ceases the clear-back signal.
	The end of reception of the clear-back signal ceases the acknowledgement signal. ←	2600 — —
2400 →	→ Receipt of the acknowledgement signal ceases the clear-back signal. 2400 — —	→
A: After 1-2 min. if there is no clear-forward signal, the international connection is released and charging and measurement of the call duration are ceased. The end of reception of the clear-back signal ceases the acknowledgement signal. ← — — 2400 — —	2600 — — →	

ANNEX 1. — TABLE 2 *(continued)*

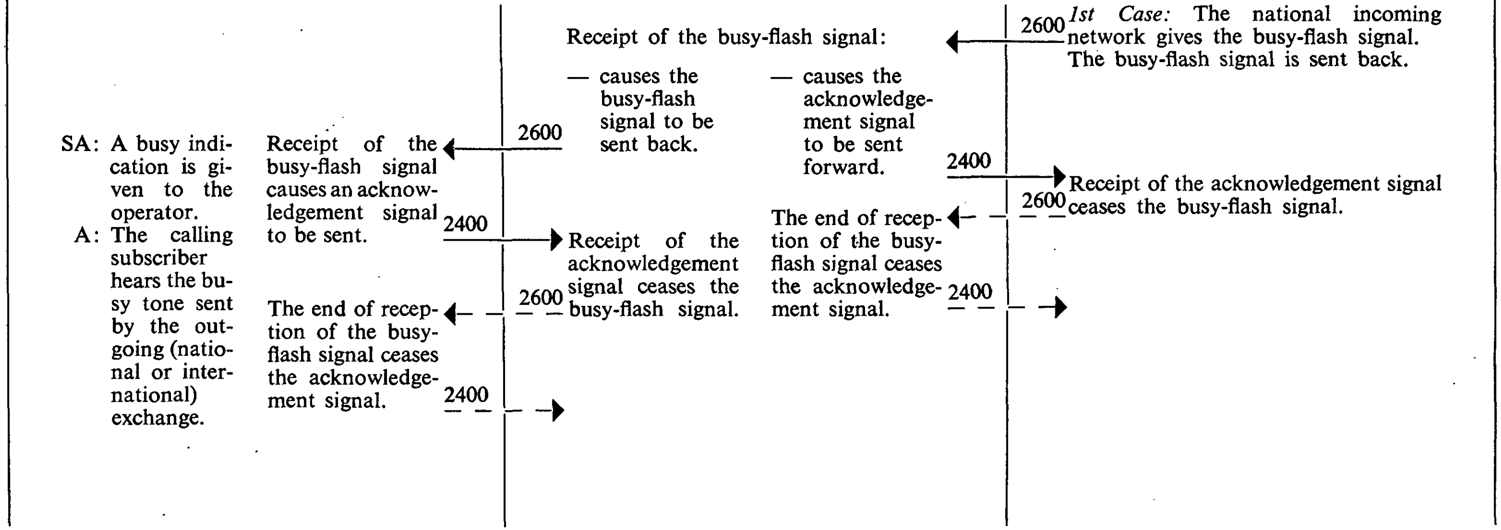
Outgoing international exchange	International transit exchange	Incoming international exchange
SA: *The controlling operator, or* A: *The calling subscriber clears.* The clear-forward signal is sent. 2400 + 2600 ———▶	Receipt of the clear-forward signal causes:	
	— a release-guard signal to be sent back: a) on receipt of the clear-forward signal, or b) when the incoming equipment has been released. — a clear-forward signal to be sent forward. 2400 + 1600 ———▶ ◀——— 2400 + 2600	The clear-forward signal causes the release-guard signal (which serves as an acknowledgement) to be sent back, a) on receipt of the clear-forward signal, or b) when the incoming equipment has been released.
◀——— 2400 + 2600 Receipt of the release-guard signal ceases the clear-forward signal. 2400 + 2600 — — —▶	Receipt of the release-guard signal ceases the clear-forward signal. 2400 + 1600 — — —▶	The clear-forward signal is sent in the country of destination.
2400 + 2600 The end of the release-guard signal ◀— — — terminates the guard condition at the outgoing end.	The release-guard signal is ceased: a) subject to the two conditions that the incoming equipment has been released and the clear-forward signal is no longer received, or b) subject to the single condition that the clear-forward signal is no longer received.	The release-guard signal is ceased: a) subject to the two conditions that the incoming equipment has been released and the clear-forward signal is no longer received, or b) subject to the single condition that the clear-forward signal is no longer received.
	2400 + 2600 The end of the release-guard signal ◀— — — terminates the guard condition at the outgoing end in the transit exchange.	The outgoing access of the incoming end is maintained busy for 200 to 300 ms after the cessation of the release-guard signal.

ANNEX 1. — TABLE 2 *(continued)*

Outgoing international exchange	International transit exchange	Incoming international exchange
	The outgoing access of the incoming end is maintained busy for 200 to 300 ms after the cessation of the release-guard signal.	

CALL TO BUSY SUBSCRIBER (OR CONGESTION)

The signal sequence is the same as for a call to a free subscriber up to the point where the incoming register releases.



1st Case: The national incoming network gives the busy-flash signal. The busy-flash signal is sent back.

Receipt of the busy-flash signal:

— causes the busy-flash signal to be sent back.

— causes the acknowledgement signal to be sent forward.

Receipt of the acknowledgement signal ceases the busy-flash signal.

SA: A busy indication is given to the operator.

A: The calling subscriber hears the busy tone sent by the outgoing (national or international) exchange.

Receipt of the busy-flash signal causes an acknowledgement signal to be sent.

Receipt of the acknowledgement signal ceases the busy-flash signal.

The end of reception of the busy-flash signal ceases the acknowledgement signal.

The end of reception of the busy-flash signal ceases the acknowledgement signal.

ANNEX 1. — TABLE 2 *(concluded)*

Outgoing international exchange	International transit exchange	Incoming international exchange
The cessation of the acknowledgement signal is followed automatically by the sending of the clear-forward signal to release the international circuit, clearance being effected from the outgoing exchange.		
SA: The operator, or A: the calling subscriber hears the busy tone and clears. The clear-forward signal is sent.	◀ ·	*2nd Case:* The national incoming network does not give the busy-flash signal. The busy tone of the incoming country is sent back.
	SPECIAL CONDITIONS	
FORWARD-TRANSFER *1st Case* SA: Following a call switched automatically to a subscriber, or following a call established via a special number incoming or delay operator, the controlling operator wishes to call in an assistance operator at the incoming international exchange. A forward-transfer signal is sent. 2600 ──▶	The forward-transfer signal causes a forward-transfer signal to be sent over the following circuit. 2600 ──▶	The forward-transfer signal causes an assistance operator to intervene at the incoming international exchange on an established connection completed automatically.
2nd Case SA: Following a call via code 11 or 12, the controlling operator wishes to recall the incoming operator at the incoming international exchange. The forward-transfer signal is sent. 2600 ──▶	The forward-transfer signal causes a forward-transfer signal to be sent over the following circuit. 2600 ──▶	Recalls the incoming operator on calls completed via the operators' positions of this exchange.

ANNEX 2

TABLE 1. — OUTGOING EXCHANGE — NORMAL CONDITIONS

Conditions		Subscriber free	Subscriber busy or national congestion		Congestion at a transit or an incoming exchange or on circuits immediately outgoing from that exchange (after register association)
			The busy-flash signal:		
			is not provided	is provided	
Operations effected	Release of register	After sending the ST signal			
	Speech position	After release of register			
	Action on the international circuit			Release of the circuit after reception of a busy-flash signal	
	SA - Local signals given to the operator			Busy	
	A - Transmission of an appropriate indication to the calling subscriber			Busy tone	
Information received from the international circuit	Signals received			Busy-flash signal	
	Audible indication received	Ringing tone	Busy tone		
References		3.6.1	3.7	3.6.1, 3.7, 1.6	

SA = Semi-automatic service
A = Automatic service
} When there is no specific indication the clause is applicable to both services.

ANNEX 2

TABLE 2. — OUTGOING EXCHANGE — ABNORMAL CONDITIONS

Conditions		The outgoing register receives no more digits	Registration of unused numerical information	Non-receipt of a proceed-to-send signal after sending the seizing signal	The outgoing register not having detected an abnormality, the incoming register receives an incomplete number or a non-existing number and it detects the abnormality
Operations effected	Release of register	SA - (local sending-finished signal not received): 10-20 seconds * after seizure or receipt of last digit. A - 15-30 seconds * after seizure of no, or less than the minimum number of digits received. (When enough digits received, 4-6 seconds after the receipt of the last digit, normal ST condition is assumed)	Immediately the abnormality is recognized	10-20 seconds after the start of sending the seizing signal	After sending the ST signal
	Speech position	(A - After release of the register should ST condition be assumed)			After release of the register
	Action on the international circuit	(A - Seized in normal manner should ST condition be assumed)		Released by clear-forward signal	
	SA - Local signals given to the operator	Determined by each Administration, as this is a national matter			
	A - Indications given to the subscriber	Appropriate audible indication			
Signals received from the intern. circuit					Busy-flash
References		3.2		3.6.2, 1.9	2.1.6 d, 3.6.1

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* Typical value.

ANNEX 2

TABLE 3. — INCOMING EXCHANGE — NORMAL CONDITIONS

Conditons / Operations effected	Called subscriber free	Subscriber busy or national congestion		Congestion at the incoming exchange or on circuits immediately outgoing from that exchange (after) register association)
		The busy-flash signal: is not provided	is provided	
Release of register	After a) sending the numerical information to, or b) sending an ST signal to, or c) receipt of an end-of-selection signal from, the national network equipment			After sending the busy-flash signal
Speech position	After release of the register			
Sending of busy-flash signal on the international circuit			After receipt of the national busy-flash signal	0-10 seconds after receipt of the information necessary for determining the route
Sending of an audible indication	National ringing tone	National busy tone	National busy tone (if present)	
References	3.6.1.b.1	3.6.1.b.1	2.1.6.d.4 3.6.1.b.2	1.6 2.1.6.d.1 3.6.1.b.2

ANNEX 2

TABLE 4. — INCOMING EXCHANGE — ABNORMAL CONDITIONS

Conditions Operations effected	Non-receipt of numerical signals	Error detected in receipt of the numerical signals	ST signal not received	Receipt of an incomplete number or a non-existing number (ST signal received)
Release of register	10-20 seconds after the start of sending the proceed-to-send signal	Immediately the error is recognized	20-40 seconds * after the start of sending the proceed-to-send signal	After a) sending the numerical information to, or b) sending an ST signal to, or c) receipt of an end-of-selection signal from, or d) receipt of a busy-flash signal from, the national network equipment or e) recognition of the abnormality by the incoming international register.
Speech position	After release of the register			
Signals sent back on the international circuit	Busy-flash			d) Busy-flash e) Busy-flash
References	2.1.3.1.e 2.1.6.d	2.1.6.d	2.1.6.d 3.6.2.b.1	2.1.6.d 3.6.2.b.2

* Typical value.

ANNEX 2

TABLE 5. — TRANSIT EXCHANGE — NORMAL CONDITIONS

Conditions Operations effected	Successful attempt (as far as transit exchange is concerned)	Congestion at the transit exchange or on international circuits immediately outgoing from that exchange (after register association)
Release of register	After sending the ST signal	After sending the busy-flash signal
Speech position	After release of the register	
Sending of busy-flash signal back		0-10 seconds after the receipt of the information necessary for determining the routing
References	3.6.1.c.1	3.6.1.c.2

ANNEX 2

TABLE 6. — TRANSIT EXCHANGE — ABNORMAL CONDITIONS

Conditions Operations effected	Non-receipt of numerical signals	Error detected in the receipt of the numerical signals	ST signal not received	Receipt of unused numerical information	Non-receipt of the proceed-to-send signal after sending the seizing signal
Release of register	10-20 seconds after the start of sending the proceed-to-send signal	Immediately the error is recognized	20-40 seconds * after the start of sending the proceed-to-send signal	After recognition of the abnormality	10-20 seconds after the start of sending the seizing signal
Speech position	After release of the register				
Signals sent back on the incoming international circuit	Busy-flash				
Action on the outgoing international circuit					Released by clear-forward signal
References	2.1.3.1.e 2.1.6.d	2.1.6.d	2.1.6.d 3.6.2.c	2.1.6.d	2.1.3.1.e 2.1.6.d 3.6.2.c

* Typical value.

PART XI

INTERWORKING OF SYSTEMS No. 4 AND No. 5

RECOMMENDATION Q.180

INTERWORKING OF SYSTEMS No. 4 AND No. 5

1. General

It is possible to ensure normal operation for both semi-automatic and automatic service when interworking takes place between signalling systems No. 4 and No. 5, in either the "4 to 5" or "5 to 4" direction.

The interworking is possible because:

- the line signals (i.e. the supervisory signals) generally have the same meaning and the same function in both systems;
- the numerical (address) information is sent in the same sequence in both systems;
- all conditions for the use of the language digit in the semi-automatic service and the discriminating digit in the automatic service are the same in both systems.

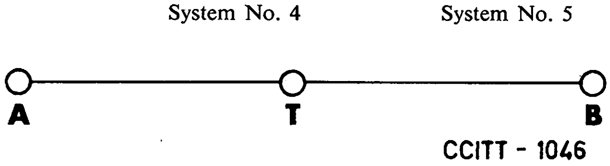
In general, the interworking of the two systems merely requires that a signal received in the code of one of the systems be converted into the corresponding signal of the code used by the other system. Nevertheless, in a transit exchange where there is interworking of systems No. 4 and No. 5, special precautions are necessary with regard to signals which are used differently in the two systems. These differences are as follows:

a) system No. 5 always uses a forward end-of-pulsing signal (the ST signal), whereas the end-of-pulsing signal (code 15) is not always given in system No. 4;

b) system No. 4 uses a backward number-received signal which is not provided in system No. 5.

2. Calls from system No. 4 to system No. 5

2.1 *Semi-automatic calls from system No. 4 to system No. 5*



1. In semi-automatic operation the outgoing exchange A of system No. 4 sends an end-of-pulsing signal over link AT and the outgoing register at A is released.

2. The end-of-pulsing signal of system No. 4, which is a numerical type signal (code 15), is acknowledged.

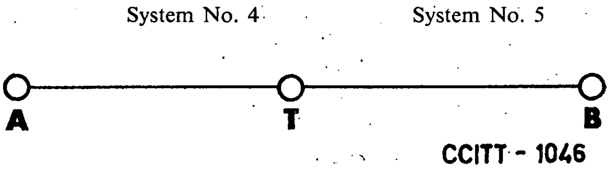
3. On receipt of an end-of-pulsing signal from A, the incoming part of system No. 4 at transit exchange T sends to A an acknowledgement of the end-of-pulsing signal and then sends to A a number-received signal.

4. At T, an end-of-pulsing signal ST is sent over link TB on system No. 5; this ST signal is obtained by converting the end-of-pulsing signal (code 15) of system No. 4.

5. At T, the outgoing register * of system No. 5 is released as soon as the signal ST has been sent over link TB on system No. 5. At T, the incoming register * of system No. 4 is released after the number-received signal of system No. 4 has been sent back to A.

Note. — The number-received signal is sent from T over link TA in order to conform to the specifications of system No. 4. Since the outgoing register at A will be released as soon as A has sent the end-of pulsing signal (in accordance with the specifications of system No. 4), the only possible role of the number-received signal at A is to indicate to the operator that the selection procedure has been effected. However, since the number-received signal relates only to operations on the link AT on system No. 4, this signal provides no information about the entire selection process from A to B; the indication to the operator is hence of little value.

2.2 *Automatic calls from system No. 4 to system No. 5*



1. The system No. 4 link AT does not provide for an end-of-pulsing signal from exchange A in automatic operation; the transit exchange T will therefore have to recognize that all the digits have been received in order to:

a) send a forward ST signal to B in system No. 5, and

b) send a backward number-received signal to A in system No. 4.

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* These register functions may be combined in a single register.

In this situation the system No. 5 register signalling at T will be *en bloc* non-overlap *. (See Recommendation Q.152, paragraph 3.2.1 b) (2) for the action to be taken by the system No. 5 register at T to recognize that all digits have been received.)

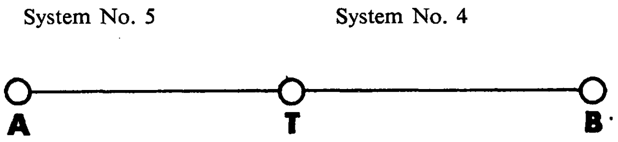
2. At A, release of the outgoing register of system No. 4 depends upon reception of the number-received signal.

At the incoming end of system No. 4 at T, the incoming register ** of system No. 4 is released as soon as the number-received signal is sent backward and all the numerical information necessary for setting up the call is sent to B.

At T, an ST end-of-pulsing signal is sent to B by system No. 5 after the numerical information has been sent, and the outgoing register ** of system No. 5 at T is then released.

3. Calls from system No. 5 to system No. 4

3.1 *Semi-automatic calls from system No. 5 to system No. 4*



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1. In semi-automatic operation at transit exchange T the incoming register ** part of system No. 5 receives an ST end-of-pulsing signal 55 ms after reception of the last numerical signal.

2. At T, the ST end-of-pulsing signal of system No. 5 is converted into an end-of-pulsing signal of system No. 4, which is sent to the incoming end B of this system.

3. The end-of-pulsing signal of system No. 4, which is a numerical type signal (code 15), is acknowledged.

4. At A, the outgoing register of system No. 5 is released after the ST signal has been sent.

5. At T, the outgoing register ** of system No. 4 is released when the end-of-pulsing signal is sent.

6. At B, the incoming register of system No. 4 is released as soon as the number-received signal is sent backward to T on system No. 4 and all the numerical information necessary for setting up the call in the incoming country has been sent forward.

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* See for this term the footnote to Recommendation Q.151.

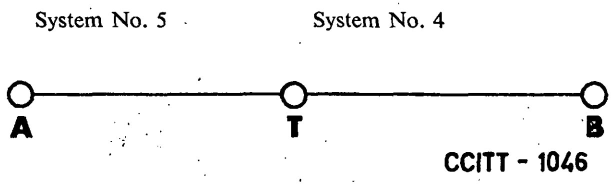
** These register functions may be combined in a single register.

7. The number-received signal is sent over link BT upon reception at B of the end-of-pulsing signal. It will be noted that the number-received signal is sent over link BT solely in order to conform to the specifications of system No. 4, even though this signal is superfluous in this case as:

a) the number-received signal is not needed to release the outgoing register of system No. 4 at T since it is released when it sends the end-of-pulsing signal:

b) this signal cannot be used to give any information to the operator at A since it cannot be passed by system No. 5 on link AT.

3.2 *Automatic calls from system No. 5 to system No. 4*



1. This situation raises no difficulties since system No. 5 possesses the ST signal which, by determining the end of pulsing at T, places the outgoing register of system No. 4 at T in conditions that are comparable to those existing with semi-automatic operation in system No. 4.

2. At T, the ST signal of system No. 5 is converted into the end-of-pulsing signal (code 15) of system No. 4.

3. The specifications of system No. 4 require that the incoming exchange B of system No. 4 must send the number-received signal as soon as:

a) an end-of-pulsing signal has been received; or

b) it has recognized that all the digits have been received.

In this case of interworking condition a) is generally fulfilled first. It may happen, however, that a complete national number is recognized before the end-of-pulsing signal is received (for example, when the number of digits in the national number of the incoming country is constant). The transit exchange T must hence be capable of receiving the number-received signal not only after emission of the end-of-pulsing signal but also when the last digit preceding that signal has been sent.

4. Exchange B must be capable of receiving the end-of-pulsing signal (code 15) on automatic calls.

4. Overflow from system No. 5 to system No. 4

4.1 In an exchange equipped with system No. 4 and system No. 5 it may be desirable to provide for overflow from a group of circuits operated by system No. 5 to a group operated by system No. 4. This may be the case for a call outgoing from an exchange A

(Figure 1) or for a call from an outgoing exchange K (Figure 2) and arriving via a group of circuits in system No. 4 at a transit exchange T where a choice must be made between a first-choice route operated by system No. 5 and an overflow route operated by system No. 4.

4.2 There are two possible ways of arranging for the overflow, in particular in respect to the moment at which the decision is taken to use the overflow route:

— Single exploration;

— Double exploration.

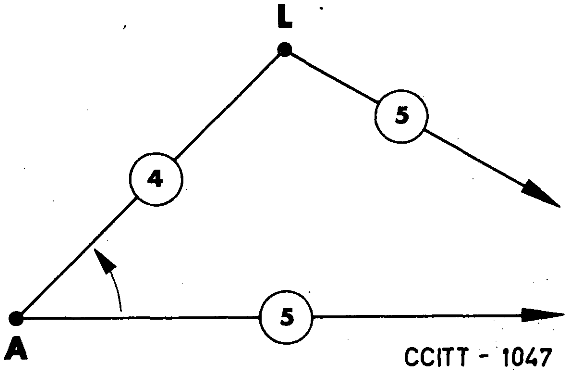


FIGURE 1

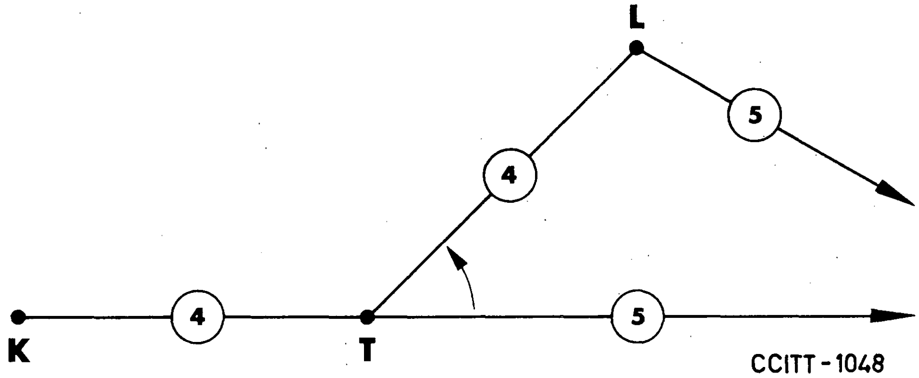


FIGURE 2

4.2.1 *Single exploration*

With single exploration, the state of occupation, or availability, of the system No. 5 group at exchange A or exchange T is considered only when the condition ST is determined at this exchange in the system No. 5 outgoing register.

a) If the exploration at A or at T shows that no free circuit in the system No. 5 group is available, overflow to the system No. 4 group takes place.

For this overflow the register has all the numerical information (even in the case of a transit register like that of the T exchange mentioned above), and the end-of-pulsing indication ST.

The register at the transit exchange T will be regarded, for successive selection operations, as an outgoing system No. 4 register. Thus, in this case, signalling between the three system No. 4 registers involved will be link-by-link and not end-to-end.

In the case of Figure 2, as soon as the ST condition is available (at the latest immediately after the 5 ± 1 seconds delay provided for in the specifications for system No. 5) the number-received signal will be sent back from T to K in system No. 4.

The ST condition will also be used to cause the end-of-pulsing signal (code 15) to be sent forward from T to L, even in automatic working. The code-15 signal will cause the number-received signal to be sent back from L to T, so that there will be no need to wait for five or ten seconds at L before it is known that a complete number has been received.

The number-received signal sent by T will be received at K and will, in the case of an automatic call, release the outgoing register at that exchange. The second number-received signal, which will be sent by L, will be received at T to release the register at that exchange, despite the fact that the register has transmitted an end-of-pulsing signal which could have been used for releasing the register. The establishment of the speech path at T takes place immediately after the release of the register.

If in the case of Figure 1 the ST condition is recognized in the outgoing exchange A, this same condition will also be used to cause the sending of the end-of-pulsing signal (code 15) from A to L, even in automatic operation. This end-of-pulsing signal will in the same way cause the number-received signal to be sent back from L to A.

b) If the exploration at A or at T shows that a free circuit in the system No. 5 group is available, the *en bloc* numerical information has to be transmitted over this circuit, followed by the end-of-pulsing signal ST, in accordance with the specifications for system No. 5.

In the case of Figure 2, the conditions for the number-received signal and the release of the outgoing register are the same as under 4.2.1 a).

4.2.2 *Double exploration*

With double exploration the state of availability of the system No. 5 circuit group is examined twice, namely:

— as soon as the direction to be chosen is determined;

— after receipt of the complete numerical information.

With the double exploration, advantage is taken of the fact that, without awaiting condition ST, exchange A or exchange T can know that the direct route by system No. 5 is occupied as soon as the direction to be chosen is determined.

a) If the first exploration at A or at T shows that no free circuit in the system No. 5 group is available, overflow to the system No. 4 group should take place immediately; the use of the signals on the system No. 4 circuit(s) must be in accordance with the normal procedure of that system:

- in the case of Figure 2, end-to-end working (K-T-L) for the numerical signals and the number-received signal;
- the end-of-pulsing signal (code 15) only for semi-automatic calls.

The procedure of overflow at this first exploration reduces post-dialling delay in automatic working since there is no need to wait until all the digital information is assembled *en bloc* before proceeding with the setting-up of the connection. On the other hand, there is a slight reduction in the efficiency of the first choice system No. 5 group.

b) After the first exploration has shown no congestion of the system No. 5 group, it may happen, during or after reception in the outgoing register at A (or transit register, in the case of T) of the digits following the digits necessary to determine the routing, that the system No. 5 group gets busy, more particularly because such a circuit group is a first-choice high-usage route with consequently a high probability of loss. When this happens, after noting by this second exploration that all circuits in the system No. 5 group are busy, overflow to the system No. 4 group takes place.
For this case of overflow, the conditions can be considered to be the same as in 4.2.1 a).

c) If also the second exploration shows no congestion of the system No. 5 group, the conditions mentioned in 4.2.1 b) fully apply.

4.3 Line signalling for calls set up in overflow through two successive No. 4 systems will be done normally, that is, end-to-end. The number-received signal, however, will be sent as stated in 4.2.1 a), 4.2.2 a) or 4.2.2 b).

5. Interworking line signalling conditions

5.1 *Forward-transfer signal*

The forward-transfer signal, in the event of a transit call going from system No. 4 to system No. 5, or from system No. 5 to system No. 4, should cause the assistance operator to intervene in the country of arrival, and not at the transit exchange.

The incoming line relay set of the first system at the transit exchange is informed, e.g. by the transit register, that the call is a transit call. Hence, when a forward-transfer signal arrives on the first system, it causes the forward-transfer signal to be transferred to the outgoing line relay set of the second system without intervention by the operator at the transit exchange.

5.2 *Answer signal*

5.2.1 *System No. 4 to system No. 5 (traffic direction)*

The answer signal on the system No. 4 link should be sent only after complete recognition of the answer signal received from the system No. 5 link, i.e. overlap transmission should not be used.

The considerations for this requirement are:

— the overlap technique could give rise to troubles in signalling system No. 4 in case of imitation of the P signal;

— in the transfer of the answer signal from system No. 5 to system No. 4, the sending end line split (silent period) before starting P is a necessity due to the pulse type signals of system No. 4. The requirement for this sending-end line split period (40 ± 10 ms) would have meant little speed advantage of overlap operation in transferring the answer signal from system No. 5 to system No. 4 (about 50 ms);

— overlap operation would be contrary to the design characteristic of system No. 4 in that once the sending of a signal has begun it must be sent completely.

5.2.2 *System No. 5 to system No. 4 (traffic direction)*

In the interworking arrangements in a transit centre for transferring the answer signal backward from system No. 4 to system No. 5, overlap transmission should not be used.

In system No. 4, overlap operation is incompatible with the use of time measurement for recognition of the suffix signal (short suffix or long suffix). The overlap operation would not permit waiting for the end of a signal PY (answer signal), to determine that it is not a PYY signal (release-guard signal).

5.3 *Busy-flash signal*

In the case of interworking at a transit point from system No. 4 to system No. 5 or vice versa, a busy-flash signal received at that transit point from the outgoing circuit is to be converted to a busy-flash signal on the incoming circuit.

In the case of interworking from system No. 5 to system No. 4, the busy-flash signal will cause the release of the international connection initiated from the outgoing exchange.

In the case of interworking from system No. 4 to system No. 5, the system No. 5 equipment at this transit exchange should function as an outgoing system No. 5 equipment on the receipt of a busy-flash signal and release the system No. 5 circuit from the transit point. Be it observed that the system No. 4 circuit is also released in the case of automatic calls.

5.4 *Time-out delays to clear a connection in the event of signal failures*

5.4.1 *Non-reception of a clear-forward signal after a clear-back signal has been sent*

In the event of transit working from system No. 4 to system No. 5 at an exchange T, this latter represents the terminal for system No. 4.

The action to be taken at an international incoming exchange for system No. 4 holds good for the exchange T. After a time-out of 2 to 3 minutes, the system No. 4 incoming equipment at T should produce an effect forward on the circuit of system No. 5, so as to release the international circuit (for example, should there be some interruption in the system No. 4 circuit). This release should proceed in the same way as the release of the national part of the connection, when the incoming exchange is indeed the incoming international exchange of the international connection.

For symmetry's sake, the action at T to release the connection should also be undertaken when there is transit working from system No. 5 to system No. 4, since a time-out of 2 to 3 minutes exists in system No. 5 to release the connection forward.

5.4.2 *Delay in clearing by the calling subscriber in automatic working*

In the case of automatic calls with interworking from system No. 4 to system No. 5, or from system No. 5 to system No. 4, release of the international connection as brought about by the time-out of 1 to 2 minutes must take place *at the outgoing exchange only*, and not at the exchange T, the point of connection of the two systems. In exchange T, the outgoing line relay sets of the second system in the connection must accordingly be marked that they are acting, not as relay sets for the terminal outgoing end of the system in question, but as transit exchange relay sets.

5.4.3 *Non-reception of an answer-signal at the outgoing exchange after reception of a number-received signal or generation of the ST condition*

When a connection passes through system No. 4 towards system No. 5, or vice versa, release must be undertaken *at the outgoing exchange only*. Hence nothing must be done at the transit exchange T, the point at which systems Nos. 4 and 5 are connected.

In the case of system No. 4 towards system No. 5, exchange T represents the connecting transit exchange for both systems. Non-reception at T of an answer-signal within 2 to 4 minutes after condition ST has been determined must produce *no* effect at exchange T. It will be for the outgoing exchange to cause release (by sending the clear-forward signal) on the 2 to 4 minutes' time-out after reception of the number-received signal from exchange T.

In the case of system No. 5 towards system No. 4, exchange T represents the connecting transit exchange for both systems. Non-reception at T of an answer-signal within 2 to 4 minutes after reception of the number-received signal from the incoming exchange must *not* affect exchange T. It will be for the outgoing exchange to cause release of the connection (by sending the clear-forward signal) after the delay of 2 to 4 minutes following the generation of the ST condition at that exchange.

ANNEXES TO INTERWORKING SPECIFICATIONS OF SYSTEMS No. 4 AND No. 5

ANNEX 1

SIGNALLING SEQUENCES IN INTERWORKING FROM SYSTEM No. 4 TO SYSTEM No. 5

ANNEX 2

SIGNALLING SEQUENCES IN INTERWORKING FROM SYSTEM No. 5 TO SYSTEM No. 4

In this tables the arrows have the following meanings:

——▶ transmission of a signalling frequency (permanent or pulse emission).

– – –▶ end of transmission of the signalling frequency in the case of its permanent transmission.

· · ·▶ transmission of an audible tone.

ANNEX 1

SIGNALLING SEQUENCES IN INTERWORKING FROM SYSTEM No. 4 TO SYSTEM No. 5

Outgoing international exchange System No. 4		International transit exchange System No. 4 to system No. 5	Incoming international exchange System No. 5
		CALL TO A FREE SUBSCRIBER	
Transit seizing signal sent forward (speech path open while register associated).	PY →	Causes transit register to be connected (speech path open while register associated).	
Causes the first digit of the country code to be sent forward.	← Y	Transit proceed-to-send signal returned.	
	Binary code →	Received in transit register.	
Causes the next digit and all the other digits of the numerical information to be sent forward.	← y	Digit acknowledgement and request for next digit required.	
	Binary code →	Received in transit register. Each digit acknowledged.	
Received in outgoing register.	← y	A: Acknowledgement of last digit of national (significant) number.	
Received in outgoing register.	← x or y	SA: the last numerical signal to be acknowledged is code 15 (end-of-pulsing) and is acknowledged by *x* or *y*.	
Release of the outgoing register and speech path established: SA: after an end-of-pulsing signal is sent. A: after the receipt of the number-received signal.	← P	The ST condition is now established. A number-received signal is sent back to the outgoing exchange.	

ANNEX 1 *(continued)*

Outgoing international exchange System No. 4		International transit exchange System No. 4 to system No. 5		Incoming international exchange System No. 5
		A seizing signal is sent to the incoming exchange.	2400 →	Causes a proceed-to-send signal to be returned when a register is connected (speech path open while register associated).
		Causes the cessation of the seizing signal followed by:	← 2600	
			2400 – – →	Causes the cessation of the proceed-to-send signal.
			← – – 2600	
		— the sending of KP1 — the language (or the discriminating) digit — the national (significant) number — the ST signal.	MF 2/6 code →	Register takes appropriate action on the language (or the discriminating) digit, passes forward the national (significant) number and releases (speech path established).
		Release of the transit register (speech path established).		
The operator (SA) or the calling subscriber (A) { hears the ringing tone	← · · · · · · · · · ·	· · · · · · · · · · · · · · · · · ·	· · · · · · · · · ·	The ringing tone of the incoming country is sent back.
		Receipt of the answer signal, causes:	← 2400	*Called subscriber answers.* Answer signal returned.
SA: answer supervisory signal to operator. A: both the charging of the subscriber and the measurement of call duration start.	← PY	— return of an answer signal. — acknowledgement signal to be sent forward.	2400 →	
			← – – 2400	Causes cessation of the answer signal.
		Causes cessation of the acknowledgement signal.	2400 – – →	

ANNEX 1 *(continued)*

Outgoing international exchange System No. 4		International transit exchange System No. 4 to system No. 5			Incoming international exchange System No. 5
					Called subscriber clears.
		Receipt of the clear-back signal, causes:		← 2600	Clear-back signal returned.
SA: clearing supervisory signal to the operator. A: after 1-2 min, in the absence of a clear-forward signal, the international connection will be released, and both the charging of the subscriber and the measurement of call duration are ceased.	← PX	— return of a clear-back signal.	— acknowledgement signal to be sent forward.	2400 →	Causes cessation of the clear-back signal.
			Causes cessation of the acknowledgement signal.	← – – 2600 2400 – – →	
SA: operator or A: calling subscriber clears.					
Clear-forward signal sent.	PXX →	Receipt of the clear-forward signal:			
		— releases the incoming part of the No. 4 circuit and when fully released sends back a release-guard signal.	— causes a clear-forward signal to be sent forward.	2400 + 2600 →	Causes release-guard signal to be returned (see Recomm. Q.141, para. 2.1.6). Clear-forward signal sent to national network of incoming country.
	← PYY		Causes cessation of clear-forward signal.	← 2400 + 2600	
Causes removal of guard from the outgoing circuit.				2400 + 2600 – – →	Causes cessation of the release-guard signal (see Recomm. Q.141).

ANNEX 1 *(continued)*

Outgoing international exchange System No. 4	International transit exchange System No. 4 to system No. 5	Incoming international exchange System No. 5
	Causes removal of guard from outgoing circuit. ←— — — — 2400 + 2600	The outgoing access of the incoming end is maintained busy for 200 to 300 ms after the cessation of the release-guard signal.

CALL TO A BUSY SUBSCRIBER (OR CONGESTION)

The sequence of signals is the same as for a call to a free subscriber up to the point at which the incoming register releases.

		1st Case
	Receipt of the busy-flash signal, causes: ←——— 2600	The national network of the incoming country can give a busy-flash signal. This is detected by the incoming international exchange which returns the busy-flash signal.
SA: the operator is given a busy indication, the operator then releases the connection. ←——— PX	— the sending back of a busy-flash signal. — the sending of the acknowledgement signal. 2400 ———→	Causes the cessation of the busy-flash signal.
A: the clear-forward signal is sent forward to automatically release the system No. 4 circuit. The calling subscriber hears the busy tone from the outgoing (national or international) exchange.	Causes the cessation of the acknowledgement signal. ←— — — 2600	
	2400 — — — →	
	The cessation of the busy-flash acknowledgement signal is followed by the sending forward of the clear-forward signal to the incoming international exchange to automatically release the system No. 5 circuit	

ANNEX 1 *(concluded)*

Outgoing international exchange System No. 4	International transit exchange System No. 4 to system No. 5	Incoming international exchange System No. 5
		2nd Case The national network of the incoming country cannot give a busy-flash signal. The busy tone of the incoming country is sent back.
The operator and/or the calling subscriber hears the busy tone and releases the connection. ◄	· ·	· · ·
	SPECIAL CONDITIONS	
1st Case SA: Following a call switched automatically to a subscriber, or following a call established via a special number incoming or delay operator, the controlling operator wishes to call in an assistance operator at the incoming international exchange. A forward-transfer signal is sent. PYY ────	──► Causes the sending of a forward-transfer signal on the next circuit. 2600 ────	──► Causes an assistance operator to intervene at the incoming international exchange.
2nd Case SA: Following a call via code 11 or 12 the controlling operator wishes to recall the incoming operator at the incoming international exchange. A forward-transfer signal is sent. PYY ────	──► Causes the sending of a forward-transfer signal on the next circuit. 2600 ────	──► Recalls the incoming operator on calls completed via the operator positions of this incoming international exchange.

ANNEX 2

SIGNALLING SEQUENCES IN INTERWORKING FROM SYSTEM No. 5 TO SYSTEM No. 4

Outgoing international exchange System No. 5		International transit exchange System No. 5 to system No. 4		Incoming international exchange System No. 4
		Setting-up of the connection		
A seizing signal is sent when the ST-condition is recognized.	2400 ⟶	Causes the connection of a register.		
Causes cessation of the seizing signal, followed by the sending *en bloc* of	⟵ 2600	When a register is connected a proceed-to-send signal is returned.		
	2400 - - →	Causes cessation of the proceed-to-send signal.		
— KP2 signal — country code — language or discriminating digit — national (significant) number — ST signal.	← - - 2600			
Release of the register (speech path established).	MF 2/6 code ⟶	Analysis of digits necessary to determine the routing. Seizure of an outgoing circuit; a terminal seizing signal is sent.	PX ⟶	Causes the connection of a register.
		Causes the sending of the language or discriminating digit, national (significant) number + code 15.	⟵ X	When a register is connected, a termina proceed-to-send signal is returned.
			Binary code ⟶	
		Release of the register (speech path established).	⟵ X	Digit-acknowledgement signals.
				Setting up of the call in the incoming country.
			⟵ P	After the determination of a "complete number" a number-received signal is sent. Release of the register (speech path established).

ANNEX 2 *(continued)*

Outgoing international exchange System No. 5	International transit exchange System No. 5 to system No. 4	Incoming international exchange System No. 4
	CALL TO A FREE SUBSCRIBER	
The operator (SA) or the calling subscriber (A) } hears the ringing tone.	◀ ·	The ringing tone of the incoming country is sent back.
	Receipt of the answer signal causes return of an answer signal. ◀——	PY —— *Called party answers.* Answer signal returned.
SA: Answer supervisory signal to the operator. Causes an acknowledgement signal to be sent.	◀—— 2400 2400 ——▶ Causes the cessation of the answer signal.	
A: Both charging of the subscriber and measurement of call duration start. Causes the cessation of the acknowledgement signal.	◀– – 2400 2400 – –▶	
	Receipt of the clear-back signal causes return of a clear-back signal. ◀——	PX —— *Called party clears.* Clear-back signal returned.
SA: Clearing supervisory signal to the operator. Causes an acknowledgement signal to be sent.	◀—— 2600 2400 ——▶ Causes the cessation of the clear-back signal.	
A: After 1 to 2 minutes, if there is no clear-forward signal, the international connection is released and charging of the subscriber and measurement of call duration are then ceased. Causes the cessation of the acknowledgement signal.	◀– – 2600 2400 – –▶	

ANNEX 2 *(continued)*

Outgoing international exchange System No. 5		International transit exchange System No. 5 to system No. 4		Incoming international exchange System No. 4
The operator (SA) or the calling subscriber (A) clears. Clear-forward signal sent.	2400 + 2600 →	Causes the sending of: — a release-guard signal backward (see Q.141, para. 2.1.6). — a clear-forward signal forward.		
Causes cessation of the clear-forward signal.	← 2400 + 2600		PXX →	Releases the connection and when the release is fully effective a release-guard signal is returned.
	2400 + 2600 - - - →	Causes cessation of the release-guard signal (see Q.141).		
		Causes removal of guard from the outgoing circuit.	← PYY	
Causes removal of guard from the outgoing circuit.	← - - - 2400 + 2600	The outgoing access of the incoming end is maintained busy for 200 to 300 ms after the cessation of the release-guard signal.		

ANNEX 2 *(continued)*

Outgoing international exchange System No. 5			International transit exchange System No. 5 to system No. 4		Incoming international exchange System No. 4
			CALL TO A BUSY SUBSCRIBER (OR CONGESTION) The sequence of signals is the same as for a call to a free subscriber up to the point at which the incoming register releases.		
					1st Case: The national network of the incoming country can give a busy-flash signal. This signal is detected by the incoming international equipment, which sends the busy-flash signal back.
		2600	Receipt of the busy-flash signal causes a busy-flash signal to be sent back. ←	← PX	
SA: A busy indication is given to the operator.	Causes an acknowledgement signal to be sent. ←	← 2600			
		2400 →	→ Causes the cessation of the busy-flash signal.		
A: The calling subscriber hears the busy tone of the outgoing (national or international) exchange.	Causes the cessation of the acknowledgement signal, followed by the automatic release of the connection (see above). ←	← – – 2600 – –			
		– – 2400 – – →			
					2nd Case: The national network of the incoming country cannot give a busy-flash signal. The busy tone of the incoming country is sent back.
The operator and/or the calling subscriber hears the busy tone and releases the connection (see above). ←		· · · · · ·	· · · · · · · · · · · · · · ·	· · · · · ·	is sent back.

ANNEX 2 *(concluded)*

Outgoing international exchange System No. 5		International transit exchange System No. 5 to system No. 4		Incoming international exchange System No. 4
		SPECIAL CONDITIONS		
1st Case: SA: Following a call switched automatically to a subscriber, or following a call established via a special number incoming or delay operator, the controlling operator wishes to call in an assistance operator at the incoming international exchange. A forward-transfer signal is sent.	2600 →	Causes the sending of a forward-transfer signal on the next circuit.	PYY →	Causes an assistance operator to intervene at the incoming international exchange.
2nd Case: SA: Following a call via code 11 or code 12, the controlling operator wishes to recall the incoming operator at the incoming international exchange. A forward-transfer signal is sent.	2600 →	Causes the sending of a forward-transfer signal on the next circuit.	PYY →	Recalls the incoming operator on calls completed via the operator positions of this exchange.

PART XII

SIGNALLING SYSTEM No. 5*BIS*

INTRODUCTION

PRINCIPLES OF No. 5*bis* SIGNALLING SYSTEM

General

System No. 5*bis* is compatible with both TASI- and non-TASI equipped circuits and may be applied for automatic and semi-automatic operation and both-way working. It requires four-wire signalling and automatic access to the outgoing circuits.

The signalling equipment is in two parts:

a) line signalling—for the so-called supervisory signals, and

b) register signalling—both forward and backward directions.

a) *Line signalling*

System No. 5*bis* uses the same line signalling as system No. 5. This line signalling is specified in Recommendations Q.141 to Q.146.

b) *Register signalling*

This is a link-by-link 2/6 multifrequency (m.f.) in-band pulse signalling system with forward and backward signalling. The frequencies (700 Hz ....1700 Hz) are outside of the line signalling frequencies and are the same in both directions. Overlap sending applies at the originating international register after formation of the initial address block. The initial address block comprises not more than seven signals beginning with the X signal (Table 1) followed by the I, Z and N signals as subsequently explained. When sending, the outgoing register pulses out the initial address block signals in a continuous sequence. Additional signals are sent individually as soon as each one is available in the outgoing register. The trunk/TASI channel association established by the seizing signal is maintained by the TASI speech detector hangover during the interval between cessation of the seizing signal (on receipt of the "proceed-to-send" signal) and the transmission of the X signal. Upon completion of X signal transmission the guard and TASI-locking frequency * (1850 Hz) is applied. This guard and TASI-locking frequency is thereafter transmitted during the intervals between subsequent signals until register dismissal. Cessation of the "Proceed-to-send" signal will be followed immediately (within the TASI hangover time) by a guard and TASI-locking frequency in the backward direction having the same characteristics as that used in the forward direction. This makes possible the sending of signals at any time in either direction because TASI association is ensured.

Overlap register signalling applies (except for the initial block) at the international transit registers and at the incoming international register to minimize the post-dialling delay.

Compandors affect signalling, particularly short-pulse compound signalling (e.g., register signalling), due to distortion and the production of intermodulation frequencies. By virtue of the link-by-link signalling and the adopted duration of the m.f. pulses, system No. 5*bis* functions correctly in the presence of compandors.

Backward register signalling may commence immediately after receipt of the first forward interregister signal on a given circuit. Interregister signalling on a given circuit is completed when a backward signal appropriately selected from Table 4 and indicating register dismissal, is received by the outgoing international exchange at the outgoing side of that circuit.

In general, care should be taken to ensure that the insertion or enabling of echo suppressors does not interfere with the simultaneous backward and forward transmission of interregister signals.

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* The term "guard and TASI-locking frequency" indicates the double function of this frequency. The guard function inhibits the response of m.f. signal receivers to spurious signals and detects interruptions.

CHAPTER I

Definition and function of signals

RECOMMENDATION Q.200

DEFINITION AND FUNCTION OF SIGNALS

1.1 The definitions and functions of the line signals given in Recommendation Q.140, paragraphs 1.1, 1.2, 1.8, 1.10 and 1.11 apply completely to system No. 5*bis*.

1.2 The signals given in Recommendation Q.140, paragraphs 1.6, 1.7 and 1.9 apply to system No. 5*bis* with the following notes:

i) *Busy-flash signal* (Q.140, paragraph 1.6)

Because of the availability of additional interregister signals in system No. 5*bis*, the busy-flash signal is sent only after the release of the incoming register. In the event that a busy-flash signal is received from a subsequent part of the connection prior to register release, a congestion signal from Table 4 (Recommendation Q.211) should be sent.

ii) *Answer signal* (Q.140, paragraph 1.7)

The answer signal will *not* start metering the charge to the calling subscriber if, prior to this signal, a no-charge interregister signal is also received. Moreover, the measurement of call duration for international accounting may not be started when a no-charge interregister signal is also received.

iii) *Clear-forward signal* (Q.150, paragraph 1.9)

In addition to the cases mentioned for system No. 5, the clear-forward signal will be sent after the receipt of a backward interregister signal calling for release of the connection by the outgoing international exchange.

1.3 Initial forward interregister signal

The initial forward interregister signal is designated as an "X" signal and has meanings as tabulated in Table 1.

1.4 Other forward interregister signals

These signals provide information to switch the call as required. The initial sequence of numerical signals including the X-signal described in 1.3 above is designated as the *Initial Address Block* and will normally take the following forms:

a) $X \quad I_1 \quad Z \quad N_1 \quad N_2 \quad N_3 \quad N_4$
b) $X \quad I_1 \quad I_2 \quad Z \quad N_1 \quad N_2 \quad N_3$
c) $X \quad I_1 \quad I_2 \quad I_3 \quad Z \quad N_1 \quad N_2$

See 3.5.2 and Tables 1, 2 and 3 for symbol meanings.

The initial address block may contain less than seven signals only if the total address comprises less than seven signals, in which case a suffix signal ST will indicate the shorter length and that forward transmission is complete. The ST signal may be sent in any case to show that no more forward interregister signals are intended. The ST signal is always sent in semi-automatic working and may be sent in automatic working provided that no register dismissal signal has yet been received. (See paragraphs 1.5 and 3.2.1.)

1.5 Interregister signals sent in the backward direction

These signals provide an element of information as indicated in Table 4. The final signal sent in the backward direction also indicates register dismissal.

1.6 Signal sequence diagrams

The sequence of signals in semi-automatic and automatic working is shown in Tables 1 and 2 of Annex 1 to this Part XII.

CHAPTER II

Line signalling

RECOMMENDATION Q.201

LINE SIGNALLING

2.1 System No. 5*bis* uses the same line signalling as system No. 5, specified in Recommendations Q.141 to Q.145. However, with regard to:

i) *The busy-flash line signal* (Q.141, paragraph 2.1.6 d))

This signal is sent only if the release of the incoming register has already occurred. In the event that a busy-flash signal is received from a subsequent part of the connection prior to the release of the incoming register, a congestion signal from Table 4 (Recommendation Q.211) should be sent.

ii) *The answer signal* (Q.141, paragraph 2.1.7 b))

The procedures for overlap compelling of the answer signal apply equally to the interconnection of:

- two No. 5*bis* circuits,
- a No. 5 circuit and a No. 5*bis* circuit, and
- a No. 5*bis* circuit and a No. 5 circuit.

RECOMMENDATION Q.202

2.2 SPEED OF SWITCHING IN INTERNATIONAL EXCHANGES

2.2.1 It is recommended that the equipment in the international exchanges shall have a high switching speed so that the switching time may be as short as possible.

2.2.2 At the outgoing international exchange the seizing of the circuit and the setting up for the connection should take place as soon as the initial address block is available.

At an international transit exchange, switching may begin before the complete initial address block is registered but forward pulsing should be restrained until the complete initial address block is received. See paragraph 3.5.2 of Recommendation Q.215.

At the incoming international exchange the setting-up of the national part of the connection should start as soon as the register has received a sufficient number of digits.

2.2.3 At international exchanges the return of a proceed-to-send signal should be as fast as possible but in any case the return should normally be guaranteed before the time-out (minimum 10 seconds) of the seizing signal.

CHAPTER III

Register signalling

RECOMMENDATION Q.211

REGISTER SIGNALLING

3.1 Signal code for register signalling

3.1.1 *General*

1) Automatic access to the international circuits must be used for outgoing traffic and the numerical signals from the operator or subscriber must be accumulated in an outgoing international register until enough information is available to form an initial address block. As soon an initial address block can be formed, a free international circuit is selected and a seizing line signal transmitted. On receipt of a "Proceed-to-send" line signal the seizing signal is terminated and the initial address block is transmitted by the register. Thereafter additional signals are sent as soon as digits are available. TASI association is ensured throughout the interregister signalling period in both directions by means of the guard and TASI-locking frequency inserted between pulses, as covered in the introduction to the No. 5*bis* specification.

2) Link-by-link register signalling applies. The register signals are always sent with an initial address block followed by additional signals if the address length demands this. Overlap switching and pulsing applies at all international exchanges in accordance with paragraph 2.2.2.

3) The register signalling is 2-out-of-6 multifrequency code with forward and backward signalling as shown in Tables 1, 2, 3 and 4.

The signals 1-15 mentioned in these tables are all composed of 2-out-of-6 frequency combinations and these combinations are identical for similarly numbered signals in all Tables. The combinations are shown only in Table 1.

3.1.2 *Sending sequence of register signals*

A. FORWARD SIGNALS

a.1) The forward sequence of interregister signals begins with an initial address block with typical composition as in the examples that follow:

1) $X \quad I_1 \quad Z \quad N_1 \quad N_2 \quad N_3 \quad N_4$
2) $X \quad I_1 \quad I_2 \quad Z \quad N_1 \quad N_2 \quad N_3$
3) $X \quad I_1 \quad I_2 \quad I_3 \quad Z \quad N_1 \quad N_2$

The following exceptional initial address blocks (fewer than seven signals in the block) may be encountered:

4) X I_1 Z Code 11, ST
5) X I_1 Z N_1 Code 11, ST
6) X I_1 Z Code 12, ST
7) X I_1 Z Code 12 *, N_2 ST
8) X I_1 Z N_1 Code 12, ST
9) X I_1 I_2 Z Code 11, ST
10) X I_1 I_2 Z Code 12, ST

The signals following the initial address block (if any) are taken from Table 3 and are normally sent as soon as received by the outgoing international register.

In the present world numbering plan the maximum number of signals in a full address sequence is 15, made up as follows:

12 signals for country code + national number
1 signal X
1 signal Z
1 signal ST

In the event of a failure to satisfy a 2-out-of-6 or other logic check during forward signalling, the incoming exchange will request that the address be retransmitted on a given circuit (see paragraph b.3 below).

When retransmission is necessary this will always commence with the repeated transmission prefix (signal 13, Table 3) and will be followed by the initial address block and any subsequent digits available in the sequence as previously sent. If an error should occur in any of the first five signals of an initial address block, the backward error detected signal should be deferred until the fifth signal of the initial block has been received. (This procedure avoids a possible conflict between signals Z = 13 and N = 13.) If address transmission has begun on the circuit immediately following the circuit engaged in error correction, the correction process should not cause retransmission of valid information already sent on that following circuit.

a.2) The ST end-of-pulsing signal should be transmitted on all semi-automatic calls and may also be transmitted on automatic calls.

a.3) Exceptionally, special numbers for giving access to incoming operators or delay operators may be dialled by outgoing operators and transmitted by outgoing international registers instead of code 11 and code 12 signals.

B. BACKWARD SIGNALS

b.1) The backward signals will be selected as required from Table 4. During initial use of system No. 5*bis* there will normally be one backward signal on each link. It is possible, however, for an error-detected signal to be sent on a given circuit when an error is detected on forward signalling. In the event that the first error-detected signal results in a successful retransmission, a backward signal relating to normal register dismissal will follow ultimately, unless a second error should occur during forward signalling

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* Code 12 is N_1 in this pattern.

TABLE 1

Forward signals

Content of the X signal

Signal No.	Frequency (compound) Hz	Meaning
1	700+900	No echo suppressors required and no satellite link included.
2	700+1100	Echo suppressors required and no satellite link included.
3	900+1100	Echo suppressor required and satellite link included.
4	700+1300	No echo suppressor available in originating CT and no satellite link included.
5	900+1300	Spare (see note)
6	1100+1300	
7	700+1500	
8	900+1500	
9	1100+1500	
10	1300+1500	
11	700+1700	
12	900+1700	
13	1100+1700	Reserved to facilitate interworking with system No. 5.
14	1300+1700	
15	1500+1700	Unavailable to avoid conflict with backward signal of same characteristic (signal 15 of Table 4).

Note. — The spare signals are available for future use:

a) to extend the precision of echo suppressor control, e.g. when a number of circuits of low propagation type are connected in tandem:

b) to monitor the number of TASI circuits in a connection.

on the same circuit. In this case a second error-detected signal will be transmitted and no further backward signalling will take place since the outgoing register receiving the error-detected signal for the second time will clear the connection forward. A backward signal in accordance with paragraph 3.7.2 should then be sent.

b.2) The backward sequence described in b.1) above can be extended in the future if route monitoring is required. In this event a backward sequence headed by the route monitoring prefix (signal 13, Table 4) will be sent from each international exchange (other than the outgoing international exchange). This backward sequence, called a "route monitoring block", is of fixed length, and is transmitted promptly upon receipt of the forward "*X*" digit. Such blocks are then repeated backward link-by-link. The error-detected signal, when required, is sent after a route monitoring block, but not until the first five signals of the initial address block have been received.

b.3) A backward signal on any link may be corrupted to the extent that it does not satisfy the 2-out-of-6 check of multi-frequency pulses. The international exchange receiving and detecting this corruption will transmit backwards signal 15 (Table 4) as a substitute for the erroneous pulse. This substitute signal is ultimately received at the originating international exchange and the action to be taken at this international exchange will be based upon the following rules:

a) if the substitute pulse occurs within the framework of the route monitoring block (excluding the route monitoring prefix itself) the switching should not be affected;

b) in all other cases receipt of signal 15 should cause release of the connection.

TABLE 2

Forward signals

Content of the Z signals

Signal No.	Meaning	
1	Language digits as in Recommendation Q.104, with the assignment of signal 7 for use as the Z signal on calls requiring access to test equipment *.	Semi-automatic calls
2		
3		
4		
5		
6		
7		
8		
9	Spare	
10	Equals “0”; subscriber without priority	Discriminating digits for automatic calls
11	Subscribers with priority	
12	Data transmission	
13	Spare	
14	Spare	
15	Note	

Note. — Signal 15 is reserved to have the same meaning (end of pulsing) as in the “N” digit table (Table 3).

* Test call address formats should be as in a), b) or c) below:

a) X I_1 7 “12” 0 N N ST;

b) X I_1 I_2 7 “12” 0 N N ST;

c) X I_1 I_2 I_3 7 “12” 0 N N ST.

TABLE 3

Forward signals

Content of the N signals

Signal No.	Meaning
1	Digits 1-10 (see Notes)
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	Code 11 operator
12	Code 12 operator or component of the test code pattern when associated with Z = 7
13	Repeated transmission prefix
14	Spare
15	ST—end of pulsing

Note 1. — The signals 1-10 are used for the country code (I-digits) and national number digits.

Note 2. — Signal 10 equals digit "0".

TABLE 4

Backward signals

Signal No.	Meaning *(Note 3)*	
1	International switching equipment	Congestion
2	International circuit group	
3	National network	
4	Spare	
5	Spare	
6	Subscriber free with charge *(Note 1)*	Called-party line conditions
7	Subscriber free no charge	
8	Subscriber busy	
9	Subscriber unavailable	
10	Spare	
11	Error detected	
12	Spare	
13	Route monitoring prefix *(Note 2)*	
14	Spare *(Note 2)*	
15	Substitute for erroneous pulse	

Note 1. — In the case where the country of destination or a signalling system further on in the chain does not supply the called party line conditions, signal No. 6 is used to indicate the number-received condition.

Note 2. — In the event that route-monitoring blocks of different lengths are used in the future, signal 14 is available as an additional route-monitoring prefix.

Note 3. — Any of the backward signals, except signal 15, may be given meanings independent of those listed if they appear in the route-monitoring block.

RECOMMENDATION Q.212

3.2 END-OF-PULSING CONDITIONS—REGISTER ARRANGEMENTS

3.2.1 *End of forward pulsing*

The end of forward pulsing may be indicated in an incoming international exchange:

a) by an examination of the received number or other suitable measures as indicated in Q.120, paragraph 1.5.5; or

b) by receipt in some cases of an ST signal.

3.2.2 *End of backward pulsing*

The end of backward pulsing is synonymous with register dismissal. The incoming international exchange indicates the end of backward pulsing by an appropriate signal from Table 4.

RECOMMENDATION Q.213

3.3 SIGNAL TRANSMISSION REQUIREMENTS

3.3.1 *Signalling frequencies to be used in both directions*

a) 700, 900, 1100, 1300, 1500 and 1700 Hz

A multifrequency signal shall consist of a combination of any two of these six frequencies. The frequency variation shall not exceed ± 6 Hz of each nominal frequency.

b) 1850 Hz

The guard and TASI-locking frequency shall consist of 1850 Hz.
The frequency variation shall not exceed ± 6 Hz.

3.3.2 *Transmitted signal level*

a) Two out of six m.f. signalling frequencies:

A level of – 7 ± 1 dBm0 per frequency should be used. The difference in transmitted level between the two frequencies comprising a signal should not exceed 1 dB.

b) Guard and TASI-locking frequency:

This frequency, transmitted in the gaps between m.f. signals, shall be sent in the forward direction initially at a level of –7 ± 1 dBm0 and shall continue at this level until a new MF signal is sent or until expiration of an interval of 90 ± 30 ms. If the interval between MF signals requires continuation of the guard frequency beyond 90 ± 30 ms, the frequency level should be reduced to –15 ± 1dBm0. In the backward direction a uniform level of –15 ± 1 dBm0 should be used.

Note. — The level of the leak current transmitted to line should be at least:

a) 50 dB below the – 7 dBm0 single-frequency level when no signal frequency (either MF or guard and TASI-locking frequency) is being transmitted;

b) 30 dB below the – 7 dBm0 single-frequency level during transmission of either an MF signal or of the guard and TASI-locking frequency.

3.3.3 *Signal durations and related time intervals*

- all m.f. signals: 55 ± 5 ms;
- interval between MF signals:
  - within the initial address block: 55 ± 5 ms,
  - later intervals: not less than 55 ± 5 ms.
- interval between cessation of the seizing line signal and the transmission of the first register signal: 80 ± 20 ms;
- interval between cessation of the proceed-to-send signal and transmission of the backward guard and TASI-locking frequency: 80 ± 20 ms;
- interval between cessation of the X-signal frequencies and the first application of the guard and TASI-locking frequency: 1 ± 1 ms.

After initial application in both directions, the guard and TASI-locking frequency shall be sent for the duration of the gap between signals and shall persist until register dismissal. The separation intervals between MF signals and the guard and TASI-locking frequency should not exceed 1 ± 1ms.

3.3.4 *Compound signal tolerance*

The interval of time between the moments when each of the two frequencies comprising a signal is sent must not exceed 1 ms. The interval of time between the moments when each of the two frequencies ceases must not exceed 1 ms.

RECOMMENDATION Q.214

3.4 MULTIFREQUENCY SIGNAL RECEIVER AND GUARD FREQUENCY DETECTOR

A. MULTIFREQUENCY SIGNAL RECEIVER

3.4.1 *Operating limits*

The signal receiver must ensure a separate output signal for each of the six voice-frequency signals received, and must operate satisfactorily for any combination of two of the frequencies, received as a single pulse or in a train of pulses, satisfying the following conditions:

a) the frequency of the received signal is within ± 15 Hz of the nominal signalling frequency;

b) the absolute power level N of each unmodulated signal shall be within the limits:

$(-14 \pm n \leqslant N \leqslant n)$ dBm

where n is the relative power level at the signal receiver input. These limits give a margin of ± 7 dB on the nominal absolute level of each received signal at the input to the signal receiver;

c) The absolute levels of the two unmodulated frequencies comprising a signal must not differ from each other by more than 4 dB;

d) when the signal frequencies and levels are within the limits specified in a), b) and c) above, and in the presence of noise as defined in section 3.4.3:

1) at the input of a signal receiver, the minimum duration of an m.f. signal necessary to ensure correct registration of the digit shall not exceed 30 ms; this includes the operate time of the signal receiver and the two-and-two-only check feature;

2) furthermore, at the input of the signal receiver, the minimum duration of an interval necessary to ensure the correct functioning of the registra-

tion device shall not exceed 30 ms; this includes the *release time* of the signal receiver and the restoration time of the two-and-two-only check feature.

Note 1. — The tolerances given in a), b) and c) are to allow for variations at the sending end and in line transmission.

Note 2. — The test values in d) are less than the working values. The difference between the test and working values will allow for pulse distortion, difference in time of the receipt of the two frequencies comprising a signal, etc.

3.4.2 *Non-operating conditions*

a) *Maximum sensitivity*

The signal receiver shall not operate under the effect of a signal as indicated in paragraph 3.4.1 a), whose absolute power level at the point of connection of the receiver is (— 17 — 7 + *n*) dBm, *n* being the relative power level at this point. This limit is 17 dB below the nominal absolute power level of the signal current at the input to the signal receiver.

b) *Transient response*

Operation of the signal receiver shall be delayed for a minimum period necessary to guard against false operation due to spurious signals generated within the receiver on reception of any signal.

c) *Short signal response*

The signal receiver should not operate to a pulse signal of 10 ms or less. This signal may be of single frequency or two frequencies received simultaneously.

Likewise the signal receiver should ignore intervals of 10 ms or less.

d) Arrangements should be made to ensure non-acceptance of 2-out-of-6 signals in the presence of the guard and TASI-locking frequency.

3.4.3 *Steady noise*

Considering that unweighted noise of a level —40 dBm0 (100 000 pW) and uniform spectrum energy may arise on the longest international circuit, the multifrequency receiver and guard tone detector should satisfy the condition indicated in paragraph 3.4.1 d), 3.4.5 c), and 3.4.6 respectively for minimum signal and interval durations in the presence of noise of level —40 dBm0 and uniform spectrum energy over the frequency range 300 to 3400 Hz.

3.4.4 *Input impedance*

The composite input impedance of the multifrequency receiver and guard frequency detector should be such that the return loss over a frequency range 300 to 3400 Hz against a 600-ohm non-inductive resistor is greater than 20 dB.

B. GUARD FREQUENCY DETECTION

3.4.5 *Operating limits*

The guard frequency detector must respond under the following conditions:

a) the frequency of the received signal is within ± 15 Hz of the nominal 1850 Hz guard frequency. (Signals of the level in b) below but outside the range 1850 ± 100 Hz should not cause operation of the guard detector);

b) the level of the received signal is in the range 0 to −22 dBm0. Signals of levels below −32 dBm0 should not cause operation of the guard frequency detector;

c) the duration of the received signal at the input of the receiver is in the range 15 to 25 ms in the presence of noise as specified in section 3.4.3.

3.4.6 *Release limits*

The guard frequency detector must release when a signal satisfying the conditions given in 3.4.5 above has been reduced to a level of −37 dBm0 or below at the input of the guard frequency detector for an interval of 10 to 20 ms and in the presence of noise as specified in section 3.4.3.

3.4.7 *Input impedance*

The composite input impedance of the multifrequency receiver and guard frequency detector should be such that the return loss over a frequency range 300 to 3400 Hz against a 600-ohm non-inductive resistor is greater than 20 dB.

C. ERROR DETERMINATION

3.4.8 *Absence of a valid signal*

If in the forward direction for an interval of 20 to 30 ms there is no valid signal present at the output of both the multifrequency receiver and the guard frequency detector, an error condition should be indicated. This error condition should result in the backward transmission of an error-detected signal unless the error occurs after reception of an ST signal. No provision need be made for detecting and acting upon discontinuities in the guard and TASI-locking frequency used in the backward direction.

RECOMMENDATION Q.215

3.5 ANALYSIS OF REGISTER SIGNALS FOR ROUTING

3.5.1 *General requirements for the transit exchange*

In an international transit exchange an analysis of some of the register signals is required to determine the routing * to the desired international incoming exchange or to another international transit exchange. As a general rule the X, I and Z signals ** are subject to this analysis. In some cases an analysis of more or fewer signals may be required (see Annex hereafter).

The transit exchange decides how many of the received digits it needs for this analysis.

3.5.2 *Maximum number of register signals to be analysed in an international transit exchange*

The standard initial address block will take the form given in paragraph 3.1.2 (a.1), and will provide a basis for making routing choices. Although signal analysis for routing may be extended at the option of an international exchange, there will be no general requirement in an international exchange receiving a standard initial address block to analyse more than six of the seven signals. The signal which is underlined in the patterns below need not be analysed if an international exchange wishes to limit analysis to six signals. At transit exchanges switching may begin before the full initial address block is registered, but forward register signalling should be restrained until the full initial address block is received since uninterrupted transmission of the initial address block on the outgoing route must be guaranteed. This takes account of possible retransmissions for error correction.

	X	I_1	Z	N_1	N_2	N_3	N_4
	X	I_1	I_2	Z	N_1	N_2	N_3
	X	I_1	I_2	I_3	Z	N_1	N_2
or	X	I_1	I_2	I_3	Z	N_1	N_2

where: I_1 I_2 I_3 = digits of the country code, Z = discriminating signal (D) or language digit (L), $N_1 \dots N_n$ = digit of the national (significant) number as indicated in Table 3.

Note. — In the case of countries with more than one incoming international exchange where code 11 or code 12 traffic requires for routing in the transit exchange a digit analysis beyond the country code, N_1 is the extra digit designating the incoming international exchange (see the Annex below, examples 1 b) and 3).

3.5.3 *Signal analysis for routing at the outgoing international exchange*

The *maximum* number of signals which have to be analysed in the outgoing international exchange to determine the routing is also six, as in section 3.5.2 for the transit exchange.

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* See Recommendation Q.11, paragraph 1.2.

** The I signals constitute the country code of the destination country.

3.5.4 *Signal analysis for inserting (or detecting) the language or discriminating signal*

1) In semi-automatic working in the case when the language digit is not sent by the operator and in automatic working, it is necessary to determine in the outgoing international exchange the position where the language digit or the discriminating signal should be automatically inserted (immediately after the country code). This position is determined by an analysis of the first or the first two digits of the country code.

2) In an international transit exchange an analysis, effective on the first or the first two digits of the country code, determines the number of digits in the country code. The position of the language or the discriminating digit which, in the sequence of numerical information, follows immediately the country code is therefore determined.

ANNEX
(to Recommendation Q.215)

Example of the signal analysis in a transit exchange

A list of possible cases for the signal analysis in a transit exchange is the following (the letters given to the international exchanges correspond to the figure, and the letters given to the digits correspond to section 3.5.2 of this Recommendation).

1. Transit traffic via C in one country routed to exchanges M or R in another country according to the first digit(s) of the national (significant) number.

a) Automatic and semi-automatic calls with normal national numbers.

Example: $\underbrace{X\ I_1\ I_2\ Z\ N_1\ N_2}_{\text{analysed}} \ldots$

b) * Semi-automatic calls to code 11 or code 12 operators.

Examples: $\underbrace{X\ I_1\ I_2\ L\ N_1\ C_{11}}_{\text{analysed}} \ldots$ or $\underbrace{X\ I_1\ I_2\ L\ N_1\ C_{12}}_{\text{analysed}} \ldots$

2. Transit traffic via C in one country routed to G or S in another country with semi-automatic traffic to S and automatic traffic to G according to the presence of the language digit (L) or the presence of the discriminating signal (D).

Examples: $\underbrace{X\ I_1\ I_2\ L}_{\text{analysed}} \ldots$ or $\underbrace{X\ I_1\ I_2\ D}_{\text{analysed}} \ldots$

3.* Traffic incoming to an international exchange C in a country and which is to be routed to code 11 or code 12 operators in another international exchange A in the same country according to the extra digit N_1.

Examples: $\underbrace{X\ I_1\ I_2\ L\ N_1\ C_{11}}_{\text{analysed}}\ ST$ or $\underbrace{X\ I_1\ I_2\ L\ N_1\ C_{12}}_{\text{analysed}}\ N_3\ N_4\ ST$

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* It is recognized that existing design of some present-day equipments does not permit the insertion of the extra digit N_1.

In this situation, agreement will be required between the relevant countries concerned that this insertion of N_1 would not be provided for at a particular outgoing international exchange as long as the equipment limitation applied.

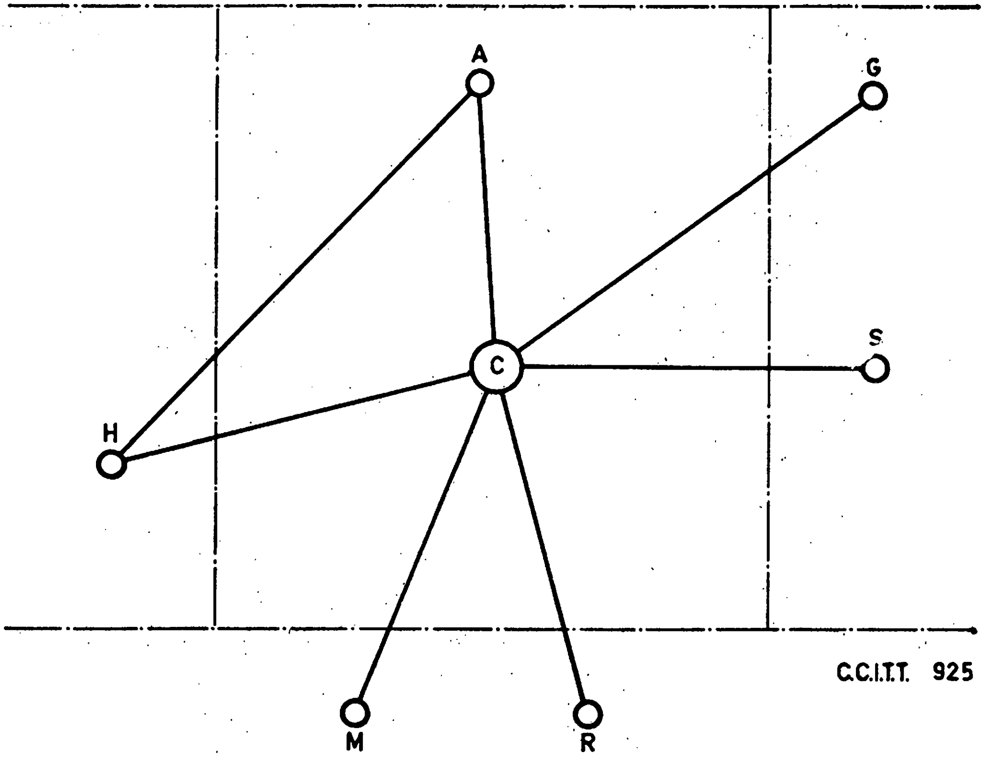

Figure 1. — **Example of the signal analysis in a transit exchange**

RECOMMENDATION Q.216

3.6 X-SIGNAL USAGE

3.6.1 *General*

The X-signals 1-12 have been made available to indicate switching control information beyond that carried in the normal address and in the Z-signal. Initially, the added information has application to echo suppressor control and to routing constraints imposed by satellites. A single X-signal uniquely characteristizes all additional control information of interest. Table 1 lists the assignments given for X = 1 through X = 4. Eight assignments remain spare.

3.6.2 *Echo suppressor control*

The signal assignments X = 1 through X = 4 anticipate the need to control a single standard type of half echo suppressor. The originating international exchange determines the X-signal to be sent by analysing the country code and by taking note of the circuit to be used. Rules for application are as follows:

1) if the originating international exchange cannot provide a half echo suppressor, use signal X = 4. If the call is transit, the first transit international exchange should require the use of a half echo suppressor on its outgoing circuit and should change the X value sent onward to X = 2 or 3 as appropriate;

2) if the originating international exchange chooses a transit route and can provide a half echo suppressor, use X = 2 or 3 as appropriate;

3) if the originating international exchange chooses a terminal route and can provide a half echo suppressor, the nature of the connection as known to the originating international exchange determines a choice of signal X = 1, X = 2 or X = 3;

4) a transit international exchange should change the X-signal from X = 2 to X = 3 if a satellite circuit is selected;

5) a transit international exchange, having received signal X = 2 or X = 3, and having selected a terminal circuit not arranged for echo suppressors, should insert the terminating half echo suppressor. The X-digit transmitted to the incoming international exchange should be passed unchanged (as X = 2 or X = 3) to retain satellite routing information. Since the incoming international exchange cannot supply a half echo suppressor in any event, this assignment procedure saves an X-signal assignment.

If echo suppressors are taken from a pool and none are free to satisfy a call requirement, the congestion signal 1 of Table 4 should be sent back.

3.6.3 *Satellite routing constraints*

Each of the signal assignments used for echo-suppressor control has an application to satellite routing as well. These assignments show if there has or has not been prior usage of a satellite circuit. In this way the X-digit guides subsequent routing choices to avoid tandem satellite links. If a call which has already traversed one satellite circuit cannot advance without recourse to a second satellite circuit, the transit international exchange must decide whether to return the congestion signal 2 of Table 4 or to accept the tandem satellite circuit connection.

3.6.4 *Other X-signals*

X-signals 13 and 14, which have the same frequency combinations as KP1 and KP2 of system No. 5 have been reserved to ease the parallel working of system No. 5 and system No. 5*bis* in the event of common equipment for those two systems.

Signal 15 is not available as, in Table 4, signal 15 is a substitute for an erroneous pulse. If X-signals were to be sent backwards within a route monitoring block, the use of X = 15 would produce a conflict.

3.6.5 *X-signal usage in the backward direction*

If it is decided in the future that an X-signal be sent backwards from any transit or incoming register to the originating register as part of a route-monitoring block, it will be the same X-signal which was transferred in the forward direction on the last circuit. However, in the case of an interface switching point an additional route monitoring block could be generated by the interworking equipment.

RECOMMENDATION Q.217

3.7 RELEASE OF INTERNATIONAL REGISTERS

3.7.1 *Normal release conditions*

a) An outgoing register shall be released * when it has received an appropriate backward interregister dismissal signal or when the connection is cleared earlier by the outgoing side.

b) An incoming international register shall be released when it has transmitted a backward interregister dismissal signal ** or when the connection is cleared earlier by the outgoing side.

c) An international transit register shall be released when it has sent a backward interregister dismissal signal or when the connection is cleared earlier by the outgoing side.

3.7.2 *Abnormal release conditions*

a) An outgoing international register shall release * and clear the forward connection in any of the following five cases:

1. if 10-20 seconds after the start of the seizing signal no proceed-to-send signal is received;
2. if 20-30 seconds after the reception of the proceed-to-send signal, owing to fault conditions, the outgoing register has not pulsed out;
3. if 20-30 seconds after the sending of the last valid forward register signal, no register dismissal signal is received;

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* Except in the case of register dismissal due to the backward signals 6 and 7 (Table 4), release of the outgoing international register will cause the connection of the appropriate tones or announcements to the calling party.

** At the discretion of the incoming international exchange the forward transmission path may be kept split until the forward guard and TASI-locking frequency ceases.

4. if a backward error-detected signal is received for the second time;
5. if a "substitute for erroneous pulse" signal is received, provided it is not part of the route-monitoring block.

b) An incoming international register shall release and clear the forward connection, if any, in the following case:

> No digits or insufficient digits to establish a connection have been received and 15-30 seconds have elapsed since the end of the proceed-to-send signal or the receipt of the last forward register signal. In this case signal 2 (Table 4) is transmitted backwards prior to release.

c) An international transit register shall be released in any one of the cases stated for the release of the outgoing and incoming international registers as in paragraphs 3.7.2 a) and b) above. When releasing because of the reception of an error-detected signal for the second time, the international transit register will send signal 2 of Table 4 backwards prior to release.

RECOMMENDATION Q.218

3.8 SWITCHING TO THE SPEECH CONDITION

At the incoming and transit international exchange the circuit shall be switched to the speech condition when the register is released after sending a backward signal indicating number received or called party line conditions as per Table 4.

At the outgoing international exchange the circuit will be switched to the speech position when the register is released due to the reception of the backward signals 6 or 7. In other cases the appropriate tones should be sent or other measures taken.

CHAPTER IV

Manual testing arrangements

RECOMMENDATION Q.221

MAINTENANCE MANUAL TEST ARRANGEMENTS FOR SIGNALLING SYSTEM No. 5*bis* *

1. General

The testing arrangements for signalling system No. 5*bis* are essentially the same as indicated in Q.161 to Q.164 for system No. 5. However, the different time specifications and the introduction of backward register signals should be taken into account.

The performance of the guard frequency detector may be checked according to the requirements of paragraph 3.4 of Recommendation Q.154 of the system No. 5*bis* specification.

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* See Question 11/IV for the automatic transmission measuring and signalling testing equipment ATME No. 2.

ANNEX TO SIGNALLING SYSTEM No. *5bis* SPECIFICATIONS

SIGNALLING SEQUENCES

Table 1: Semi-automatic (SA) and automatic (A) terminal traffic.

Table 2: Semi-automatic (SA) and automatic (A) transit traffic.

In these tables, the arrows have the following meanings:

———▶ transmission of a signalling frequency (permanent or pulse emission).

– – –▶ end of transmission of the signalling frequency in the case of its permanent transmission.

• • •▶ transmission of an audible tone.

TABLE 1. — SEMI-AUTOMATIC (SA) AND AUTOMATIC (A) TERMINAL TRAFFIC

Outgoing international exchange		Incoming international exchange
	CALL TO A FREE SUBSCRIBER	
After the initial address block is registered in the outgoing register, a seizing signal is sent forward (the speech path is open as long as the register is connected).	2400 →	Receipt of the seizing signal causes a register at the incoming exchange to be connected; when the latter is ready to receive the digital information, a proceed-to-send signal is sent back (the speech path is open as long as the incoming register is connected).
Receipt of the proceed-to-send signal causes the seizing signal to cease.	← 2600	
	2400 ⇢ ⇠ 2600	The end of reception of the seizing signal causes the proceed-to-send signal to cease.
	← 1850	Upon the cessation of the proceed-to-send signal the incoming register sends back the guard and TASI-locking frequency.
The cessation of the seizing signal is followed (in 80 ± 20 ms) by the sending en bloc in MF code of the initial address block. The initial address block typically consists of 7 signals: — the X signal — I digit(s) (country code) — the Z signal — N digits (initial part of national number)	1st MF 2/6 code → 1850 → 2nd MF 2/6 code → 1850 → etc.	The MF signals are received in the incoming register. This register starts the setting-up of the call in the incoming country when enough digits have been received to determine the routing. The incoming register carries out the appropriate operations according to the X and Z signals (typically X is an echo suppressor/satellite link control signal). In SA operation for code 11 or 12 calls, the register directs the call to the operators' positions.

TABLE 1 *(continued)*

Outgoing international exchange	Incoming international exchange
When the initial address block consists of less than 7 signals (e.g., code 11 or 12 calls), a suffix ST signal terminates the block. The ST is always sent on SA calls.	
The "guard and TASI-locking frequency" is sent during the signal gaps beginning after the X signal until the register is dismissed. 1850 ⟶	
Any address signals which follow the initial address block are forwarded as received.	
⟵ — — —	— — 1850 —
Upon receiving the register dismissal signal the register releases. ⟵	MF 2/6 code
Release of the register causes the guard and TASI-locking frequency to cease. The speech path through the outgoing exchange is established. 1850 — — —	— — ⟶ After performing all necessary functions, the register sends back a register dismissal signal. The incoming register releases without further transmission of the backward guard and TASI-locking frequency. The speech path through the incoming exchange is established (the return path immediately, the forward path after the forward guard and TASI-locking frequency ceases, if the incoming international exchange chooses this option).

TABLE 1 *(continued)*

Outgoing international exchange		Incoming international exchange
SA: The operator or A: the calling subscriber hears the ringing tone.	◄ · · · · · · · · · · · · · ·	The ringing tone of the country of destination is sent back.
SA: An "answer" indication is given to the controlling operator. A: Charging and measurement of the call duration begin.	◄———————— 2400	The called subscriber answers. An answer signal is sent back.
Receipt of the answer signal causes an acknowledgement signal to be sent.	2400 ————————►	
	◄— — — — — — 2400	Receipt of the acknowledgement ceases the answer signal.
The end of reception of the answer signal ceases the acknowledgement signal.	2400 — — — — — —►	
SA: A clearing supervisory signal is given to the controlling operator. A: After 1-2 min., if there is no clear-forward signal, the international connection is released and charging and measurement of the call duration are ceased.	◄———————— 2600	The called subscriber clears. The clear-back signal is sent back.
The clear-back signal causes acknowledgement to be sent.	2400 ————————►	Receipt of the acknowledgement ceases the clear-back signal.
	◄— — — — — — 2600	
The end of reception of the clear-back signal ceases the acknowledgement signal.	2400 — — — — — —►	

TABLE 1 *(continued)*

Outgoing international exchange		Incoming international exchange
The outgoing operator (SA) or the calling subscriber (A) clears. A clear-forward signal is sent.	2400 + 2600 →	The clear-forward signal causes a release-guard signal to be sent back: a) on receipt of the clear-forward signal, or b) when the incoming equipment has been released.
The receipt of the release-guard signal ceases the clear-forward signal.	← 2400 + 2600	The clear-forward signal is sent to the country of destination.
	2400 + 2600 — — →	The release-guard signal is ceased: a) subject to the two conditions that the incoming equipment has been released and that the clear-forward signal is no longer received; or b) subject to the single condition that the clear-forward signal is no longer received.
The end of the release-guard signal terminates the guard condition at the outgoing end.	← — — 2400 + 2600	
		The outgoing access of the incoming end is maintained busy for 200 to 300 ms after the cessation of the release-guard signal.

CALL TO A BUSY SUBSCRIBER (OR CONGESTION)

The signal sequence is the same as for a call to a free subscriber, up to the point where the busy subscriber (or congestion) is encountered.

	1850 →	*1st case*
	← 1850	The national network of the incoming country gives a busy flash, a congestion, or a busy signal. These signals should cause the incoming register to send back signal 8 of Table 4 in case of busy and signal 3 of Table 4 in the other cases. The incoming register releases. The speech path through the incoming exchange is established.
The release of the outgoing register is initiated. The path through the outgoing exchange is established.	← MF 2/6 code	

TABLE 1 *(continued)*

Outgoing international exchange		Incoming international exchange
The outgoing register releases	1850 — — — →	The busy-flash signal may also be returned via the line signalling system after register dismissal upon receipt of a busy-flash signal from the national network.
SA: A "busy" indication is given to the operator. The busy-flash signal causes the acknowledgement signal to be sent.	← 2600	
	2400 →	
A: The calling subscriber hears the busy tone of the outgoing (national or international) exchange. The end of reception of the busy-flash signal ceases the acknowledgement signal.	← — — — 2600	The acknowledgement signal ceases the busy-flash signal.
	2400 — — — →	
After busy, congestion, or busy-flash signalling via the interregister or line signalling system is completed, the clear-forward signal is automatically sent which releases the international connection.		*2nd case*
SA: The operator, or A: the calling subscriber hears the busy tone and clears and the clear-forward signal is sent.	← · · · · · · · · · · · · · ·	The national network of the incoming country cannot give the busy-flash signal. The busy tone of the incoming country is sent back.
	SPECIAL CONDITIONS	
1. FORWARD TRANSFER		
1st case		
SA: Following a call switched automatically to a subscriber, or following a call established via a special number incoming or delay operator, the controlling operator wishes to call in an assistance operator at the incoming international exchange. A forward-transfer signal is sent.	2600 →	The forward-transfer signal causes an assistance operator to intervene at the incoming international exchange.

TABLE 1 *(concluded)*

Outgoing international exchange	Incoming international exchange
2nd case	
SA: Following a call via code 11 or 12, the controlling operator wishes to recall the incoming operator at the incoming international exchange. A forward-transfer signal is sent. 2600 →	Recalls the incoming operator on calls completed via the operator positions of this exchange.
2. DOUBLE SEIZING	
The outgoing end sends the seizing signal. 2400 →	
←	2400 The incoming end also sends the seizing signal.

The two ends of the circuit send and receive the seizing signal for a sufficiently long time to ensure that the signal can be recognized at both ends.
The two ends recognize the double seizing by this condition.
The equipment is cleared at each end without the sending of a clear-forward signal; then:

a) either a second automatic attempt to set up the connection takes place, or

b) SA: a re-order indication is given to the operator;
A: a busy tone is sent to the subscriber.

TABLE 2. — SEMI-AUTOMATIC AND AUTOMATIC TRANSIT TRAFFIC

Outgoing international exchange	International transit exchange	Incoming international exchange
	CALL TO A FREE SUBSCRIBER	
After the initial address block is registered in the outgoing register, a seizing signal is sent forward (the speech path is open as long as the register is connected).	2400 → Receipt of the seizing signal causes a register at the transit exchange to be connected. The proceed-to-send signal is sent back when the register is connected. (The speech path is open as long as the register is connected.)	
Receipt of the proceed-to-send signal ceases the seizing signal.	← 2600 2400 - - →	
	← - - 2600 The end of reception of the seizing signal causes the proceed-to-send signal to cease.	
	← 1850 Upon the cessation of the proceed-to-send signal the incoming register sends back the guard and TASI-locking frequency.	

TABLE 2 *(continued)*

Outgoing international exchange		International transit exchange		Incoming international exchange
Following the cessation of the seizing signal (within 80 ± 20 ms) the outgoing register sends *en bloc* in MF code the initial address block which typically consists of 7 signals — the X signal — I digits (country code) — the Z signal — N digits (initial part of national number)	1st code MF 2/6 → 1850 → 2nd code MF 2/6 → 1850 → etc.	The MF signals are received in the register at the transit exchange.		
When the initial address block is less than 7 signals (e.g. code 11 or 12 calls), a suffix ST signal terminates the block. The ST is always sent on SA calls.		When enough signals have been received to determine the routing, a circuit is selected and a seizing signal is sent forward.	2400 →	Receipt of the seizing signal causes a register at the incoming exchange to be connected; when the latter is ready to receive the digital information a proceed-to-send signal is sent back (the speech path is open as long as the incoming register is connected).
		Receipt of the proceed-to-send signal causes the seizing signal to cease.	← 2600	
			2400 →	The end of reception of the seizing signal causes the proceed-to-send signal to cease.
			← 2600	

TABLE 2 *(continued)*

Outgoing international exchange	International transit exchange	Incoming international exchange
The guard and TASI-locking frequency (1850 Hz) is sent during the signal gaps after the X signal until the register is dismissed. 1850 →		
	← 1850	Upon the cessation of the proceed-to-send signal, the incoming register sends back the guard and TASI-locking frequency.
Any address signals which follow the initial address block are forwarded as received. Code MF2/6 → 1850 →	Following the cessation of seizing signal the register sends forward *en bloc* the initial address block. Code MF2/6 →	The MF signals are received in the incoming register. This register starts the setting up of the call in the incoming country when enough signals have been received to determine the routing. The incoming register carries out the appropriate operations according to the X, I, Z and N signals. In SA operation for code 11 or 12 calls, the register directs the call to operator positions.
	The guard and TASI-blocking frequency is sent forward during the signal gaps after the X signal until the register is dismissed. 1850 → etc. 1850 →	

TABLE 2 *(continued)*

Outgoing international exchange	International transit exchange	Incoming international exchange
	Any address signals which follow the initial address block are forwarded as received. Code MF2/6 → 1850 →	
	← 1850 ← Code MF2/6	After receiving all forward signals and performing all necessary routing functions, the incoming register sends back a register dismissal signal.
Receipt of the register dismissal signal causes the register to release. ← 1850 ← Code MF2/6	The register receives the register dismissal signal and repeats it backward.	
	The register releases causing the forward guard and TASI-locking frequency to cease and without further transmission of this frequency in the backward direction the speech path is established. 1850 →	The register releases without further transmission of the guard and TASI-locking frequency. The speech path is established (the return path immediately, the forward path after the forward guard and TASI-locking frequency ceases if the incoming international exchange chooses this option).
Release of the register causes the guard and TASI-locking frequency to cease. The speech path is established. 1850 →		
SA: The operator A: The calling subscriber hears the ringing tone ← · · · · · · · · · ·	· · · · · · · · · · · · · · · · · ·	· · · · The ringing tone of the incoming country is sent back.

TABLE 2 *(continued)*

Outgoing international exchange		International transit exchange		Incoming international exchange
		Receipt of the answer signal:	← 2400	*The called subscriber answers.* An answer signal is sent back.
		— causes an answer signal to be sent back in "overlap compelled" manner. — causes an acknowledgement signal to be sent forward.	2400 →	Receipt of the acknowledgement signal ceases the answer signal.
		The end of reception of the answer signal ceases the acknowledgement signal.	← 2400	
SA: An answer indication is given to the controlling operator.			2400 →	
	Receipt of the answer signal causes an acknowledgement signal to be sent forward. ← 2400			
	2400 →	Receipt of the acknowledgement signal ceases the answer signal.		
A: Charging and measurement of the call duration begin.				
	The end of reception of the answer signal ceases the acknowledgement signal. ← 2400			
	2400 →			

TABLE 2 *(continued)*

Outgoing international exchange		International transit exchange		Incoming international exchange
		Receipt of the clear-back signal: ←		2600 *The called subscriber clears.* The clear-back signal is sent back.
SA: A clearing supervisory signal is given to the controlling operator.	Receipt of the clear-back signal causes an acknowledgement signal to be sent forward. ← 2600	— causes a clear-back signal to be sent back.	— causes an acknowledgement signal to be sent forward. 2400 →	Receipt of the acknowledgement signal ceases the clear-back signal.
	2400 →	Receipt of the acknowledgement signal ceases the clear-back signal.	The end of reception of the clear-back signal ceases the acknowledgement signal. ← – 2600 –	
			2400 – →	
A: After 1-2 min. if there is no clear-forward signal, the international connection is released and charging and measurement of the call duration are ceased.	The end of reception of the clear-back signal ceases the acknowledgement signal. ← – 2600 –			
	2400 – →			

TABLE 2 *(continued)*

Outgoing international exchange		International transit exchange			Incoming international exchange
SA: *The controlling operator, or* A: *The calling subscriber clears.*					
The clear-forward signal is sent.	2400 + 2600 →	Receipt of the clear-forward signal causes:			
		— a release-guard signal to be sent back	— a clear-forward signal to be sent forward.	2400 + 2600 →	The clear-forward signal causes the release-guard signal (which serves as an acknowledgement) to be sent back,
		a) on receipt of the clear-forward signal, or	Receipt of the release-guard signal ceases the clear-forward signal.	2400 + 2600 ←	a) on receipt of the clear-forward signal, or b) when the incoming equipment has been released.
Receipt of the release-guard signal ceases the clear-forward signal.	2400 + 2600 ←	b) when the incoming equipment has been released.			
	2400 + 2600 — — →			2400 + 2600 — — →	The clear-forward signal is sent in the country of destination.
		The release-guard signal is ceased:			The release-guard signal is ceased:
The end of the release-guard signal terminates the guard condition at the outgoing end.	2400 + 2600 ← — —	a) subject to the two conditions that the incoming equipment has been released and the clear-forward signal is no longer received, or			a) subject to the two conditions that the incoming equipment has been released and the clear-forward signal is no longer received, or
		b) subject to the single condition that the			b) subject to the single condition that the clear-forward signal is no longer received.

TABLE 2 *(continued)*

Outgoing international exchange	International transit exchange	Incoming international exchange
	clear-forward signal is no longer received. The end of the release-guard signal terminates the guard condition at the outgoing end in the transit exchange. 2400 + 2600 ←— — —	The outgoing access of the incoming end is maintained busy for 200 to 300 ms after the cessation of the release-guard signal.
	The outgoing access of the incoming end is maintained busy for 200 to 300 ms after the cessation of the release-guard signal.	

CALL TO BUSY SUBSCRIBER (OR CONGESTION)

The signal sequence is the same for a call to a free subscriber up to the point where the busy (or congestion) is encountered.

1850 ——→ ←—— 1850	Interregister guard and TASI-locking frequencies. 1850 ——→ ←—— 1850	*1st Case* The national network of the incoming country gives a busy flash, congestion, or busy signal. These signals should cause the incoming register to send back signal 8 of Table 4 in case of busy or signal 3 in the other cases.
←— — 1850 Code MF2/6 ←——	←— — 1850 Code MF2/6 ←—— The transit exchange register receives and repeats the congestion signal backwards. The register releases and the forward guard and TASI-locking frequencies cease. The backward guard and TASI-locking frequency is not reapplied.	
The originating international register receives the congestion or busy signal and initiates action to return the appropriate response to the calling subscriber or operator.	1850 — — —→	The register releases without further transmission of the guard and TASI-locking frequency. The speech path is established.
The originating register releases and the guard and TASI-locking frequency ceases. 1850 — — —→		

TABLE 2 *(continued)*

Outgoing international exchange	International transit exchange	Incoming international exchange
		The busy-flash signal may be returned via the line signalling system after register dismissal. Upon receipt of a busy-flash signal from the national incoming network, at this time the busy-flash signal is sent back.
	Receipt of the busy-flash signal:	← 2600
SA: A busy indication is given to the operator. A: The calling subscriber hears the busy tone sent by the outgoing (national or international) exchange.	— causes the busy-flash signal to be sent back. — causes the acknowledgement signal to be sent forward.	
Receipt of the busy-flash signal causes an acknowledgement signal to be sent.	← 2600	
	2400 →	Receipt of the acknowledgement signal ceases the busy-flash signal.
2400 →	Receipt of the acknowledgement signal ceases the busy-flash signal.	2600 — —
	The end of reception of the busy-flash signal ceases the acknowledgement signal.	←
2600 — —		2400 — — →
The end of reception of the busy-flash signal ceases the acknowledgement signal.	←	
2400 — — →		
After busy, congestion, or busy-flash signalling via the interregister or line signalling system is completed, the clear-forward signal is automatically sent which releases the international connection.		

TABLE 2 *(concluded)*

Outgoing international exchange		International transit exchange		Incoming international exchange
SA: The operator, or A: the calling subscriber hears the busy tone and clears. The clear-forward signal is sent.	◄ · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	· · · · · ·	*2nd case* The national incoming network does not give the busy-flash signal. The busy tone of the incoming country is sent back.
FORWARD-TRANSFER		SPECIAL CONDITIONS		
1st case SA: Following a call switched automatically to a subscriber, or following a call established via a special number incoming or delay operator, the controlling operator wishes to call in an assistance operator at the incoming international exchange. A forward-transfer signal is sent.	2600 ►	The forward-transfer signal causes a forward-transfer signal to be sent over the following circuit.	2600 ►	The forward-transfer signal causes an assistance operator to intervene at the incoming international exchange on an established connection completed automatically.
2nd case SA: Following a call via code 11 or 12, the controlling operator wishes to recall the incoming operator at the incoming international exchange. The forward-transfer signal is sent.	2600 ►	The forward-transfer signal causes a forward-transfer signal to be sent over the following circuit.	2600 ►	Recalls the incoming operator on calls completed via the operators' positions of this exchange.

PART XIII

INTERWORKING OF SYSTEM No. *5bis* WITH SYSTEMS No. 4 AND No. 5 *

RECOMMENDATION Q.230

1. INTRODUCTION

Since system No. *5bis* is expected to be suitable for use in existing international exchanges of electromechanical design and will be an improved system furnishing additional features, Administrations may wish to install such equipment to gain these advantages. Then situations where the new No. *5bis* system may be operated in parallel with existing No. 5 and other systems will arise.

The following arrangement might be considered:

1.1 Use of the respective equipments to serve different routes.

1.2 Use of two separate circuit groups between the same two international exchanges. Unless the two separate groups are large, this may lead to inefficient use of the circuits and would then only be acceptable for a short, transient, period of time. The disadvantage of insufficient circuit usage might be reduced by applying overflow techniques between the two groups. The group served by system No. *5bis* may be used particularly for transit calls, whilst the other is reserved solely for terminal traffic.

1.3 The principles discussed above are applied in the network pattern of Figure 1. Reference to Figure 1 suggests the following conclusions:

- A No. 4 circuit group may be operated in parallel with a No. *5bis* circuit group; if overflow is applied to increase circuit usage, then it should preferably be from No. 4 to No. *5bis* for the same reasons as described in paragraph 1.2.
- No. 5 circuits connecting CT1s should preferably be reserved for routing of traffic directed to the zone served by the CT1 at their incoming end and not for handling traffic necessitating the switching in tandem of a further link of the intercontinental type (traffic towards the same and only the same continent).

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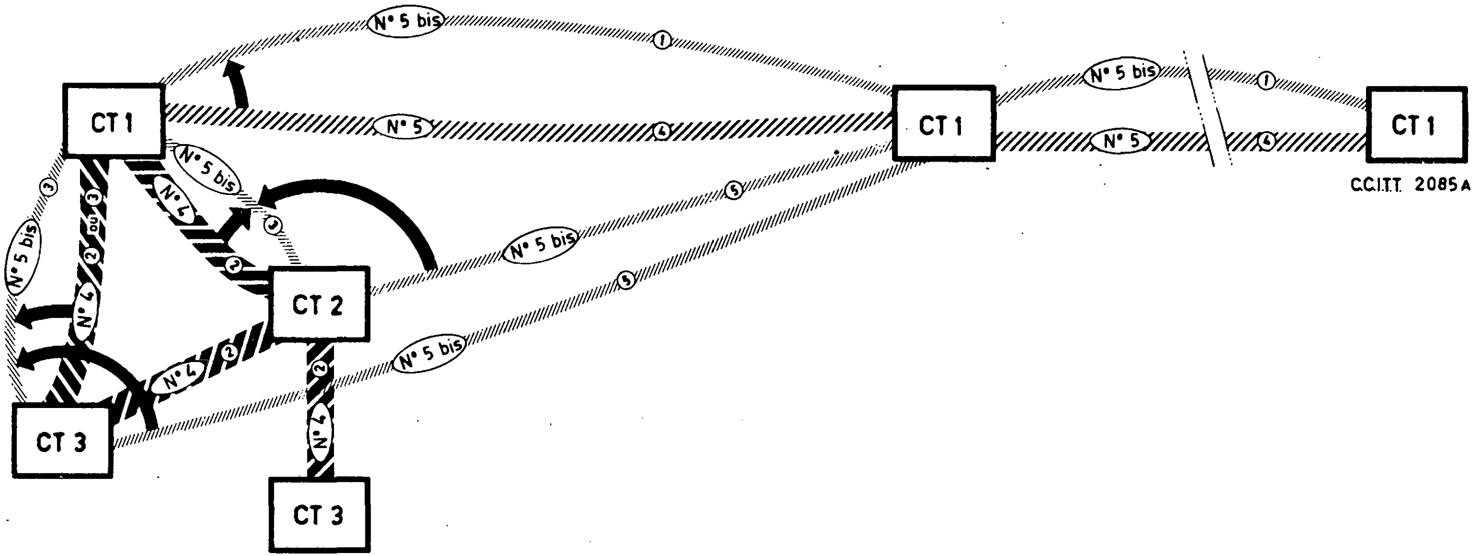
* Interworking with system No. 6 is described in the specification of that system, Part XIV, Chapter IV.



① Intercontinental traffic (transit and terminal)

② Continental traffic

③ Intercontinental and continental traffic

④ Intercontinental traffic (terminal only)

⑤ Intercontinental traffic

↶ Overflow

FIGURE 1

RECOMMENDATION Q.231

2. INTERWORKING OF SYSTEMS No. 5 AND No. *5bis*

2.1 *General*

It is possible to ensure satisfactory operation for both semi-automatic and automatic service when interworking takes place between signalling systems No. 5 and No. *5bis* in either the "5 to *5bis*" or "*5bis* to 5" direction.

The interworking is simplified because:

- the line signals (i.e., the supervisory signals) have exactly the same meaning and the same function in both systems;
- the numerical (address) information is sent in the same sequence in both systems;
- the language digits in the semi-automatic service are the same in both systems.

In a transit exchange where there is interworking of systems No. 5 and No. *5bis*, special precautions are necessary with regard to signals which are lacking in one system or are used differently in the two systems. This applies for the following signals:

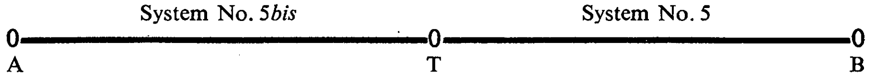
a) the X-signal in system No. *5bis* has no corresponding signal in system No. 5;

b) the number of discriminating signals in system No. *5bis* is more extended than in system No. 5;

c) there are no backward register signals in system No. 5.

Note. — The register at the interface point may determine the X-signal information not furnished by the adjacent signalling system from other sources and take care of its further transmission.

2.2 *Calls from system No.* 5bis *to system No.* 5



2.2.1 *Semi-automatic calls*

1. In semi-automatic operation the outgoing centre A ends the transfer of information in the forward direction over link AT by the ST end-of-pulsing signal (code 15) *.

2. When a No. 5 outgoing circuit TB has been seized effectively, which operation is only to be started on recognizing the above-mentioned end-of-pulsing signal, the number-received signal No. 6 (Table 4 of Part XII of the Specifications of system No. *5bis*) is sent backward over link AT. The other No. *5bis*—number-received signal No. 7 (no charge) is not used because the relevant information cannot be obtained via link TB.

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[*] It is assumed that whenever the "Z" digit has a value of 1 to 8, the ST end-of-pulsing signal is sent by rule.

3. In case equipment or circuit congestion in T should occur, signal No. 1 or 2 is sent toward A. Signal No. 1 may be sent before the end-of-pulsing signal is received when there is cross-office equipment congestion and it is known that the congestion condition will last.

4. The reception of the backward signals 1 or 2 will provoke the dismissal of the outgoing No. 5*bis* register at A.

5. At T, the outgoing No. 5 register sends the numerical information in the *en bloc* non-overlap mode over link TB. The No. 5 outgoing register is released as soon as the end-of-pulsing signal has been transmitted to B. The incoming No. 5*bis* register at T is released after the number-received signal has been sent to A. If instead of the two registers one combined register is used, the end-of-pulsing condition determines the dismissal of the combined register.

6. With regard to signals which are used differently in the two systems, the following requirements are to be met in the case of terminal traffic:

- generate the KP1 signal,
- suppress the X-signal and the I digits which must not be sent over the link TB.

Note. — The case in which at B a further international transit is effected is not dealt with, since it represents a non-preferred arrangement (see paragraph 1.2 in Recommendation Q.230).

7. At T the X-signal received over link AT is interpreted to ensure correct routing of the call (satellite/no satellite) and to control insertion of an echo suppressor if no echo suppressor is available at B.

8. The facility of the No. 5*bis*-interregister signalling system to carry information concerning the called subscriber's line (Nos. 8 and 9, Table 4 of the Specifications of system No. 5*bis*) is not used since no corresponding signals are supplied over the link BT.

Note. — Since the line signalling of No. 5 *bis* and No. 5 is identical, each line signal can be transferred through T. This applies in particular to the busy-flash signal.

2.2.2 *Automatic calls*

1. In automatic operation the system No. 5*bis* link AT does not always provide for an end-of-pulsing signal from centre A; the transit exchange T will therefore have to recognize that all the digits have been received in order to:

a) determine the appropriate time to seize the circuit TB:
  - commence *en bloc* transmission,
  - send a forward end-of-pulsing signal over the No. 5 link;

b) send a backward signal No. 6 (Table 4 of the Specifications of system No. 5*bis*) to A.

2. The points 2 to 8 under 2.2.1 are also applicable to automatic calls. Under point 6 of 2.2.1 the following requirement is to be added:

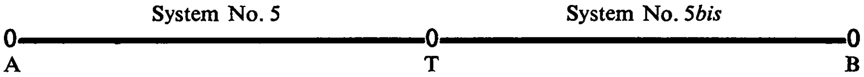
- Translation of the "Z" signals 11 and 12 into 10 (discriminating digits).

2.2.3 *Route monitoring*

1. If route-monitoring procedures are applied, the exchange at T sends back the route-monitoring block relating to the link with 5*bis* signalling AT as specified for the 5*bis* system.

2. If route-monitoring information relating to the link TB having No. 5 signalling is introduced, a special route-monitoring block must be generated at T and is sent in addition after the block mentioned in 1.

2.3 *Calls from system No.* 5 *to system No.* 5bis



2.3.1 *Semi-automatic and automatic calls*

1. At transit exchange T the incoming register * part of system No. 5 receives an ST end-of-pulsing signal 55 ms after reception of the last numerical signal.

2. At A, the outgoing register of system No. 5 is released after the ST signal has been sent.

3. At T, the ST end-of-pulsing signal of system No. 5 is transferred over the No. 5*bis* link to the incoming end B.

4. At T, the incoming No. 5 register * releases after having transferred the ST end-of-pulsing signal.

5. At B, the incoming register of system No. 5*bis* is released as soon as the register dismissal signal is sent backward to T.

6. At T, the outgoing register * of system No. 5*bis* is released on receipt of the register dismissal signal.

7. If congestion occurs at T, the busy-flash signal is sent back to A. If congestion occurs at B a No. 5*bis* register congestion signal is sent back to T when it has to be converted into the busy-flash signal to A.

8. If other backward signals indicating causes of ineffective calls are received at T, an appropriate audible tone may be sent back to A.

9. If backward signal 7 is received at T, an incompatibility arises and it is recommended that a subsequent answer signal not be passed from T to A. It is recognized that in some instances there will be a limit on conversation time since time-outs may occur.

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* These register functions may be combined in a single register.

RECOMMENDATION Q.232

3. INTERWORKING OF SYSTEMS No. 4 AND No. 5*bis*

3.1 *General*

It is possible to ensure satisfactory operation for both semi-automatic and automatic service when interworking takes place between signalling systems No. 4 and No. 5*bis* in either the "4 to 5*bis*" or "5*bis* to 4" direction.

The interworking is simplified because:

— the line signals (i.e., the supervisory signals) generally have the same meaning and the same function in both systems,

— the numerical (address) information is sent in the same sequence in both systems,

— the language digits in the semi-automatic service are the same in both systems.

In a transit exchange where there is interworking of systems No. 4 and No. 5*bis*, special precautions are necessary with regard to signals which are lacking in one system or are used differently in the two systems. This applies to the following signals:

a) the X-signal in system No. 5*bis* has no corresponding signal in system No. 4*;

b) the number of discriminating signals in system No. 5*bis* is more extended than in system No. 4;

c) if route-monitoring signals are to be applied in system No. 5*bis*, there are no corresponding signals in system No. 4;

d) the repeat transmission facility in system No. 5*bis* does not exist in system No. 4;

e) different register dismissal signals combined with called party line conditions can be used in system No. 5*bis* and one of these signals per call is sent as a backward register signal, while in system No. 4 the number-received signal is sent as a line signal;

f) different congestion signals can be used in system No. 5*bis* and one of these signals per call is sent as a backward register signal, while in system No. 4 the busy-flash signal is sent as a line signal.

3.2 *Calls from system No. 4 to system No. 5* bis

System No. 4 System No. 5*bis*
0————————0————————0
A T B

3.2.1 *Semi-automatic calls*

1. In semi-automatic operation the outgoing exchange A of system No. 4 sends an end-of-pulsing signal over link AT and the outgoing register at A is released.

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* The register at the interface point may determine the X-signal information not furnished by the adjacent signalling system from other sources and take care of its further transmission.

2. The end-of-pulsing signal of system No. 4, which is a numerical type signal (code 15), is acknowledged.

3. On receipt of an end-of-pulsing signal from A, the incoming part of system No. 4 at transit exchange T sends to A an acknowledgement of the end-of-pulsing signal and then sends to A a "premature" number-received signal.

Note. — Instead of sending the "premature" number-received signal, it is possible to convert the called-party-line-condition signal from the system No. 5 *bis* link to the number-received signal for the system No. 4 link. However, this implies modification of an existing system No. 4 incoming register and prolonged holding time of this register.

4. At T, an end-of-pulsing signal ST is sent over link TB on system No. 5*bis*; this ST signal is obtained by converting the end-of-pulsing signal (code 15) of system No. 4.

5. At T, the outgoing register * of system No. 5*bis* will be released after the receipt of one of the register dismissal signals from B and after appropriate measures are taken. The register dismissal signal need not be converted backwards to A, as the number-received signal has already been sent by the system No. 4 incoming register * at T.

6. If backward signal 7 of Table 4 of Part XII in the Specifications of system No. 5*bis* is received at T, an incompatibility arises and it is recommended that a subsequent answer signal not be passed from T to A. It is recognized that in some instances there will then be a limit on conversation time since time-outs may occur.

7. A congestion register signal from B has to be converted into the busy-flash line signal back to A.

Note. — The number-received signal is sent from T over link TA in order to conform to the specifications of system No. 4. Since the outgoing register at A will be released as soon as A has sent the end-of-pulsing signal (in accordance with the specifications of system No. 4), the only possible role of the number-received signal at A is to indicate to the operator that the selection procedure has been effected. However, since the number-received signal relates only to operations on the link AT on system No. 4, this signal provides no information about the entire selection process from A to B; the indication to the operator is hence of little value.

3.2.2 *Automatic calls*

1. At A, release of the outgoing register of system No. 4 depends upon reception of the number-received signal.

2. The system No. 4 link does not always provide for an end-of-pulsing signal from A in automatic operation.

In the case that an end-of-pulsing signal is received from A, the system No. 4 incoming register * at T will send a "premature" number-received signal to A.

When no end-of-pulsing signal comes from A, the system No. 4 incoming register * at T will send the number-received signal to A as soon as a register dismissal signal is received from B. Points 5 and 6 of paragraph 3.2.1 are applicable in both cases.

3. At the incoming end of system No. 4 at T, the incoming register * of system No. 4 is released as soon as the number-received signal is sent backward.

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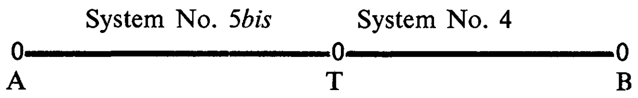
* These register functions may be combined in a single register.

3.3 *Calls from system No.* 5bis *to system No. 4*



3.3.1 *Semi-automatic calls*

1. In semi-automatic operation the outgoing exchange A of system No. 5*bis* sends an ST end-of-pulsing signal over link AT.

Note. — It is assumed that whenever the Z-digit has a value of 1 to 8, the ST end-of-pulsing signal is sent by rule.

2. At T, the ST end-of-pulsing signal of system No. 5*bis* is converted into an end-of-pulsing signal of system No. 4, which is sent to the incoming end B of this system.

3. At T, the system No. 5*bis* incoming register * sends the "premature" called-party-line-condition signal No. 6 as soon as the ST end-of-pulsing signal is received from A. This incoming 5*bis* register releases after the sending of this signal and after pulsing the complete address information forward.

If congestion (equipment or circuit) occurs, a congestion signal (No. 1 or No. 2) is sent backward to A. For these signals recognition of the ST end-of-pulsing signal is not needed.

4. The register dismissal signal provokes the release of the system No. 5*bis* outgoing register at A.

5. At T, the outgoing register * of system No. 4 is released when the end-of-pulsing signal is sent.

6. At B, the incoming register of system No. 4 is released as soon as the number-received signal is sent backward to T.

7. If a busy-flash signal is received at T before the 5*bis* incoming register has sent a register dismissal signal No. 6 to A, the busy-flash must be converted to signal 2 of Table IV of the Specifications of system No. 5*bis* for sending to A.

3.3.2 *Automatic calls*

1. The system No. 5*bis* link does not always provide for an ST end-of-pulsing signal from exchange A in automatic operation.

2. At T, the ST end-of-pulsing signal of system No. 5*bis*, if received, is converted to the end-of-pulsing signal (code 15).

3. At T, the system No. 5*bis* incoming register * will send the called-party-line-condition signal No. 6 as soon as system No. 4 outgoing circuit TB is effectively seized and

— the ST end-of-pulsing signal has been received, or
— the number-received signal has been received, or
— it has otherwise recognized that all the digits have been received.

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* These register functions may be combined in a single register.

This register releases after the sending of this signal and after pulsing the complete address information forward.

If congestion (equipment or circuit) occurs, a congestion signal (No. 1 or No. 2) is sent backward to A. For these signals recognition of the ST end-of-pulsing signal is not needed.

4. At T, the system No. 4 outgoing register * will release as soon as the number-received signal has been received from B.

5. If a busy-flash signal is received at T before the *5bis* incoming register has sent a dismissal signal No. 6 to A, the busy-flash must be converted to signal No. 2 of Table 4 of the Specifications of system No. *5bis* for sending to A.

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* These register functions may be combined in a single register.

THE INTERNATIONAL TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

(C.C.I.T.T.)

WHITE BOOK

VOLUME VI

Part XIV

Specifications of Signalling System No. 6

Mar del Plata
October 1968

SIGNALLING SYSTEM C.C.I.T.T. No. 6

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SIGNALLING SYSTEM C.C.I.T.T. No. 6

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PART XIV

SIGNALLING SYSTEM No. 6

INTRODUCTION

General

Signalling system No. 6 can be used to control the switching of all types of international circuits to be used in a world-wide connection, including TASI-derived circuits and satellite circuits.

The system meets all requirements defined by the C.C.I.T.T. concerning the service features for world-wide international semi-automatic and automatic telephone traffic.

Moreover, a large unused signal code capacity will allow for adding new signals to cater for unknown future requirements. This spare capacity may be used for increasing the number of telephone signals as well as for introducing other signals, e.g. network management signals and network maintenance signals.

These system features are obtained by entirely removing the signalling from the speech paths and introducing the concept of a separate common signalling link over which all signals for a number of speech circuits are transferred. A number of these common signalling links interconnected by a number of transit centres and signal transfer points will form a coherent signalling network which can transfer all signals for all speech circuit groups within that network area.

Modes of operation

The signalling system may be operated both in an associated and in a non-associated mode. In the associated mode of operation the signals are transferred between the two No. 6 exchanges which are the end points of a group of speech circuits over a common signalling link terminating at the same No. 6 exchanges. In the non-associated mode of operation the signals are transferred via two or more common signalling links in tandem associated with other groups of circuits, the signals being processed and forwarded through one or more intermediate No. 6 exchanges acting only as signal transfer points.

The associated mode of operation is suited for use with large circuit groups, while a non-associated mode makes the signalling system economically suitable for use with small circuit groups.

A signalling link may be operated in the associated mode for one circuit group and in a non-associated mode for other circuit groups, either under normal or under breakdown conditions.

Common signalling link

The separate common signalling link is capable of operation over standard international voice bandwidth channels including the 3-kHz spaced telephone channels used for some intercontinental circuits. Signalling information is transmitted in the serial data mode on a link-by-link basis—i.e., the signals are transferred from one link to the next only after processing.

The stream of pulses, transmitted normally at a rate of 2400 bits per second using the four-phase modulation method, is divided into signal units of 28 bits each and into blocks of 12 signal units each.

The error control necessary for a common signalling link is based on error detection by coding and on error correction by retransmission. Error detection is based on decoding of checking bits included in each signal unit and on data carrier failure detection. This provides the desired system reliability. Error-free signal messages are used without delay. Provision is made for automatic transfer to an alternative link in the event of failure caused by breakdown or excessive error rate.

Signal messages

Signal messages carry information to identify the telephone circuit concerned. Since the circuit identity, i.e. the label, requires a large proportion of the bits (11 out of the 20 available information bits), provision is made for sending multi-unit messages consisting of several signal units under one label. A single digit or a random telephone signal will normally be transferred in a one-unit message while several or even all digits may be transferred in a multi-unit message.

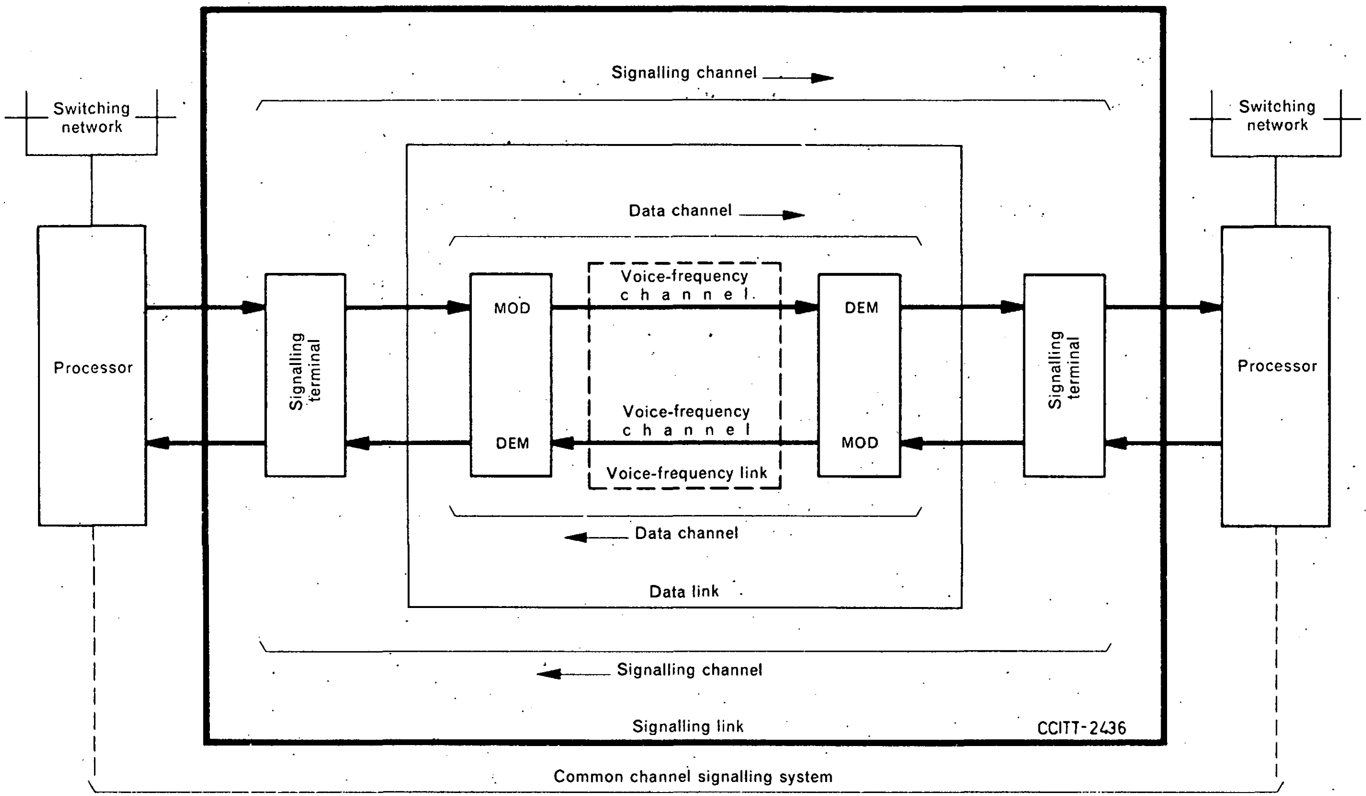
Signal processing

All signals are processed at each transit centre or signal transfer point which has to be passed.

The processing of messages at a signal transfer point is minimal and includes label translation, if necessary, and the sending of signal messages within the proper priority category. In addition to the processing required at a signal transfer point, a transit centre examines sufficient signal information to perform proper switching action.

Signalling equipment

Because of the new technique based on a separate common signalling link on data type transmission and on central processing of the signalling information, signalling system No. 6 will be used in general between exchanges of the stored programme control type.



Voice-frequency channel:
a one-way voice-frequency transmission path from the output of a data modulator to the input of a data demodulator made up of one or more voice-frequency carrier channels in tandem

Voice-frequency link:
a two-way voice-frequency transmission path between two data modems made up of one voice-frequency channel in each direction

Data channel:
a one-way data transmission path between two points made up of a modulator, a voice-frequency channel and a demodulator

Data link:
a two-way data transmission path between two points, made up of one data channel in each direction

Signalling channel:
a one-way signalling path from the processor of one switching machine to the processor of another switching machine

Signalling link:
a two-way signalling path from processor to processor made up of one signalling channel in each direction

FIGURE 1. — **Basic diagram of the common channel signalling system**

CHAPTER I

Functional description of the signalling system

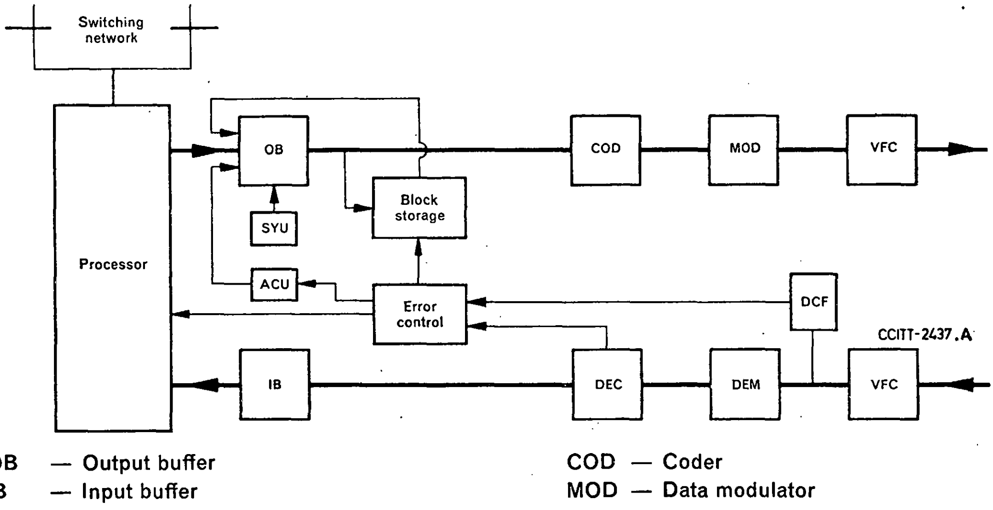
RECOMMENDATION Q.251

1.1 FUNCTIONAL BLOCK DIAGRAMS

1.1.1 General

Because common channel signalling, used in conjunction with exchanges having stored programme control, allows a wide latitude in distribution of signalling functions between the processor and peripheral equipment, and because common channel signalling is not limited to exchanges of this type, it is not practicable to specify well-defined equipment interfaces.

The major signal transfer functions are shown in Figures 1 and 2. The blocks indicated in Figure 2 should not be construed as depicting equipment arrangements.



OB — Output buffer
IB — Input buffer
SYU — Synchronization signal unit generator
ACU — Acknowledgement signal unit generator
DEC — Decoder

COD — Coder
MOD — Data modulator
DEM — Data demodulator
DCF — Data carrier failure detector
VFC — Voice-frequency channel

FIGURE 2. — **Functional block diagram of a system No. 6 terminal**

1.1.2 Common signalling link

Each signalling channel of the system (shown in Figure 1) is operated synchronously; that is, a continuous stream of data flows in both directions. The data stream is divided into signal units of 28 bits each, of which the last 8 are check bits, and these signal units in turn are grouped into blocks of 12 signal units. The 12th and last signal unit of each block is an acknowledgement signal unit coded to indicate the number of the block being transmitted, the number of the block being acknowledged and whether or not each of the 11 signal units of the block being acknowledged was received without detected errors.

In normal operation, the first 11 signal units within a block will consist of signal units carrying either telephone signals or management signals, or of synchronization signal units. Synchronization signal units, which are transmitted only in the absence of other signalling traffic, are coded to indicate the number of the position they occupy within the block to facilitate locating the acknowledgement signal unit. Their format has been chosen to produce a large number of dibit transitions to facilitate achieving or maintaining bit synchronism.

During system-synchronizing procedures only synchronization and acknowledgement signal units are transmitted until bit, signal unit, and block synchronism has been achieved at both ends of the system.

1.1.3 Transmitting terminal

The transmission of a signal in system No. 6 starts in the processor as shown in Figure 2. Signals corresponding to the information to be transmitted are formed in accordance with the format specified and delivered in parallel form to the output buffer. These signals, which may be one-unit messages or multi-unit messages, are stored in this buffer according to their priority level. The output buffer delivers the highest priority signal awaiting transmission to the coder in serial form in the next available time slot. In the coder, each signal unit is encoded by the addition of check bits in accordance with the check bit polynomial. The signal is then modulated and delivered to the outgoing voice-frequency channel for transmission to the distant receiving equipment.

1.1.4 Receiving terminal

The receiving function, as indicated in Figure 2, starts with acceptance of modulated serial data from the voice-frequency channel. After demodulation serial data are delivered to the decoder, where each signal unit is checked for error on the basis of the associated check bits. Signal units received with detected errors are discarded. Signal units carrying telephone signals or management signals which are error-free are transferred to the input buffer after deletion of the check bits. The input buffer delivers the signal units in parallel form to the processor where the processor analyses the signals and takes appropriate action.

1.1.5 Error control

Error control is based on error detection by redundant coding and on error correction by retransmission of those signal messages found to be in error. This procedure requires that each transmitted signal message be stored until acknowledged as being received correctly. In the case of multi-unit messages each signal unit of the message must be stored until all units of the message are acknowledged as being received correctly. When an acknowledgement signal unit is received it is analysed in the box marked error control in Figure 2. If an acknowledgement bit indicates that a signal unit being acknowledged was received in error, the retransmission process is started. Request for retransmission of a synchronization signal unit is ignored. If any unit of a multi-unit message is in error the entire multi-unit message must be retransmitted in its initial order.

The data carrier failure detector complements the decoder for longer error bursts. When activated by a data carrier failure it gives an indication to the box marked error control in Figure 2. An error indication from either the decoder or the data carrier failure detector is associated with the position of the erroneous signal unit(s) within the block. This information is used by the acknowledgement signal unit generator to control the marking of the acknowledgement bits.

As shown in Figure 2 the processor may also be notified whenever an error is detected in a signal unit. This information may be used by the processor to erase the memory of any signal unit(s) of a multi-unit message received which is associated with the one found in error, since this entire message will be retransmitted.

RECOMMENDATION Q.252

1.2 SIGNAL TRANSFER TIME DEFINITIONS

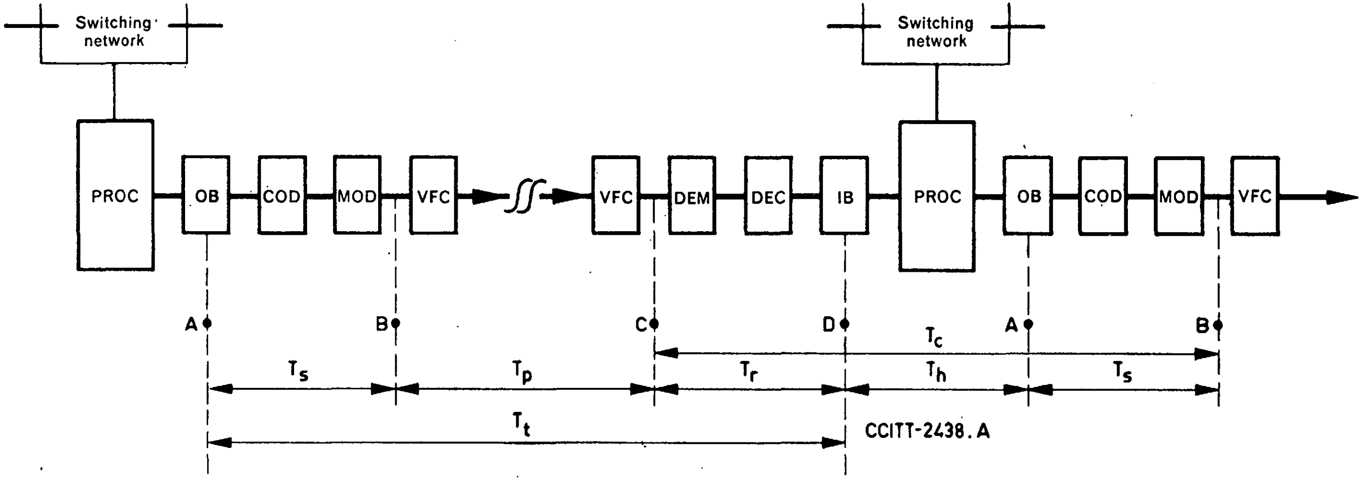
1.2.1 Functional reference points

The major functional reference points are as indicated in Figure 3: Points A, B, C and D, which are defined below:

Point A. — That point in a switching centre where the signal as a signal unit, before being coded (check bits added), is delivered in parallel form from the processor to an output buffer store.

Point B. — That point where the modulated signal unit (check bits included) in serial form will be delivered to the outgoing voice-frequency channel.

Point C. — That point where the modulated signal unit (check bits included) in serial form will be delivered to the data demodulator.



VFC — Voice-frequency channel
MOD — Data modulator
DEM — Data demodulator
COD — Coder
DEC — Decoder
PROC — Processor
OB — Output buffer
IB — Input buffer

T_c — Cross-office transfer time
T_h — Processing (handling) time
T_p — Voice-frequency channel propagation time
T_r — Receiver transfer time
T_s — Sender transfer time
T_t — Total signal transfer time

FIGURE 3. — **Functional signal transfer time diagram**

Point D. — That point in a switching centre where the signal unit, after being decoded (check bits deleted), will be presented in parallel form from an input buffer store to the processor.

The functional reference points B and C are typically those points which define the voice-frequency channel used for common channel signalling.

1.2.2 Signal transfer time components

The various components of signal transfer time between two switching centres are defined as follows:

T_c = cross-office transfer time

T_e = emission time of a signal unit (included in T_s)

T_h = processing (handling) time

T_p = voice-frequency channel propagation time

T_q = queueing delay in the output buffer store (included in T_s)

T_r = receiver transfer time

T_s = sender transfer time

T_t = total signal transfer time

T_h is that period from the moment the signal is available for acceptance by the processor to the moment the signal is placed, in parallel form, in the output buffer and is available for transmission.

T_r is that period of time from the moment when the last bit of the signal unit leaves the voice-frequency channel to that time when the signal in parallel form is in the input buffer and is available for acceptance by the processor. T_r thus includes the following actions: demodulation, decoding (error detection) and serial to parallel conversion.

T_s is that period of time from the moment when the signal in parallel form enters the output buffer store to that time when the last bit of the signal unit passes into the voice-frequency channel. T_s thus includes the following times and actions: emission time of signal unit(s) (one-unit or multi-unit message), queueing delay in the output buffer store, parallel to serial conversion, encoding (adding check bits) and modulation.

The definitions of signal transfer times give rise to the following time relationships:

$$T_c = T_r + T_h + T_s$$

$$T_t = T_s + T_p + T_r$$

In cases when an error is detected, retransmission will occur and the above time relationships are not valid. Rather, the time involved in retransmission and the extra queueing delays, which may occur on a retransmitted signal, must be taken into consideration.

RECOMMENDATION Q.253

1.3 ASSOCIATION BETWEEN SIGNALLING AND SPEECH NETWORKS

1.3.1 Definitions

The signals pertaining to a given group of speech circuits between two No. 6 exchanges can be transferred in the following ways:

1.3.1.1 *Associated mode of operation*

In the associated mode of operation the signals are transferred between the two No. 6 exchanges over a common signalling link which terminates at the same No. 6 exchanges as the group of speech circuits to which the signalling link has been assigned.

1.3.1.2 *Non-associated mode of operation*

In a non-associated mode of operation the signals are transferred between the two No. 6 exchanges over two or more common signalling links in tandem, the signals being processed and forwarded through one or more intermediate *signal transfer points* (see section 1.3.3). Following this definition there may be a range of non-associated modes of operation which vary in the degree of rigidity imposed on the choice of the path utilized by the signals pertaining to the speech circuit. The ends of this range can be described as fully dissociated mode and quasi-associated mode of operation.

a) *Fully dissociated mode of operation*

The fully dissociated mode of operation is the extreme case of the non-associated mode. It is assumed that there is an established network of common signalling links and signal transfer points which may have its own routing principles.

In the fully dissociated mode of operation the signals are transferred between the two No. 6 exchanges via any available path in the signalling network according to the rules of that network.

b) *Quasi-associated mode of operation*

The quasi-associated mode of operation is the limited form of the non-associated mode. The common signalling links to be used are each operating in the associated mode with a group of circuits.

In the quasi-associated mode of operation the signals are transferred between the two No. 6 exchanges over two or more common signalling links in tandem, but only over certain predetermined paths and through predetermined signal transfer points.

1.3.2 Association methods provided

Signalling system No. 6 is designed to provide associated and quasi-associated modes of operation as defined in sections 1.3.1.1 and 1.3.1.2 b).

As far as quasi-associated structures are concerned, the number of signal transfer points in the signalling path between the two No. 6 exchanges of a group of speech circuits should be kept as low as practicable. Normally, one such signal transfer point should suffice. However, there may be groups of circuits without associated common signalling links which will need more than one signal transfer point to handle the signalling traffic.

Attention is drawn to the fact that the addition of a signal transfer point involves the handling time at that point and one additional signal transfer time. Extensive use of signal transfer points will reduce some of the advantages of the high signalling speed of system No. 6.

Note. — It should be noted that, where a speech circuit group has an associated signalling link, dependability requirements may be met economically by using quasi-associated operation under breakdown condition when the associated signalling link is non-operative.

1.3.3 Signal transfer point

1.3.3.1 *Definition*

A signal transfer point is a signal relay centre handling and forwarding telephone signals from one signalling link to another in case of signalling in a non-associated mode of operation as defined in section 1.3.1.2.

Note. — Following this definition there is no need for a signal transfer point to have any connection with or relation to a switching centre.

However, in case of a quasi-associated mode of operation as defined in section 1.3.1.2. b), it is obvious that a signal transfer point may coincide with the No. 6 exchange where the data-signalling links terminate and that the equipment may be incorporated into the signalling equipment of that No. 6 exchange

1.3.3.2 *Functions of a signal transfer point*

The equipment at a signal transfer point has to analyse the label and telephone signal information of every telephone signal message received in order to offer the message to the proper outgoing data-signalling channel, taking account of its priority, if any.

In doing so, it may be necessary to change the label of the received telephone signal message according to some preset rules. However, the telephone signal information included in the message will never be changed by the equipment of a signal transfer point.

Note. — The last-mentioned fact and the fact that the analysis of the received message will never be accompanied by the switching of speech circuits provide a distinction between a signal transfer point and a transit exchange.

In general, a transit exchange will be designed to perform both the normal transit exchange functions and the signal transfer point functions.

CHAPTER II

Definition and function of signals

RECOMMENDATION Q.254*

2.1 TELEPHONE SIGNALS

Signals concerning a particular call or a particular speech circuit.

2.1.1 Address signal

A call set-up signal sent in the forward direction containing one decimal element of information (digit 1, 2, . . . 9 or 0) about the called party's number.

For each call a succession of address signals is sent.

An address signal is transmitted in a four-bit binary coded form. The 11th and 12th combinations of this binary code are called *code 11* and *code 12* and are considered as address signals; they are used on semi-automatic calls in order to obtain access to an incoming and a delay operator respectively.

2.1.2 Terminal or transit indicator

Information sent in the forward direction required to discriminate at the receiving international exchange between terminal and transit calls:

- — *terminal* to indicate that the address information will not contain the country code, or
- — *transit* to indicate that the address information will contain the country code.

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* Some section numbers have been reserved for future use.

2.1.3 Nature-of-circuit indicator

Information sent in the forward direction about the nature of the circuit(s) already engaged in the connection:

- — *satellite circuit,* or
- — *no satellite circuit.*

An international exchange receiving this information will use it (in combination with the appropriate part of the address information) to determine the nature of the outgoing circuit to be chosen.

2.1.4 Echo-suppressor indicator

Information sent in the forward direction indicating whether or not a half echo suppressor has been inserted.

2.1.5 Calling-party's-category indicator

Information sent in the forward direction about the *category of the calling party* and, in case of semi-automatic calls about the *service language* to be spoken by the incoming, delay and assistance operators.

The following categories are provided:

- — operator,
- — ordinary calling subscriber,
- — calling subscriber with priority,
- — data call,
- — test call.

2.1.6 End-of-pulsing (ST) signal

A signal sent in the forward direction to indicate that there are no more address signals to follow.

2.1.11 Confusion signal

A confusion signal is sent by an international exchange in the backward direction to indicate to the preceding international exchange that it is unable to act upon forward signal information received from that international exchange.

2.1.12 Switching-equipment-congestion signal

A signal sent in the backward direction indicating the failure of the call set-up attempt due to congestion encountered at international switching equipment.

2.1.13 Circuit-group-congestion signal

A signal sent in the backward direction indicating the failure of the call set-up attempt due to congestion encountered on an international circuit group.

2.1.14 National-network-congestion signal

A signal sent in the backward direction indicating the failure of the call set-up attempt due to congestion encountered in the national destination network (excluding the busy condition of the called party's line(s)).

2.1.15 Address-incomplete signal

A signal sent in the backward direction indicating that the number of address signals received is not sufficient for setting up the call. This condition may be determined in the incoming international exchange (or in the national destination network):

- immediately after the reception of an ST signal or
- on time-out after the last digit received.

2.1.16 Address-complete signal

A signal sent in the backward direction indicating that all the address signals required for routing the call to the called party have been received. Generation of this signal will take place in the incoming international exchange (or in the national destination network).

2.1.17 Vacant-national-number signal

A signal sent in the backward direction used to indicate that the received national number is not in use (for example spare level, spare code, vacant subscriber's number).

2.1.18 Ringing signal (electrical), charge *

A signal sent in the backward direction indicating that the called party's line has been found free and that the call must be charged on answer.

2.1.19 Ringing signal (electrical), no charge *

A signal sent in the backward direction indicating that the called party's line has been found free and that the call must not be charged. This signal is used on calls to particular destinations only.

2.1.20 Coin-box signal

A signal sent in the backward direction indicating that the called number is a coin (box) station.

2.1.21 Subscriber-busy signal (electrical)

A signal sent in the backward direction indicating that the line(s) connecting the called party with the exchange is (are) engaged. The subscriber-busy signal will also be sent in case of complete uncertainty about the place where the busy or congestion conditions are encountered and in the case where a discrimination between subscriber busy and national-network congestion is not possible (see also under item 2.1.14).

2.1.22 Line-out-of-service signal

A signal sent in the backward direction indicating that the called party's line is out-of-service or faulty.

2.1.31 Forward-transfer signal

On semi-automatic calls this signal is sent in the forward direction when the outgoing international exchange operator wants the help of an operator at the incoming inter-

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* Two electrical ringing signals are provided for interworking with signalling system No. 5*bis*.

national exchange. The signal will normally serve to bring an assistance operator (see Recommendation Q.101) into the circuit if the call is automatically set up at that exchange. When a call is completed via an operator (incoming or delay operator) at the incoming international exchange, the signal should preferably cause this operator to be recalled.

2.1.32 Answer signal, charge

A signal sent in the backward direction indicating that the call is answered and subject to charge.

In semi-automatic working this signal has a supervisory function. In automatic working the signal is used:

- — to start metering the charge to the calling subscriber (Recommendation Q.28) and
- — to start the measurement of call duration for international accounting purposes (Recommendation Q.50).

2.1.33 Answer signal, no charge

A signal sent in the backward direction indicating that the call is answered but is not subject to charge. It is used for calls to particular destinations only.

In semi-automatic working this signal has a supervisory function. In automatic working, the reception of this signal shall not start the metering to the calling subscriber but may or may not be used to start the measurement of call duration for international accounting.

2.1.34 Clear-back signal

This signal is sent in the backward direction to indicate that the called party has cleared.

In the semi-automatic service, it performs a supervisory function. In automatic working, arrangements must be made according to Recommendation Q.118, section 3.3.2.

2.1.35 Reanswer signal

A signal sent in the backward direction to indicate that the called party, after having cleared, again lifts his receiver or in some other way reproduces the answer condition.

In semi-automatic working the signal performs a supervisory function. In automatic working the reception of this signal cancels the 1-2 minutes time-out condition in the clear-back situation (Recommendation Q.118).

2.1.36 Clear-forward signal

Signal sent in the forward direction at the end of a call when the calling party clears.

2.1.37 Release-guard signal

Signal sent in the backward direction in response to the clear-forward signal when the speech circuit concerned has been brought into the idle condition.

2.1.41 Blocking signal

A signal sent to the exchange at the other end of a circuit to cause engaged conditions of that circuit for subsequent calls outgoing from that exchange.

2.1.42 Unblocking signal

A signal sent to the exchange at the other end of a circuit to cancel in that exchange the engaged conditions of that circuit caused by a preceding blocking signal.

2.1.43 Check-OK signal

A signal sent in the backward direction to indicate successful continuity check of the speech circuit(s).

2.1.44 Check-not-OK signal

A signal sent in the backward direction to indicate unsuccessful continuity check of the speech circuit(s).

2.1.45 Continuity signal

A signal sent in the forward direction with link-by-link checking to indicate successful continuity check of the preceding speech circuit(s).

RECOMMENDATION Q.255

2.2 SIGNALLING-SYSTEM-CONTROL SIGNALS

Signals used for the proper functioning of the signalling system via the common signalling link (see also Recommendation Q.258).

2.2.1 Acknowledgement indicator

Information sent to indicate whether or not an error is detected in a signal unit received.

2.2.2 Synchronization signal

A signal sent in order to establish and maintain synchronization between the two ends of a signalling channel.

2.2.3 Change-over signal

A signal sent to indicate the necessity to change over to the next nominated stand-by signalling facility.

2.2.4 Change-back signal

A signal sent to indicate the wish to change back to the original signalling facility.

RECOMMENDATION Q.256

2.3 MANAGEMENT SIGNALS

Signals concerning the management of the speech circuit network.

These signals have not yet been defined; only the two following categories of signals are distinguished.

2.3.1 Network-management signals

Information regarding the conditions of circuit groups or equipment sent from one point in the network to one or more other points. This excludes information relevant to individual calls or individual speech circuits.

The nature and use of network-management signals are being studied in 1969-1972 by the C.C.I.T.T. (Question 2/XIII).

2.3.2 Network-maintenance signals

Management signals used for maintenance purposes.

The nature and use of network-maintenance signals are being studied in 1969-1972 by the C.C.I.T.T. (Questions 3/XIII and 4/XIII).

CHAPTER III

Signal unit formats and codes

RECOMMENDATION Q.257

3.1 TELEPHONE SIGNALS

The telephone signals are transferred by means of *one-unit messages* or *multi-unit messages.*

A one-unit message contains one *signal unit* (SU), a multi-unit message may contain 2, 3, 4 or 5 signal units in tandem.

The multi-unit message is mainly designed to carry a number of address signals for the same call in an efficient way. However, provision has been made for the first signalling message of a call, viz. the *initial address message* (IAM), to combine address signals and other routing information for the same call. *Subsequent address messages* (SAM) which may be either one-unit messages or multi-unit messages, carry address signals only.

The signal unit of a one-unit message carrying a telephone signal is called a *lone signal unit* (LSU). The first signal unit of a multi-unit address message is called the *initial signal unit* (ISU); the other signal units of a multi-unit message are called *subsequent signal units* (SSU).

3.1.1 **Signal unit formats**

In the following format representations of signal units it should be noted that bit No. 1 is transmitted first, the rest following in the order shown (see, however, the order of the check bits given in Table 1 of Recommendation Q.277). The first bit of each field is the most significant.

3.1.1.1 *Format of a lone signal unit*

The format of a lone signal unit is given in Figure 4.

x / x x x x x x x x x x x / x x x x / x x x x / x x x x x x x x

1	2 - 12	13 - 16	17 - 20	21 - 28
*	label	heading	signal inform-ation	check

* = label indicator

FIGURE 4. — **Format of a lone signal unit**

In order to indicate whether a signal unit is carrying a label for speech circuit identification (or for other purposes) or not, each telephone signal unit starts with a label indicator field of one bit.

The heading field provides means for splitting up all telephone signals into signal groups and for numbering the address messages for setting up a call.

3.1.1.2 *Format of the initial signal unit of a multi-unit message*

The format of the initial signal unit of any multi-unit message is the same as that for a one-unit message (see Figure 4). Distinction between an initial signal unit of a multi-unit message and a lone signal unit is determined by a reserved code in the signal information field as given in section 3.1.3.2 (see, however, also note 2 to section 3.1.1.4).

3.1.1.3 *Format of a subsequent signal unit of a multi-unit message*

The format of a subsequent signal unit of a multi-unit message is given in Figure 5.

```
x / x x x / x x x x ¦ x x x x ¦ x x x x ¦ x x x x / x x x x x x x x
1    2 - 4                5 - 20                          21 - 28
*    **              signal information                    check

          *  = label indicator
          ** = length indicator
```

FIGURE 5. — **Format of a subsequent signal unit of a multi-unit message**

The format of a subsequent signal unit does not contain label and heading fields which have already been included in the initial signal unit of the multi-unit message, for the multi-unit message will only carry telephone signals belonging to the same call (circuit label) and to the same signal group (heading). A 3-bit field is provided for indicating the length of the multi-unit message. The signal information field, therefore, has a length of 16 bits in order to carry as much telephone signal information as possible.

As the main purpose of a subsequent signal unit of an initial address message or a subsequent address message is to carry address signals, its signal information field may be considered to consist of 4 sub-fields of 4 bits each. According to the arrangements made, each sub-field may carry an address signal or other routing information. The sub-fields of the signal information field of the subsequent signal unit are indicated by broken strokes in Figure 5.

3.1.1.4 *Format of an initial address message*

Owing to the inclusion of other information for routing purposes in the initial address message (the first message of each call), the format of the initial address message differs a little from the format of a multi-unit subsequent address message.

The difference is restricted to the first subsequent signal unit of the initial address message. In this first subsequent signal unit the bits 5-12 are reserved for other routing information; the first address signal, therefore, will be placed in the third sub-field (bits 13-16) of the signal information field.

The format of an initial address message containing 3 signal units is given in Figure 6.

ISU	x /	x x x x x x x x x x x /	x x x x /	x x x x /	x x x x x x x x		
	*	label	heading	ISU code	check		
1st SSU	x /	x x x /	x x x x x x x x /	x x x x /	x x x x /	x x x x x x x x	
	*	**	other routing information	1st address signal	2nd address signal	check	
2nd SSU	x /	x x x /	x x x x /	x x x x /	x x x x /	x x x x /	x x x x x x x x
	*	**	3rd address signal	4th address signal	5th address signal	6th address signal	check

* = label indicator   ** = length indicator

FIGURE 6. — **Format of an initial address message with three signal units**

Note 1. — An initial address message of maximum length (5 signal units) has the capability to carry up to 14 address signals.

Note 2. — If required in the future, additional information to be included in the initial address message of a call may be carried by the initial signal unit (instead of the special initial signal unit code which in this case is not strictly necessary, for this initial signal unit can also be recognized by inspection of the heading code) or by the first subsequent signal unit (instead of the information field now being occupied by the first address signal). As the latter expansion method would reduce the address capacity of the initial address message by one address signal, the first expansion method is preferred.

3.1.2 Codes for the general parts of signal units

3.1.2.1 *Label indicator*

The label indicator is coded as follows:

0 no label (as in a subsequent signal unit)

1 label (as in a lone signal unit and an initial signal unit of a multi-unit message)

3.1.2.2 *Label*

A unique binary label code will be assigned to identify each speech circuit to be served by a particular common signalling link. The 11 bits provide for 2048 labels.

The label codes will be assigned by the Administrations concerned.

A small number of label codes has to be excluded from the capacity available for speech circuit identities in order to provide for labels for other purposes (see sections 3.2.2.2, 3.2.3.2 and 3.3).

3.1.2.3 *Length indicator*

The length of a multi-unit message is indicated in each subsequent signal unit of that message by means of the following code (the same code is used in each of the subsequent signal units of a multi-unit message):

0 0 0	one subsequent signal unit
0 0 1	two subsequent signal units
0 1 0	three subsequent signal units
0 1 1	four subsequent signal units

Note. — So far, there has been no need for a multi-unit message other than for address information, such a message being restricted in length to a maximum of 5 signal units (i.e. 4 subsequent signal units). If it should be necessary in future, however, to use longer messages either for telephone signal information or for other information; the length indicator codes 1 0 0 and 1 0 1 can also be used. Codes starting with combination 1 1, i.e. 1 1 0 and 1 1 1 , shall not be used as long as the discriminating function of this combination is applied as described in Recommendation Q.258, section 3.2.1.2.

3.1.2.4 *Check*

The patterns for the check bits are determined by the rules for the cyclic polynomial code chosen (see Recommendation Q.277).

3.1.3 **Codes for telephone signals**

A telephone signal is normally represented by the combination of codes in the heading and signal information fields of a lone signal unit, i.e. by 4 + 4 = 8 bits. A number of telephone signals, although never more than 15 due to the one code reserved for the initial signal unit, can have the same heading code of 4 bits but will then have different signal information codes of 4 bits.

Some telephone signal information, in particular some routing information included in the initial address message is coded by less than 4 bits. This method of code assignment is possible only in a multi-unit message where different kinds of signal information may be combined under one common heading included in the initial signal unit of that message. It is also possible to code some telephone signal information carried by a multi-unit message by more than 4 bits. In these cases the unique meaning of a telephone signal is given by the common heading code in the initial signal unit, by the signal information code in a subsequent signal unit and by the fixed position of the signal information code within that subsequent signal unit.

3.1.3.1 *Heading codes*

The *heading* field of 4 bits provides 16 different codes in order to discriminate between a number of signal groups. Out of these 16 codes, 8 are reserved for the address information group to provide for the required *sequence numbering of address messages*, viz. the codes 1 0 0 0 (for the initial address message), and 1 0 0 1 to 1 1 1 1 (for the subsequent address messages).

The telephone signals other than the address information are subdivided into three groups with heading codes 0 1 0 0, 0 1 0 1 and 0 1 1 0.

Two heading codes are reserved for special spare headings (e.g. to be used for national purposes), viz. the codes 0 0 0 0 and 0 0 0 1.

The remaining codes 0 0 1 0, 0 0 1 1 and 0 1 1 1 are reserved for international use.

3.1.3.2 *Address information in the initial address message*

The initial address message is provided with *heading code* 1 0 0 0.

The number of address signals involved in an initial address message depends on the length of that initial address message (see format of the initial address message in section 3.1.1.4, Figure 6). These address signals are always included in the subsequent signal units.

The signal information field of the initial signal unit of the initial address message is coded as 0 0 0 0 (see section 3.1.1.2).

The address signals are coded as follows:

0 0 0 0	filler (no information)
0 0 0 1	digit 1
0 0 1 0	digit 2
0 0 1 1	digit 3
0 1 0 0	digit 4
0 1 0 1	digit 5
0 1 1 0	digit 6
0 1 1 1	digit 7
1 0 0 0	digit 8
1 0 0 1	digit 9
1 0 1 0	digit 0
1 0 1 1	code 11
1 1 0 0	code 12
1 1 0 1	spare
1 1 1 0	spare
1 1 1 1	ST

The filler code 0 0 0 0 may be used only to complete the signal information field of the last subsequent signal unit of the initial address message.

3.1.3.3 *Additional information in the initial address message*

The common heading code for all signals to be carried by the initial address message is 1 0 0 0.

The bits 5-12 of the first subsequent signal unit of the initial address message are available for other information which is needed in combination with the address signals for setting up the call.

a) *Bit 5: terminal or transit indicator*

0	terminal call
1	transit call

b) *Bit 6: nature-of-circuit indicator*

0	no satellite circuit in the connection
1	one satellite circuit in the connection

c) *Bit 7: echo-suppressor indicator*

0	no echo suppressor inserted
1	echo suppressor inserted

d) *Bit 8: spare*

This bit is reserved, e.g. for expanding either the echo-suppressor indicator code or the calling-party's category code. For the time being this bit is coded as 0.

e) *Bits 9-12: calling-party's category*

0 0 0 0	spare
0 0 0 1	operator, language French
0 0 1 0	operator, language English
0 0 1 1	operator, language German
0 1 0 0	operator, language Russian
0 1 0 1	operator, language Spanish
0 1 1 0	available to Administrations for selecting a particular language provided by mutual agreement
0 1 1 1	
1 0 0 0	
1 0 0 1	spare (see Recommendation Q.104)
1 0 1 0	ordinary calling subscriber
1 0 1 1	calling subscriber with priority
1 1 0 0	data call
1 1 0 1	test call
1 1 1 0	spare
1 1 1 1	spare

3.1.3.4 *Address information in a subsequent address message*

A subsequent address message which may be a lone signal unit or a multi-unit message is provided with one of the *heading codes* **1 0 0 1** *to* **1 1 1 1** depending on the sequence number of the subsequent address message concerned.

When transferred by a lone signal unit the address sigual is placed in the signal information field (see section 3.1.1.1, Figure 4).

When a number of address signals are transferred by means of a subsequent multi-unit message, the address signals are placed in the signal information field of the subsequent signal units of that message. The signal information field of the initial signal unit of that message is coded as **0 0 0 0** (see section 3.1.3.2). The following address signals may be transferred by a subsequent address message:

0 0 0 0	filler (only in a multi-unit message)
0 0 0 1	digit 1
0 0 1 0	digit 2
0 0 1 1	digit 3
0 1 0 0	digit 4
0 1 0 1	digit 5
0 1 1 0	digit 6
0 1 1 1	digit 7
1 0 0 0	digit 8
1 0 0 1	digit 9
1 0 1 0	digit 0
1 1 1 1	ST

The remaining codes **1 0 1 1**, **1 1 0 0**, **1 1 0 1**, and **1 1 1 0** are not used in a subsequent address message.

The filler code **0 0 0 0** may only be used to complete the signal information field of the last subsequent signal unit of a multi-unit subsequent address message.

3.1.3.5 *Other telephone signal information in a lone signal unit*

a) *Telephone signals with heading code* 0 1 0 0

The following signal codes associated with heading code 0 1 0 0 are allocated to signals sent in the forward direction:

0 0 0 1	continuity
0 0 1 0	forward-transfer
0 1 0 0	blocking
1 0 0 0	unblocking
1 1 1 0	clear-forward

Signal code 0 0 0 0 is reserved for other purposes (see sections 3.1.1.2 and 3.1.3.2).

The 10 remaining codes are spare codes.

Note. — The blocking signal will also be sent in the backward direction as an acknowledgement for the same signal sent in the forward direction; the same applies to the unblocking signal (see Recommendation Q.266).

b) *Telephone signals with heading code* 0 1 0 1

Signals sent in the backward direction associated with heading code 0 1 0 1 are:

0 0 0 1	check-OK
0 0 1 0	check-not-OK
0 0 1 1	switching-equipment-congestion
0 1 0 0	circuit-group-congestion
0 1 0 1	national-network-congestion
0 1 1 0	address-incomplete
0 1 1 1	address-complete
1 0 0 0	ringing (electrical), charge
1 0 0 1	ringing (electrical), no charge
1 0 1 0	subscriber-busy (electrical)
1 0 1 1	vacant-national-number
1 1 0 0	line-out-of-service
1 1 0 1	coin-box
1 1 1 0	confusion

Signal code 0 0 0 0 is reserved for other purposes (see sections 3.1.1.2 and 3.1.3.2).

The one remaining code 1 1 1 1 is a spare code.

c) *Telephone signals with heading code* 0 1 1 0

The following codes assigned to signals sent in the backward direction are associated with heading code 0 1 1 0:

0 0 0 1	clear-back (No. 1)
0 0 1 0	reanswer (No. 1)
0 0 1 1	clear-back (No. 2)
0 1 0 0	reanswer (No. 2)
0 1 0 1	clear-back (No. 3)
0 1 1 0	reanswer (No. 3)
0 1 1 1	release-guard
1 1 0 1	answer, charge (priority)
1 1 1 0	answer, no charge (priority)

Signal code 0 0 0 0 is reserved for other purposes (see sections 3.1.1.2 and 3.1.3.2).

The six remaining codes are spare codes.

3.1.4 Examples of address messages

In an Annex to this recommendation examples of address messages are given to elucidate the formats and codes adopted for address messages. As there is no relevant telephone signal information contained in the check field of the signal units, these fields are not shown in these examples.

ANNEX
(to Recommendation Q.257)

Examples of address messages

1. *Transit call* from USA (international exchange New York) to the Netherlands (international exchange Amsterdam) via the United Kingdom (transit exchange London).

Assumptions: — Semi-automatic traffic, English language.

— The signalling links New York–London and London–Amsterdam are both associated with their respective speech circuit groups.

— Speech path New York–London is a satellite circuit equipped with echo suppressors, speech path London–Amsterdam is a cable circuit, not equipped with echo suppressors (due to bilateral agreement between the Administrations concerned).

— Dialled information: 31 2150 43551.

— "En bloc" operation.

a) Address message New York–London

```
1/000 0101 0011/1000/0000
0/011/1110 0010/0011/0001
0/011/0010/0001/0101/1010
0/011/0100/0011/0101/0101
0/011/0001/1111/0000/0000
```

b) Address message London–Amsterdam

```
1/000 0000 1010/1000/0000
0/010/0100 0010/0010/0001
0/010/0101/1010/0100/0011
0/010/0101/0101/0001/1111
```

The intermediate CT London serves as *transit centre.*

2. *Direct call* from the Netherlands (international exchange Amsterdam) to the United States (international exchange New York).

Assumptions:
- Automatic traffic, ordinary subscriber.
- Speech path Amsterdam–New York is a cable circuit equipped with echo suppressors.
- Speech circuit group Amsterdam–New York has no associated signalling link.
  Signal information will be transferred via the two signalling links Amsterdam–London and London–New York in tandem, thus using a quasi-associated mode of operation.
- Dialled information: 1 201 949 5813.
- "Overlap with subscribers' dialling" operation.

a) Address messages Amsterdam–London

```
1st 1/001 0000 1001/1000/0000
    0/001/0010 1010/0010/1010
    0/001/0001/1001/0100/1001
2nd 1/001 0000 1001/1001/0101
3rd 1/001 0000 1001/1010/1000
4th 1/001 0000 1001/1011/0001
5th 1/001 0000 1001/1100/0011
6th 1/001 0000 1001/1101/1111*
```

* = ST-signal, sent if the end of the address has been recognized.

b) Address messages London–New York

Exactly the same messages are sent as under a).
The London exchange serves as *signal transfer point* only.
By agreement between the Administrations concerned there is no need for label translation at this signal transfer point.

RECOMMENDATION Q.258

3.2 SIGNALLING-SYSTEM-CONTROL SIGNALS

The signalling-system-control signals are not related to telephone signal information. They are necessary for the proper functioning of the signalling system.

All system-control signals specified (see Recommendation Q.255, section 2.2) are transferred as one-unit messages.

3.2.1 Acknowledgement signal unit (ACU)

3.2.1.1 *Format of the ACU*

The format of the ACU is given in Figure 7 below:

x x x /	x x x x x x x x x x x /	x x x /	x x x /	x x x x x x x x
1 - 3	4 - 14	15 - 17	18 - 20	21 - 28
Invariable pattern	acknowledgement indicators	*	**	check

* = sequential number of block being acknowledged
** = sequential number of block completed by this ACU

FIGURE 7. — **Format of the acknowledgement signal unit**

3.2.1.2 *Codes for the ACU parts*

a) *Invariable pattern*

The invariable pattern is coded as 0 1 1. This code starts with a zero in order to discriminate between an ACU which carries no label and a lone signal unit or initial signal unit (sections 3.1.1.1, 3.1.1.2 and 3.1.2.1 of Recommendation Q.257) and continues with two ones in order to discriminate as far as possible between an ACU and a subsequent signal unit of a multi-unit message (sections 3.1.1.3 and 3.1.2.3 of Recommendation Q.257).

b) *Acknowledgement indicator*

The ACU contains eleven acknowledgement indicators to acknowledge sequentially the corresponding eleven signal units of a block received. Each indicator will be coded in the following way:

0	no error detected
1	error detected

c) *Numbering of blocks*

Both the block being acknowledged and the block completed by the ACU are indicated by cyclic sequence numbers from the series 0 0 0, 0 0 1, 0 1 0, 0 1 1, 1 0 0, 1 0 1, 1 1 0, 1 1 1 , 0 0 0, ...

3.2.2 Synchronization signal unit (SYU)

3.2.2.1 *Format of the SYU*

The format of the SYU is given in Figure 8.

x x x x x x x x x x x x x x x x /	x x x x /	x x x x x x x x
1 - 16	17 - 20	21 - 28
synchronization pattern	*	check

* = sequence number of signal unit in the block

FIGURE 8. — **Format of the synchronization signal unit**

3.2.2.2 *Codes for the SYU parts*

a) *Synchronization pattern*

This pattern is coded as

1 1 1 0 1 1 1 0 1 1 1 0 0 0 1 1

This code starts with a one, thus indicating that the SYU is provided with a label which is found to be

1 1 0 1 1 1 0 1 1 1 0

This *particular label* must be excluded from the label capacity for speech circuit identification (section 3.1.2.2 of Recommendation Q.257).

The four bits following this special label, namely 0 0 1 1, do *not* represent a heading code but are part of the synchronization pattern.

b) *Signal unit sequence number*

The sequence number may have any code of the 4-bit binary counting code 0 0 0 0, 0 0 0 1, 0 0 1 0 up to 1 0 1 0 inclusive. The number chosen for a synchronization signal unit is determined by the position of that synchronization signal unit in the block of signal units.

The remaining codes 1 0 1 1 to 1 1 1 1 are not assigned.

3.2.3 System control signal units (SCU)

3.2.3.1 *Format of an SCU*

The format of an SCU is exactly the same as for an LSU for telephone signals (Recommendation Q.257, section 3.1.1.1, Figure 4).

3.2.3.2 *Codes for the SCU parts*

a) *Label indicator*

The label indicator is coded as 1.

b) *Label*

The *special label* which must be excluded from the label capacity for speech circuit identification (section 3.1.2.2 of Recommendation Q.257), is coded as

1 1 1 1 1 1 1 1 1 1 1

being the highest possible binary number.

c) *Heading*

Since a special label is used for the SCU's, in principle all possible heading codes are available for use.

Code 0 0 0 0 is used for the group of change-over and change-back signals.

d) *Signal information*

Only two signals are defined, change-over and change-back (sections 2.2.3 and 2.2.4 of Recommendation Q.255).

It may be necessary, however, to use a number of codes for each signal in order to discriminate between different signalling links terminating at a CT, or signal transfer point.

It is recommended to use for each signalling link (whether regular or reserve) a pair of codes for the two signals of which one is the binary inversion of the other and vice versa, e.g.

0 1 1 0 and 1 0 0 1

The codes 0 0 0 0 to 0 1 1 1 inclusive are reserved for change-over signals; the codes 1 1 1 1 to 1 0 0 0 inclusive (taken in the inverted order for pairing purposes) are reserved for change-back signals.

The choice of code pairs should be made by the Administrations involved.

RECOMMENDATION Q.259

3.3 MANAGEMENT SIGNALS

Management signals may include

— network-management signals,

— network-maintenance signals,

— etc.,

i.e., signals concerned with the management of the speech circuit network.

These signals may be transferred by means of one-unit messages or multi-unit messages consisting of one or more signal units respectively. To distinguish management signals from telephone signals, *special labels* may be used which are excluded from the label capacity for speech circuit identification (see section 3.1.2.2 of Recommendation Q.257). These special labels may provide for other subdivisions of the signal units according to the nature of information to be transferred. As these signals have not yet been defined, no detailed format and code information can be given.

CHAPTER IV

Signalling procedures *

RECOMMENDATION Q.261

4.1 NORMAL CALL SET-UP

4.1.1 Initial address message

An initial address message which is sent as the first message of a call set-up generally includes all of the information required by the next international exchange to route the call. The seizing signal is implicit in the reception of this initial address message. The format of the initial address message is given in Recommendation Q.257.

The initial address message (IAM) will contain the following signalling information:

a) terminal or transit indicator,
b) nature-of-circuit indicator,
c) echo-suppressor indicator,
d) calling-party's category,
e) address signals.

As the country code is not sent to the incoming international exchange, the *terminal or transit indicator* is necessary for the proper interpretation of the address digits. This indicator must be translated to the appropriate signal for transmission over succeeding circuits using other signalling systems.

The *nature-of-circuit indicator* provides information as to whether or not a high-altitude satellite circuit has already been included in the connection, and makes it possible for a transit exchange to ensure that a second high-altitude circuit is included only in known exceptional circumstances.

The *echo-suppressor indicator* provides information as to whether or not a half echo suppressor has been included in the forward direction at a preceding international exchange. Receipt of this signal at a terminating exchange indicates that a standard half echo suppressor should be included in the backward direction. Exceptionally, it is possible for the echo suppressors to be inserted at a point other than the terminating international exchange on the basis of this signal.

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* This chapter also includes the procedures for *interworking* between system No. 6 and other standardized C.C.I.T.T. signalling systems.

The use of an echo suppressor at an intermediate international exchange must be by agreement and only in those connections which have been analysed and where it has been found that the transmission requirements are fulfilled.

The *calling-party's-category indicator* is used to indicate the type of caller originating the call, e.g., ordinary caller, operator or data caller and may indicate that a special routing is required. The *language and discriminating information* is included in the calling-party's category. It will be necessary to translate the language digit received from an operator in semi-automatic working or a discriminating digit received from a preceding link to the appropriate calling-party's-category code. The language or discriminating information must be translated from the calling-party's-category indicator to the appropriate digit for transmission over a circuit using system No. 4 or system No. 5 in a succeeding link.

The *sending sequence of address information* will be the country code (not sent to an incoming international exchange) followed by the national (significant) number. For calls to code 11 and code 12, refer to Recommendation Q.107.

All digits required for routing the call will be sent in the initial address message. Except in the case of calls to special operators or to test codes, it will contain a minimum of four digits and should contain as many as are available. All digits of the address may be included. In a terminal link the initial address message may contain one digit, e.g. special operator access code 11 and ST. Thus, the initial address message may consist of as few as two signal units (one digit and ST) or as many as five signal units (13 digits and ST).

Selection of the outgoing national circuit normally can start at the incoming international exchange on receipt of the initial address message and signalling can proceed on the first national link.

Note. — When interworking towards another signalling system with fewer facilities, it will be necessary to discard some of the signals, e.g. nature-of-circuit indicator and echo-suppressor indicator.

When no echo suppressor or nature-of-circuit indication is received from a preceding circuit using a signalling system with fewer facilities, the indicators will be considered as received "*no*" unless positive knowledge is available.

4.1.2 Subsequent address messages

The remaining digits, if any, of the address may be sent individually in one-unit messages or in groups in multi-unit messages. Efficiency can be gained by grouping together as many digits as possible. However, to prevent an increase in post-dialling delay in those cases where overlap operation with subscribers' dialling is used, it may be desirable to send the last few digits individually. The number of signal units used in a subsequent address message may be from one to four. If the outgoing circuit from a transit exchange is equipped with system No. 5, any digits received in overlap must be grouped for "en bloc" sending.

Subsequent address messages can be sent on to the national network as they are received. The incoming Administration may choose to withhold the last digit of the national number until the transmission path continuity check has been completed to eliminate the possibility that the called subscriber might answer before the transmission path has been switched through.

The *sequence of address messages* may be disturbed in the event that one or more messages have been retransmitted because of an error. To prevent the assembly of digits in an incorrect sequence the last system No. 6 exchange must examine the sequence number included in each address message and reassemble the digits if necessary.

4.1.3 End-of-pulsing (ST) signal

The ST signal is always sent in the following situations:

a) semi-automatic calls,

b) test calls, and

c) when the ST is received from a preceding circuit.

In automatic working this signal will be sent whenever the outgoing international exchange is in a position to know, by digit analysis, that the final digit has been sent. Digit analysis may consist of an examination of the country code and counting of the maximum (or fixed) number of digits of the national number. In other cases, the ST signal is not sent and the end-of-address information is determined by the receipt of the address-complete or address-incomplete signal from the incoming international exchange.

4.1.4 Continuity check of the speech path

The procedure for making the continuity check is described in Chapter V. The use of the loop method of continuity checking requires that any echo suppressors in the check loop be disabled. It is assumed that any echo suppressors which may be located at international transit exchanges are disabled as prescribed in Recommendation Q.115. Each international exchange must disable any echo suppressor in that exchange, which is required to be active for the speech connection, for the period of attachment of the continuity-check loop or transceiver.

4.1.4.1 *End-to-end checking*

The check-OK (or check-not-OK) signal shall be sent as promptly as possible. On transmission of the check-OK signal the continuity-check transceiver will be removed and the speech path switched through. In addition, if the last digit of the national number has been withheld it can be released. An intermediate No. 6 exchange will send the check-OK signal to the preceding No. 6 exchange as soon as possible after receipt of the signal. On receipt of the check-OK signal at the outgoing No. 6 exchange, the continuity-check loop will be removed and the speech path switched through.

On transmission of the check-not-OK signal, a clear-forward signal will be sent to any succeeding links using system No. 4 or system No. 5, or to the national network, the continuity-check transceiver should be removed, the outgoing terminal of the circuit will be removed from service, and the routing and address information removed from memory.

On receipt of a check-not-OK signal at an intermediate No. 6 exchange, the check-not-OK signal should be sent to the preceding No. 6 exchange (if the preceding circuit utilizes system No. 6), the outgoing circuit should be removed from service by sending the blocking signal, the outgoing terminal of the incoming circuit should be removed from service, and the record of address and routing information can be removed from memory. A record of the speech path through the No. 6 exchange should be retained until appropriate checks have been made. The outgoing circuit should be checked as soon as possible after receipt of the blocking acknowledgement signal using the continuity-check loop and transceiver (by making a call to a test number) or by using the automatic transmission measuring equipment. If found OK the circuit should be returned to service by sending the unblocking signal. If found not-OK the maintenance staff will be alerted that a failure has occurred and the circuit has been blocked.

On receipt of the check-not-OK signal at the outgoing international exchange (or the first exchange of the No. 6 section of the connection) :

— the continuity-check loop will be removed,

— the outgoing circuit removed from service by sending the blocking signal,

— and an automatic attempt will be made to complete the call on another outgoing circuit.

The outgoing circuit which was removed from service will be checked as described above for the intermediate No. 6 exchange.

4.1.4.2 *Link-by-link checking*

The outgoing international exchange (or the first exchange of the No. 6 section of the connection) will send forward a continuity signal as soon as possible after sending the initial address message. Succeeding intermediate No. 6 exchanges will send forward the continuity signal after receipt of a continuity signal from the preceding link and after (or in parallel with) sending a check-OK signal to the preceding No. 6 exchange.

Each No. 6 exchange will send the check-OK (or check-not-OK) signal as promptly as possible. On transmission of the check-OK signal, the continuity-check transceiver will be removed and the speech path switched through. If a digit of the national number was withheld it can be released as soon as a check-OK signal has been sent and a continuity signal received. On receipt of the check-OK signal the continuity-check loop will be removed and the speech path switched through.

On transmission of the check-not-OK signal :

— a clear-forward signal will be sent to succeeding links,

— the continuity-check transceiver will be removed,

— the outgoing terminal of the faulty circuit will be removed from service,

— and the routing and address information removed from memory.

On receipt of the check-not-OK signal at the preceding No. 6 exchange, the continuity-check loop will be removed, the outgoing circuit should be removed from service by sending the blocking signal, and an automatic repeat attempt will be made on another circuit. Maintenance staff will be alerted that a failure has occurred and the circuit has been blocked.

4.1.5 Address-complete signal

The incoming international exchange shall send the address-complete signal to the outgoing international exchange as soon as possible after the end of address signalling. On receipt of the address-complete signal at any international transit exchange, it will be sent to the preceding exchange if the signalling system on the incoming circuit is equipped to transmit this or an equivalent signal (e.g. number-received signal in system No. 4).

The end-of-address signalling can be determined:

a) by receipt of an ST signal,

b) by receipt of the maximum number of digits used in the national numbering plan,

c) by analysing the first digits of the national (significant) number to decide how many digits there are in the subscriber's number in the particular national numbering zone, or

d) by receipt of an end-of-selection signal or "electrical" ringing signal from the national network.

Note. — When interworking from system No. 4 to system No. 6, if no end-of-pulsing signal is received, the intermediate international exchange will await an address-complete signal from the system No. 6 link which will be returned as a number-received signal over the system No. 4 link.

4.1.6 Address-incomplete signal

The address-incomplete signal is sent whenever it can be determined that the proper number of digits has not been received. This determination can be made at once if the ST signal is received by receipt of an address-incomplete signal (or equivalent) from the national network, or if it has not been determined otherwise (section 4.1.5) that an address is complete within 15-30 seconds after the latest address digit received.

Each No. 6 exchange, on receipt of the address-incomplete signal, will send the signal to the preceding No. 6 exchange whenever possible, clear-forward the connection, and remove the record of the call from memory. The outgoing international exchange will send the appropriate tone or announcement, if any, for the national network concerned to the calling party.

4.1.7 Normal release of routing and address information

Routing and address information may be released from memory in each No. 6 exchange on receipt of either the address-complete, or check-OK signals, whichever is received later, or the address-incomplete signal. It should be noted that the sequence of these signals will vary according to the number of circuits in the connection and whether link-by-link or end-to-end continuity checking is used.

4.1.8 Congestion signals

The three types of congestion signals are defined in sections 2.1.12 to 2.1.14 of Recommendation Q.254. The congestion signals may be sent without waiting for the completion of the continuity-check sequence. Reception of a congestion signal at any No. 6 exchange will cause the clear-forward signal to be sent and

a) an automatic repeat attempt to be made, or
b) the appropriate signal or the appropriate audible tone or announcement to be sent to the preceding international exchange or to the national network.

If a busy-flash signal is received from a succeeding international link which uses another signalling system, it shall be coded as a circuit-group-congestion signal on system No. 6. Any of the congestion signals from system No. 6—i.e., switching equipment, circuit group, national network—will be converted to a busy-flash signal for transmission over a preceding link using system No. 4 or system No. 5.

If a signal equivalent to a busy-flash signal is received by an incoming international exchange from a national network, it should be coded as a national-network-congestion signal to be transmitted on the No. 6 system.

4.1.9 Called-party's-line-condition signals

The following signals will be sent only if the relevant information is received at the incoming international exchange from the national networks:

Ringing signal (electrical) charge,
Ringing signal (electrical) no charge,
Coin-box signal *,
Subscriber-busy signal (electrical),
Line-out-of-service signal,
Vacant-national-number signal.

These signals will be sent without waiting for the completion of the continuity check. On receipt of

— one of the ringing signals,
— the subscriber-busy signal (electrical),
— the line-out-of-service signal, or
— the vacant-national-number signal,

the outgoing international exchange shall send the appropriate audible tone to the originating subscriber or operator. Each No. 6 exchange on receipt of a subscriber-busy, line-out-of-service, or vacant-national-number signal can clear-forward the connection.

If a succeeding international link or the incoming national network cannot provide the ringing signal no charge, the ringing signal, charge will be sent on receipt of a ringing or equivalent electrical signal and the answer signal will be withheld.

Preceding links using system No. 4 or system No. 5 will be able to transmit only the busy-flash signal; other conditions must be indicated by appropriate audible tones, as agreed.

4.1.10 Answer signals

The signals "answer, charge" and "answer, no charge" are sent as received from the national network or from the succeeding international link. The signal "answer,

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* If the incoming international exchange is able to determine from number analysis that the called party is a coin station, it may generate this signal.

charge" will be used unless a signal "answer, no charge" is available from the national network or from a succeeding link. The signal "answer, charge" will be converted to an answer signal for transmission over a preceding link using a signalling system with a single answer signal. The signal "answer, no charge" will be suppressed when the preceding signalling system does not include a no-charge signal, either ringing or answer.

The signals "answer, charge" and "answer, no charge" are used only as a result of the first off-hook signal from the called party and are priority signals. Neither answer signal should be entered in the output buffer until the check-OK signal has also been entered.

Receipt of either answer signal or the check-OK signal at any No. 6 exchange will provoke the removal of the continuity-check loop, and switching through of the speech path. At the outgoing international exchange, moreover, the audible ringing tone will be removed.

4.1.11 Clear-back signal

The clear-back signal is sent when the called party clears before a clear-forward signal has been received at the incoming international exchange. The clear-back signal must not open the speech path at the outgoing international exchange.

4.1.12 Reanswer and clear-back signal sequences

Subsequent off-hook, on-hook signals from the called party, such as will result from switch-hook flashing, will cause the following sequence of signals to be sent:

Clear-back	1
Reanswer	1
Clear-back	2
Reanswer	2
Clear-back	3
Reanswer	3
Clear-back	1
etc.	

In contrast to the answer signal the reanswer signal has no special priority. The sequence numbering of the clear-back and reanswer signals makes it possible for the first system No. 6 exchange to reassemble the sequence in proper order in the event that the original sequence is disturbed as a result of retransmission of one or more of the signals. It is only necessary, however, that a flashing sequence be retransmitted to the operator (or the preceding link) and that the final condition of the circuit represents the final position of the called party's switch hook. A reanswer signal is transmitted as an answer signal over a preceding link using system No. 4 or system No. 5.

4.1.13 Forward-transfer signal

The forward-transfer signal may be sent in semi-automatic working in either of the following two cases:

a) Following a call switched automatically to a subscriber, or following a call established via a special operator, the controlling operator wishes to call in an assistance operator. On receipt of the forward-transfer signal at the incoming international exchange an assistance operator is called in.

b) Following a call via code 11 or code 12, the controlling operator wishes to recall the incoming operator at the incoming international exchange. Receipt of the forward-transfer signal at the incoming international exchange recalls the incoming operator on calls completed via the operator positions at the exchange.

4.1.14 Clear-forward and release-guard signal sequence

The clear-forward signal is overriding and all international exchanges must be in a position to respond at any time during the progress of a call. It will cause all associated equipment to be returned to the idle condition and all information concerning the call to be released from memory. If sent while a circuit is blocked, however, it will *not* result in unblocking the circuit concerned (see section 4.6).

The release-guard signal is sent in response to the clear-forward signal, but not until the circuit is available for a new call (except in case of a blocked circuit).

4.1.15 Diagrams showing signal sequence

The normal call set-up sequences are shown diagrammatically in the Annex to the Specifications of system No. 6.

RECOMMENDATION Q.262

4.2 ANALYSIS OF DIGITAL INFORMATION FOR ROUTING

4.2.1 General requirements for the transit exchange

In an international transit exchange an analysis of some of the digits is required to determine the routing to the desired international incoming exchange or to another international transit exchange*. As a general rule, the country code of the destination country is subject to this analysis. In some cases an analysis of more or fewer digits may be required. Since the initial address message will contain all digits required for routing the call (see section 4.1.1.), selection of the outgoing circuit can start as soon as this message has been received.

It should be noted that, in addition to the digital information, other routing information is contained in the initial address message, e.g., terminal or transit indicator, nature-of-circuit indicator, calling-party's-category indicator, and echo-suppressor indicator, some or all of which must be analysed as described in section 4.1.1 of Recommendation Q.261.

It will not normally be necessary for a transit exchange to analyse more than the initial address message. Subsequent address messages can be forwarded to the next international exchange without analysis as soon as the outgoing circuit is determined.

If address information is received "en bloc" at a transit exchange it is normally transmitted "en bloc"; conversely, if received in overlap it is forwarded in overlap.

4.2.2 Maximum number of digits to be analysed in an international transit exchange

a) The maximum number of digits* which has to be analysed in an international transit exchange to determine the routing at this exchange is as follows:

$$I_1\ N_1\ N_2\ N_3$$
$$I_1\ I_2\ N_1\ N_2$$
$$I_1\ I_2\ I_3\ N_1\ N_2$$

where I_1, I_2, I_3 = digits of the country code

$N_1, \ldots, N_n$ = digits of the national (significant) number.

Note. — In the case of countries with more than one incoming international exchange where code 11 or code 12 traffic requires for routing in the transit exchange a digit analysis beyond the country code, N_1 is the extra digit designating the incoming international exchange (see the Annex to this Recommendation, examples 1b and 3).

b) Accordingly, the maximum number of digits that has to be analysed at an international transit exchange is five.

4.2.3 Digit analysis for routing at the outgoing international exchange

The maximum number of digits which has to be analysed in the outgoing international exchange to determine the routing is also five, as in section 4.2.2 for the transit exchange.

4.2.4 Digit analysis for routing at the incoming international exchange

The country code will not be sent on the final link in the international connection and therefore the terminal-call indication will be used.

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* See Recommendation Q.11, section 1.2.

ANNEX

(to Recommendation Q.262)

Example of the digit analysis in an international transit exchange

A list of possible cases for the digit analysis in an international transit exchange is the following (the letters given to the international exchanges correspond to the figure and the letters given to the digits correspond to section 4.2.2 of this Recommendation):

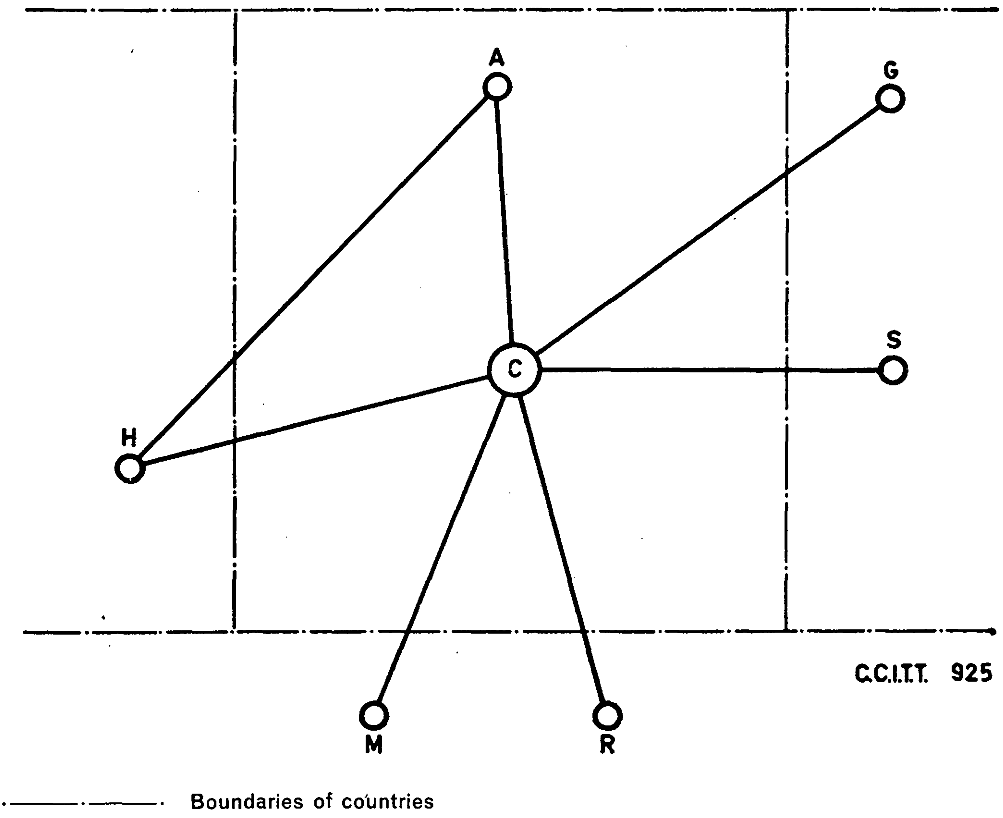

Figure 9. — **Example of the digit analysis in an international transit exchange**

1. Transit traffic via C in one country routed to exchanges M or R in another country according to the first digit(s) of the national (significant) number.

a) Automatic and semi-automatic calls with normal national numbers

Example: $\underbrace{I_1\ I_2\ N_1\ N_2}_{\text{Analysed}}\ \ldots\ldots$

b) * Semi-automatic calls to code 11 or code 12 operators

Examples: $\underbrace{I_1\ I_2\ N_1\ C_{11}}_{\text{Analysed}}$ or $\underbrace{I_1\ I_2\ N_1\ C_{12}}_{\text{Analysed}}$

2. Transit traffic via C in one country routed to G or S in another country with semi-automatic traffic to S and automatic traffic to G as indicated by the calling party category.

Example: $\underbrace{I_1\ I_2}_{\text{Analysed}}$

3. * Terminal traffic incoming to an international exchange C in a country and which is to be routed to code 11 or code 12 operators in another international exchange A in the same country according to the extra digit N_1.

Examples: $\underbrace{N_1\ C_{11}}_{\text{Analysed}}$ ST or $\underbrace{N_1\ C_{12}}_{\text{Analysed}}$ X X ST

RECOMMENDATION Q.263

4.3 DOUBLE SEIZING WITH BOTH-WAY OPERATION

4.3.1 Unguarded interval

Considering that with signalling system No. 6:

a) circuit propagation time may be relatively long,

b) the initial address message may consist of up to 5 signal units,

c) there may be significant queueing delay, and

d) non-associated operation may add extra cross-office delay(s),

the unguarded interval during which double seizing can occur may be relatively long in some instances. The exchange must therefore detect double seizing and take action as defined in section 4.3.4.

4.3.2 Detection of double seizing

A double seizure is detected by an exchange from the fact that it receives an initial address message for a circuit for which it has sent an initial address message.

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* It is recognized that the existing design of some present-day equipments does not permit the insertion of the extra digit N_1.

In this situation, agreement will be required between the Administrations concerned that this insertion of N_1 would not be provided for at a particular outgoing international exchange as long as the equipment limitation applied.

4.3.3 Preventive action

Double seizing should be minimized by the use of an opposite order of selection at each terminal exchange of a both-way circuit group. It is necessary to use this method of selection in cases where system No. 6 uses a voice-frequency link with long propagation time.

4.3.4 Action to be taken on detection of double seizing

It is expected that each exchange will control one half of the circuits in a both-way circuit group. On detection of a double seizure, the call being processed by the control exchange for that circuit will be completed and the received initial address message will be disregarded. The call being processed by the non-control exchange will be backed off (remove continuity-check loop, release switches, etc. but do not send a clear-forward signal) and an automatic repeat attempt made either on the same, or on an alternative route.

RECOMMENDATION Q.264

4.4 POTENTIAL FOR AUTOMATIC REPEAT ATTEMPT

The potential for automatic repeat attempt as defined in Recommendation Q.12 is provided in system No. 6. Backward signals are included to provide information on which to base a decision as to whether or not it would be advantageous to invoke an automatic repeat attempt.

An automatic repeat attempt will be made

— after a check-not-OK signal,

— on receipt of the confusion signal,

— on detection of double seizing (at the non-control exchange),

— and on receipt of a blocking signal after sending an initial address message.

The potential for automatic repeat attempt on receipt of either the circuit-group-congestion or the switching-equipment-congestion signal is provided and may be used when specified.

RECOMMENDATION Q.265

4.5 SPEED OF SWITCHING AND SIGNAL TRANSFER IN INTERNATIONAL EXCHANGES

4.5.1 General

It is recommended that the equipment in the international exchanges (terminal or transit) shall have a high switching speed so as not to lose the advantage of the high speed of system No. 6.

The speech path of circuits served by system No. 6 is not split, but the speech path of interconnected circuits using in-band signalling is split (see Recommendation Q.27); consequently, an answer signal should be transferred cross-office as rapidly as possible.

The operation of switching devices to attach and disconnect continuity-check equipment must be as rapid as possible to minimize post-dialling delay.

The signals switching-equipment congestion or circuit-group congestion should be returned as soon as practicable following receipt of the information necessary to determine the routing.

4.5.2 Outgoing international exchange

At the outgoing international exchange:

— if overlap operation is used, the sending of the initial address message shall take place as soon as sufficient digits are received (normally a minimum of 4) and analysed to permit the selection of an outgoing circuit;

— if "en bloc" operation is used, the initial address message should be sent as soon as all the digits of the address including the ST signal are available and the outgoing circuit has been chosen.

4.5.3 Intermediate transit exchange

At the international transit exchange, the selection of an outgoing circuit should begin as soon as the digits necessary to determine the routing have been received and analysed.

4.5.4 Incoming international exchange

At incoming international exchanges:

— if overlap operation is used in the national network, the setting-up of the national part of the connection should start as soon as a sufficient number of digits has been received for routing;

— if "en bloc" operation is used in the national network, the setting-up of the national part of the connection should start as soon as all of the digits (including ST) have been received.

The address-complete signal should be sent towards the outgoing exchange as soon as possible and not later than 6 seconds after the last digit is received.

RECOMMENDATION Q.266

4.6 BLOCKING AND UNBLOCKING SEQUENCES

Since the circuits served by system No. 6 have both-way capability, the blocking and unblocking signals can be originated by either terminal. Acknowledgement sequences are used for both the blocking and unblocking signals; the acknowledgement for the blocking signal is the blocking signal sent in the opposite direction, and the acknowledgement for the unblocking signal is the unblocking signal. The acknowledgement is not sent until the appropriate action, either blocking or unblocking, has been taken. The clear-forward signal should not override the blocking signal and return circuits to service which might be faulty. The blocked circuit will be returned to service on transmission of the unblocking acknowledgement signal at one exchange and on receipt of the unblocking acknowledgement signal at the other exchange. In the event of the receipt of a blocking signal

— after an initial address message has been sent and

— before a signal relating to that call has been received,

an automatic repeat attempt should be made on another circuit. The end receiving an initial address message after sending a blocking signal will ignore the received initial address message.

The blocking and unblocking signals are used in connection with the continuity check of the speech path as described in section 4.1.4 of Recommendation Q.261 and in Recommendation Q.271.

Blocking of a circuit by use of the blocking signal should not exceed 5 minutes, after which an alarm should be given at each terminal of the circuit. If the work on the circuit must exceed 5 minutes, the circuit should be withdrawn from service by the Control International Switching Maintenance Centre.

If the blocking signal is sent while a call is in progress, steps will be taken by the exchange receiving the signal to prevent the circuit being seized for subsequent calls outgoing from that exchange.

RECOMMENDATION Q.267

4.7 RECEIPT OF SUPERFLUOUS AND ERRONEOUS SIGNALS

4.7.1 Rejection of signals

In case the acknowledgement of a signal unit is not received, some signals may be received a second time. Logic must be included in the processor to prevent faulty operation as a result of the multiple receipt of signals.

Signals received with an unreasonable signal unit content or at an unreasonable place in a call sequence should be discarded.

4.7.2 Spillover of signals from one call sequence to another

a) It is possible that, in the event of a second call following immediately after the completion of a previous call, there could be a spillover of signals from the first call to the second, but only if a signal of the first call is received correctly a second time owing to a retransmission. Faulty operation and/or loss of a call can be prevented by the use of reasonableness checks and by the use of automatic repeat attempts in indeterminate cases. Where automatic repeat attempts are used, there may be some advantage in making the repeat attempt on another circuit within the group, if possible.

b) An extreme example of a spillover could occur if an initial address message is retransmitted owing to a detected error or to a mutilated or omitted acknowledgement with premature abandonment of the call and a new call started on the same circuit immediately after receiving the release-guard signal. The signal sequence at the incoming international exchange is as follows:

IAM$_1$ $\longrightarrow$
Clear-forward $\longrightarrow$
Release-guard $\longleftarrow$
IAM$_1$ $\longrightarrow$ (retransmitted)
IAM$_2$ $\longrightarrow$

This sequence is somewhat similar to the more usual case when an initial address message is received a second time without an intervening clear-forward signal, i.e.

Clear-forward $_1$ $\longrightarrow$
Release-guard $_1$ $\longleftarrow$
IAM$_2$ $\longrightarrow$
IAM$_2$ $\longrightarrow$ (retransmitted)

There are two procedures available. In the first procedure the receipt of two initial address messages would call for the contents to be compared. Should the two be identical, one or the other is discarded; should the two be different, the call can be rejected by sending a confusion signal in the backward direction.

On receipt of the confusion signal, the outgoing international exchange will send a clear-forward signal for the circuit in question, after which an automatic repeat attempt should be made of the call which is to be completed.

In the second procedure the receipt of two initial address messages would call for the first to be discarded and the other to be used.

RECOMMENDATION Q.268

4.8 RELEASE OF INTERNATIONAL CONNECTIONS AND ASSOCIATED EQUIPMENT

4.8.1 Normal release conditions

a) Address and routing information stored at the outgoing international exchange can be erased on receipt of the appropriate backward signal(s) as covered in section 4.1 or when the connection is cleared earlier by the outgoing international exchange.

b) Address and routing information stored at the incoming international exchange can be erased when the appropriate signal(s) as covered in section 4.1 has been sent to the outgoing international exchange, or on receipt of a clear-forward signal.

c) Address and routing information stored at an intermediate transit exchange can be erased on receipt of the appropriate signal(s) as covered in section 4.1 or on receipt of a clear-forward signal.

4.8.2 Abnormal release conditions

4.8.2.1 *Outgoing international exchange*

An outgoing international exchange shall

a) release all equipment and clear-forward the connection in the following cases:

- failure to receive one of the signals address-complete, address-incomplete, or one of the signals check-OK, check-not-OK within 20-30 seconds after sending the last address message, or
- failure to receive a release-guard signal within 4-15 seconds after sending a clear-forward signal;

b) repeat the blocking or unblocking signal and alert maintenance personnel on:

- failure to receive an acknowledgement signal in response to either the blocking or unblocking signals within 4-15 seconds.

In this connection the end originating the blocking or unblocking signal is considered to be the outgoing end of the circuit.

4.8.2.2 *Incoming international exchange*

An incoming international exchange shall

a) release all equipment and clear-forward the connection into the national network in the following cases:

- failure to receive a national address-complete or address-incomplete signal (where expected) within 10-15 seconds after receipt of the last address message. An address-incomplete signal should be sent to the outgoing international exchange;
- failure to receive a continuity signal (link-by-link checking) within 10-15 seconds after receipt of the initial address message;

b) remove the outgoing terminal of the incoming circuit from service and send a blocking signal:

- on failure to receive a blocking signal within 4-15 seconds after sending a check-not-OK signal.

4.8.2.3 *Intermediate transit exchange*

An intermediate transit exchange shall

a) release all equipment and clear-forward the connection:

- on failure to receive the check-OK or check-not-OK signal in 20-30 seconds after sending the last address message,
- on failure to receive a release-guard signal within 4-15 seconds after sending a clear-forward signal, or
- on failure to receive a continuity signal (link-by-link checking) within 10-15 seconds after receipt of the initial address message.

b) remove the outgoing terminal of the incoming circuit from service and send a blocking signal:

- on failure to receive a blocking signal within 4-15 seconds after sending a check-not-OK signal.

CHAPTER V

Continuity check of the speech path

RECOMMENDATION Q.271

5.1 GENERAL

Facilities should be provided for making a continuity check of the speech path. This check should be made on a "per call" basis prior to the commencement of conversation.

The check is introduced because the signalling in system No. 6 does not pass over the speech path. The check is not intended to eliminate the need for systematic testing of the transmission path.

This specification relates only to that part of an international connection served by signalling system No. 6. The part of the speech path to be checked may include a TASI circuit.

Alternative methods of checking are described; one employing an end-to-end check and the other checking link-by-link. Both methods are based on a loop-checking technique as described hereafter.

As the presence of an echo suppressor which is required to be active in the circuit would interfere with the continuity check it is necessary to disable the suppressors during the check and to re-enable them after the check has been completed.

5.2 END-TO-END METHOD

5.2.1 Preparations for continuity checking

The circuit should be prepared for continuity checking by connecting the check loop to the GO and RETURN paths of the outgoing circuit at the first No. 6 exchange. The transceiver (check-tone transmitter and receiver) should be connected to the GO and RETURN paths at the last exchange of the part of the connection served by signalling system No. 6. During the setting-up of a connection it is necessary to determine at each intermediate transit exchange whether the speech path should be extended, or terminated in the transceiver.

5.2.2 Transmission considerations for the continuity check

5.2.2.1 *Transmitting equipment*

The check-tone frequency should be 2100 ± 20 Hz.
The sending level of the check tone should be —9 ± 1 dBm0.

5.2.2.2 *Check loop*

The check loop should have a loss of 3 dB, taking into account any difference between the relative levels of the two paths at the point of attachment.

5.2.2.3 *Receiving equipment*

The check-tone receiver has the following operating requirements:

Signal frequency:	2100 ± 100 Hz
Signal level range:	—25 to 0 dBm0
Recognition time:	30-60 ms.

The non-operating requirements are:

Signal frequency:	outside the frequency band 1900-2300 Hz,
Signal level:	below —35 dBm0, or
Signal duration:	shorter than 30 ms.

The level range of —25 to 0 dBm0 will serve as a GO/NO-GO check on that part of an international connection served by the signalling system No. 6. This part of the connection may consist of up to 6 GO and 6 RETURN paths. The check-tone receiver should, however, have adjustments to narrow the acceptable level values should the transmission conditions so permit.

5.2.3 Continuity-check signals

A response of the check-tone receiver will lead to the emission of a check-OK signal in the backward direction to cause the disconnection of the check loop at the first No. 6 exchange and the reconnection of the speech path. Should the check-tone receiver fail to respond within the prescribed time, a check-not-OK signal should be emitted in the backward direction to allow an automatic repeat attempt to be made (see Recommendation Q.264). The check-not-OK signal should be emitted if the receiver has not responded in 2-3 seconds.

5.2.4 Timing requirements

The connection and disconnection of the equipment used for the continuity check and also the disabling and subsequent enabling of echo suppressors should be related to the following stages of progress in the establishment of the connection.

a) *Preparation at first No. 6 exchange.* — Action should be initiated at the termination of the handling time T_h of the initial address message, i.e. when it is inserted in the output buffer and is available for emission.

b) *Preparation at last No. 6 exchange.* — Action should be initiated as soon as it is known that this is the last system No. 6 exchange.

c) *Disconnection at last No. 6 exchange.* — Action follows the response of the check-tone receiver or the emission of signals indicating that the call cannot be established, e.g. circuit-group-congestion signal.

d) *Disconnection at first No. 6 exchange.* — Action should be initiated at the moment of recognition of the check-OK signal, answer signals or signals indicating that the call cannot be established.

e) *Action at intermediate No. 6 exchange.* — The disabling and enabling of echo suppressors, where necessary, should be initiated by the controls listed above for the first No. 6 exchange.

The recommended mean time for connection and disconnection is 100 ms. A mean time of 200 ms should not be exceeded.

5.3 LINK-BY-LINK METHOD

5.3.1 Preparations for continuity checking

The circuit should be prepared for continuity checking by connecting the check loop to the GO and RETURN paths of the outgoing circuit at the first and each succeeding exchange, excluding the last exchange, in that part of the international connection served by signalling system No. 6. The transceiver (check-tone transmitter and receiver) should be connected to the GO and RETURN paths of the incoming circuit at each exchange except the first in that part of the international connection served by the signalling system No. 6.

5.3.2 Transmission considerations for the continuity check

5.3.2.1 *Transmitting equipment*

The check-tone frequency should be 2100 ± 20 Hz.
The sending level of the check tone should be -9 ± 1 dBm0.

5.3.2.2 *Check loop*

The check loop should have a loss of 3 dB, taking into account any difference between the relative levels of the two paths at the point of attachment.

5.3.2.3 *Receiving equipment*

The check-tone receiver has the following operating requirements:

Signal frequency:	2100 ± 100 Hz
Signal level range:	—18 to —6 dBm0
Recognition time:	30-60 ms.

The non-operating requirements are:

Signal frequency:	outside the frequency band 1900-2300 Hz,
Signal level:	below −22 dBm0, or
Signal duration:	shorter than 30 ms.

The level range of −18 to −6 dBm0 will serve as a GO/NO-GO check on the links in that part of the international connection served by the signalling system No. 6.

5.3.3 Continuity-check signals

After a positive continuity check in an intermediate No. 6 exchange, signals are sent in each direction:

- a check-OK signal sent in the backward direction for causing the disconnection of the check loop, and
- a continuity signal sent in the forward direction.

Should the check-tone receiver fail to respond, a check-not-OK signal should be emitted in the backward direction to allow an automatic repeat attempt to be made (see Recommendation Q.264). The check-not-OK signal should be emitted if the receiver has not responded in 0.75 to 1.25 seconds.

5.3.4 Timing requirements

The connection and disconnection of the equipment used for the continuity check and also the disabling and subsequent enabling of echo suppressors should be related to the following stages of progress in the establishment of the connection:

a) *Preparation at No. 6 exchange connecting the check loop.* — Action should be initiated at the termination of the handling time T_h of the initial address message, i.e. when it is inserted in the output buffer and is available for emission.

b) *Preparation at No. 6 exchange applying the transceiver.* — Action should be initiated at the moment of recognition of the initial address message received.

c) *Disconnection at No. 6 exchange applying the transceiver.* — Action follows the response of the check-tone receiver or the emission of signals indicating that the call cannot be established, e.g. circuit-group-congestion signal.

d) *Disconnection at No. 6 exchange connecting the check loop.* — Action should be initiated at the moment of recognition of the check-OK signal, answer signals or signals indicating that the call cannot be established.

The recommended mean time for connection and disconnection is 100 ms. A mean time of 200 ms should not be exceeded.

CHAPTER VI

Signalling link

RECOMMENDATION Q.272

6.1 TRANSMISSION REQUIREMENTS FOR THE DATA LINK

6.1.1 General

a) The data link shall be made up of standard international voice-frequency channels, either 3 kHz or 4 kHz spaced, and associated modems. The overall transmission characteristics of the voice-frequency channels must be equalized if necessary to meet the recommendations of section 6.1.2.

b) To reduce the possibility of the initial verbal answer of the called party being distorted or clipped, the propagation time of the voice-frequency link should be as low as possible and should not be greater than that of any speech circuits with which it is associated.

c) The data channel should have a nominal bit error rate of no greater than one bit error in 10^5 bits received in normal operation (see Recommendation Q.276, section 6.6.1).

d) The data link shall be dedicated to the use of a system No. 6 between two points, the only switching to be provided being that required for the security arrangements (see Recommendation Q.292).

e) A means must be furnished for disabling the echo suppressors associated with the reserve circuits. Disabling may be accomplished by local action by the processor at each terminal, if the reserve consists of a single link, or in any case by the use of the echo suppressor disabling frequency 2100 Hz (section C of Recommendation G.161).

6.1.2 Transmission characteristics of the voice-frequency channel

The following transmission characteristics are based on those given in Recommendation M.102, section 3, *White Book*, Volume IV.

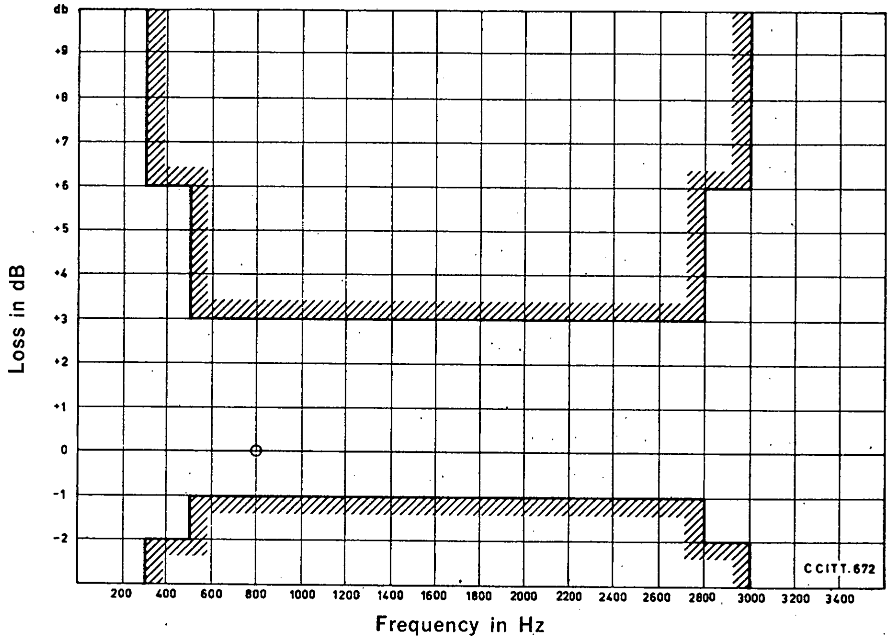

FIGURE 10. — **Permissible variation of overall loss with frequency for the voice-frequency channel**

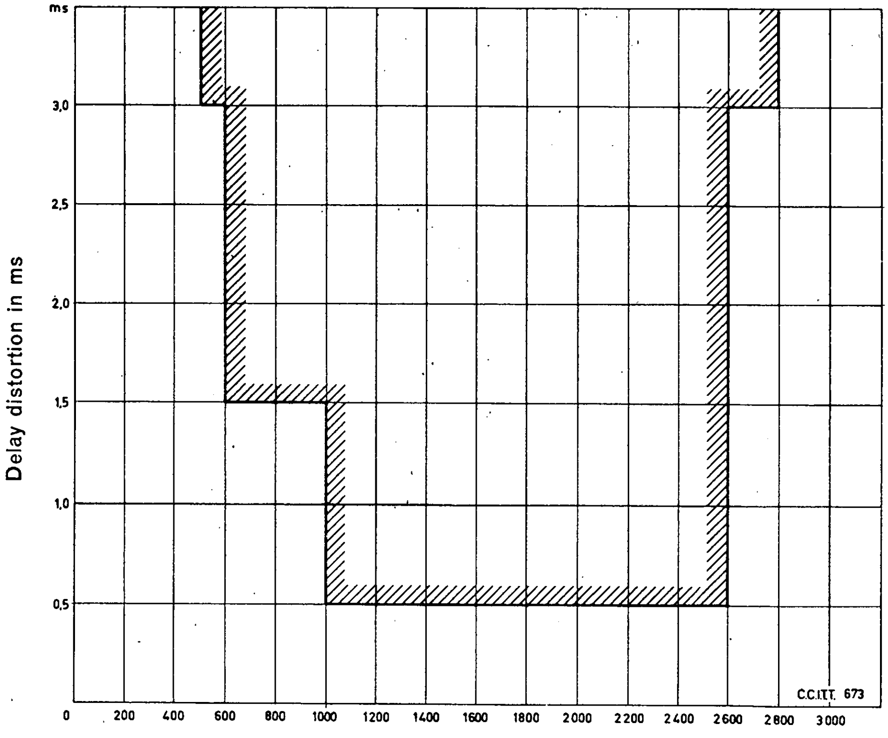

FIGURE 11. — Permissible variation of overall delay distortion with frequency for the voice-frequency channel

a) Overall loss at 800 Hz — The voice-frequency channel loss at 800 Hz should be nominally zero *.

b) Variation of overall loss at 800 Hz — The variation with time of the overall loss at 800 Hz should be as small as possible but should not exceed the following limits:

Short-term variation . . . . (over a period of a few seconds)	±3 dB
Long-term variation . . . . (over long periods including daily and seasonal variations).	±4 dB

c) Attenuation/frequency distortion — The variation of the overall loss of the channel with frequency over the range of 300 to 3000 Hz should not exceed the limits shown in Figure 10.

d) Delay/frequency distortion — The delay/frequency distortion in the band of frequencies from 500 to 2800 Hz should not exceed the limits given in Figure 11. It will be necessary to select channels and/or provide suitable delay distortion equalizers to ensure that these limits are not exceeded **. In addition, it may be necessary to restrict the number of 3 kHz-spaced channels used in any data link.

e) Uniform spectrum random circuit noise — The value of the uniform spectrum noise for the voice-frequency channels should not exceed a mean value of 7.7 millivolts psophometric at a zero relative level point, measured across a 600-ohm pure resistance (−40 dBm0p) ***.

f) Impulsive noise — Impulsive noise on the voice-frequency channel should not exceed 70 noise peaks per hour greater than −24 dBm0 (long-term average) ****.

6.1.3 Nominal data power level

The nominal data power level will be −15 dBm0*****.

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* Recommendation M.102 covers the loss of the extensions between renters' premises and the international exchanges as well as the international section and allows up to 13 dB (15 dNp) total loss. In the system No. 6 application these extensions do not exist.

** Where security is provided by the use of a full-time reserved TASI *circuit* this characteristic may not be met unless all TASI *channels* are equalized.

*** In Recommendation V.55 a new noise weighting is recommended to be used in place of the psophometric weighting for data transmission. At this time, there is no conversion factor available for the new weighting, so dBm0p is used.

**** Recommendation M.102 states that the impulsive noise requirements are under study. The value given is based on the annex to Recommendation V.55, modified for a nominal data power level of −15 dBm0. The measurement instrument is described in Recommendation V.55.

***** Recommendations H.41, M.102 and V.2 of the *White Book* allow a power level of −10 dBm0 when no more than 5% of the channels in a multichannel system are used for non-speech applications simultaneously in both directions. If the proportion of channels in this type of service is considerably more than 5%, the power should be reduced. Recommendation Q.15 allows a mean absolute power level of −15 dBm0.

RECOMMENDATION Q.273

6.2 DATA TRANSMISSION RATE

6.2.1 Preferred rate

The preferred data transmission rate on analog channels is 2400 bits per second.

6.2.2 Exceptionally allowed rate

The data transmission rate of 2000 bits per second is exceptionally allowed as:

a) the rapid development of pulse code modulation transmission systems may make it desirable to use a submultiple of 8000 bits per second;

b) the use of randomly selected telephone connections to serve as a data link for security purposes may preclude the use of 2400 bits per second (see Recommendation Q.292, section 8.4.4);

c) the data rate of 2000 bits per second may be used for the common channel signalling systems within national (or regional) networks and these networks may carry international traffic as well.

RECOMMENDATION Q.274

6.3 MODULATION METHOD

The modulation technique described in this recommendation uses phase shift keying to transmit serial binary data over analog telephone channels. The binary data signal is encoded by first grouping it into bit pairs or dibits. Each dibit is represented by one of four possible carrier phase shifts. Thus, the line signal from the phase modulator consists of a serial train of phase-shifted carrier pulses at half the data bit rate. The phase shift between the previous and the present signalling element contains the information to be transmitted.

In the data transmitter, the bit timing and carrier frequency are derived from the same source to facilitate receiver timing recovery.

The data set receiver uses differentially coherent detection to recover the sense of the binary data from the line signal. This type of detection has proven to be relatively insensitive to the types of distortions and interference encountered on telephone type transmission facilities. It also allows rapid recovery from such catastrophic impairments as drop-outs and large phase hits.

Receiver timing recovery can be accomplished in several ways. A very rapid timing recovery scheme can be provided using certain properties of the transmitted spectrum.

Receiver timing information can also be extracted from the zero crossings, on a dibit basis, of the received baseband data signals. The latter method is capable of providing synchronization holdover through extended drop-outs and periods of high noise.

6.4 MODEM REQUIREMENTS

6.4.1 Principal requirements

The principal requirements for a modem for the system No. 6 are as follows:

a) Use of differential four-phase modulation; *

b) Use of differential coherent four-phase demodulation;

c) Full duplex operation over a four-wire data link·

d) A modulation rate of 1200 bauds **;

e) A bit rate of 2400 bits per second **.

6.4.2 Frequency requirements

a) The basic timing frequency shall be 2400 Hz (one cycle per bit);

b) The carrier frequency shall be 1800 Hz;

c) The carrier envelope frequency shall be 600 Hz (see section 6.4.4);

d) All frequencies generated in the modem shall have a stability of at least 0.005%. They must have a constant phase relationship with respect to one another ***.

6.4.3 Encoding phase relationships

The encoding phase relationships must be as follows:

Dibit	*Phase shift* ****	*Vector shift* ****
11	+ 45 degrees	−135 degrees
10	+135 degrees	− 45 degrees
00	−135 degrees	+ 45 degrees
01	− 45 degrees	+135 degrees

---

* See *Blue Book*, Volume VIII, Supplement 49 for details of modulation method.

** Except for the conditions of section 6.2.2 of Recommendation Q.273. The requirements for a 2400-bits-per-second modem only will be given.

*** This implies that all frequencies should be derived from a basic clock or that they be phase-locked.

**** Phase shift refers to the phase difference between the phase of the line signal at a given point on a signalling element to the phase at a corresponding point (1/1200 second earlier) on the previous signalling element. The term vector shift is the actual on-line phase shift from one signalling element to the next.

6.4.4 Line signal envelope

The data carrier pulse shape can be closely approximated by the following expression for a signal element centred at $t = 0$ (see Figure 12):

$$\text{Envelope } (t) = \frac{\cos\frac{2\pi f_d . t}{2} - \cos\frac{2\pi f_d \cdot \frac{3}{4}T}{2}}{1 - \cos\frac{2\pi f_d \cdot \frac{3}{4}T}{2}}$$

$$\text{for } -\tfrac{3}{4}T \leqslant t \leqslant \tfrac{3}{4}T$$

and

$$\text{Envelope } (t) = 0 \text{ for } -T \leqslant t \leqslant -\tfrac{3}{4}T \text{ and}$$
$$\tfrac{3}{4}T \leqslant t \leqslant T$$

where f_d = the dibit rate of 1200 Hz
and T = the dibit period of 1/1200 s.

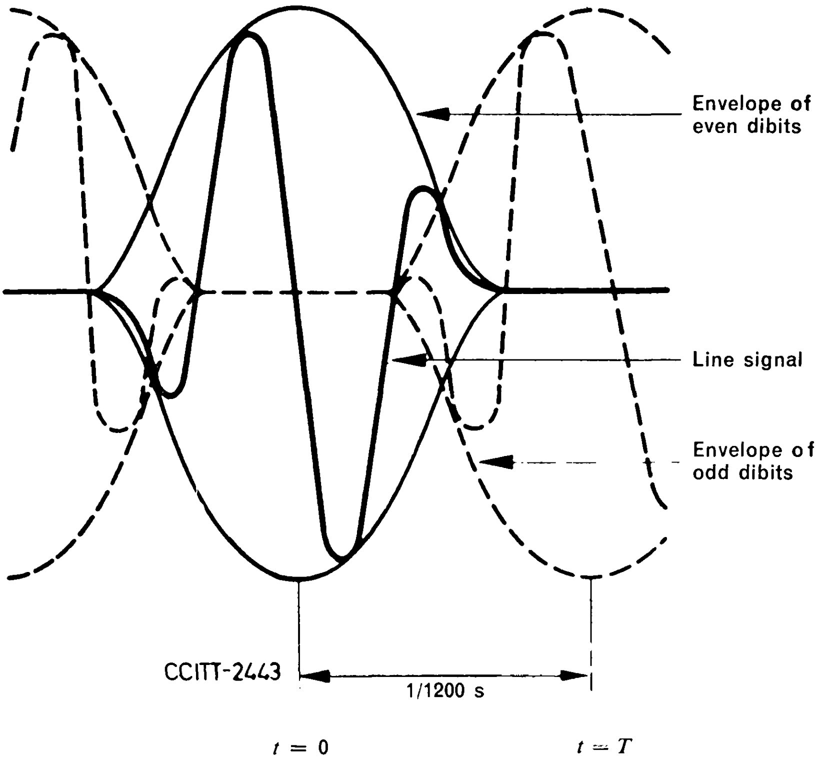

FIGURE 12. — Composite line signal

6.4.5 Line power spectrum

The line power spectrum produced by the transmission of random data is shown in Figure 13. The spectral lines produced by the transmission of repeated dibits (using the encoding phase relationship of section 6.4.3) are also shown.

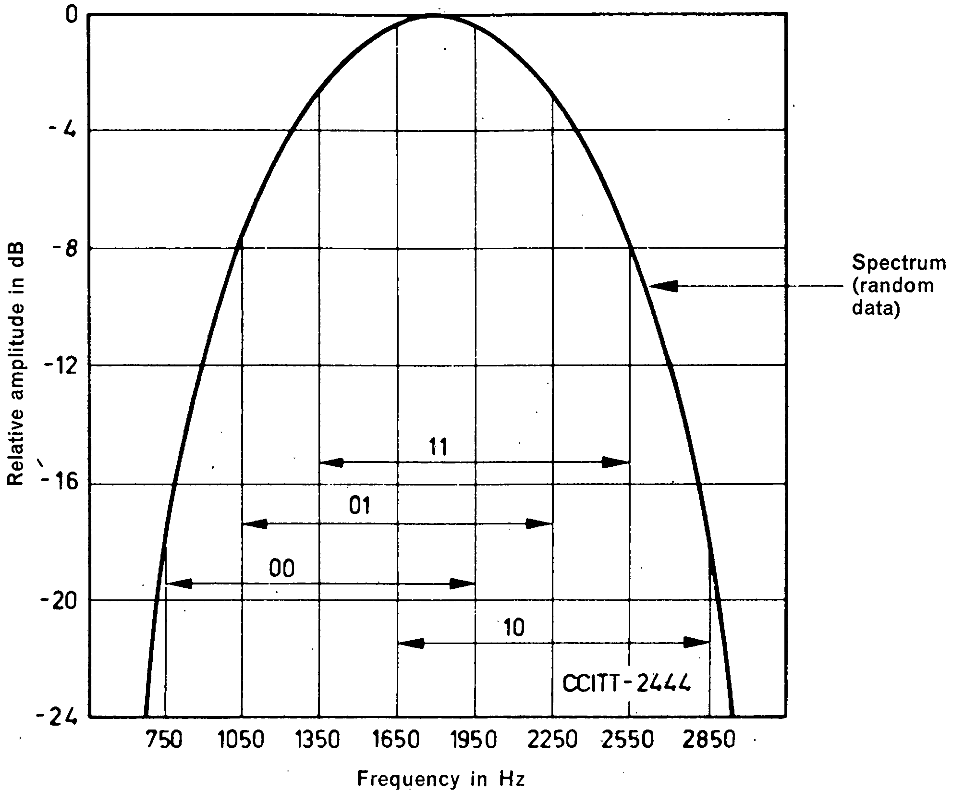

FIGURE 13. — Line power spectrum

6.4.6 Transmitter requirements

a) The transmitter output level shall be —15 ±1 dBm0 (see also Recommendation Q.272, section 6.1.3).

b) The transmitting signalling terminal should derive its timing from the basic timing frequency of the modem transmitter *.

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* It is desirable to operate in this manner as the eventual use of pulse code modulation transmission systems may require it.

6.4.7 Receiver requirements

a) The receiver sensitivity range shall be at least -15 ± 8 dBm0 (see section 6.4.6 and Recommendation Q.272, section 6.1.2).

b) The modem receiver should be capable of establishing bit synchronization as fast as possible, but in any case within 150 milliseconds while receiving synchronization signal units.

c) The receiver shall maintain bit synchronization with the distant transmitter during a loss of data carrier of one second or less after initial bit synchronization has been established.

d) The receiving signalling terminal should derive its timing from the modem receiver timing frequency.

6.4.8 Interface requirements

Each Administration may at its discretion integrate the modem into the signalling terminal equipment or use a separate modem. If the modem is a separate unit, then the interface recommendations of Recommendation V.24, Volume VIII, *Blue Book*, should be followed in so far as possible.

RECOMMENDATION Q.275

6.5 DATA CARRIER FAILURE DETECTOR

6.5.1 General

A data carrier failure detector is required to supplement the eight-bit cyclic code in the error detection system. A failure signal from the data carrier failure detector indicating unsatisfactory data transmission conditions should be given to the terminal for use in the error control equipment (see Recommendation Q.277, section 6.7.2).

6.5.2 Requirements

a) The data carrier failure detector is required to indicate failure when transmission becomes unsatisfactory because of decreased carrier level. A failure should be indicated when the received carrier is below the minimum sensitivity of the modem used, and should indicate no failure when the level is above -23 dBm0.

b) The detector is required to detect the loss of carrier even though the decrease in carrier power may be accompanied by an increase in noise power. If a signal guard technique is used to distinguish carrier power from noise power, the received spectrum from 300 Hz to 500 Hz should be used to detect the amount of noise power.

c) The indication of failure or of re-established carrier should have a nominal delay of 5 milliseconds with limits of 4 milliseconds minimum and 8 milliseconds maximum.

6.5.3 Interface

The interface between the data carrier failure detector and the terminal should follow the provisions of Recommendation V.24, circuit 109, in Volume VIII.

RECOMMENDATION Q.276

6.6 SERVICE DEPENDABILITY

6.6.1 Dependability requirements

It is expected that data transmitted at 2400 bits per second with four-phase modulation over a voice-frequency link as specified will result in a bit error rate of approximately 1 in 10^5. This figure excludes interruptions exceeding 350 milliseconds in length. The following dependability requirements should be obtained with signalling links having such characteristics. These requirements refer to each signalling link.

a) Signal units which carry telephone signal information and which are delayed as a consequence of correction by retransmission:

not more than one in 10^4 of such signal units to be delayed as a long-term average.

b) Signal units of any type which give rise to wrongly accepted signals due to undetected errors and causing false operation (e.g., false clear-back signal):

not more than one error in 10^8 of all signal units transmitted.

c) As in item b) but causing serious false operation (e.g., false metering or false clearing of a connection):

not more than one error in 10^{10} of all signal units transmitted.

d) Interruption to the signalling service (including both normal and reserve links):

interruption of duration between 2 seconds and 2 minutes—not more than once a year; interruption of duration exceeding 2 minutes—not more than once in 10 years.

Items a), b) and c) assume one telephone signal per signal unit. Results for a multi-unit message will be at least comparable to those for one-unit messages transmitting the same information.

6.6.2 Retransmission considerations

The requirement 6.6.1 a) is inserted to limit the percentage of the answer signals which are delayed through the retransmission process. The amount of retransmission depends on the number of bits in the signal units and on interferences such as those caused by short interruptions and intermittent bursts of noise up to the point at which switch-over to the reserve link occurs.

6.6.3 Undetected error considerations

The requirements 6.6.1 b) and c) relate to undetected errors and are likely to be largely due to disturbance of the synchronization signal units. The undetected signal unit error rate will be a function of the number of check bits and the use of the data carrier failure detector; only a percentage of the signal units with undetected errors will be labelled for working circuits and, again, only a percentage of such signals will be meaningful. The percentage of false signals will depend on the maximum number of speech circuits served by the data signalling link. This number has not been established.

6.6.4 Service-interruption considerations

Requirement 6.6.1 d) depends very largely on the performance of the voice-frequency links assigned for signalling. Precautions should be taken in the design of the terminal equipments to ensure that their contribution to the total is relatively small.

RECOMMENDATION Q.277

6.7 ERROR CONTROL

6.7.1 Error detection by the use of check bits

Disturbance to an SU during transfer will be detected by the use of coders and decoders connected at the transmitting and receiving terminals respectively. The coder will generate 8 check bits based on the polynomial $x^8 + x^2 + x + 1$ (see Table 1 for the matrix and for a typical implementation) *.

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* During the field trial period it is proposed that two further codes should be tested:

a) 7-bit check code with polynomial $x^7 + x^6 + x^2 + 1$ (see Table 2);

b) 6-bit check code with polynomial $x^6 + x^5 + x^3 + x^2 + x + 1$ (see Table 3).

These check bits will constitute bits 21-28 of each SU and are inverted before transmission to provide protection against a single bit slip of synchronization.

When the decoder at the receiving terminal has received all 28 bits of an SU after the check bits have been reinverted it will indicate whether or not the SU has checked correctly. This information will be stored for inclusion in the acknowledgement field of an ACU to be emitted in the return direction. An ACU will be transmitted after each 11 signal units to form a block.

6.7.2 Error detection by data carrier failure detector

A data carrier failure detector will supplement the error detection by the use of check bits. Indication of data carrier failure due to unsatisfactory transmission conditions will cause the rejection of signal units in the process of reception. Regardless of the result of decoding, the ACU should acknowledge the signal unit as received incorrectly.

6.7.3 Error correction

Correction is achieved by retransmission of the messages which are not acknowledged to have been received correctly. The contents of the ACU has been described in Recommendation Q.258, section 3.2.1. The acknowledgement indicators should be transmitted in the same sequence as the SU to which they refer.

A retransmission to comply with the information in the ACU will be made possible by storing at the transmitting terminal the signal units with their block reference numbers at the time of emission. This record must be maintained until the receipt of the associated ACU when the record of messages which are acknowledged to have been correctly received should be eliminated. In the case of multi-unit messages the complete message should be retransmitted if any of its constituent signal units fail to check correctly. A multi-unit message may contain signal units which are transmitted in two adjacent blocks, but it must be ensured that the records of the constituent signal units of the multi-unit message remain until the acknowledgement indicators show that the complete multi-unit message has been received correctly.

The messages, which are not acknowledged to have been correctly received should be presented for retransmission, at which time the record of their previous transmission should be eliminated. The exception to the general rule is that acknowledgement and synchronization signal units should never be retransmitted.

All signal units in a block except the SYU and ACU must be retransmitted if the ACU referring to that block is not received correctly. This may arise owing to the fact that the ACU fails to check correctly on account of errors during transmission or owing to drift between the data streams in the two directions (see Recommendation Q.279).

The invariable pattern 0 1 1 for the first three bits of the acknowledgement signal unit may be used for identification purposes (see Recommendation Q.258, section 3.2.1.2). If the ACU checks to be error-free and the pattern is correct the possibility of any undetected error is extremely small.

TABLE 1

EIGHT-BIT CHECK CODER

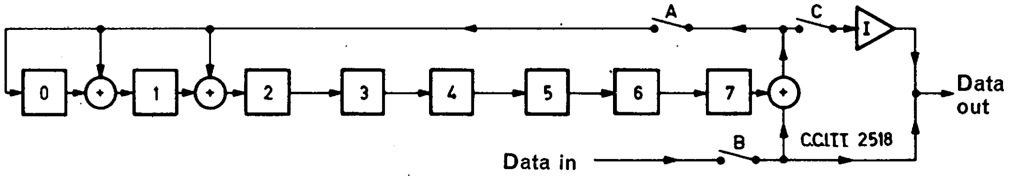
Eight-bit check code matrix

	1	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}	b_{13}	b_{14}	b_{15}	b_{16}	b_{17}	b_{18}	b_{19}	b_{20}
c_7	1	0	1	1	0	1	0	1	0	1	0	0	0	1	1	1	0	0	0	0	0
c_6	1	1	0	1	1	0	1	0	1	0	1	0	0	0	1	1	1	0	0	0	0
c_5	1	0	1	0	1	1	0	1	0	1	0	1	0	0	0	1	1	1	0	0	0
c_4	1	1	0	1	0	1	1	0	1	0	1	0	1	0	0	0	1	1	1	0	0
c_3	1	0	1	0	1	0	1	1	0	1	0	1	0	1	0	0	0	1	1	1	0
c_2	1	0	0	1	0	1	0	1	1	0	1	0	1	0	1	0	0	0	1	1	1
c_1	1	0	1	1	1	1	1	1	1	0	0	1	0	0	1	0	0	0	0	1	1
c_0	1	1	1	0	1	0	1	0	1	0	0	0	1	1	1	0	0	0	0	0	1

The *ones* in a row of the matrix under b_1 .... b_{20} indicate those bits that should be *added modulo 2* to determine the check bit indicated at that row.

The *inversion* of the check bits is shown in this matrix by column 1.

Typical shift register coder implementation



When information bits are being transmitted: Switches A and B closed, C open.

When check bits are being transmitted: Switches A and B open, C closed.

Shift registers in coders should be zero set at start.

Eight-bit check code

Polynomial: $p(x) = (x + 1)(x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + 1) = x^8 + x^2 + x + 1$

Code name: Primitive polynomial plus parity check.

Information bits: $b_1 \ldots. b_{20}$, check bits: $c_7 \ldots. c_0$.

Sequence on the line: b_1 (first) $b_2 \ldots. b_{19}\, b_{20}\, c_7\, c_6 \ldots c_1\, c_0$ (last).

TABLE 2

SEVEN-BIT CHECK CODER

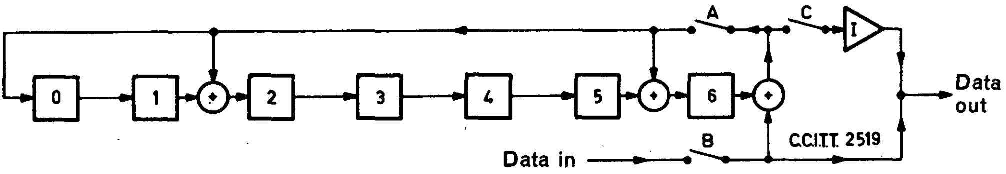
Seven-bit check code matrix

	1	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}	b_{13}	b_{14}	b_{15}	b_{16}	b_{17}	b_{18}	b_{19}	b_{20}
c_6	1	0	1	1	0	1	0	1	1	1	0	0	1	1	1	1	0	1	1	1	1
c_5	1	0	1	0	1	1	1	1	0	0	1	0	1	0	0	0	1	1	0	0	0
c_4	1	0	0	1	0	1	1	1	1	0	0	1	0	1	0	0	0	1	1	0	0
c_3	1	0	0	0	1	0	1	1	1	1	0	0	1	0	1	0	0	0	1	1	0
c_2	1	1	0	0	0	1	0	1	1	1	1	0	0	1	0	1	0	0	0	1	1
c_1	1	1	0	1	0	1	1	1	0	0	1	1	1	1	0	1	1	1	1	1	0
c_0	1	1	1	0	1	0	1	1	1	0	0	1	1	1	1	0	1	1	1	1	1

The *ones* in a row of the matrix under b_1 .... b_{20} indicate those bits that should be *added modulo 2* to determine the check bit indicated at that row.

The *inversion* of the check bits is shown in this matrix by column 1.

Typical shift register coder implementation



When information bits are being transmitted: Switches A and B closed, C open.
When check bits are being transmitted: Switches A and B open, C closed.
Shift registers in coders should be zero set at start.

Seven-bit check code

Polynomial: $p(x) = (x + 1)(x^6 + x + 1) = x^7 + x^6 + x^2 + 1$

Code name: Primitive polynomial plus parity check.

Information bits: $b_1 \ldots . b_{20}$, check bits: $c_6 \ldots . c_0$.

Sequence on the line: b_1 (first) $b_2 \ldots . b_{19}\, b_{20}\, c_6\, c_5 \ldots . c_1\, c_0$ (last).

TABLE 3

SIX-BIT CHECK CODER

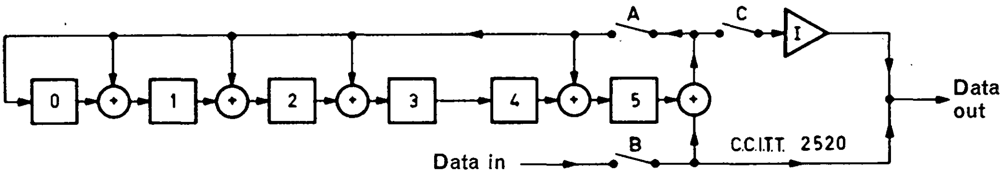
Six-bit check code matrix

	1	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9	b_{10}	b_{11}	b_{12}	b_{13}	b_{14}	b_{15}	b_{16}	b_{17}	b_{18}	b_{19}	b_{20}
c_5	1	0	1	1	0	1	1	1	1	0	1	0	1	0	0	0	1	0	0	1	1
c_4	1	1	1	0	1	1	0	0	0	1	1	1	1	1	0	0	1	1	0	1	0
c_3	1	1	1	1	0	1	1	0	0	0	1	1	1	1	1	0	0	1	1	0	1
c_2	1	0	0	0	1	1	0	0	1	0	1	1	0	1	1	1	1	0	1	0	1
c_1	1	0	1	1	0	0	0	1	1	1	1	1	0	0	1	1	0	1	0	0	1
c_0	1	1	1	0	1	1	1	1	0	1	0	1	0	0	0	1	0	0	1	1	1

The *ones* in a row of the matrix under b_1 .... b_{20} indicate those bits that should be *added modulo 2* to determine the check bit indicated at that row.

The *inversion* of the check bits is shown in this matrix by column 1.

Typical shift register coder implementation



When information bits are being transmitted: Switches A and B closed, C open.

When check bits are being transmitted: Switches A and B open, C closed.

Shift-registers in coders should be zero set at start.

Six-bit check code

Polynomial: $p(x) = (x + 1)(x^5 + x^2 + 1) = x^6 + x^5 + x^3 + x^2 + x + 1$

Code name: Primitive polynomial plus parity check.

Information bits: b_1 .... b_{20}, check bits: c_5 .... c_0.

Sequence on the line: b_1 (first) b_2 .... b_{19} b_{20} c_5 c_4 .... c_1 c_0 (last).

RECOMMENDATION Q.278

6.8 SYNCHRONIZATION

The SYU will contain, in addition to the 8 check bits, a 16-bit pattern for bit and SU synchronization and a 4-bit number for block synchronization. The same 16-bit pattern will appear in every SYU. The 4-bit number will describe the position of the SYU within its block (see Recommendation Q.258, section 3.2.2).

Synchronization will be established in the following manner: both terminals will emit a series of blocks containing eleven SYU plus one ACU. The instant of commencement of emission at the terminals is immaterial.

After bit synchronism has been established in the demodulator, the incoming bit stream will be monitored to find the SYU pattern. The monitoring of the bit stream for the SYU pattern must take place before inversion of the check bits and decoding. Once this pattern is found and verified, the sequence number can be determined and the ACU position located.

In due course an ACU should be correctly received with its block number. The establishment of synchronization at a terminal will be signalled by information inserted in the ACU.

Until synchronization is achieved an ACU should contain a series of ones for the 11 acknowledgement indicators and a series of zeros for the 3-bit cyclic number of the block being acknowledged. The 3-bit cyclic number indicating the number of the block it completes should be systematically advanced by one for each new block.

When a terminal has established synchronization by recognition of the SYU pattern and has also received an ACU which checks correctly, it should include in the next ACU which it emits, the cyclic number of the block being acknowledged and an indication as to whether each of the signal units within that received block contains a detected error or not. The reception of an ACU which checks correctly and acknowledges one or several SU indicates that both terminals are in synchronism. This marks the time from which messages can be emitted in place of SYU (but not in place of ACU).

Bit synchronization is maintained by the transition between dibits; loss of synchronization will result in SU failing to check correctly. Loss of SU synchronism will result in continuous failure of SU to check. However, incorrect SU are more likely to result from line interference than loss of synchronism. Monitoring of the bit stream should result in the recognition of the 16-bit pattern of an SYU and enable synchronization to be restored if it had been lost.

RECOMMENDATION Q.279

6.9 DRIFT COMPENSATION

The difference in clock rates at the two terminations of a signalling link will result in a drift between the bit streams transmitted in the two directions.

The slower terminal will find at some stage that it has two blocks awaiting acknowledgement. When this occurs only the second (later block) should be acknowledged. On receipt of the acknowledgement of the second block the sending terminal will initiate the transmission of all messages in the first block as if they were received in error before proceeding with any necessary retransmission relating to the second block.

Moreover, the faster terminal will find at some stage that it has no complete new block to acknowledge in the ACU it is about to transmit. In this case the acknowledgement fields for the indicators and block number (bits 4 to 17) from the previous block are repeated. This ACU will be recognized to be a repetition by the cyclic number (bits 15 to 17) and should be ignored by the slow terminal. (See Recommendation Q.258, section 3.2.1.)

CHAPTER VII

Signal traffic characteristics

RECOMMENDATION Q.285

7.1 SIGNAL PRIORITY CATEGORIES

7.1.1 Rules for signal priority

The following rules for establishing priority categories must be followed in normal operation:

a) Acknowledgement signal units (12th signal unit of each block) have absolute priority for emission at their fixed predetermined positions.

b) The first answer signal of a call has priority over other waiting telephone signal messages.

c) All other telephone signals, one-unit or multi-unit messages, have priority over management or other signals concerned with the bulk handling of traffic.

d) Any signal which is to be retransmitted because of error detection will take precedence over other waiting signals in the same priority category.

e) Management signal messages have priority over synchronization signal units.

f) Synchronization signal units have no priority.

7.1.2 Break-in

a) Potential for a priority one-unit message to break into multi-unit messages is provided in the design of the format, but initially this feature will not apply.

b) In the event multi-unit messages are used for network-management signals, all telephone signals must have the potential to break into these messages.

RECOMMENDATION Q.286

7.2 SIGNALLING CHANNEL LOADING AND QUEUEING DELAYS

7.2.1 Loading potential

According to Recommendation Q.257, section 3.1.2.2, the system No. 6 design provides the potential in circuit labels to identify approximately 2000 telephone circuits. Considering that the load per signalling system will vary according to the traffic characteristics of the circuits served and the number of signals in use, it is not practicable to specify a general maximum limit of circuits that a system can handle. The maximum number of circuits to be served must be determined for each situation, taking into account the traffic characteristics which apply, so that the total signalling load is held to a level which will maintain an acceptable signalling delay value resulting from queueing.

7.2.2 Queueing delays

Common channel signalling systems handle the required signals for many circuits on a time-shared basis. With time-sharing, signalling delay occurs when it is necessary to process more than one signal in a given interval of time. When this occurs, a queue is built up from which signals are transmitted in order of their time of arrival and of their priority. Formulae, which are in close agreement with computer simulation tests and are recommended for calculating average queueing delays for the signals listed and the variables noted, are given in the Annex to this Recommendation.

ANNEX

(to Recommendation Q.286)

Queueing delay formulae for telephone signals

Answer signal: One-unit message with priority

$$Q_w = \frac{1 + (D - 1)a_d}{(1 - a_c)(1 - a_c - a_w)} \times \frac{T_e}{2} \tag{1}$$

Other telephone signals: One-unit message without priority

$$Q_o = \frac{1 + (D - 1)a_d}{(1 - a_c - a_p)(1 - a_c - a_w)} \times \frac{T_e}{2} \tag{2}$$

Address signal: Multi-unit message without priority

$$Q_d = Q_o + \frac{(D - 1)a_c}{1 - a_c} \times T_e, \tag{3}$$

where Q_w, Q_o, Q_d = average queueing delay,
a_w = traffic of answer signals,
a_d = traffic of multi-unit address messages,
a_p = traffic of all telèphone signals,
a_c = traffic of acknowledgement (signal) units,
T_e = emission time of a signal unit,
D = number of SU's composing a multi-unit address message.

When multi-unit address messages are of different length, the average queueing delay for the messages composed of D_i SU's is given by formula (3) using D_i for D. In formulae (1) and

(2), the following values should be used:

$$D = \frac{\sum D_i a_{di}}{a_d}, \text{ and } a_d = \sum a_{di}$$

where a_{di} is the traffic of the messages composed of D_i SU's.

Note 1. — The unit of traffic is the erlang. The traffic a_p includes a_w, a_d and the traffic of other one-unit messages, but excludes a_c.

Note 2. — These formulae include the effects of systematic delay (due to synchronous operation and block composition) and of traffic delay, but do not include the emission time of the signal message and the delay resulting from eventual retransmission of signal messages.

Note 3. — In addition, formula (3) includes the effect of break-in by acknowledgement (signal) units.

Note 4. — Signal units of lower priority, e.g., management (signal) units and synchronization (signal) units, have no influence on the delay of telephone signals.

Example of queueing delays

The traffic model assumed is given in Table 4, from which the proportion of signal traffic may be obtained as shown in Table 5.

Using Table 5, average queueing delays are calculated as shown in Figure 14.

TABLE 4. — *Traffic model*

Sending procedure			"En bloc"				Overlap			
Type of call			AW	SB	CC	AB	AW	SB	CC	AB
Percent calls			30	10	5	5	30	10	5	5
Messages per call	Address	5-SU	1	1	1	0				
		3-SU					1	1	1	1
		2-SU					1	1	0	1
		1-SU					3	3	0	0
	Answer		1	0	0	0	1	0	0	0
	Other		6.5	6	3	0	6.5	6	3	2

Note 1. — AW = answered, SB = subscriber busy and not answered, CC = circuit congestion, AB = abortive.

Note 2. — The assumptions used in this model are chosen for illustrative purposes, and should not be considered to be typical.

TABLE 5. — *Proportion of traffic*

Type of message		SUs per call	Percent traffic
Answer		0.60	5.0
Address	D = 5	2.25	18.8
	D = 3	1.50	12.5
	D = 2	0.90	7.5
Other		6.75	56.2
Total per call		12.00	100.0

Note. — In Table 5, "other" also includes the one-unit address messages.

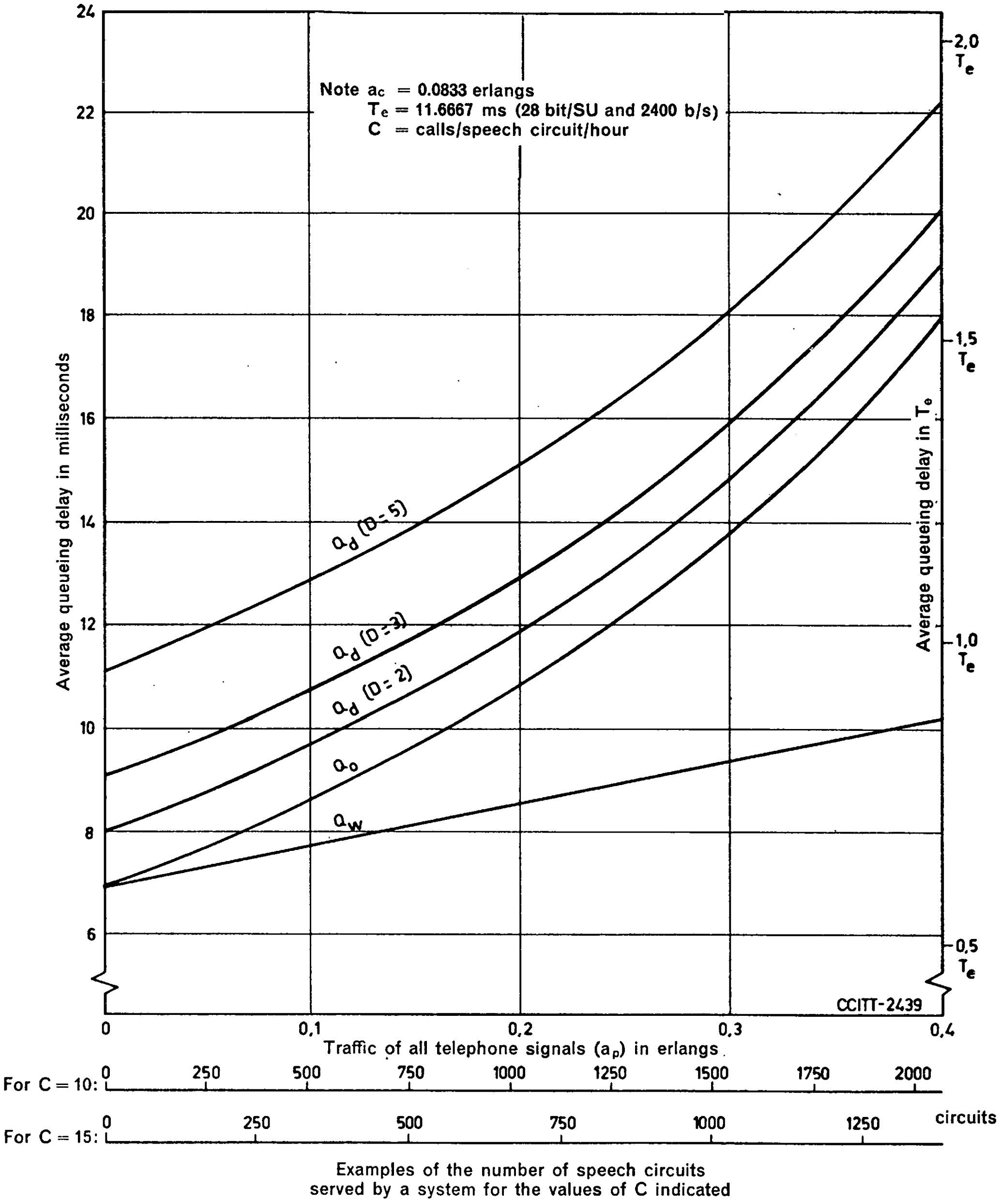


FIGURE 14. — Average queueing delays for traffic model shown in Table 4

RECOMMENDATION Q.287

7.3 SIGNAL TRANSFER TIME REQUIREMENTS

Signal transfer time should be fast so as not to lose the advantage of the fast signal transfer of the system No. 6. While no firm time requirements in regard to the various components of signal transfer time have been established, the Annex to this Recommendation contains design objectives in terms of average and 95% level time values for T_h and T_c for answer signals, other one-unit messages and the initial address message. These figures are to be viewed as reasonable objectives and not as firm requirements.

ANNEX

(to Recommendation Q.287)

Estimates for transfer times

1. *Design objectives*

The design objectives for the handling time T_h, and the cross office transfer time T_c are shown in Table 6.

TABLE 6. — *Design-objectives*

Type of message		Answer	Other one-unit messages	IAM of 5 SU
T_h in ms	Average	12	25	25
	95% level	25	60	60
T_c in ms	Average	40	60	120
	95% level	70	140	200

Note. — These figures have to be viewed as reasonable estimates and not as firm requirements.

2. *Calculation for cross-office transfer time*

Average value:

The average value of the cross-office transfer time, $T_{c\ \mathrm{AV}}$, is calculated by the following formula:

$$T_{c\ \mathrm{AV}} = T_r + T_{h\ \mathrm{AV}} + T_{s\ \mathrm{AV}}. \quad (1)$$

The average value of the sender transfer time, $T_{s\ \mathrm{AV}}$, is approximated as follows:

$T_{s\ \mathrm{AV}} = T_{q\ \mathrm{AV}} + T_m + T_e$, for one-unit messages (2a)

$T_{s\ \mathrm{AV}} = T_{q\ \mathrm{AV}} + T_m + (D \times T_e)$, for multi-unit messages (2b)

where T_e = emission time of a signal unit,
T_m = time for parallel to serial conversion, encoding and modulation,
T_r = receiver transfer time,
D = number of SUs composing a multi-unit message.

The average queueing delay, $T_{q\ \mathrm{AV}}$, is equivalent to Q_w, Q_o or Q_d which is calculated by the formula in the Annex to Recommendation Q.286.

95% level value:

The 95% level value of the cross-office transfer time, $T_{c\ 95\%}$, is approximated by the following formula:

$$T_{c\ 95\%} = T_{c\ \mathrm{AV}} + \sqrt{(\Delta T_h)^2 + (\Delta T_q)^2}, \tag{3}$$

where $\Delta T_h = T_{h\ 95\%} - T_{h\ \mathrm{AV}}$,
$\Delta T_q = T_{q\ 95\%} - T_{q\ \mathrm{AV}}$.

The 95% level value of the queueing delay, T_q (95%), may be determined by simulation.

Example:

Table 7 shows a calculated example of $T_{c\,\mathrm{AV}}$ and $T_{c\,95\%}$ for $a_p = 0.4$ erlang with the traffic model in the Annex to Recommendation Q.286. As a result of simulation for this model, it has been determined that $T_{q\ 95\%} = 3.5 \times T_{q\ \mathrm{AV}}$. The values of $T_{h\ \mathrm{AV}}$ and $T_{h\,95\%}$ are those assumed for Table 4, and $T_r = T_m = 2$ ms is assumed.

TABLE 7. — *Calculated example*

Type of message		Answer	Other one-unit messages	IAM of 5 SU
T_c in ms	Average	38	59	110
	95% level	65	115	167

CHAPTER VIII

Security arrangements

RECOMMENDATION Q.291

8.1 GENERAL

Since a common signalling link carries the signals for many speech circuits, a failure of this link will affect all the speech circuits served. Therefore, arrangements must be made to ensure continuity of service for the circuits.

The security arrangements involve the provision of reserve facilities, either by signalling links in the quasi-associated mode of operation, data links or speech circuits.

When the regular signalling link fails, the signalling traffic should be transferred to the reserve facility provided, but only after the proper preparations have been made. During the change-over period, measures must be taken to prevent exceeding the storage capacity of the failed signalling system. It is recommended that all free speech circuits should be made busy at once to permit the traffic to overflow to other routes which are serviceable. In case there is no overflow facility, appropriate circuit-group-congestion signals should be returned.

8.2 BASIC SECURITY REQUIREMENT

The basic security requirement is taken from the dependability requirements for interruption of signalling service (Recommendation Q.276, sections 6.6.1 d and 6.6.4.)

This requirement and other considerations make it desirable to open up the service of a reserve facility after a period of 350 ms during which faulty conditions persist.

Once the reserve facility has been taken into service, the regular signalling link should not be brought back into service for signalling traffic until it has been checked to be in normal operating condition for about one minute.

Should it happen that the reserve signalling link also fails, another reserve facility should be opened up. In case there is no other reserve facility available, a change back to the regular signalling link must take place as soon as this link is giving a reasonable service and even before the proving period of one minute is completed.

8.3 TYPE OF FAILURE AND FAILURE RECOGNITION

8.3.1 Type of failure

The interruption of signalling link service may be caused by several types of faults affecting the voice-frequency channels, the data modems or the signalling terminal equipment.

The failure may be indicated as follows:

a) loss of data carrier,
b) continuous failure of signal units to check correctly, or
c) unacceptable intermittent failure of signal units to check correctly.

8.3.2 Recognition of failure

Monitoring equipment is provided to recognize all types of signalling channel failures.

At each terminal the monitoring will be performed on the incoming signalling channel by

a) a data carrier failure detector, and
b) a signal unit error rate monitor.

The *data carrier failure detector* is specified in Recommendation Q.275. This detector also supplements the error detection by the use of check bits (Recommendation Q.277) and, accordingly, will aid the error rate monitor.

The *signal unit error rate monitor* is intended to recognize high percentages of signal units in error during a very short period as well as lower percentages during a longer period of time.

The error rate/time period characteristic has not been completely defined. However, two limiting points of this characteristic have been established, namely:

— 100% signal units in error over a period of 350 ms,
— 20% „ „ „ „ „ „ „ „ 30 s.

RECOMMENDATION Q.292

8.4 RESERVE FACILITIES PROVIDED

The reserve facilities provided can be subdivided into four groups following below in the order of ready availability:

a) quasi-associated signalling links,
b) full-time reserved voice-frequency links,
c) nominated direct circuits,
d) switched speech connections.

Within each group one or more arrangements can be distinguished which differ in the preparatory actions to be taken to bring the reserve facility into active service.

The choice of the particular facilities to be used can be governed by several factors, e.g. the possibility to use quasi-associated signalling links, the number of circuits served, the geographical distance between the No. 6 exchanges, etc. The choice of method(s), therefore, will be made by the Administrations involved according to the circumstances which apply.

As a matter of principle, the reserve facility to be used should follow a route different from the route of the regular signalling link.

8.4.1 Quasi-associated signalling links

The method to use a quasi-associated signalling link as a reserve facility is directly derived from the principles accepted for the system No. 6 (Recommendation Q.253).

This method assumes an adequate signalling network and requires prior agreements on its adoption between the Administration(s) through whose signal transfer point(s) the signalling traffic may overflow.

8.4.2 Full-time reserved voice-frequency links

A voice-frequency link is permanently assigned to provide the reserve signalling link.

The following arrangements can be distinguished:

a) The voice-frequency link is *not equipped with modems and signalling terminals.* A switching operation is thus required to convert the voice-frequency link into a signalling link, before synchronizing of the signalling channels can start.

b) The voice-frequency link is *equipped with modems and signalling terminals,* thus forming a reserve signalling link.

The link is not in use, but its channels are synchronized.

c) As in case b) but with the link in use on the basis of *duplicate working with load sharing.* Each link in this method is the reserve for the signal load on the other link. The exact manner in which duplicate working with load sharing between the two links is to be arranged is not defined.

Arrangement c) is considered particularly suitable for international exchanges at which very large groups of signalling links will terminate in future.

Of the arrangements a) and b), the latter is considered to be the more normal and will no doubt be the general rule in the case of a full-time reservation of a voice-frequency link. However, for international exchanges at which very large groups of signalling links will terminate in future, Administrations may prefer not to use the arrangements b) and c) above but to pool available modems and signalling terminals for common use to a number of reserve voice-frequency links.

8.4.3 Nominated direct circuits

A nominated direct circuit is permanently assigned to be converted into a signalling link, when required. The following arrangements can be distinguished:

a) The nominated circuit is normally *in speech condition.* Switching action and synchronizing must be performed in case the voice-frequency link of the speech circuit is required for the reserve signalling link. The switching action is allowed only when the voice-frequency link is not in use for speech. For this reason, the nominated circuit must be a last-choice circuit in order to guarantee a high probability of its being available.

The available modems and signalling terminals may be pooled for common use to a number of speech circuit groups.

b) The nominated circuit is normally a reserve signalling link *in data condition.* When all other speech circuits of the group are engaged and a new call arrives, the modems and signalling terminals of the reserve link are disconnected and the nominated circuit is used for this call. After the clearance of the call, the nominated circuit will revert to a reserve signalling link in data condition.

c) The nominated circuit is *a TASI-through circuit.* This circuit is not to be used for speech. When it is required to open up a reserve signalling link, data carrier power is applied in the normal way. This power will be sufficient to operate the speech detector at each end and cause TASI channels to be associated with the circuit for as long as the power is applied.

As far as arrangements a) and b) are concerned, the latter arrangement is preferred.

Arrangement c) cannot be ranked as a general solution since it depends on having a TASI system between the two international exchanges involved.

8.4.4 Switched speech connections

A replacement signalling link can be provided over a switched speech circuit connection via one or more international transit exchanges. There are two ways in which this can be done:

a) pre-assigned, nominated, or

b) randomly selected circuits.

The circuits making up the switched connection can use any signalling system; it is only necessary that sufficient routing information be sent to the international transit exchanges to permit switching.

In the case of a) only the pre-assigned nominated circuits will be selected by the international exchanges involved. In this way the method resembles the nominated speech circuit reserve. If the pre-assigned circuits are busy, a delay will be involved in establishing the link. Since the speech circuits are pre-assigned they can be equalized, if necessary, to meet the requirements for data transmission at 2400 bits per second.

In case b) any available circuits along the routes approved will be selected by the international exchanges involved to establish the connection. Since any available circuits can be selected, delays in establishing the connection will be minimized; however, the connection may not meet the requirements for data transmission at 2400 bits per second and a lower rate will be necessary. This method will be used only by special agreement and provision for it need not be made in all equipment.

The provision of replacement signalling links over switched speech circuit connections may prove especially valuable where the first reserve facility to be opened is a quasi-associated signalling route and where there is a danger of overloading this route.

RECOMMENDATION Q.293

8.5 INTERVALS AT WHICH SECURITY MEASURES ARE TO BE INVOKED

The following action points are defined:

T_o = time when signalling fault indication starts,

T_w = time when warning of failure is issued (for example, to busy a nominated speech circuit reserve),

T_d = time when decision to change over is made,

T_u = time when signalling traffic is offered to the reserve link.

The intervals T_w-T_o and T_u-T_d are not specified. It is recognized that these intervals will vary from one method or arrangement to another.

As far as the interval T_d-T_o is concerned, values relating to continuous failure conditions (see Recommendation Q.291, section 8.3.1 a) and b)) are given below:

350 ms for all reserve facilities being in data condition (synchronized channels),

1 second for all reserve facilities which need switching action and synchronizing.

For intermittent failure conditions (Recommendation Q.291, section 8.3.1 c)), action point T_d will be determined by the instant when the signal unit error rate monitor (Recommendation Q.291, section 8.3.2) gives an output indicating that the signal unit error rate has become unacceptable.

8.6 CHANGEOVER PROCEDURE

a) Consider two terminals A and B with a fault in signalling link AB, affecting both directions.

Detection of failure at both terminals A and B will at T_d initiate the commencement of synchronization procedures (Recommendation Q.278), where applicable, on the reserve signalling link. When both ends are in synchronism over the reserve link the processors can switch over and use this link.

On detection of failure, each terminal starts sending *faulty-link information* on the regular channel. This information consists of a number of changeover signals (completing the block being sent) plus ACU, followed by a continuous stream of alternating blocks of changeover signals and of SYU (11 changeover signals + ACU, 11 SYU + ACU, 11 changeover signals + ACU, etc.). Each terminal recognizing the faulty-link information received via the regular channel (proving that the fault on that channel has cleared) will replace the changeover signals by SYU and send only blocks of SYU (plus ACU).

b) A fault affecting only one direction (for example A to B) will be detected at terminal B. At T_d this terminal will act as under a. Terminal A commences synchronization procedures on the reserve signalling link upon receipt of two correct changeover signals within a period of approximately 150 ms. Moreover, terminal A will send blocks of SYU (plus ACU) on the regular channel.

As soon as terminal B correctly receives and recognizes these SYU, it replaces the changeover signals by SYU.

c) When both ends are again in synchronism over the regular link and a proving period of about one minute has elapsed, an indication is given that the regular link is available for use.

Change back to the regular link can be initiated automatically or manually, as desired by the Administrations concerned. To return to the regular link, two changeback signals are sent over the reserve signalling link temporarily in use.

CHAPTER IX

Testing and maintenance

RECOMMENDATION Q.295

9.1 OVERALL TESTS OF SIGNALLING SYSTEM No. 6

9.1.1 Automatic operational tests of circuits served

Information can be gained on faulty operation of system No. 6 from overall operational tests of international circuits served by the system. Such tests can be performed by the use of the automatic operational test device*. The test code format recommended is the following:

Calling-party's-category indicator: . . . Test call
Terminal or transit indicator: . . . . Terminal
Nature-of-circuit indicator: . . . . As appropriate
Echo-suppressor indicator: . . . . No echo suppressor
Address signal(s): . . . . X + ST

This format with one X digit allows 16 types of tests, transmission and signalling. If more are required, an additional digit can be used. Since this digit position would require a third signal unit in the initial address message, the second digit will not be added until necessary.

9.1.2 Signal unit error rate monitor

The signal unit error rate monitor, which is described in Recommendation Q.291, also provides a means of detecting deterioration of the data system. The monitor can be arranged to operate an alarm to alert maintenance personnel when the error rate exceeds the normal range.

9.1.3 Monitoring system parameters

It is expected that the many parameters of the system will be monitored during the field trial, and that the most meaningful of these will be specified at a later date for use in the maintenance and management of the system.

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* See COM IV No. 1, COM XI No. 1 (1968-1972).

9.2 DATA LINK

The data link is composed of two 1-way data channels. In general the maintenance functions are performed independently for each direction of transmission.

For maintenance purposes, each data channel may be considered to be composed of:

a) a voice-frequency channel,
b) the modulator at the near end and the demodulator at the far end,
c) a data carrier failure detector.

The data channel and its constituent parts must be tested to ensure that they meet the requirements of Recommendation Q.272.

9.2.1 Maintenance safeguard

Since interruptions of the data link will affect many speech circuits, the data channels must be treated with the utmost care. Appropriate special measures should be taken to prevent unauthorized maintenance access which could result in interruptions to service. These special measures may include marking or flagging the equipment and appearances on distribution frames or test bays where access is possible (see Recommendation M.102 of Volume IV).

9.2.2 Voice-frequency channel line-up and maintenance

The recommendations for the line-up and maintenance of the voice-frequency channel are taken from Recommendation M.102—*International circuits provided for private data transmission.*

9.2.2.1 *Line-up*

The voice-frequency channel line-up must be done in such a way as to ensure that the attenuation/frequency and delay/frequency distortions meet the requirements of Recommendation Q.272 at all baseband test points along the voice-frequency channel. In addition, the uniform spectrum random noise and impulsive noise requirements of Recommendation Q.272 must be met at the receiving end.

9.2.2.2 *Maintenance*

To ensure proper operation of the common channel signalling system, it will be necessary to schedule preventive maintenance for the voice-frequency channel. The tests to be made as a routine measure are:

Test	*Periodicity*
a) Overall loss at 800 Hz	See Volume IV, Recommendation M.64, Table 1, column 3
b) Attenuation/frequency distortion	Annually
c) Delay/frequency distortion	Annually
d) Noise	See Volume IV, Recommendation M.64, Table 1, column 3

9.2.3 Data carrier failure detector test

No tests are specified at this time for the data carrier failure detector. However, local tests should be applied to ensure that the data carrier failure detector meets the requirements given in Recommendation Q.275.

9.2.4 Modem tests

Modems should be tested locally to ensure that the requirements of Recommendation Q.274 are met. Loop-around equipment should be provided so that tests may be made independent of the voice-frequency channel.

9.2.5 Data channel line-up and maintenance

9.2.5.1 *Line-up*

After verifying that the voice-frequency channel meets the requirements (section 9.2.2.1) the data channel error rate should be checked for a period of 15 minutes using the equipment described in section 9.2.6. The error rate requirement is given in Recommendation Q.276.

9.2.5.2 *Routine maintenance*

The tests described in the preceding section should be made each time that routine noise tests of the voice-frequency channel are required (see section 9.2.2.2).

9.2.6 Data test equipment

The equipment for testing the data channel error rate consists of a pseudo-random bit stream generator to be connected to the input of the transmitting end of the data channel and a monitor to be connected to the output of the corresponding receiving end.

The bit stream to be generated, as specified in Recommendation V.26 of Volume VIII, is reproduced in the Annex to this Recommendation.

ANNEX

(to Recommendation Q.295)

Pseudo-random test pattern

In order to test circuits for data transmission on an international basis, it is necessary to standardize the test patterns to be used. Such a pattern should be a pseudo-random one having the following characteristics:

1) it should contain all or at least the majority of eight-bit sequences likely to be met in the transmission of actual data;

2) it should contain sequences of zeros and ones as long as possible compatible with ease of generation;

3) the pattern should be of sufficient length such that at modulation rates higher than 1200 bits per second its duration is significant compared with line noise disturbances.

Accordingly, a 511-bit test pattern is chosen. The pattern is generated in a nine-stage shift register whose fifth and ninth stage outputs are added together in a modulo-two addition stage, and the result is fed back to the input of the first stage. The modulo-two adder is such that the output produces an output "0" when the two inputs are similar and an output "1" when the two inputs are dissimilar.

Table 8 shows the state of each stage of the shift register during the transmission of the first 15 bits. The pattern over a longer period is

1 1 1 1 1 1 1 1 1 0 0 0 0 0 1 1 1 1 0 1 1 1 1 1 0 0 0 1 0 1 1 1 0 0 1 1 0 0...........

It is clear from the table that this pattern is the sequence of bits in stage 9 of the shift register but it also represents the sequence in any other stage shifted in time. The choice of stage to be connected to the output is therefore a matter of circuit convenience.

TABLE 8

Shift-register stages during pseudo-random test pattern generation

Output

1	2	3	4	5	6	7	8	9
1	1	1	1	1	1	1	1	1
0	1	1	1	1	1	1	1	1
0	0	1	1	1	1	1	1	1
0	0	0	1	1	1	1	1	1
0	0	0	0	1	1	1	1	1
0	0	0	0	0	1	1	1	1
1	0	0	0	0	0	1	1	1
1	1	0	0	0	0	0	1	1
1	1	1	0	0	0	0	0	1
1	1	1	1	0	0	0	0	0
0	1	1	1	1	0	0	0	0
1	0	1	1	1	1	0	0	0
1	1	0	1	1	1	1	0	0
1	1	1	0	1	1	1	1	0
1	1	1	1	0	1	1	1	1

GLOSSARY OF TERMS

SPECIFIC TO SIGNALLING SYSTEM C.C.I.T.T. No. 6

ACKNOWLEDGEMENT SIGNAL UNIT: ACU	The twelfth signal unit of a block, which carries the acknowledgement information for the error control system.
ASSOCIATED SIGNALLING:	A mode of operation of system No. 6 in which the signals carried by the system relate to a group of circuits which terminate in the same No. 6 exchanges as the signalling system.
BLOCK:	A group of 12 signal units on the line.
CHECK LOOP:	A device which is attached to interconnect the GO and RETURN, paths of a circuit at the outgoing end of a circuit to permit the incoming end to make a continuity check on a loop basis, and which includes suitable transmission attenuators.
COMMON CHANNEL SIGNALLING:	A signalling method, using a signalling link common to a number of speech circuits, for the transmission of all signals necessary for the traffic via these circuits.
CONTINUITY CHECK:	A check made of the circuit or circuits in a connection to verify that a speech path exists.
DATA CARRIER FAILURE DETECTOR:	A monitoring device designed to indicate that the level of the data carrier is below the minimum sensitivity of the receiver.
DATA CHANNEL:	A one-way path for data signals which includes a voice-frequency channel and an associated data modulator and demodulator.
DATA LINK:	A combination of two data channels operating together in a single signalling system.
DRIFT COMPENSATION:	The process of adjusting for the difference in relationship of the backward acknowledgement information contained in the ACU to the forward signal units it acknowledges which occurs as a result of drift in the bit rates of the data channels.
ERROR RATE MONITOR:	A device associated with the decoder which receives an indication for each signal unit found in error and which measures the rate of occurrence of errors according to a prescribed rule.

ERROR SIGNAL UNIT:	A signal unit containing one or more erroneous bits.
FIELD:	A subdivision of the bits comprising a signal unit, which performs a particular function or which carries a certain type or classification of information—e.g. label field, signal information field, etc.
FULLY DISSOCIATED SIGNALLING	A form of non-associated signalling in which the path that signals may take through the network is only restricted by the rules and configuration of the signalling network.
INITIAL ADDRESS MESSAGE: IAM	A multi-unit message which is sent as the first message in a call set-up, consisting of a minimum of two and a maximum of five signal units, and generally containing enough information to route the call through the international network.
INITIAL SIGNAL UNIT: ISU	The first signal unit of a multi-unit message.
LONE SIGNAL UNIT: LSU	A signal unit carrying a one-unit message.
MANAGEMENT SIGNALS:	Signals concerning the management of the speech circuit network.
MULTI-UNIT MESSAGE:	A signal message which requires more than one signal unit for transmission on the line.
NON-ASSOCIATED SIGNALLING:	A mode of operation in which the signals for a group of circuits are sent over two or more common signalling links in tandem. The signals being processed and forwarded to the next link by equipment at one or more signal transfer points.
ONE-UNIT MESSAGE:	A signal message which is transmitted entirely within one signal unit.
QUASI-ASSOCIATED SIGNALLING:	A form of non-associated signalling in which the route the signals may take through the network is prescribed.
QUEUEING DELAY:	The delay incurred by a signal message as a result of the sequential transmission of signal units on the line.
SECURITY:	The measures provided to ensure continuity of service of the signalling system in the event of the failure of one or both of the data channels.

SIGNALLING CHANNEL:	A data channel in combination with the associated signalling terminal equipment at each end.
SIGNALLING LINK:	A combination of two signalling channels operating together in a single signalling system.
SIGNALLING SYSTEM:	The combination of all of the equipment and channels necessary to provide signalling for one or more groups of circuits between two No. 6 exchanges. It thus includes a data link, signalling terminal equipment, and necessary portion of the processor at each No. 6 exchange.
(SIGNAL) MESSAGE:	Signal information pertaining to one call or management action sent at one time on the line. A message may consist of one or more signals transmitted in one or more signal units.
SIGNAL TRANSFER POINT:	A signal relay centre handling and forwarding signals from one signalling link to another in a non-associated mode of operation.
SIGNAL UNIT: SU	The smallest defined group of bits on the line (28 bits) used for the transfer of signal information.
SUBSEQUENT ADDRESS MESSAGE: SAM	An address message, which may be either a one-unit or a multi-unit message, sent following the initial address message.
SUBSEQUENT SIGNAL UNIT: SSU	Those signal units of a multi-unit message other than the initial signal unit.
SYSTEM CONTROL SIGNAL UNIT: SCU	A signal unit carrying a signal concerning the operation of the signalling system—e.g. changeover, change-back.
SYNCHRONIZATION SIGNAL UNIT: SYU	A signal unit containing a bit pattern and information designed to facilitate rapid synchronization and which is sent on the line when synchronizing or when no signal messages are available for transmission.
TELEPHONE SIGNAL:	Any signal which pertains to a particular telephone call or to a particular speech circuit.
TRANSCEIVER:	A combination of a transmitter and a receiver applied to the continuity check.

ANNEX TO SIGNALLING SYSTEM No. 6 SPECIFICATIONS (see Recommendation Q. 261)

TABLE 1 — SEMI-AUTOMATIC (SA) AND AUTOMATIC (A) TERMINAL TRAFFIC

(Error-free operation assumed)

Outgoing international exchange		Incoming international exchange
	NORMAL CALL TO A FREE SUBSCRIBER	
Digits from the national network are analysed. The outgoing circuit is seized. The initial address message is sent: — all digits plus ST in "en bloc" operation, or — all available digits in overlap operation. The loop for the speech path continuity check is attached to the outgoing circuit. The echo suppressor, if present, is disabled so that the speech path continuity check may be performed.	Initial address message * →	The address message is analysed to determine: The circuit to be seized Terminal or transit call Nature-of-circuit (satellite or terrestrial) Echo-suppressor control Calling-party's-category. The echo suppressor, if present, is disabled so that the speech path continuity check may be performed.
	← Check tone *	The transceiver for the speech path continuity check is attached, and the check tone is transmitted on the incoming circuit. Set-up of the call in the national network begins when enough digits are received for routing (overlap operation).
	Check tone →	
The check loop is removed. The speech path is switched through. (When the continuity check fails, the blocking signal is sent forward. An automatic repeat attempt is made.) The echo suppressor, if present, is enabled as appropriate. The remaining digits in overlap operation are sent forward.	← Check-OK (or Check-not-OK)	When the speech path continuity check has been completed, the check-OK (or check-not-OK) signal is returned, the continuity-check transceiver is removed, and the echo suppressor, if present, is enabled. Digits are passed into the national network. The speech path is switched through.
	Continuity (link-by-link case only)** →	
	Subsequent address messages →	The address is analysed to determine that all the required digits have been received (where applicable)***.
On receipt of the address-complete signal, the digital information is erased. Subsequent supervisory signals are handled by the processor as appropriate.	← Address complete	Set-up of the speech path is completed. Subsequent supervisory signals are handled by the processor as appropriate. Signals from the national network are passed to the outgoing international exchange as follows:

---

* Solid arrows denote common channel signals; dotted arrows are tones, sent via the speech path (check tone and audible tones).

** Sent as soon as possible after the initial address message, by rule.

*** Address-complete signal may come from the national network.

TABLE 1 *(concl.)*

Outgoing international exchange		Incoming international exchange
If the ringing signal (electrical) is received, it is converted, here or in the outgoing national network, to the national audible ringing tone.	← Audible ringing tone	Audible ringing tone or the ringing signal (electrical).
On receipt of the answer signal, charging, measurement of call duration and conversation begin.	← Answer	The called subscriber answers (charge or no charge).
"Clear-back" is recognized. SA: A clearing supervisory signal is given to the controlling operator. A: After 1-2 min., if there is no clear-forward signal, the international connection is released and charging and measurement of the call duration are ceased.	← Clear-back	The called subscriber hangs up.
The outgoing operator (SA) or the calling subscriber (A) clears.	Clear-forward →	"Clear-forward" is recognized. The connection is released, and "clear-forward" is sent to the national network of destination.
"Release-guard" is recognized, terminating the guard condition.	← Release-guard	When the incoming equipment has released, a release-guard signal is sent back. The circuit is made available for new traffic.

TABLE 2 — SEMI-AUTOMATIC (SA) AND AUTOMATIC (A) TRANSIT TRAFFIC

(error-free operation assumed)

Outgoing international exchange	International transit exchange	Incoming international exchange
	CALL TO A FREE SUBSCRIBER *Case I: end-to-end continuity check*	
Digits from the national network are analysed. The outgoing circuit is seized. The initial address message is sent: — all digits plus ST in "en bloc" operation, or — all available digits in overlap operation. The loop for the speech path continuity check is attached to the outgoing circuit. The echo suppressor, if present, is disabled so that the speech path continuity check may be performed.	Initial address message → The address message is analysed to determine: The circuit to be seized Terminal or transit call Nature-of-circuit (satellite or terrestrial) Echo-suppressor control Calling-party's-category.	
	When enough digits have been received to select a route, the outgoing circuit is seized. The address message is sent. The echo suppressors, if present, are disabled. The speech path is switched through.	Initial address message → The address message is analysed to determine: The circuit to be seized Terminal or transit call Nature-of-circuit (satellite or terrestrial) Echo-suppressor control Calling-party's-category.

TABLE 2 *(contd)*

Outgoing international exchange		International transit exchange		Incoming international exchange
	←······ Check tone ······ ······→		←······ Check tone ······ ······→	The transceiver is attached, and the check tone is transmitted on the incoming circuit. When the check is completed, the check-OK signal is returned, and the transceiver is removed.
The loop is removed. The speech path is switched through. (When the check fails, the blocking signal is sent forward. An automatic repeat attempt is made from the outgoing international exchange.) The remaining digits in overlap operation are sent forward. The echo suppressor, if present, is enabled as appropriate.	← Check-OK (or Check-not-OK)	The check-OK signal must be passed to the outgoing international exchange. (When the check fails each transit exchange sends back the check-not-OK signal and sends the blocking signal forward.)	← Check-OK (or Check-not-OK)	The echo suppressor, if present, is enabled as appropriate. The speech path is switched through. (When the check fails, the check-not-OK signal is sent back and the connection is cleared forward.)
	Subsequent address message →	Digits are passed to the incoming international exchange.	Subsequent address message →	Digits are passed into the national network. The address is analysed to determine that all required digits have been received (where applicable).
On the receipt of the address-complete signal, the digital information is eased. Subsequent supervisory signals are handled by the processor as appropriate.	← Address-complete	"Address-complete" is passed on to the outgoing international exchange. The digital information is erased. Subsequent supervisory signals are handled by the processor, as appropriate.	← Address-complete	Set-up of the speech path is completed. Subsequent supervisory signals are handled by the processor as appropriate. Signals from the national network are passed to the outgoing international exchange, as follows:
The ringing signal (electrical) is converted, here or in the outgoing national network, to the national audible ringing tone.	← Ringing (electrical)	The ringing signal (electrical) is passed back to the outgoing international exchange.	← Ringing (electrical)	*First case:* The incoming national network returns the ringing signal (electrical).
The operator (SA), or the calling subscriber (A) hears the audible ringing tone.	←······ Audible ringing tone ······		←······ Audible ringing tone ······	*Second case:* Audible ringing tone of the incoming national network is sent back.

TABLE 2 *(contd)*

Outgoing international exchange		International transit exchange		Incoming international exchange
On receipt of the answer signal, charging, measurement of call duration and conversation begin.	← Answer	"Answer" is passed on to the outgoing international exchange.	← Answer	The called subscriber answers (charge or no charge).
"Clear-back" is recognized. SA: A clearing supervisory signal is given to the controlling operator. A: After 1-2 min., if there is no clear-forward signal, the international connection is released and charging and measurement of the call duration are ceased.	← Clear-back	"Clear-back" is passed on to the outgoing international exchange.	← Clear-back	The called subscriber hangs up.
The outgoing operator (SA) or the calling subscriber (A) clears.	Clear-forward →	"Clear-forward" is passed on to the incoming international exchange. Release of the connection begins.	Clear-forward →	"Clear-forward" is recognized, the connection is released, and "clear-forward" is sent to the national network of destination.
"Release-guard" is recognized, terminating the guard condition.	← Release-guard	When the incoming equipment has released, "release-guard" is sent back to the outgoing international exchange. The incoming circuit is made available for new traffic.		
		"Release-guard" is recognized, terminating the guard condition on the outgoing circuit.	← Release-guard	When the incoming equipment has released, the release-guard signal is sent back. The circuit is made available for new traffic.

TABLE 2 *(contd)*

Outgoing international exchange		International transit exchange		Incoming international exchange
		CALL TO A FREE SUBSCRIBER *Case II: link-by-link continuity check*		
Digits from the national network are analysed. The outgoing circuit is seized. The initial address message is sent. — All digits plus ST in "en bloc" operation or — All available digits in overlap operation.	Initial address message →	The address message is analysed to determine: The circuit to be seized Terminal or transit call Nature-of-circuit (satellite or terrestrial Echo-suppressor control Calling-party's-category.		
The loop for the speech path continuity check is attached to the outgoing circuit. The echo suppressor, if present, is disabled so that the speech path continuity check may be performed.		When enough digits have been received to select a route, the outgoing circuit is seized. The address message is sent. The echo suppressors, if present, are disabled.	Initial address message →	The address message is analysed to determine: The circuit to be seized Terminal or transit call Nature-of-circuit (satellite or terrestrial) Echo-suppressor control Calling-party's-category.
	← Check tone ┈┈┈ ┈┈┈→	The transceiver is attached and the check tone is transmitted on the incoming circuit; the loop is attached to the outgoing circuit. The check is completed, the check-OK signal is returned, and the transceiver is removed. (When the check fails, the check-not-OK signal is sent back, and the connection is cleared forward.)		
The loop is removed. (When the continuity check fails, the blocking signal is sent forward. An automatic repeat attempt is made.)	← Check-OK (or Check-not-OK)			The echo suppressor, if present, if disabled so that the speech path continuity check may be performed. When enough digits are received to select the national route, a circuit is seized and the available digits are passed into the national network.
	Continuity* →	On receipt of continuity signal from preceding link, "continuity" is sent forward, when the check-OK indication is given by the transceiver.	Continuity →	

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* Sent as soon as possible after the initial address message, by rule.

TABLE 2 *(contd)*

Outgoing international exchange		International transit exchange		Incoming international exchange
The echo suppressor, if present, is enabled as appropriate. The speech path is switched through.	Subsequent address messages →	Digits are passed to the incoming international exchange.	Subsequent address messages →	Digits are passed into the national network.
		The loop is removed. The speech path is switched through. (When the continuity check fails, the blocking signal is sent forward. An automatic repeat attempt is made.)	← Check tone → Check-OK or Check-not-OK	The transceiver is attached and the check tone is transmitted on the incoming circuit. When the check is completed, the check-OK signal is returned, and the transceiver is removed. The echo suppressor, if present, is enabled as appropriate. (When the check fails, the check-not-OK signal is sent back, and the connection is cleared forward.)

From this point on, the signal sequence is the same as that for the end-to-end continuity check case from the point where the address-complete signal is transmitted from the incoming international exchange.

TABLE 2 *(contd)*

Outgoing international exchange		International transit exchange		Incoming international exchange
		CALL TO A BUSY SUBSCRIBER		
The signal sequence is the same as for a call to a free subscriber up to the point where all of the digits have been passed into the incoming national network.				
			← Subscriber-busy signal (electrical)	*First case:* The incoming national network returns the subscriber-busy signal (electrical).
SA: A busy indication is given to the operator. A: The calling subscriber hears the local national busy tone sent by the outgoing (national or international) exchange.	← Subscriber-busy signal (electrical)	" Subscriber-busy " (electrical) is passed back to the outgoing international exchange.		
		The circuit is cleared automatically.	Clear-forward →	"Clear-forward" is recognized, the connection is released, and "clear-forward" is sent to the national network of destination.
The circuit is cleared automatically.	Clear-forward →	When the incoming equipment has released, "release-guard" is sent back to the outgoing international exchange. The incoming circuit is made available for new traffic.		
"Release-guard" is recognized terminating the guard condition.	← Release-guard			
		"Release-guard" is recognized, terminating the guard condition on the outgoing circuit.	← Release-guard	When the incoming equipment has released, "release-guard" is sent back. The circuit is made available for new traffic.
The operator (SA), or the calling subscriber (A) hears the busy tone of the distant country and clears. The clear-forward sequence follows as above.	←…………	Busy tone	…………	*Second case:* The busy tone of the incoming national network is sent back.

TABLE 2 *(concl.)*

Outgoing international exchange		International transit exchange		Incoming international exchange
		CONGESTION		
Digits from the national network are analysed. The outgoing circuit is seized. The initial address message is sent.	Initial address message →	When enough digits have been received to select a route, an attempt is made to seize an outgoing circuit. When blockage occurs in the switching equipment, the switching-equipment-congestion signal is sent backward.		
Appropriate action is taken. (For example, an indication is given to the calling subscriber or an automatic repeat attempt is made, etc.)	← Switching-equipment-congestion ← Circuit-group-congestion	When the circuit group is fully occupied, the circuit-group-congestion signal is sent backward (if overflow is inappropriate).		
SA: An indication is given to the operator. A: An indication is given to the calling subscriber.	← National-network-congestion	The national-network-congestion signal is passed backward. For the other congestion signals, appropriate action is taken. (For example, the congestion signal is sent backward or an automatic repeat attempt is made, etc.)	← National-network-congestion ← Switching-equipment-congestion	If congestion occurs in the national network, the national-network-congestion signal is sent backward. If blockage occurs in the switching equipment at the international exchange, the switching-equipment-congestion signal is sent backward.
The outgoing operator (SA) or the calling subscriber (A) clears.				
Appropriate action is taken. (For example, an indication is given to the calling subscriber, or an automatic repeat attempt is made, etc.)	← Switching-equipment-congestion			

PART XV

SIGNALLING SYSTEM R1

INTRODUCTION

Principles of Signalling System R1

General

The development of new exchanges, especially those utilizing stored programme control, has introduced new concepts in the division of functions between various components of signalling and switching systems. To allow the maximum freedom in incorporating new concepts which can contribute to the overall economy and efficiency of the system, the requirements as covered in this specification are for the combination of equipments necessary to provide a function. For example, the requirements for line signal receiving equipment as given here may be met by various subdivisions of functions between signal receiver, trunk relay sets and stored programme control.

System R1 may be applied for automatic and semi-automatic operation of one-way and both-way circuits within an international region (world numbering zone). When utilized in an integrated world numbering zone (e.g., zone 1) the numbering and routing plans and operating facilities of that zone should apply.

The system is applicable to all types of circuits (except TASI derived circuits *) meeting C.C.I.T.T. transmission standards, including satellite circuits.

The signalling equipment used in system R1 consists of two parts:

a) line signalling for line or supervisory signals, and

b) register signalling for address signals.

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* Register signalling can be made compatible with TASI providing a TASI locking tone.

a) *Line signalling*

Continuous tone type in-band line signalling is used for the link-by-link transmission of all supervisory signals except the ring-forward (forward-transfer) signal which is a spurt signal. A single frequency, 2600 Hz, is used in each direction of the four-wire transmission path, the presence or absence of this frequency indicates a specific signal dependent upon when it occurs in the signalling sequence and in certain cases upon its duration. When the circuit is idle, low level signalling tone is continuously present in both directions.

b) *Register signalling*

Link-by-link multifrequency (MF) in-band pulse signalling is used for the transmission of address information. The signalling frequencies are 700 Hz to 2700 Hz, in 200-Hz steps, and combinations of two, and two only, determine the signal. The address information is preceded by a KP signal (start-of-pulsing) and terminated by an ST signal (end-of-pulsing). Either en bloc *, en bloc-overlap *, or overlap sending may apply. This register signalling arrangement is used extensively with other in-band and out-band line signalling systems.

Compandors may affect signalling, particularly short-pulse compound register signals, due to pulse length distortion and the production of intermodulation frequencies. By virtue of the link-by-link signalling and the adopted duration of register and line signal pulses, system R1 functions correctly in the presence of compandors designed in accordance with C.C.I.T.T. recommendations.

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* See Recommendation Q.151 note to section 3.1.1 for an explanation of these terms.

CHAPTER I

Definition and function of signals

RECOMMENDATION Q.310

1. DEFINITION AND FUNCTION OF SIGNALS *

1.1 *Connect (seizing) signal* (sent in the forward direction)

This line signal is transmitted at the beginning of a call to initiate circuit operation at the incoming end of the circuit to busy the circuit and to seize equipment for switching the call.

1.2 *Delay-dialling signal* (sent in the backward direction)

This line signal is transmitted by the incoming exchange following the recognition of the connect (seizing) signal to verify receipt of the connect (seizing) signal and to indicate that the incoming register equipment is *not* yet attached or ready to receive address signals.

1.3 *Start-dialling (proceed-to-send) signal* (sent in the backward direction)

This line signal is sent from the incoming exchange subsequent to the sending of a delay-dialling signal to indicate that the incoming register equipment has been connected and is ready to receive address signals.

1.4 *KP (start-of-pulsing) signal* (sent in the forward direction)

This register signal is sent subsequent to the recognition of a start-dialling signal and is used to prepare the incoming register for the receipt of subsequent interregister signals.

1.5 *Address signal* (sent in the forward direction)

This register signal is sent to indicate one decimal element of information (digit 1, 2, . . ., 9 or 0) about the called party's number. For each call a succession of address signals is sent.

1.6 *ST (end-of-pulsing) signal* (sent in the forward direction)

This register signal is sent to indicate that there are no more address signals to follow. The signal is always sent in semi-automatic as well as automatic working.

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* In this part the North American designation for line signals is used. The designation of the signal in system No. 5 which most nearly corresponds to a particular North American signal is shown in parentheses. There is not always exact correspondence in function, e.g., the ring-forward signal can only be effective when a connection has been established through an incoming operator.

1.7 *Answer signal* (sent in the backward direction)

This line signal is sent to the outgoing exchange to indicate that the called party has answered *.

In semi-automatic working, the signal has a supervisory function.

In automatic working, it is used:

- — to start metering the charge to the calling subscriber,
- — to start the measurement of call duration for international accounting purposes, if this is desired.

1.8 *Hang-up (clear-back) signal* (sent in the backward direction)

This line signal is sent to the outgoing exchange to indicate that the called party has cleared. In the semi-automatic service, it performs a supervisory function.

In automatic working, arrangements are made to clear the connection, stop the charging, and stop the measurement of call duration if within 3 to 120 seconds ** after recognition of the hang-up signal, the calling subscriber has not cleared. Clearing of the connection should preferably be controlled from the point where the charging is carried out.

1.9 *Ring-forward (forward-transfer) signal* (sent in the forward direction)

This line signal is initiated by an operator to recall an operator at a point further ahead in the connection.

1.10 *Disconnect (clear-forward) signal* (sent in the forward direction)

This line signal is sent in the forward direction at the end of a call when:

a) in semi-automatic working, the operator at the outgoing exchange withdraws the plug from the jack, or when an equivalent operation is performed,

b) in automatic working, the calling party hangs up, or when time-out as discussed in section 1.8 occurs.

1.11 *Diagrams showing signal sequence.*

Typical sequences of signals in semi-automatic and automatic working are shown in the Annex to these Specifications.

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* See Recommendation Q.27 for the actions to be taken to assure that answer signals, both national and international, are transmitted as quickly as possible.

** In world numbering zone 1, 13-32 seconds is used.

CHAPTER II

Line signalling

RECOMMENDATION Q.311

2.1 GENERAL

The line-signal coding arrangement is based on the application and removal of a single frequency tone (2600 Hz) as shown in Table 1.

By taking advantage of the fixed order of occurrence of specific signals, both tone-on and tone-off signals are used to indicate more than one signal condition. For example, in the backward direction tone-on is used to indicate start-dialling (proceed-to-send), and terminating end hang-up (clear-back) signals without conflict. The equipment must retain memory of the preceding signal states and the direction of signals in order to differentiate between like tone-on and tone-off signals.

RECOMMENDATION Q.312

2.2 LINE SIGNAL SENDER * (TRANSMITTER)

2.2.1 *Signal frequency*

2600 ± 5 Hz.

2.2.2 *Transmitted signal level of tone-on signals*

-8 ± 1 dBm0 for the duration of the signal or for a minimum of 300 ms (whichever is shorter) and for a maximum of 550 ms after which the level of the signal shall be reduced to -20 ± 1 dBm0.

2.2.3 *Transmitted signal durations*

The transmitted signal durations are shown on Table 1.

2.2.4 *Signal frequency leak*

The level of signal frequency leak power transmitted to the line should not exceed -70 dBm0, during the tone-off condition.

2.2.5 *Extraneous frequency components*

The total power of extraneous frequency components accompanying a tone signal should be at least 35 dB below the fundamental signal power.

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* See also Recommendation Q.112.

TABLE 1

Line signal code

Signal	Signal Direction (1 and 2)	Transmitted (Sending) Duration	Transmitted Tone on or off	
			Originating end	Terminating end
Idle	◀—— ——▶	continuous	on	on
Connect (seizing)	·······▶	continuous	off	on
Delay-dialling	◀·······	continuous [3]	off	off
Start-dialling (proceed-to-send)	◀——	continuous [3]	off	on
Answer	◀·······	continuous	off	off
Hang-up (clear-back)	◀——	continuous	off	on
Disconnect (clear-forward)	——▶	continuous	on	on or off
Ring-forward (forward-transfer)	——▶	65-135 ms	on	on or off
Busy, Reorder (congestion) [1]			off	on

Notes to Table 1

[1] ——▶, ······▶ indicates forward tone-on and tone-off signals, respectively.

[2] ◀——, ◀······ indicates backward tone-on and tone-off signals, respectively.

[3] The durations of these signals are variable and depend upon when the succeeding signal occurs. To ensure proper registration of these signals, the transmitted signal durations should not be less than 140 ms.

[4] Busy and recorder (congestion) conditions are indicated by audible tones.

2.2.6 *Transmitting line split*

The following splitting arrangements are required when transmitting line signals to prevent incorrect operation of the receiving equipment due to transients caused by the opening or closing of direct current circuits in the exchange at the transmitting end:

a) when a tone-on signal is to be transmitted, the speech path from the exchange shall be split (disconnected), if not already split, within an interval from 20 ms before to 5 * ms after tone is applied to the line, and remain split for a minimum of 350 ms and a maximum of 750 ms;

b) when a tone-off signal is to be transmitted, the speech path from the exchange shall be split (disconnected), if not already split, within an interval from 20 ms before to 5 ms after tone is removed from the line, and remain split for a minimum of 75 ms and a maximum of 160 ms after the tone is removed;

c) when the signalling equipment is receiving and sending tones simultaneously the split shall be maintained until:

- i) the transmitted tone is terminated, in which case the split must be removed in the interval from 75 to 160 ms after tone is removed (as in b) or,
- ii) the incoming tone ceases, in which case the split must be removed in the interval from 350 to 750 ms after tone ceases,

d) when the signalling equipment is sending tone, a split shall be introduced, if not already split, within 250 ms of receipt of an incoming tone.

The above requirements given in a), b), c) and d) establish a transmitting path split at both ends of the circuit during the idle condition.

RECOMMENDATION Q.313

2.3 LINE SIGNAL RECEIVING EQUIPMENT **

2.3.1 *Operate limits (tone-on signals)*

The receiving equipment shall operate on a received tone signal, in the presence of the maximum noise expected on an international circuit, —40 dBm0 uniform spectral energy over the range of 300 to 3400 Hz, that meets the conditions listed below:

a) 2600 ± 15 Hz,

b) to ensure proper operation in the presence of noise, the signal level of the initial portion of each tone-on signal shall be augmented by 12 dB (see section 2.2.2). As a result, the following requirement reflects both the augmented and steady-state signal levels. The absolute power level N of each signal is within the limits $(-27 + n \leqslant N \leqslant -1 + n)$ dBm where n is the relative power level at the input to the receiving equipment.

The minimum absolute power level $N = (-27 + n)$ gives a margin of 7 dB on the steady-state nominal absolute power level of the received signal at the input to the receiving equipment. With augmentation the effective margin is increased from 7 to 19 dB.

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* The 5 ms may be relaxed to 15 ms if tone is applied while tone is being received.

** See also Recommendation Q.112.

The maximum absolute power level $N = (-1 + n)$ gives a margin of 7 dB on the augmented nominal absolute power level of the received signal at the input to the receiving equipment.

The above tolerances are to allow for variations at the sending end and variations in line transmission.

Note. — Since higher steady noise as well as impulsive noise may be encountered on intra-regional circuits, especially over certain compandored carrier systems, the maximum expected noise within a region must be taken into account in the design of equipment for that region.

2.3.2 *Non-operate limits*

1) The receiving equipment shall neither operate on signals originating from subscriber stations (or other sources) if the total power in the band from 800 Hz to 2450 Hz equals or exceeds the total power present at the same time in the band from 2450 Hz to 2750 Hz, as measured at the station, nor degrade these signals. Allowances shall be made in the receiving equipment design to accommodate expected deviations from these values due to attenuation distortion and carrier frequency shift on the total transmission path between the station and the receiving equipment.

2) The receiving equipment shall not operate on any tone or signal whose absolute power level at the point of connection of the receiving equipment is $(-17 -20 +n)$ dBm or less, n being the relative power level at this point.

2.3.3 *Recognition of signals*

1) system R1 must be protected against false signal recognition caused by:

a) signal simulation of tone-on or tone-off signals by speech or other signals;

b) signal simulation of tone-off signals by momentary interruptions of the transmission path.

The method of providing this protection is left to each administration concerned to allow for maximum flexibility in the implementation of the signalling and switching system design. However, the overall system requirements given in paragraphs 2) and 3) below shall be met.

2) The following requirements for signal recognition are specified in terms of signal duration at the input to the signal receiving equipment and further assumes that signal levels, frequency and accompanying noise are within the limits specified in Section 2.3.1:

a) a tone-on signal lasting 30 ms or less must be rejected; that is, it must not be recognized as a signal;

b) a tone-off signal lasting 40 ms or less must be rejected if the previous tone-on signal is 350 ms or longer; that is, it must not be recognized as a signal;

c) subsequent to establishing the speech path, a tone-on ring-forward (forward-transfer) spurt signal lasting 65-135 ms must be recognized as a valid signal;

d) a tone-on forward signal lasting 300 ms or longer must be recognized as a valid disconnect (clear-forward) signal. Prior to attaching a register, a forward tone-on signal lasting 30 ms or longer may be recognized as a valid disconnect (clear-forward) signal;

e) Other tone-on and tone-off signals should be recognized as valid signals, subsequent to the minimum limits imposed by a) and b) above, as soon as possible.

Note. — Delays introduced by line signalling equipment should be held to a minimum consistent with the requirements covered herein to minimize signal transfer times. Minimizing the delay is especially important in the case of the answer signal and in the case of satellite circuit operation. In this latter case, if a hang-up (clear-back) signal has not been sent prior to recognition of a disconnect (clear-forward) signal, it is necessary that the idle tone-on signal, sent by the incoming exchange in response to the disconnect signal, be recognized by the outgoing exchange prior to the elapse of the guard timing specified in Recommendation Q.314, section 2.4.1.

3) The following signal simulation rates shall not be exceeded:

a) on the average not more than one false recognition of a disconnect (clear-forward) signal shall occur per 1500 call hours of speech, at the *minimum* disconnect recognition time, as selected according to section 2.3.3, 2) c) and d). (In some older designs, this requirement may not be met, but for these cases the call hour figure must not be less than 500 * call hours.)

b) on the average, not more than one false ring-forward (forward-transfer) signal shall occur per 70 * call hours of speech, at the *minimum* ring-forward recognition time;

c) speech or other electrical signals such as audible tone signals, with levels up to +10 dBm0 shall not cause any false simulation of answer signals;

d) the number and characteristics of false splits of the speech path caused by speech or other signals shall not cause a noticeable reduction in the transmission quality of the circuit.

2.3.4 *Receiving line split*

To prevent line signals of the signalling system from causing disturbances to signalling systems on subsequent circuits, the receiving transmission path to the connected exchange should be split when the signal frequency is received to ensure that no portion of any signal exceeding 20 ms duration may pass out of the circuit. The use of a band-stop filter for splitting is necessary since in the case of non-charged calls a continuous

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* In the case when no answer signal is transmitted (non-charged calls), the simulation rates specified in a) and b) may, in some existing designs, be somewhat in excess of the values quoted.

signal tone persists in the return transmission path during conversation. The level of signal leak current transmitted to the subsequent circuit with the band-stop filter inserted should be at least 35 dB below the received signal level. In addition, the band-stop filter must not introduce more than 5 dB loss at frequencies 200 Hz or more above or below the midband frequency nor more than 0.5 dB loss at frequencies 400 Hz or more above or below the midband frequency.

The receiving line split must be maintained for the duration of the incoming tone signal, but must cease within 300 ms of tone removal.

Note. — In some existing designs, the initial cut may be a physical line disconnection but the filter must be inserted within 100 ms of tone reception.

RECOMMENDATION Q.314

2.4 FURTHER SPECIFICATION CLAUSES RELATIVE TO LINE SIGNALLING

2.4.1 Access to the outgoing circuit shall be denied (guarded) for 750 to 1250 ms (1050 to 1250 ms for satellite circuits) after initiation of the disconnect (clear-forward) signal to ensure sufficient time for the release of the equipment at the incoming exchange. (See also the note to section 2.3.3, paragraph 2, of Recommendation Q.313.)

2.4.2 The disconnect (clear-forward) signal may be sent at any time in the call sequence.

2.4.3 The release of the chain of circuits in an established connection is only initiated from the originating exchange or the charge-recording exchange.

2.4.4 The start of metering the charge should be delayed by an appropriate time after recording of the answer signal to prevent false charging resulting from possible false recognition of an invalid answer signal.

RECOMMENDATION Q.315

2.5 DOUBLE SEIZING WITH BOTH-WAY OPERATION

2.5.1 *General*

To minimize the probability of double seizing the circuit selection at the two ends of both-way circuit groups should be such that, as far as possible, double seizing can occur only when a single circuit of the group remains free (e.g., by selection of circuits in opposite order at the two ends of the circuit group).

2.5.2 *Unguarded interval*

In general the unguarded interval is small, except in the case of satellite operation where the circuit propagation time is long. However, system R1 does provide a means of detecting double seizing.

2.5.3 *Detection of double seizing*

In the event of double seizing, the incoming connect (seizing) signal is recognized at each end as a delay dialling signal. If a start-dialling (proceed-to-send) signal is not received within the time-out interval (e.g., 5 seconds) double seizing is assumed.

In this event, either of the following arrangements may apply:

a) an automatic repeat attempt to set up the call, or

b) a recorder indication is given to the operator or to the calling subscriber and no automatic repeat attempt is made.

With either method, means must be provided to ensure positive release of the double seized circuit.

RECOMMENDATION Q.316

2.6 SPEED OF SWITCHING IN INTERNATIONAL EXCHANGES

2.6.1 It is recommended that the equipment in international exchanges shall have a high switching speed so that the switching time may be as short as possible.

2.6.2 At the outgoing, transit and incoming international exchanges, the seizing of the circuit and the setting up of the connection should take place as soon as possible after receipt of the digits of the address that are necessary to determine the routing.

2.6.3 At international exchanges the delay-dialling signal should be returned as soon as possible after recognition of the connect (seizing) signal. The start-dialling (proceed-to-send) signal should be returned as soon as possible but in any case, the return should be before the time-out of the outgoing register. (See Recommendation Q.322 section 3.6.2, paragraph 1. b).)

CHAPTER III

Register signalling *

RECOMMENDATION Q.317

3.1 SIGNAL CODE FOR REGISTER SIGNALLING

3.1.1 *General*

1) Either semi-automatic working (with automatic machine or direct operator access), or automatic working (with automatic machine access) may be used for outgoing traffic. With automatic machine access the incoming address signals are stored in a register until sufficient address information is received to route the call properly, at which time a free circuit may be selected and a connect (seizing) line signal sent. Subsequent to the recognition of a delay-dialling line signal and a start-dialling (proceed-to-send) line signal a KP (start-of-pulsing) signal followed by the address and ST (end-of-pulsing) signals are transmitted. The KP signal, which is nominally 100 ms in duration, prepares the receiving equipment to accept subsequent register signals. The transmission of the KP signal should be delayed by a minimum of 140 ms, but not more than 300 ms. after recognition of the start-dialling line signal.

2) Link-by-link register signalling applies.

3) Register signalling is in a forward direction only and shall be in accordance with the two-out-of-six multifrequency code shown in Table 2. Three of the 15 possible codes are unused in international service and are available for special purposes.

4) The receiving equipment must furnish a two-and-two only frequency check on each received signal to ensure its validity.

3.1.2 *Sending sequence of register signals*

1) The sending sequence of address signals conforms to the sequence indicated in Recommendation Q.107. However, for traffic within an integrated world numbering zone (e.g., zone 1) the language or discriminating digit and country codes may have no application and may not be sent.

In zone 1, the sequence of signals sent from the operator or subscriber is as follows:

a) semi-automatic working for calls to a subscriber within zone 1:
    i) KP
    ii) National (significant) number of the called subscriber
    iii) ST

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* As used in this chapter the term register includes traditional registers in electromechanical exchanges and also the equivalent receiving device, memory and logic in stored programme exchanges.

TABLE 2

Register signal code of system R1

Signals	Frequencies (compound) Hz
KP (start-of-pulsing)	1100 + 1700
Digit 1	700 + 900
Digit 2	700 + 1100
Digit 3	900 + 1100
Digit 4	700 + 1300
Digit 5	900 + 1300
Digit 6	1100 + 1300
Digit 7	700 + 1500
Digit 8	900 + 1500
Digit 9	1100 + 1500
Digit 0	1300 + 1500
ST (end-of-pulsing)	1500 + 1700
Spare	700 + 1700
Spare	900 + 1700
Spare	1300 + 1700

b) semi-automatic working for calls to operators within zone 1:
  i) KP
  ii) Special decimal numbers *
  iii) ST

c) automatic working for calls to a subscriber within zone 1:
  i) National (significant) number of the called subscriber.

2) The sending sequence of register signals shall conform to above, noting the following:

a) a KP (start-of-pulsing) signal shall precede the sequence of signals in all cases;

b) the ST (end-of-pulsing) signal shall follow the sequence of signals in all cases.

RECOMMENDATION Q.318

3.2 END-OF-PULSING CONDITIONS — REGISTER ARRANGEMENTS CONCERNING ST SIGNAL

3.2.1 The register signalling arrangements shall provide for the sending of an ST signal for both semi-automatic and automatic operation; the arrangements in the outgoing international register for recognizing the ST (end-of-pulsing) signal condition may vary as follows:

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* The special numbers used to reach operators are by agreement between administrations.

a) Semi-automatic operation

The ST condition is determined by the receipt of the end-of-pulsing signal initiated by the operator.

b) Automatic operation

  i) Where the ST condition is determined by the originating national network, an ST signal is transmitted to the outgoing international register. No further arrangements are necessary in that register for this purpose.
  ii) Where the ST condition is not received from the originating national network, the outgoing international register will be required to determine the ST condition. (See for example the requirements for system No. 5, Recommendation Q.152.)

RECOMMENDATION Q.319

3.3 MULTIFREQUENCY SIGNAL SENDER

3.3.1 Signalling frequencies 700, 900, 1100, 1300, 1500 and 1700 Hz. A signal shall consist of a combination of any two of these six frequencies. The frequency variation shall not exceed ±1.5% of each nominal frequency.

3.3.2 Transmitted signal level −6 ±1 dBm0 per frequency. The difference in transmitted level between the two frequencies comprising a signal shall not exceed 0.5 dB.

3.3.3 Signal frequency leak and modulation products. The level of the signal leak current transmitted to the line should be at least:

a) 50 dB below the single frequency level when a multifrequency signal is not being transmitted;

b) 30 dB below the transmitted signal level of either of the two frequencies when a multifrequency signal is being transmitted. The modulation products of a signal shall be at least 30 dB below the transmitted level of either of the two frequencies comprising the signal.

3.3.4 *Signal durations*

KP signal: 100 ms ± 10 ms

All other signals: 68 ± 7 ms

Interval between all signals: 68 ± 7 ms.

3.3.5 *Compound signal tolerance*

The interval of time between the moments when the two frequencies comprising a signal are sent must not exceed 1 ms. The interval of time between the moments when the two frequencies cease must not exceed 1 ms.

RECOMMENDATION Q.320

3.4 MULTIFREQUENCY SIGNAL RECEIVING EQUIPMENT

3.4.1 *Operate limits*

The signal receiving equipment must operate satisfactorily on any combination of two of the frequencies received as a single pulse or train of pulses in the presence of maximum expected noise on an international circuit, −40 dBm0 uniform spectral energy over the range of 300 to 3400 Hz, that meets the conditions listed below:

a) each frequency of the received signal is within ±1.5% ±10 Hz of the nominal signalling frequency;

b) the absolute power level N of each received frequency is within the limits

$$(-13 + n \qquad N \qquad + 1 + n)\ \text{dBm}$$

where n is the relative power level at the signal receiver input. Assuming a nominal circuit loss of 0 dB these limits give a margin of ±7 dB on the nominal absolute level of each received signal. Considering that a single equipment may serve circuits whose designed loss (nominal loss) is greater than 0 dB (e.g., circuits that are not equipped with echo suppressors) account must be taken of the highest circuit loss in the design of the receiving equipment (e.g., by increasing must-operate sensitivity) to ensure that the minimum margin is 7 dB;

c) the difference in level between the frequencies comprising a received signal is less than 6 dB;

d) the signal receiving equipment must accept signals meeting the following conditions:

- i) signals within the limits specified in a), b), and c) above in the presence of maximum expected noise and subject to the maximum expected delay distortion,
- ii) the duration of each frequency comprising a signal is 30 ms or greater, and
- iii) the silent interval preceding the signal is 20 ms or greater.

The tolerances given in a), b), and c) are to allow for variations at the sending end and in line transmission.

The test values indicated in d) are less than the working values. The difference between the test value and the working values will allow for pulse distortion, variations in registration devices, etc.

Note. — Since higher steady noise as well as impulsive noise may be encountered on intra-regional circuits especially over certain compandored carrier systems, the maximum expected noise within a region must be taken into account in the design of equipment for that region.

3.4.2 *Non-operate limits*

1) The receiving equipment shall not operate on any signal whose absolute power level at the point of connection of the receiving equipment is 9 dB or more below the must-operate sensitivity required to satisfy the conditions established in 3.4.1 b).

2) The receiving equipment shall release when the signal level falls 1 dB below the level established in 1) above.

3) Operation of the receiving equipment shall be delayed for a minimum period necessary to guard against false operation due to spurious signals generated internally on reception of any signal.

4) The receiving equipment should not operate on a pulse signal of 10 ms or less. This signal may be of a single frequency or two frequencies received simultaneously. Likewise the equipment shall ignore short intervals.

3.4.3 *Input impedance*

The value of the input impedance should be such that the return loss over a frequency range of 500 to 2700 Hz against a 600-ohm non-inductive resistor in series with a two microfarad capacitor is greater than 27 dB.

RECOMMENDATION Q.321

3.5 ANALYSIS OF ADDRESS INFORMATION FOR ROUTING

In the application of system R1 to intra-regional networks, the routing plan of that network shall apply. The routing plan is such that analysis is limited to a maximum of six digits.

RECOMMENDATION Q.322

3.6 RELEASE OF REGISTERS

3.6.1 *Normal release conditions*

1) An outgoing register shall be released when it has transmitted the ST signal.

2) An incoming register shall be released on the forward transmission of the ST signal to the next exchange, or when all pertinent information has been transferred to an outgoing register.

3.6.2 *Abnormal release conditions*

1) An outgoing register shall release in any of the following situations:

a) on failure to recognize a delay-dialling signal within 5 seconds of circuit seizure unless a longer interval is preferred for particular traffic conditions;

b) on failure to recognize a start-dialling (proceed-to-send) signal within 5 seconds of recognition of the delay-dialling signal unless a longer interval is preferred for particular traffic conditions;

c) on recognition of an unexpected tone-off signal subsequent to the recognition of a start-dialling (proceed-to-send) signal, but prior to completion of outpulsing. This signal sequence will occur in the event of double seizing and therefore a repeat attempt may be invoked and as a result, the register may not be released prior to completion of the second attempt. (See Recommendation Q.315);

d) on exceeding overall register timing of 240 seconds.

2) An incoming register shall release in any of the following situations:

a) on failure to receive the KP signal within 10 to 20 seconds of register seizure;

b) on failure to receive the 1st through 3rd digits within 10 to 20 seconds of receipt of the KP signal;

c) on failure to receive the 4th through 6th digits within 10 to 20 seconds of the registration of the 3rd digit;

d) on failure to receive the remaining digits and ST signal within 10 to 20 seconds of registration of the 6th digit;

e) on error detection such as receipt of one or more than two frequencies in a pulse;

f) on failure to gain access to associated switching equipment within appropriate intervals of time.

The timing intervals given in 1) and 2) are representative values but need not necessarily apply to all types of switching systems or all traffic loads.

Abnormal releases should result in the return of an audible reorder (congestion) tone toward the originating end.

RECOMMENDATION Q.323

3.7 SWITCHING TO THE SPEECH POSITION

At all exchanges, the circuit shall be switched to the speech position when the registers (incoming or outgoing) are released.

CHAPTER IV

Testing arrangements for signalling system R1

RECOMMENDATION Q.324

4.1 GENERAL ARRANGEMENTS FOR TESTING

The guiding principles for the maintenance of automatic circuits as covered in Part V (Recommendations Q.70 to Q.78) are in general applicable to testing of system R1.

RECOMMENDATION Q.325

4.2 ROUTINE TESTING OF EQUIPMENT (LOCAL MAINTENANCE)

4.2.1 Test equipment for routine testing of individual items of equipment such as circuit equipment, connecting circuits, registers, etc. should be provided in every international exchange. Routine tests should be made in accordance with the practice followed in each country for the local maintenance of switching equipment and may be made with suitable semi-automatic or automatic test equipment if available.

4.2.2 The testing equipment must conform to the following principles:

a) an item of equipment must not be taken for test until it is free;

b) an item of equipment taken for test will be marked engaged (busy) for the duration of the test. Before a circuit equipment is taken for test, the circuit will be withdrawn from service at both international exchanges;

c) as an alternative to b), a like item of equipment, known to be properly adjusted, may be switched in, and the item of equipment to be tested is switched out during the test.

4.2.3 Testing of the circuit and signalling equipment should include a check that the specifications of system R1 are met in regard to the following:

a) *Line signalling system*

- — signal frequency
- — transmitted signal levels
- — signal frequency leak
- — receiving equipment operate and non-operate limits
- — receiving-end line split
- — sending-end line split
- — sending duration of signals

b) *Register signalling system*

- — signal frequencies
- — transmitted signal levels
- — signal frequency leak
- — sending duration of signals
- — receiving equipment operate and non-operate limits
- — operation of the receiving equipment in response to a series of pulses
- — error-checking features

RECOMMENDATION Q.326

4.3 MANUAL TESTING

4.3.1 *Functional testing of signalling arrangements*

Functional tests from one end of the circuit to the other can be made by verification of satisfactory signal transmission by initiating a test call to:

a) technical personnel at the distant-end international exchange, or

b) a test call signal testing and answering device, if such equipment is available at the distant-end international exchange.

4.3.2 *Test calls*

1) Steps in the verification of satisfactory transmission of signals involved in the completion of test calls (manual method):

a) place a call to the technical personnel at the distant international exchange;

b) on completion of the connection the audible ringing tone should be heard and the answer signal should be received when the call is answered at the distant end;

c) request distant end to initiate a hang-up (clear-back) signal, followed by a re-answer signal;

d) a hang-up (clear-back) signal should be received and recognized when the distant end hangs up and a second answer signal should be received and recognized when the distant end re-answers the call;

e) initiate a ring-forward (forward-transfer) signal which should be recognized at the distant end;

f) terminate the call and observe that the circuit restores to the idle condition.

2) If incoming signalling testing devices are available at the distant international exchange, the signal verification tests should be made using this equipment to the extent that the applicable features indicated in 1) above are available.

RECOMMENDATION Q.327

4.3 AUTOMATIC TRANSMISSION AND SIGNALLING TESTING

Considering that automatic transmission and signalling testing of international circuits is extremely desirable, administrations using or intending to use system R1 are encouraged to provide for this type of testing. Existing automatic testing equipment, presently in use in world numbering zone 1, may be used. When the automatic transmission measuring and signalling testing equipment No. 2, currently being studied by the C.C.I.T.T.*, becomes available, it may be used as an alternative by agreement of the administrations concerned.

RECOMMENDATION Q.328

4.4 TEST EQUIPMENT FOR CHECKING EQUIPMENT AND SIGNALS

4.4.1 *General*

For local checks of correct equipment operation and for readjusting the equipment, international exchanges should have test equipment available which includes:

a) line and register signal generators,

b) signal-measuring apparatus.

4.4.2 *Signal generators*

The signal generators should be able to simulate all line and register signals. The generators may be part of test equipment which cycles the equipment to be tested through actual signalling sequences, in a manner which enables rapid complete testing to determine whether the equipment meets system specifications.

1) Line signal generator characteristics as follows:

a) signal frequency should be within ±5 Hz of the nominal signal frequency and shall not vary during the time required for testing;

b) signal levels should be variable between the limits given in the specification and be able to be set within ±0.2 dB;

c) signal durations should be long enough so that the signals can be recognized.

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* See Question 11/IV (1968-1972).

2) Register signal generator characteristics as follows:

a) signal frequencies should be within ±1.5% of the nominal signal frequency or frequencies and shall not vary during the time required for testing;

b) signal levels should be variable between the limits given in the specification and be able to be set within ±0.2 dB;

c) signal durations and intervals between signals shall be within the limits given in the specification in Recommendation Q.319, section 3.3.4, for normal operate values and in Recommendation Q.320, section 3.4.1 d), for test operate values.

4.4.3 *Signal-measuring equipment*

Equipment capable of measuring signal frequencies, signal levels, signal durations and other significant signal time intervals may be part of the test equipment referred to in section 4.4.2, or separate instruments.

1) Line signal measuring equipment characteristics as follows:

a) signal frequency between the extreme limits given in the specification should be measured with an accuracy of ±1 Hz;

b) level of the signal frequency measured over the range given in the specification should be measured with an accuracy of ±0.2 dB;

c) signal durations, and other significant time intervals as given in the specification should be measured with an accuracy of ±1 ms or ±1% of the nominal duration, whichever yields the higher value.

2) Register signal measuring equipment characteristics as follows:

a) signal frequency or frequencies between the extreme limits given in the specification, should be measured with an accuracy of ±1 Hz;

b) level of the signal frequency or frequencies over the range given in the specification should be measured with an accuracy of ±0.2 dB;

c) signal duration and intervals between signals as given in the specification should be measured with an accuracy of ±1 ms.

3) In regard to measuring time intervals a recorder having a minimum of two input channels may be useful. The recorder characteristic should conform with the accuracy requirements quoted in 1) and 2) above and be easily connected to the circuit under test. The recorder input characteristic should be such as to have a negligible effect on circuit performance.

CHAPTER V

Interworking of system R1 with other standardized systems

RECOMMENDATION Q.329

INTERWORKING

5. *General*

System R1 is capable of interworking with any of the C.C.I.T.T. standardized signalling systems.

Specifications on interworking of system R1 with other C.C.I.T.T. signalling systems are not yet available.

Typical information is found in Recommendation Q.180.

ANNEX

TABLE 1 — SEMI-AUTOMATIC (SA) AND AUTOMATIC (A) TRAFFIC IN ZONE 1

Outgoing (or Transit) Exchange		Incoming (or Transit) Exchange
	CALL TO FREE SUBSCRIBER	
Idle	2600 Hz →	Idle
	← 2600 Hz	
The connect (seizing) signal (removal of 2600 Hz) is sent forward after the circuit is selected (the speech path is open as long as the register is attached).	– – – – → ← – – – –	Receipt of the connect (seizing) signal causes the circuit to be made busy, a delay-dialling signal to be sent (removal of tone), and the selection process of the register to be started.
	← 2600 Hz	When a register is attached and ready to receive address information a start-dialling (proceed-to-send) signal is returned (the speech path is open as long as the incoming register is attached).
140 ms after receipt of the start-dialling (proceed-to-send) signal interregister signals are sent as follows: KP National significant number ST The outgoing register releases after the ST (end-of-pulsing) signal has been sent. The speech path through the outgoing exchange is established.	MF 2/6 code →	The address signals are received in the incoming register. The register starts setting up the call when sufficient information has been received to determine the routing. The incoming register releases, and establishes the speech path as soon as it has sent forward all the necessary information.

ANNEX *(continued)*

Outgoing (or Transit) Exchange		Incoming (or Transit) Exchange
SA: The operator or A: the calling subscriber hears the ringing tone.	◄··························	The ringing tone of the country of destination is sent back.
SA: An "answer" indication is given to the controlling operator. A: Charging and measurement of the call duration begins after an appropriate delay.	◄— — — — — — — —	The called subscriber answers; an answer signal (removal of tone) is sent back.
SA: A clearing supervisory signal is given to the controlling operator. A: After 13-32 seconds, if there is no disconnect (clear-forward) signal the connection is released and the charging and measurement of the call duration are ceased.	◄———————— 2600 Hz	The called subscriber clears; the hang-up (clear-back) signal is sent back.
The outgoing operator (SA) or calling subscriber (A) clears. A disconnect (clear-forward) signal is sent.	2600 Hz ————————►	The disconnect (clear-forward) signal causes the release of the incoming equipment and the circuit. The disconnect signal is repeated to the next link.
The outgoing access is maintained busy for 750 to 1250 ms (cable circuits) 1050 to 1250 ms (satellite circuits)		

CALL TO A BUSY SUBSCRIBER OR CONGESTION

The signal sequence is the same as for a call to a free subscriber, up to the release of the incoming register.

The operator (SA) or calling subscriber (A) hears the audible tone and clears. The disconnect (clear-forward) signal is sent.	◄·························· ◄··························	Busy subscriber. The audible busy tone of the country of destination is returned. Congestion. The audible congestion tone of the country of destination is returned.

Outgoing (or Transit) Exchange		Incoming (or Transit) Exchange
	SPECIAL CONDITIONS	
1. Ring-forward (forward-transfer). Following a call established by operators, if the outgoing controlling operator wishes to recall the incoming operator, a ring-forward (forward-transfer) signal is sent.	2600 Hz pulse (100±35 ms) →	Recalls the incoming operator.
2. Double seizing. The outgoing end sends the connect (seizing) signal (removal of 2600 Hz).	— — — — — — — → ← — — — — — — —	The incoming end also sends the connect (seizing) signal (removal of 2600 Hz).

Each end interprets the connect (seizing) signal as a delay-dialling signal. If the start-dialling (proceed-to-send) signal is not recognized within the specified timing interval, double seizing is assumed and the following may apply:

a) an automatic repeat attempt is made or,

b) a reorder (congestion) audible tone is given to the calling subscriber or operator and no automatic repeat attempt is made.

(See Recommendation Q.315).

PART XVI

SIGNALLING SYSTEM R2

PRINCIPLES OF THE SYSTEM

The following specifications have been drafted in the same form and spirit as the specifications of the other standardized systems, on the basis of the "Detailed Specifications of Signalling System R2" published by the ITU (Geneva 1969). The recommendations they contain thus concern the use of this system only for international telephone operation. In particular, they include no recommendations regarding its use in national networks, although its suitability for this purpose is one of the features of the system. Similarly, they include only the minimum information required for the manufacture of R2 system equipment for international use. Reference should therefore be made to the detailed specifications for any further information regarding the use of the R2 system in national networks or any information of a documentary nature.

General

The R2 system can be used as an international signalling system within an international region (world numbering zone). Recommendations Q.12 and Q.13 therefore apply to it. Moreover, the R2 system can be used to establish an integrated national-international signalling system if it is already employed, with a few local adaptations, as a signalling system in the national networks of the region concerned. It lends itself equally to both automatic and semi-automatic working. It requires automatic access to the outgoing circuits. The system is specified for one-way operation of four-wire carrier circuits. Both-way operation is possible but calls for more complicated equipment [1].

It is not designed for use on satellite circuits of TASI circuits.

There are two types of signalling equipment:

a) line signalling equipment for supervisory signals

b) interregister signalling equipment for forward and backward signalling.

A. *Line signalling*

This is a link-by-link signalling method using an out-band signalling frequency at 3825 Hz for each direction of transmission. All signalling is effected by the "change of condition" method and each operation simply involves passage from one signalling

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[1] For both-way operation, see 2.2.5.

condition to another, except for the clearing sequence which is based on additional timing criteria [1]. The signalling frequency is sent continuously in both directions over the idle circuits.

All the recognition times of the signals are the same, i.e. a nominal value of 20 ms. It is necessary to have a device for protection against the effect of interruption in the signalling channel since interruption of the signalling frequency simulates a false seizure or answer signal. The signalling frequency is transmitted at a low level to avoid possible overloading of the transmission system due to continuous sending of the frequency in both directions on all the idle circuits.

Note. — The multifrequency interregister signalling specified for the R2 system could be used with any other line-signalling system if necessary.

B. *Interregister signalling*

This is of the continuously compelled in-band, end-to-end, 2 out of 6 (2/6) multi-frequency code type with forward and backward signalling. The signalling frequencies do not therefore overlap with the line signalling frequency and differ according to the direction of transmission with a view to possible use of the system on two-wire circuits.

The system is designed to use six signalling frequencies (1380, 1500, 1620, 1740, 1860 and 1980 Hz) in the forward direction and six signalling frequencies (1140, 1020, 900, 780, 660 and 540 Hz) in the backward direction.

The signalling is sent with an overlap by the outgoing international register as soon as the information required to send the first signal is available. Signalling is of the continuously compelled type. Each forward signal is therefore slaved to a backward signal which may have the following supplementary meanings in addition to its role as an acknowledgement signal:

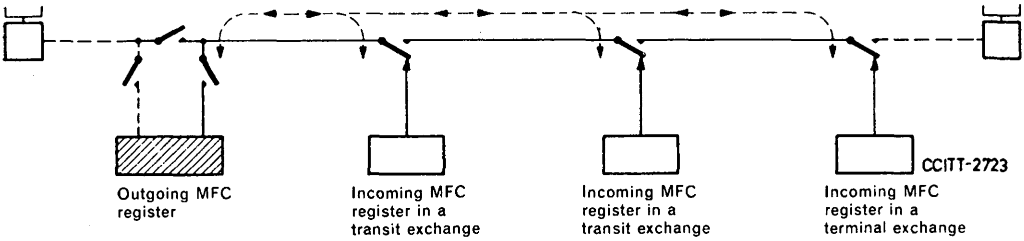

FIGURE 1

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[1] The R2 system does not include a forward-transfer signal. However, such a signal may be introduced by bilateral agreement (see 1.9).

- — request for the repetition of information starting from the preceding signal, or possibly from the last but second signal or the last but third signal;
- — information on the progress of selection operations: congestion, occupation, end of selection;
- — request for information on the origin or nature of the call: subscriber, operator, identity of the CT of origin, data transmission, maintenance equipment, need to insert a half-echo suppressor;
- — transmission of information concerning the called subscriber: subscriber's line out-of-order, subscriber transferred, unused number, non-chargeable call, etc.

The outgoing register controls the setting up of the connection from end to end and communicates in turn with each of the registers encountered in the transit exchanges. Each of the latter clears down as soon as it has set up the connection from the outgoing register to the following CT (see Figure 1). If the connection is prolonged in a national network, the outgoing register may also control the national R2 registers in the same manner, provided certain conditions are respected (described in 4.6.4).

CHAPTER I

RECOMMENDATION Q.350

DEFINITIONS AND FUNCTIONS OF THE SIGNALS

1.1 **Seizing signal** (sent in the forward direction)

This signal is sent at the beginning of the call to initiate switching of the circuit at the incoming end from the idle condition to the operating condition. At the incoming exchange it causes seizure of equipment capable of receiving register signals.

1.2 **Forward register signals**

1.2.1 The following signals are involved:

- address signals (see 1.2.2);
- international transit and echo suppressor indication (see 1.2.3);
- signal identifying the origin of the call (see 1.2.4);
- signal indicating the nature of the caller (see 1.2.5);
- end-of-pulsing signal (see 1.2.6).

1.2.2 *Address signal* (sent in the forward direction)

Register signal sent in the forward direction, containing a decimal information element (digit 1, 2, ... 9 or 0) of the called number (signals I-1 to I-10 of Table 2 in Recommendation Q.361). The language or discrimination digit forms part of the address signals.

For each call a series of address signals is sent. An address signal is transmitted by a 2-out-of-6 additive code. Combinations 11 and 12 of this code are called *code 11* and *code 12* and are considered to be address signals; they are used for semi-automatic calls and give access respectively to an incoming operator and a delay operator (Signals I-11 and I-12 of Table 2 in Recommendation Q.361).

Note. — Combination 13 of this code, called *code 13,* is also considered to be an address signal in the same way as a language digit. It is used to give access to the automatic test equipment (signal I-13 of Table 2 in Recommendation Q.361).

1.2.3 *International transit and echo suppressor indication*

Signal sent in the forward direction, enabling the international exchange receiving them

a) to recognize transit calls and distinguish them from incoming calls (signals I-11, I-12 and I-14 of Table 2 of Recommendation Q.361)

b) to determine:

- whether the connection needs echo suppressors and whether an outgoing half-echo suppressor should be inserted in the international exchange reached (signal I-11)[1], an incoming half-echo suppressor should be inserted in the international exchange reached (signal I-14), an outgoing half-echo suppressor having already been inserted earlier in the circuit;
- whether the connection does not need an echo suppressor (signal I-12).

1.2.4 *Signal identifying the origin of the call*

Signals sent in the forward direction, in response to A-13 (see 1.3.1.2) signals inquiring the origin of the call, indicating the country code (and possibly the area trunk code as well) of the CT where the outgoing register is situated.

1.2.5 *Signal indicating the nature of the calling party*

In addition to the information contained in the language or discrimination digit, a special group of forward signals (group II of Recommendation Q.361) provides supplementary information on the nature of the calling party in the international service and the national service.

For the international service, the following signals are specified:

- initiated by an operator capable of sending the forward-transfer signal[2] (signal II-10 of Table 3 in Recommendation Q.361);
- initiated by an ordinary subscriber or an operator with no forward-transfer facility at her disposal[2] (signal II-7 of Table 3 in Recommendation Q.361);
- data transmission call (signal II-8 of Table 3 in Recommendation Q.361).

1.2.6 *End-of-pulsing signal* (code 15)

Signal sent in the forward direction to indicate (in the semi-automatic service) that no other address signal will follow or (in the automatic service) that the transmission of the outgoing CT code is over (signal I-15 of Table 2 in Recommendation Q.361).

1.3 Backward register signals

1.3.1 Each forward register signal sets off a backward interregister signal, which has the role of an *acknowledgement signal* with continuous compelled operation. These acknowledgement signals also carry back information and thus fall within the following categories:

- request for address signals (see 1.3.2);

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[1] This signal which is used to request the insertion of an outgoing half-echo suppressor can be used only on relations where this facility has been agreed upon bilaterally between the Administrations concerned.

[2] This distinction applies only on relations in which the Administrations concerned have agreed bilaterally to provide a forward-transfer facility (see 1.9).

- signals inquiring the origin of the call (see 1.3.3);
- congestion signals (see 1.3.4);
- "number complete" signal (see 1.3.5);
- signals indicating the called subscriber line situation (see 1.3.6).

1.3.2 *Request for address signals*

Five backward signals are provided; four of them are interpreted with reference to the last address signal received:

- signal requesting the despatch of the address signal following the last address signal sent (signal A-1 of Table 4 in Recommendation Q.361);
- signal requesting repetition of the address signal preceding the last address signal sent (last but one) (signal A-2 of Table 4 in Recommendation Q.361);
- signal requesting the repetition of the last but two address signal sent (signal A-7 of Table 4 in Recommendation Q.361);
- signal requesting the repetition of the last but three address signal sent (signal A-8 of Table 4 in Recommendation Q.361);
- signal requesting the despatch or repetition of the language or discrimination digit (signal A-12 of Table 4 in Recommendation Q.361).

1.3.3 *Signals inquiring the origin of the call*

Four backward signals are provided to interrogate the outgoing CT on the origin of the call:

- signal inquiring the nature of the caller (signal A-5 of Table 4 in Recommendation Q.361);
- signal requesting the despatch or repetition of the international transit indication (signal A-11 of Table 4 in Recommendation Q.361);
- signal inquiring as to the country code (and possibly the area trunk code as well) of the CT where the outgoing international register is situated (signal A-13 of Table 4 in Recommendation Q.361);
- signal requesting information on the use of echo suppressors (signal A-14 of Table 4 in Recommendation Q.361).

1.3.4 *Congestion signals*

Two backward signals are provided:

International congestion signal (signal A-15 of Table 4 in Rec. Q.361). — Signal sent in the backward direction to indicate that the attempt to set the call-up has failed owing to congestion of the group of international circuits, or congestion in the international switching equipment, or to time-out or abnormal release of an international transit register.

Congestion signal in a national network (signal A-4 in Table 4 of Recommendation Q.361 and B-4 in Table 5 of the same Recommendation). — Signal sent in the backward direction to indicate that the attempt to set the call-up has failed owing to congestion in a selection stage or circuit system of the national network (excluding a busy called subscriber's line) or to time-out or abnormal release of a national incoming register.

In all cases reception of these signals causes release of the forward circuit chain and the sending back of the appropriate signal, audible tone, or spoken announcement, or possibly causes an automatic repeat attempt.

1.3.5 *"Number complete" signal*

Signal sent in the backward direction to indicate that it is no longer necessary to send another address signal, and

- either cause immediate passage to the speech position to enable the calling subscriber to hear a tone or a recorded announcement of the national incoming network (signal A-6 of Table 4 in Recommendation Q.361);
- or announce (signal A-3 of Table 4 of Recommendation Q.361) the despatch of a signal indicating the condition of the called subscriber's line.

1.3.6 *Signals indicating the condition of the called subscriber's line*

Seven signals sent in the backward direction are provided to give information about the called subscriber's line and to indicate the end of interregister signalling.

"Subscriber line free with call charging" signal[1] (signal B-6 of Table 5 in Recommendation Q.361). — Signal sent in the backward direction to indicate that the called subscriber's line is free and that the call is to be charged.

Subscriber line free, non-chargeable call signal[1] (signal B-7 of Table 5 in Recommendation Q.361). — Signal sent in the backward direction to indicate that the called subscriber's line is free and that the call is not to be charged. This signal is used only for calls to special destinations.

Subscriber line engaged signal (signal B-3 of Table 5 in Recommendation Q.361). — Signal sent in the backward direction to indicate that the line or lines connecting the called subscriber to the exchange are busy.

Subscriber line out of order signal (signal B-8 of Table 5 in Recommendation Q.361). — Signal sent in the backward direction to indicate that there is a fault on the subscriber's line.

Number not in use signal (signal B-5 of Table 5 in Recommendation Q.361). — Signal sent in the backward direction to indicate that the number received is not in use (i.e. that it corresponds, for instance, to an unused selection stage, an unused country code, an unused trunk code or a number that has not been allocated).

Transferred subscriber signal (signal B-2 of Table 5 in Recommendation Q.361). — Signal sent in the backward direction to indicate that the national number received has ceased to be used and that the subscriber to whom it was allocated must be reached via another number.

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[1] Since two "subscriber line free" signals are provided, interworking with signalling systems No. 5 *bis* and No. 6 is possible.

Congestion signal (signal B-4 of Table 5 in Recommendation Q.361); see 1.3.4 above.

1.3.7 *Signals available for the national service*

Some of the backward signals available (A-9, A-10, B-1, B-9 and B-10 of Tables 4 and 5 in Recommendation Q.361) have been allocated for the national service. Since the incoming register cannot know the origin of the connection in all cases and since end-to-end signalling is used, it may happen that the above-mentioned signals are sent to the outgoing international R2 register. When this register receives them it must react as indicated in Tables 4 and 5 of Recommendation Q.361.

1.4 **Answer signal** (sent in the backward direction)

This signal is sent to the outgoing international exchange to indicate that the called subscriber has answered the call[1].

With semi-automatic working this signal brings supervision into play.

With automatic working this signal is used

- to start metering the charge to the calling subscriber, unless the register signal indicating "not to be charged" has been sent previously;
- to start measurement of the call duration for international accounting purposes unless the register signal indicating "not be to charged" has been sent previously, in which case reception of this signal may or may not start this measurement.

1.5 **Clear-back signal** (sent in the backward direction)

This signal is sent to the outgoing international exchange to indicate that the called party has cleared. In semi-automatic working, this signal brings supervision into play; it must not cause permanent interruption of the speech channel at the outgoing international exchange.

In automatic working, arrangements must be made to release the international connection, stop the charging and stop the measurement of call duration if between one and two minutes after receipt of the clear-back signal the calling subscriber has not cleared. Release of the international connection should preferably be controlled from the point where the charging of the calling subscriber is carried out.

Notes concerning the answer and clear-back signals. — (see the relevant notes in Recommendation Q.120.)

1.6 **Clear-forward signal** (sent in the forward direction)

This signal is sent in the forward direction at the end of a call when

a) in semi-automatic working, the operator of the outgoing international exchange takes the plug out or performs an equivalent operation;

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[1] See Recommendation Q.27 for the action to be taken to ensure that the international or national answer signals are to be transmitted as quickly as possible.

b) in automatic working, the calling subscriber clears or performs an equivalent operation.

This signal is also sent by the outgoing international exchange upon receiving a busy signal or a backward register signal requesting the outgoing international exchange to clear the connection, or in the case of forced clearance of the connection as mentioned in 4.3.1 and 4.3.2 (automatic working) or 4.3.1 (semi-automatic working) of Recommendation Q.118. This signal may also be sent as the result of abnormal release of an outgoing register.

1.7 **Release-guard signal** (sent in the backward direction)

This signal is sent in the backward direction in response to a clear-forward signal. It protects an international circuit against subsequent seizure as long as the disconnection operations set in motion by reception of the clear-forward signal have not been completed at the incoming end.

1.8 **Blocking signal** (sent in the backward direction)

This signal is sent on an idle circuit to the outgoing exchange to cause blocking to be applied to this circuit guarding it against subsequent seizure at the outgoing exchange.

1.9 **Forward-transfer signal** (sent in the forward direction)

This signal is sent to the incoming international exchange when the outgoing operator of the outgoing international exchange needs the assistance of an operator at the incoming international exchange. This is an in-band end-to-end signal, identical with that of system No. 4 (PYY, see Recommendations Q.120 to Q.124).

This signal does not normally form part of the R2 system, but it may be introduced on some relations by bilateral agreement between the Administrations concerned (see 1.2.5 and 2.9.4 of the Detailed Specifications).

CHAPTER II

Line signalling

RECOMMENDATION Q.351

2.1 LINE SIGNAL CODE

2.1.1 General

The code used for the transmission of line signals is based on the "tone-on idle signalling" method. In such a system, the line signals are transmitted link by link and the circuits use an outband signalling channel in each direction of transmission.

When the circuit is idle, a low-level signalling tone is sent continuously in both directions over the signalling channels. This tone is removed in the forward direction at the moment of seizure and in the backward direction when the called subscriber answers.

The connection is released when the signalling tone is restored in the forward direction; release causes the tone to be restored in the backward direction. If the called subscriber is the first to clear, the signalling tone is restored in the backward direction first. It is then restored in the forward direction either when the caller clears or when a certain interval has elapsed after recognition of the signalling tone in the backward direction.

The signalling system is specified for one-way operation on four-wire carrier circuits. Both-way operation is possible, but requires more complicated equipment (see Annex II to the Detailed Specifications).

2.1.2 Line conditions

Tone-on or tone-off denotes a certain signalling condition. The line thus has two possible conditions in each direction, i.e. a total of four signalling conditions. Taking into account the time sequence, the circuit will have the six characteristic operating conditions shown in the following table:

Operating condition of the circuit	Signalling condition	
	forward	backward
1. Idle	Tone on	Tone on
2. Seized	Tone off	Tone on
3. Answered	Tone off	Tone off
4. Clear-back	Tone off	Tone on
5. Release	Tone on	Tone on or off
6. Blocked	Tone on	Tone off

The transition from one signalling condition to another corresponds to the transfer of a signal. To change from "release" to "idle" additional criteria (timing) are necessary to ensure a defined sequence corresponding to the transfer of the release-guard signal (see 2.2.2.6).

RECOMMENDATION Q.352

2.2 CLAUSES FOR LINE-SIGNALLING EQUIPMENT

2.2.1 Recognition time for transition of signalling condition

The recognition time for a changed condition (transition from tone-on to tone-off or vice versa) is 20 ± 7 ms.

This value does not include the response time of signalling receivers (see 2.3.2) but it is assumed that there is interruption control (see Chapter III).

2.2.2 Normal conditions (one-way operation)

2.2.2.1 *Seizure*

The outgoing end removes the tone in the forward direction.

If seizure is immediately followed by release, removal of the tone must be maintained for at least 100 ms to make sure that it is recognized at the incoming end.

2.2.2.2 *Answer*

The incoming end removes the tone in the backward direction. When another link of the connection using tone-on-continuous signalling precedes the outgoing exchange, the "tone-off" condition must be established on this link immediately it is recognized in this exchange.

2.2.2.3 *Clear-back*

The incoming end restores the tone in the backward direction. When another link of the connection using tone-on-continuous signalling precedes the outgoing exchange the "tone on" condition must be established on this link immediately it is recognized in this exchange.

The provisions set forth in 2.2.2.6 must also be taken into consideration.

2.2.2.4 *Clear forward*

The outgoing end restores the tone in the forward direction (see 2.2.2.1). The circuit chain onward is released and the release-guard sequence begins as soon as the changed signalling condition is recognized at the incoming end. In the outgoing exchange the circuit remains blocked until the release-guard sequence is terminated (see 2.2.2.6).

2.2.2.5 *Blocking*

At the outgoing centre, the circuit stays blocked so long as the tone remains off in the backward direction.

Restoration of the tone in the backward direction—accompanied by the presence of the tone in the forward direction—restores the circuit to idle. The circuit may then be seized for a new call.

2.2.2.6 *Release-guard*

2.2.2.6.1 *Release prior to answered condition*

The tone in the backward direction is removed at the incoming end as soon as restoration of the tone sent by the outgoing end has been recognized (see Figure 2 below).

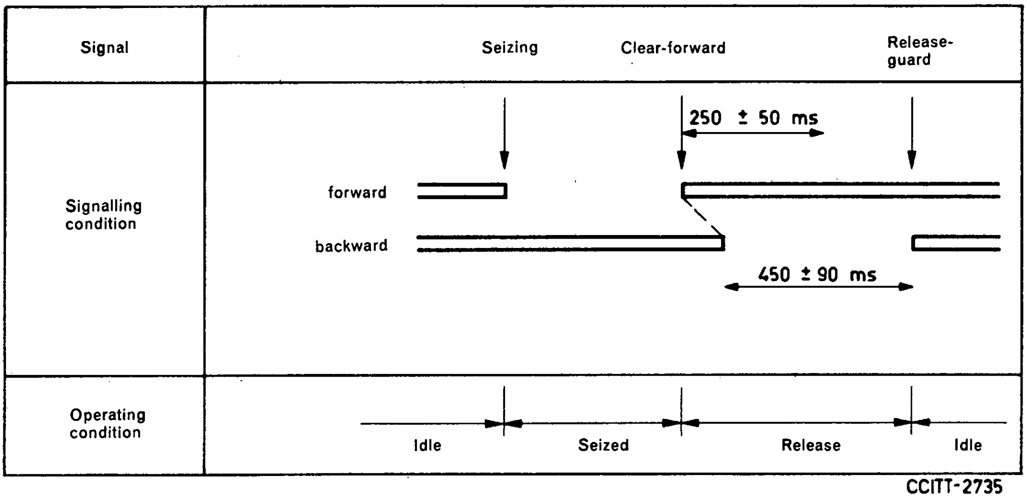

FIGURE 2. — **Release-guard sequence prior to answered condition**

Once an interval of 450 ± 90 ms[1] has elapsed after the removal, the tone is again restored at the incoming end in the backward direction. The circuit returns to idle as soon as the restored tone is recognized, following recognition of the“ tone-off” condition, at the outgoing end.

Establishing the “tone-off” interval at the incoming end and recognition at the outgoing end of the two successive changes in condition (transition from tone-on to tone-off followed by the inverse transition) together constitute the “release-guard sequence”.

Transition from tone-off to tone-on in the backward direction must not be interpreted, at the outgoing end, as part of the release-guard sequence until an interval of 250 ± 50 ms[1] has elapsed after application of the tone in the forward direction.

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[1] The reasons for a delay of this duration are given in the Detailed Specifications (para. 4.4.2.6.2).

2.2.2.6.2 *Release in answered condition (speech)*

The circuit returns to idle as soon as the outgoing end recognizes the tone restored in the backward direction after release operations have been completed at the incoming end. Transition in the backward direction from the "tone-off" to the "tone-on" signalling condition must not be interpreted as part of the release-guard sequence until the interval of 250 ± 50 ms described in 2.2.2.6 above has elapsed after application of the tone in the forward direction (see Figure 3 below).

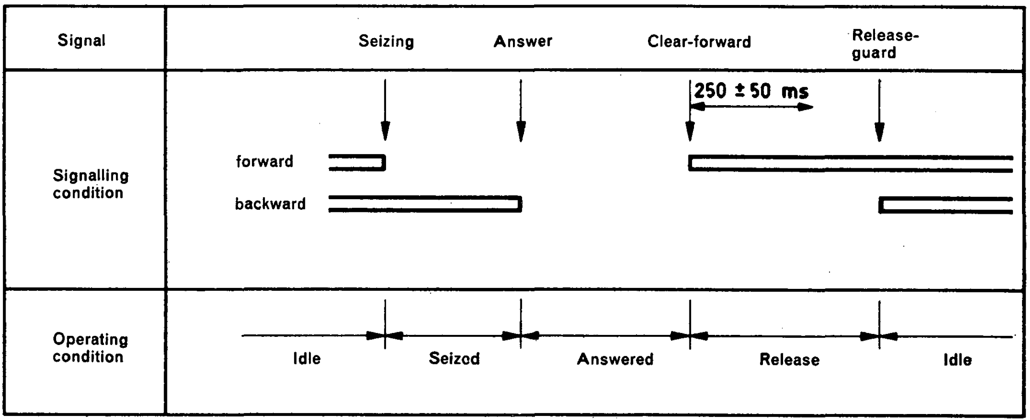

FIGURE 3. — **Release-guard sequence (speech position)**

2.2.2.6.3 *Release in clear-back condition*

The incoming equipment removes the tone in the backward direction at least for the interval 450 ± 90 ms and the release-guard sequence takes place as described in 2.2.2.6.1.

2.2.3 Erroneous reception of the answer signal

If an exchange erroneously recognizes an answer signal (i.e. tone-off condition in the backward direction) before the outgoing MFC register has been dismissed, the connection must be released.

2.2.4 Abnormal conditions (in one-way operation)

Note. — The situations described below are those in which interruption control of signalling channels (see Recommendation Q.356) does not function and which occur only during interruptions of individual channels or in the event of a fault in an individual line-signalling equipment.

2.2.4.1 In the case of non-reception of the answer signal, of delay in clearing by the calling subscriber in automatic working, or of non-reception of the clear-forward signal by the incoming exchange after the clear-back signal has been sent, the provisions of Recommendation Q.118 apply.

2.2.4.2 If, in the case of 2.2.2.6.1, the signalling tone in the backward direction is not removed, the circuit will remain blocked indefinitely, since it cannot return to idle condition of its own accord. The action to be taken in such cases is described in Chapter VI of the Detailed Specifications [1].

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[1] The R2 system is specified for one-way working. The following clauses 2.2.5 and 2.2.6 therefore apply only to cases where the interested Administrations have undertaken by bilateral agreement to use both-way working. See also the Annex to Chapter IV of the Detailed Specifications.

2.2.4.3 If after sending of the clear-forward signal the signalling tone in the backward direction is not restored, the circuit stays blocked, as described in 2.2.2.5. The same occurs when, in the idle position, the signalling tone in the backward direction is interrupted by a fault [1].

2.2.4.4 When the signalling tone in the forward direction of an idle circuit is interrupted owing to a fault, the incoming end recognizes a seizure and connects the multifrequency-signalling equipment, but no multifrequency signals follow.

a) When the interruption is long enough for the time-out device of the incoming multifrequency register to come into play (see 4.8.2 of Recommendation Q.369), the register will release and the circuit must be brought into blocked condition by removal of the signalling tone in the backward direction.

b) When the interruption is not long enough for the time-out device to come into play, restoration of the signalling tone in the forward direction will return the circuit to idle.

2.2.5 Additional clauses [1] on both-way working — Normal conditions

A peculiarity of both-way working is that a blocking signal cannot be distinguished from a seizing signal at either end of a circuit, since the change in signalling condition corresponding to these signals is the same, namely from "tone-on" to "tone-off".

When a both-way circuit is seized simultaneously at both ends, the signalling tone is disconnected in both directions of transmission; this is the criterion for detecting the double-seizure situation.

The special arrangements required for both-way working relate to the two cases mentioned above. For all other signalling phases the specifications for one-way working remain valid without modification.

2.2.5.1 *Double seizure*

When one end of a both-way circuit indicates the seized condition by disconnecting the signalling tone, the signalling equipment at that end must be satisfied that cessation of the signalling tone in the opposite direction has not occurred within 250 ± 50 ms of the disconnection of the signalling tone in the forward direction.

If the signalling equipment finds that the signalling tone has been removed within that interval, a double-seizure situation is recognized.

In such a situation the line-signalling equipment at both ends must remain in the double-seizure condition for 1250 ± 250 ms (see 2.2.6). The end at which time-out first occurs sends the clear-forward signal and the line-signalling equipment at the other end of the circuit responds by returning to idle.

2.2.5.2 *Blocking in both-way working*

To avoid certain difficulties (see 2.2.6.1 and 2.2.6.2) and *in contrast to specification 2.2.4.4*, the "tone-off" signalling condition is not applied in the opposite direction (B-A) to the blocking direction (A-B). When the blocking is removed at end A the signalling tone is again transmitted in direction A-B and the B end interprets the onset of the signalling tone as a clear-forward signal, thereby initiating the release-guard sequence in the B-A direction.

2.2.6 Abnormal conditions in both-way working

(see Note in 2.2.4)

2.2.6.1 When an interruption of the signalling channel in one of the two directions brings about a signalling condition corresponding to blocking, the release-guard sequence will be initiated the moment the interruption ends (see 2.2.5.1). The following *additional requirements* should then be met:

— when the "tone-off" signalling condition has lasted for an interval of less than 750 ± 150 ms the return to "tone-on" signalling condition must not initiate a release-guard sequence;

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[1] The situations described in 2.2.4.2 and 2.2.4.3 may also result from operation of interruption control at the incoming end of the circuit. In that case the circuit automatically returns to normal at the command of interruption control. As a general rule, an alarm should be given to technical staff when a circuit is blocked (see 4.4.4 of the Detailed Specifications).

— once the signalling condition corresponding to seizing has been established, it must be maintained for at least 1250 ± 250 ms (exception to specification 2.2.2.1).

2.2.6.2 An interruption of both signalling channels on any circuit will be interpreted by the equipment at the ends of the line as "seizing" and the said equipment will be blocked after the lapse of the time-out delay of the incoming multifrequency registers.

When both signalling channels are simultaneously restored, the terminal equipment at both ends will interpret the onset of the signalling tone as a clear-forward signal and this will bring the release-guard sequence into operation. The result will be that the terminal equipment at both ends will again note the "tone-off" signalling condition for a brief interval.

The following additional clause must be observed, to avoid permanent blocking of the circuit in this condition:

When, after blocking, the line-signalling equipment at one end (A) of a both-way circuit has recognized the clear-forward signal, it must complete the emission of the release-guard signal and restore the signalling tone in the direction A-B, even if the tone in direction B-A is interrupted. If such interruption (in direction B-A) lasts for less than 750 ± 150 ms, the circuit returns to idle when the signalling tone is restored in both directions. If the interruption is longer than 750 ± 150 ms, restoration of the signalling tone in direction B-A will cause a new release-guard signal to be sent in direction A-B (see 2.2.6.1).

RECOMMENDATION Q.354

2.3 CLAUSES FOR LINE-SIGNALLING TRANSMISSION EQUIPMENT

2.3.1 Signal sender

2.3.1.1 *Signalling frequency*

The nominal value of the signalling frequency is 3825 Hz. Measured at the sending point, the frequency variation from the nominal value must not exceed ± 4 Hz.

2.3.1.2 *Send level*

The send level of the signalling frequency, measured at the group distribution frame or an equivalent point, must be — 20 ± 1 dBm0.

2.3.1.3 *Leaks*

The level of any signal frequency leak current which may be transmitted to line (e.g. when static modulators are used), must be at least 25 dB below the level of the signalling tone.

2.3.1.4 *Phase distribution of the signalling frequencies*

As the signalling frequency is sent on any circuit in idle condition, the addition of these tones in moments of low traffic may give rise to overloading of the system, intelligible crosstalk and unwanted tones.

One method recommended to avoid these effects is to inject the signalling frequencies with random 0 and Π radian phases in the channels. An equivalent method is to use carrier frequencies of which the phases are randomly distributed 0 and Π radians. With these methods the probability of occurrence of 0 and Π radian phases should be 0.5.

Other methods may be used provided they give comparable results. For further details, see the Detailed Specifications.

2.3.1.5 *Protection of the signalling channel at the sending end*

The signalling channel must be protected at the sending end against disturbance from the associated and the adjacent speech channel.

When a sine wave at 0 dBm0 level is applied to the audio-frequency input of the associated channel or the adjacent channel, the level measured at the group distribution frame or at an equivalent point must not exceed the levels shown in Figure 4.

When the go path is looped to the return path at the group distribution frame or an equivalent point, the signalling receiver must not change condition when:

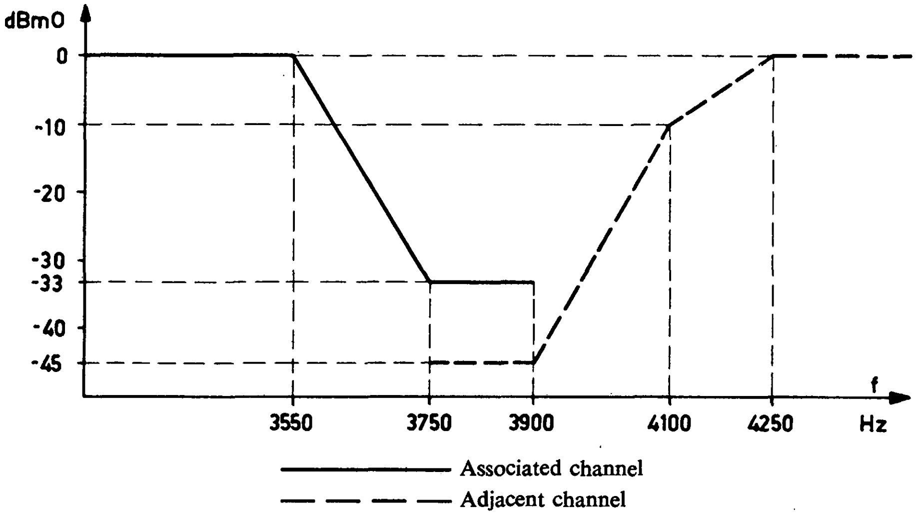

FIGURE 4. — **Maximum level of permissible disturbance from the associated and the adjacent channel**

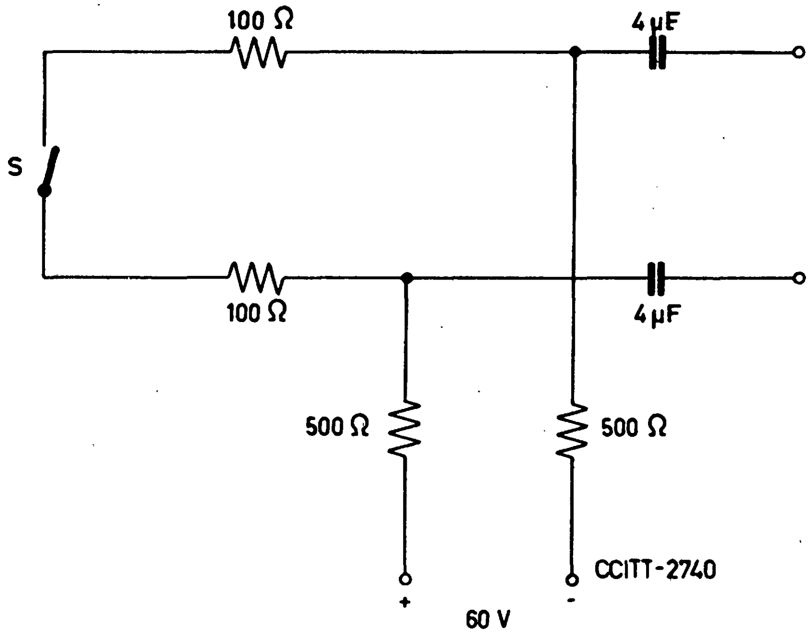

FIGURE 5. — **Click generator**

- the click generator shown in Figure 5 [1] is connected to the associated speech channel or to the adjacent speech channel at the very point where this channel is connected to the switching equipment;
- to take the most difficult circumstances possible, the channel level adjusting devices are set to such values encountered in practice which give rise to the worst disturbance;
- gain is introduced in the loop at the group distribution frame or at the equivalent point, so that the receive level at the point in question is + 3 dBm0.

2.3.1.6 *Response time*

The response time of the signalling sender is defined as the interval between the instant when the change signalling condition command is applied to the sender and the instant at which the envelope of the signalling frequency, measured at the group distribution frame or at an equivalent point, reaches half of its value in the steady state. For each of the two possible changes of signalling condition the response time must be less than 7 ms.

RECOMMENDATION Q.355

2.3.2 Signalling receiver

2.3.2.1 *Recognition of the "tone-on" condition*

The receiver must have assumed or assume the "tone-on" state when at the group distribution frame or at an equivalent point:

- the level of the received frequency has risen to — 27 dBm0 or more;
- its frequency lies between 3825 ± 6 Hz.

2.3.2.2 *Recognition of the "tone-off" condition*

The receiver must have assumed or assume the "tone-off" state when the level of the test frequency, at the group distribution frame or at an equivalent point, has dropped to the values shown in Figure 6.

2.3.2.3 *Protection against near-end disturbances*

The signalling receiver must not change state when any one of the following disturbing signals is applied at the four-wire output of the associated speech channel looped at the group distribution frame or at an equivalent point:

- a sinusoidal signal whose level as a function of the frequency is shown in Figure 7;

or

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[1] Provisional specification.

— a transient signal produced by the click generator (described in 2.3.1.5) applied at the point where the channel is connected to the switching equipment, all level adjusting devices being set to such values encountered in practice which give rise to the worst disturbance.

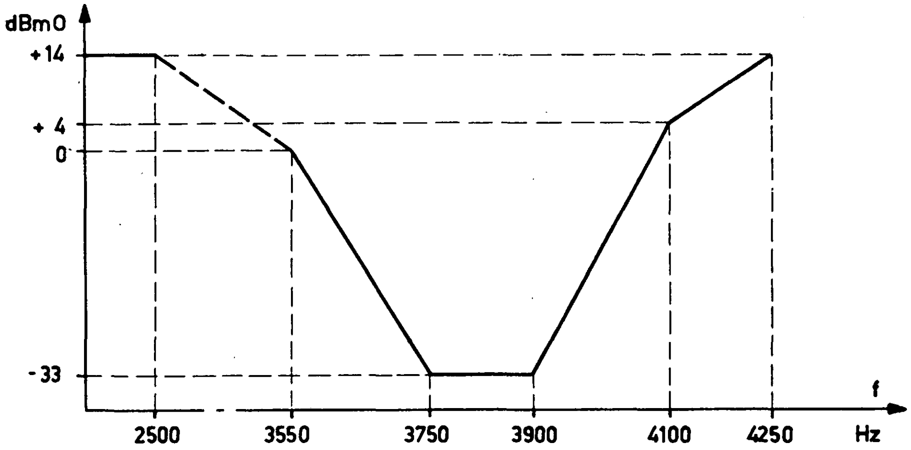

FIGURE 6. — **Level limits for recognition of the "tone-off" condition**

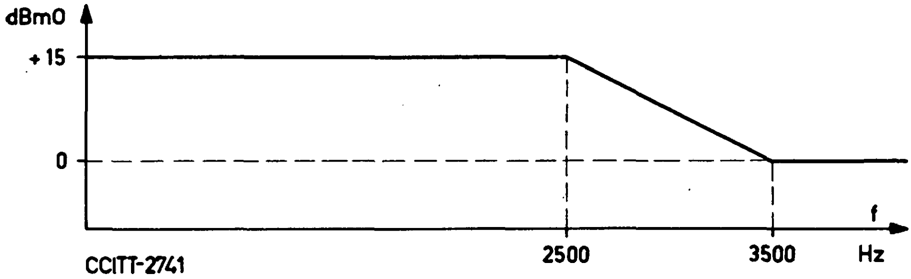

FIGURE 7. — **Level limit for a sinusoidal disturbance signal to which the signalling receiver must remain insensible**

2.3.2.4 *Overall response time of signal sender and receiver*

When the modulation equipment is looped at the group distribution frame or at an equivalent point, the overall response time is defined as the interval between the instant when a change of signalling condition command is applied to the sender and the moment when this changed signalling condition appears at the receiver output. For each of the two possible changes of signalling condition, the overall response time must be less than 30 ms.

2.3.2.5 *Interference by carrier leaks*

The requirements stated in 2.3.2.1, 2.3.2.2, 2.3.2.3 and 2.3.2.4 above must be fulfilled in the presence of carrier leaks.

It is assumed that:

— when the receive level of the signalling tone is at its nominal value at the group distribution frame or an equivalent point, each carrier leak is present at a level of −26 dBm0;

— the level of the carrier leak varies proportionally with any variations in the level of the signalling tone.

2.3.2.6 *Interference by pilots*

The specified signalling system is not intended to work in the presence of pilots specified by C.C.I.T.T. and having a frequency differing by 140 Hz from the nearest multiple of 4 kHz.

On the other hand, the requirements stated in 2.3.2.1, 2.3.2.2, 2.3.2.3, 2.3.2.4 and 2.3.2.5 must be met in the presence of any other pilot recommended by the C.C.I.T.T.

It is assumed that variations in level of the pilot and of the signalling tones are correlated.

CHAPTER III

Protection of the R2 system from the effect of interruptions on the signalling channels

RECOMMENDATION Q.356

3.1 GENERAL

In the R2 system, removal of the signalling frequency corresponds to the sending of the seizing and answer signals. Any unwanted interruption of the signalling channels may therefore result in false signalling.

It is therefore recommended to fit each direction of transmission of a carrier circuit connection with interruption control equipment using the group pilot to detect interruptions. Other methods may be used provided they are equally reliable and have the same response time.

The receiver at one end supervises the pilot transmitted by the other end. When it detects a considerable fall in the level of the pilot, it deduces that an interruption has occurred on the signalling channels associated with the carrier circuits. It then reacts through the wiring system on the equipments of these circuits to prevent the unwanted transmission of certain signals on those circuits which have already been seized or to ensure that idle circuits are blocked.

To ensure proper interruption control, it is essential that the individual transmission or switching equipments should not react to any change of signalling condition due to a fault. The action initiated by the interruption control must therefore be completed in less time than the sum of the response time of the signalling receiver and the recognition time for the "tone-off" signalling condition caused by interruption of the signalling channel. Again, to prevent the unwanted transfer of certain signals, interruption control, during re-establishment of the pilot, must return to "alarm off" after an interval long enough for the signalling equipment to revert to normal (see 3.4).

Interruption control operates independently for each direction of transmission.

Blocking of a circuit at the outgoing end therefore takes place in two different ways:

- immediate blocking by intervention of interruption control at the outgoing end;
- blocking on recognition in the backward direction of the "tone-off" signalling condition caused by interruption control intervention at the incoming end.

When the transmission system is re-established, interruption control reverts to its normal condition and the signalling equipment must automatically revert to normal operating.

Since the action to be taken on the individual circuits differs according to their operating condition at the time the fault occurs, the different possibilities are dealt with in detail in Recommendations Q.357 and Q.358 below. For any further information on the reasons for these clauses, see the Detailed Specifications.

RECOMMENDATION Q.357

3.2 MODE OF OPERATION OF INTERRUPTION CONTROL AT THE INCOMING END

(transmission interrupted in the forward direction)

3.2.1 **Circuit in idle condition**

Transition of interruption control to alarm brings about:

a) removal of the signalling tone in the backward direction by blocking of the sending unit in the "tone-off" condition, for one-way circuits; *for both-way circuits, on the contrary,* the sending unit must be blocked in the "tone-on" condition;

b) locking of the receiving unit in its position, i.e., in the "tone-on" condition.

Note. — Return of interruption control to normal ensures return to idle of the circuits affected by the fault by switching the transmitting units at the incoming end to the "tone-on" position.

3.2.2 **Circuit seized prior to answer**

Transition of interruption control to alarm brings about:

a) locking of the sending unit in its position, i.e. in the "tone-on" condition;

b) locking of the receiving unit in its position, i.e. in the "tone-off" condition;

c) start of a time-out device which after a certain interval clears the chain beyond the faulty circuit; this time-out device may be the one specified in Recommendation Q.118, 4.3.3.

If the called subscriber, after lifting the receiver during the time-out delay mentioned in c), has cleared, the part of the connection beyond the faulty circuit must be released without waiting for this time-out delay to elapse.

Note. — When interruption control reverts to normal before the called subscriber has answered, the call may still mature normally, provided the caller is holding the line, even if at the moment when interruption control reverts to normal the called subscriber has just answered; as long as the caller is still connected, the answer signal may be sent. If at the moment when interruption control reverts to normal the called subscriber has already cleared or his line has been released, or if the outgoing exchange has already sent the clear-forward tone, operation b) ensures that in all cases the release-guard sequence will take place according to Recommendation Q.352, 2.2.2.6.

3.2.3 **Circuit in "answered" condition**

Transition of interruption control to alarm brings about:

a) locking of the sending unit in its position, i.e. in the "tone-off" condition;

b) locking of the receiving unit in its position, i.e. in the "tone-off" condition.

When the called subscriber clears, the part of the circuit chain beyond the faulty circuit (including the called subscriber's line) must be released immediately.

Note. — When interruption control reverts to normal with both subscribers still on the line, the connection is maintained.

When the caller has already cleared by the time interruption control reverts to normal, the release-guard signal is sent in accordance with Recommendation Q.352, 2.2.2.6.2 or 2.2.2.6.3.

3.2.4 Circuit in clear-back condition

Transition of interruption control to alarm causes:

a) locking of the sending unit in its position, i.e. in the "tone-on" condition;

b) locking of the receiving unit in its position, i.e. in the "tone-off" condition;

c) immediate release of the part of the circuit chain beyond the faulty circuit (including the called subscriber's line).

Note. — When interruption control reverts to normal, the release-guard signal is sent in accordance with Recommendation Q.352, 2.2.2.6.3, as soon as the clear-forward signal is recognized.

3.2.5 Circuit in release condition

When interruption control functions after a clear-forward signal has been recognized at the incoming end, it causes:

a) locking of the sending unit in the "tone-off" condition; if at the instant interruption control operates the "tone-on" condition exists in the backward direction, it will be switched to the "tone-off" condition following recognition of the clear-forward signal and locking in the "tone-off" condition can take place as prescribed;

b) locking of the receiving unit in its position, i.e. in the "tone-on" condition.

Note. — When interruption control reverts to normal, the "tone-on" condition is established in the backward direction and causes the circuit at the outgoing exchange to return to idle.

RECOMMENDATION Q.358

3.3 MODE OF OPERATION OF INTERRUPTION CONTROL AT THE OUTGOING END

(transmission in the backward direction interrupted)

3.3.1 Circuit in idle condition

Transition of interruption control to alarm is immediately followed by locking of the outgoing circuit.

3.3.2 Circuit seized but not in "answered" condition

3.3.2.1 Transition of interruption control to alarm causes blocking of the receiving unit in its position, i.e. in the "tone-on" condition.

3.3.2.2 As soon as a clear-forward signal is sent on the circuit chain preceding the faulty circuit, the signalling tone must be established in the forward direction to ensure that the circuit chain beyond the faulty circuit is released.

3.3.2.3 When interruption control reverts to normal, the tone may already have been sent in the forward direction as a clear-forward signal, whereas the release-guard sequence cannot be received at the outgoing end. Exceptionally, therefore, return of the outgoing circuit to the idle condition must take place simply on recognition of the "tone-on" condition in the backward direction.

3.3.3 Circuit in answered condition

In this case transition of interruption control to alarm does not cause immediate action. A clear-forward signal sent on the circuit chain preceding the faulty circuit must be retransmitted to ensure that the circuit chain beyond the faulty circuit is cleared.

Note. — Once interruption control reverts to normal, the connection is maintained provided the caller and the called subscriber are still on the line. On the other hand, by the time interruption control reverts to normal, the clear-forward signal may already have been sent and the situation will be the one described in 3.3.2.3.

3.3.4 Circuit in release condition

As in Recommendation Q.357, 3.2.5.

3.3.5 Special conditions for both-way working

1. As soon as an operating condition has been established on a both-way circuit and the outgoing and incoming ends of the circuit have been determined with certainty, the interruption-control specifications for one-way working become equally applicable to both-way circuits.

2. When a both-way circuit is idle, transition to alarm of the interruption control of one direction of transmission must bring about operations to ensure that the signalling condition existing at that moment on the signalling channel of the opposite direction is maintained—in contrast to specification 3.2.1. a) for one-way working. This precaution obviates a permanent blocking of a both-way circuit when interruption of the signalling channels occurs simultaneously in both directions. It does not ensure immediate blocking of the circuit; this will not occur until the circuit has been seized by the next call.

3. In all operating conditions intermediate between 'idle' and the condition at the moment when the direction of seizing of the both-way circuit is determined (see above),

the line-signalling equipment at both ends will be blocked by interruption control in the condition in which it was before interruption control passed to alarm.

RECOMMENDATION Q.359

3.4 CLAUSES ON INTERRUPTION CONTROL EQUIPMENT

Adoption of thresholds with widely differing levels makes for economy in the design of interruption control equipment. Against this must be set the fact that the device cannot cope with the effects of certain slow drops in level. However, the probability of these occurring in practice is very small.

3.4.1 Pilots

Interruption control uses the 84.08 kHz group pilot or by bilateral agreement and, at the request of the receiving end country, the 104.08 kHz group pilot.

However, if the ends of the supergroup link coincide with the end of the five group links it is carrying, the supergroup pilot may also be used.

3.4.2 "Alarm-on" threshold

Interruption control must pass to "alarm-on" when the pilot level, measured at the group distribution frame or at an equivalent point, drops to — 29 dBm0.

3.4.3 "Alarm-off" threshold

Interruption control must revert to alarm-off, i.e. normal when the pilot level, measured at the group distribution frame or at an equivalent point, rises to — 24 dBm0.

3.4.4 Response time for a drop in level

Interruption control must pass from normal to alarm-on within an interval $t\downarrow$ such that:

$$5 \text{ ms} \leqslant t\downarrow \leqslant t_{\text{rs min}} + 13 \text{ ms}$$

when the pilot level, measured at the group distribution frame or at an equivalent point, suddenly drops from its nominal level to — 33 dBm0.

In the above formula, $t_{\text{rs min}}$ is the minimum response time of the signalling receiver for a drop in level, taking into account a possible variation of ± 3 dB in the signalling tone level from its nominal value, the level being measured on the receiving side of the group distribution frame or at an equivalent point.

3.4.5 Response time for rise in level

Interruption control must revert from the alarm-on to normal in an interval $t\uparrow$ such that:

$$t_{\mathrm{rs\ max}} - 13 \text{ ms}^{1} \leqslant t\uparrow \leqslant 500 \text{ ms}$$

when the pilot level, measured at the group distribution frame or at an equivalent point, suddenly rises from — 33 dBm0 to its nominal value.

In the above formula, $t_{\mathrm{rs\ max}}$ is the maximum response time of the signalling receiver for a rise in level, taking into account a possible variation of ± 3 dB in the signalling tone level from its nominal value, the level being measured on the receiving side of the group distribution frame or at an equivalent point.

3.4.6 Precautions against noise

An interruption may produce increased noise on the group link. Interruption control must be capable of distinguishing between the pilot itself and a high level noise simulating the pilot.

Interruption control must not revert to normal in the presence of white noise of a power of not more than — 47 dBm0 per Hz.

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[1] This figure is derived on the assumption that the output of the interruption control equipment acts upon the input of the device which regulates the recognition time for tone-on and tone-off condition (20 ± 7 ms).

CHAPTER IV

Interregister signalling

RECOMMENDATION Q.361

4.1 INTERREGISTER SIGNALLING CODE

4.1.1 General

1. Outgoing traffic must have access to circuits by automatic switching and the digital signals from an operator or a subscriber must be stored in an outgoing international R2 register [1] until sufficient data are available for selection of an idle international circuit and sending of the seizing signal (seizure-line signal). The sending of this signal is immediately followed by the sending of the first forward register signal.

2. Signalling is end-to-end by a continuous compelled procedure between the outgoing international R2 register and the incoming international R2 register [2] which come into action one after the other (see Figure 1).

3. Interregister signalling is carried out by means of a "2-out-of-6" multifrequency code using six frequencies in the forward direction and six other frequencies in the backward direction, as shown in Tables 1, 2, 3, 4 and 5.

Both the forward and the backward frequency combinations have a primary meaning which, by the use of certain backward signals, may be replaced by a secondary meaning. Each primary or secondary meaning of a frequency combination is considered to be an independent signal.

4.1.2 Signalling code

4.1.2.1 *Continuous compelled signalling procedure*

The continuous compelled signalling procedure operates as follows (see Figure 8):

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[1] In these specifications, by "outgoing international R2 register" is understood the first international register which is inserted on the connection and from which the R2 signalling system is used on the succeeding international circuits. It controls the setting-up of a connection over either the whole or only part of this route. It sends forward multifrequency signals and receives backward multifrequency signals. It receives information via the preceding links of the connection by the signalling code used on these links (see point 4.6.4 concerning the centre in which the outgoing international R2 register may be located).

[2] By an "incoming international R2 register" is understood any of the international registers inserted on the connection at the incoming end of a circuit on which the R2 signalling system is used. It receives forward multifrequency signals via the preceding circuits and sends backward multifrequency signals to the outgoing international R2 register. It uses the information received to control local selection stages. If necessary, it may send all or part of this information forward, but in this case the signalling system used on preceding circuits is never the R2 system.

a) on seizure of a circuit, the outgoing multifrequency register automatically starts sending the first forward multifrequency signal;

b) as soon as the incoming multifrequency register to which the signal is addressed recognizes this signal, it starts sending a backward multifrequency signal which has its own meaning and at the same time serves as an acknowledgement signal;

c) as soon as the outgoing multifrequency register recognizes the acknowledging signal, it stops sending the forward multifrequency signal;

d) as soon as the incoming multifrequency register recognizes the cessation of the forward signal, it stops sending the backward signal;

e) as soon as the outgoing multifrequency register recognizes the cessation of the acknowledging backward signal, it may, if necessary, start sending the appropriate next forward signal (according to the meaning of the preceding backward signal; see 4.1.2.2).

Note 1. — In the detailed specifications, Figure 10 shows a complete compelled signalling cycle and 3.6.2 gives information on the duration.

Note 2. — When the duration of the forward and backward signals is not controlled by the compelling mechanism mentioned above, it is:

- either limited by the time-out delay for release of the registers indicated in Recommendation Q.369;
- or determined by the nature of the pulse imposed on them, in accordance with 4.2.6 of Recommendation Q.362.

4.1.2.2 *Information transmitted by backward multifrequency signals*

Besides being a functional part of the compelled procedure, the acknowledging backward signals serve to convey special information concerning the required forward signals or the condition of the called subscriber's line.

4.1.3 Meanings of multifrequency combinations

4.1.3.1 *Multiple meaning*

Both the forward and backward frequency combinations have a primary meaning; this can be changed by the use of certain backward signals. The changed meaning, or "secondary" meaning, is specific to the signal which caused the change.

4.1.3.2 *Meanings of the forward frequency combinations*

The meanings of forward frequency combinations are indicated in Tables 2 and 3. Group I (Table 2) represents the primary meanings of the forward frequency combinations, group II (Table 3) the secondary meanings. The change from primary to secondary meanings is commanded by a backward signal A-3 or A-5.

Secondary meanings can be changed back to primary only when the original change from primary to secondary was made by the use of A-5.

Note. — Apart from the primary and secondary meanings, the first forward signal transmitted on an international circuit enables a distinction to be made between terminal and transit calls. In this case, where terminal calls are involved, it carries the language or discriminating digit whereas, in transit calls, it serves the dual purpose of indicating that it is a transit call and that an echo suppressor is required (column (b), Table 2).

4.1.3.3 *Meanings of backward frequency combinations*

The meanings of backward frequency combinations are indicated in Tables 4 and 5. Group A (Table 4) represents the primary meanings of backward frequency combinations, group B (Table 5) the secondary meanings. The change from primary to secondary meanings is commanded by a backward signal A-3. Secondary meanings of backward signals cannot be changed back to primary meanings.

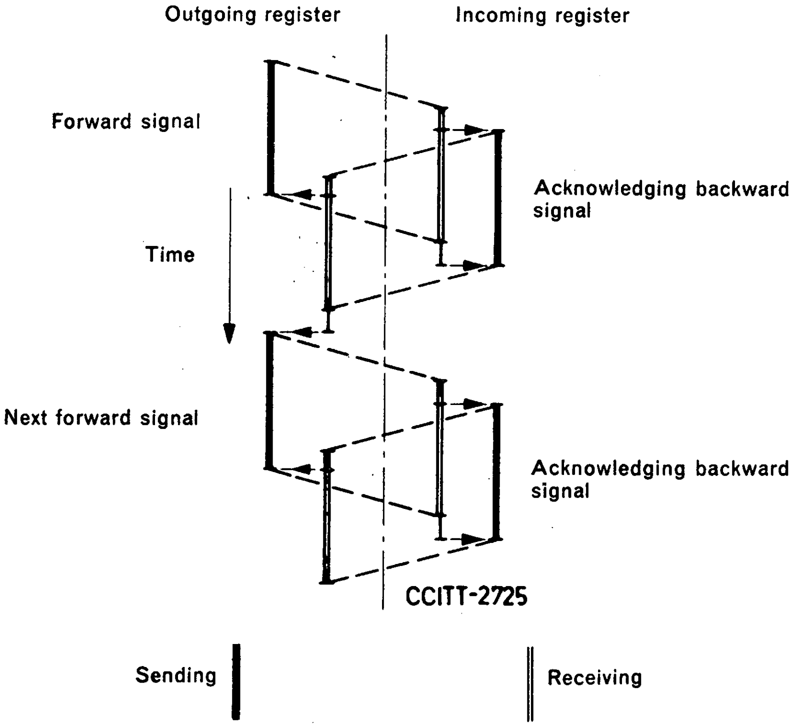

FIGURE 8. — Continuous compelled signalling procedure

TABLE 1. — **Composition of the R2 multifrequency code**

Signals		Frequencies (Hz)						
Index (n) of the abbreviated designation (I_n, II_n, A_n, B_n)	Numerical value = $x + y$	1380	1500	1620	1740	1860	1980	Forward direction Groups I and II
		1140	1020	900	780	660	540	Backward direction Groups A and B
		f_0	f_1	f_2	f_3	f_4	f_5	Index (x)
		0	1	2	4	7	11	Weight (y)
1	0 + 1	x	y					
2	0 + 2	x		y				
3	1 + 2		x	y				
4	0 + 4	x			y			
5	1 + 4		x		y			
6	2 + 4			x	y			
7	0 + 7	x				y		
8	1 + 7		x			y		
9	2 + 7				x	y		
10	3 + 7				x	y		
11	0 + 11	x					y	
12	1 + 11		x				y	
13	2 + 11			x			y	
14	3 + 11				x		y	
15	4 + 11					x	y	

TABLE 2. — **Group I forward signals**

Abbreviated designation of the signal	Meaning of the signal		Remarks (see also Note 1 below)
	When first signal on an international circuit	When other than the first signal on an international circuit	
(a)	(b)	(c)	(d)
I-1	Language digit: French	Digit 1	Col. (b) — These signals make up the first signal transmitted on an international circuit when the circuit terminates in the country of destination of the call. When a circuit terminates in an international transit centre, however, these signals may be transmitted on the circuit after the transit call indication and the country code. See also Recommendation Q.107
I-2	English	» 2	
I-3	German	» 3	
I-4	Russian	» 4	
I-5	Spanish	» 5	
I-6	Spare (language digit)	» 6	
I-7	,, ,, ,,	» 7	
I-8	,, ,, ,,	» 8	
I-9	Spare (discriminating digit)	» 9	
I-10	Discriminating digit	» 10	
I-11	Transit call indication; outgoing half-echo suppressor required	Code 11	Col. (b) — See 1.2.3 above and Note 2 below Col. (c) — See Recommendation Q.107
I-12	Transit call indication; no echo suppressor required	i Code 12 or ii Request not accepted	Col. (c) — See Recommendation Q.107 Col. (c) — See Note 3 Col. (b) — See 1.2.3 above and Notes 2 and 4 below
I-13	Code 13 (call by automatic test equipment)	Signal at disposal	Col. (b) — See Recommendation Q.104 (1.4.2.3) Col. (b) — See 1.2.3 above and Notes 2 and 4 below
I-14	Transit call indication; incoming half-echo suppressor required	Incoming half-echo suppressor required	Col. (c) — In response to signal A-14 (see Note 8 to Table 4)
I-15	Signal cannot be used	End of pulsing (Code 15)	Col. (c) — See Recommendation Q.107 and Note 5 below

Notes on Table 2

Note 1. — With regard to the order of transmission of the signals, see Recommendation Q.107.

Note 2. — It may be decided *by bilateral agreement* that signal I-11, when sent as the first forward signal on the international circuit, shall serve as transit indication instead of signal I-14 to show that the first international transit centre must insert an outgoing half-echo suppressor.

If the international connection passes through two or more transit centres, signal I-11 shall not be sent beyond the first transit centre.

Signal I-12 is used solely when no echo suppressor has to be inserted on the international connection.

Signal I-14, sent as the first digit on the international circuit, serves as transit indication and shows that the connection requires echo suppressors and that the outgoing half-echo suppressor has already been inserted. In response to a signal A-14, the only meaning of the signal is that an incoming path echo suppressor is necessary.

See 2.8.4 in the Detailed Specifications.

Note 3. — An outgoing international R2 register which receives a signal A-9 or A-10 the use of which is exclusively national, or which receives by signal A-13 a request to identify the international outgoing R2 centre to which it is unable to reply, should indicate by transmitting signal I-12 that it cannot answer the query (see the Note in 4.7.2 in Recommendation Q.368).

Note 4. — The sending of signals I-12 and I-14 may be repeated, as often as necessary, on request by a signal A-11.

Note 5. — Code 15 is also used to indicate (in response to a signal A-1) that transmission of the code of the outgoing international R2 centre is terminated (see 4.7.2 in Recommendation Q.368).

TABLE 3. — **Group II forward signals**
(category of the calling party)

Abbreviated designation of the signal (a)	Meaning of the signal (category of the calling party) (b)	Remarks (c)
II-1 II-2 II-3 II-4 II-5 II-6	Signals assigned to the national service [1]	For the meaning of these signals, see 2.4.1 to 2.4.6 in the Detailed Specifications
II-7	Subscriber (or operator without forward transfer facility)	
II-8	Data transmission call	
II-9	Spare	
II-10	Operator with forward transfer facility	See above 1.2.5 in Recommendation Q.350 (footnote)
II-11 II-12 II-13 II-14 II-15	Spare signals for the national service [1]	

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[1] The outgoing international R2 register which receives one of these signals converts it into a signal II-7, II-8 or II-10.

TABLE 4. — **Group A backward signals**

Abbreviated designation of the signal (a)	Meaning of the signal (b)	Remarks (c)
A-1	Send next digit $(n + 1)$	See Notes 1 and 2
A-2	Send last but one digit $(n - 1)$	See Notes 1 and 2
A-3	Changeover to reception of B signals	See Notes 3, 4 and 9
A-4	Congestion on the national network	See Note 4
A-5	Send nature of originating equipments	See Note 5
A-6	Set up speech conditions	See Notes 4 and 9
A-7	Send last but two digits $(n - 2$	See Notes 1 and 2
A-8	Send last but three digits $(n - 3)$	See Notes 1 and 2
A-9, A-10	Spare signals for the national service	See Note 6
A-11	Send international transit call indication	See 4.2.5 of Recommendation Q.362 and Recommendation Q.367
A-12	Send language or discriminating digit	See Notes 2 and 7
A-13	Send location of outgoing international R2 register	See Note 2 and 4.6.2 of Recommendation Q.367
A-14	Request for information on use of echo suppressor (is an incoming half-echo suppressor required?)	See Note 8 and 2.8.4 in the Detailed Specifications
A-15	Congestion in an international centre or at its output	See Note 4

Notes on Table 4

Note 1. — This meaning concerns the last address digit sent; this digit is part of the signal sequence mentioned in Recommendation Q.107 and is assumed to have the rank (*n*).

Note 2. — Reply expected in the form of a group I forward signal.

Note 3. — Reply expected in the form of a group II forward signal.

Note 4. — The meaning of this signal is given in 1.3.4 of Recommendation Q.350. It may be sent:

- — either as acknowledgement of any forward signal;
- — or automatically in pulse form when there is no forward signal (see 4.2.3 of Recommendation Q.362).

Note 5. — This signal, used to acknowledge a group I forward signal, requests transmission of a group II signal. It may be followed by any other A signal, but the latter will be linked to the sequence of group I forward signals already received and will automatically cause the group II forward signals to revert to their primary meanings (group I).

Note 6. — Reply by signal I-12 (request not accepted). See Note 3 to Table 2.

Note 7. — The outgoing international R2 register is informed by signal A-12 that a national circuit connected to an international terminal centre has been added to the circuit chain and that the call is now proceeding on the incoming national network directly under its control.

Note 8. — This signal is used at an incoming international centre where it is possible to insert an incoming half-echo suppressor. It is sent to acknowledge the discrimination digit or the language digit and the reply is received:

a) in the form of signal I-14, when an incoming half-echo suppressor is required;

b) in the form of the next digit of the address information when no incoming half-echo suppressor is required.

Note 9. — When the incoming exchange is unable to send information on the condition of the called subscriber's line, transmission of signal A-3 followed by a B signal is not necessary; transmission of the signal A-6 may suffice.

TABLE 5. — **Group B backward signals**
(signals indicating the condition of the called subscriber's line)

Abbreviated designation of the signal (a)	Meaning of the signal (b)	Remarks (see also Note 1 below and Note 9 to Table 4) (c)
B-1	Spare signal for the national service	See Note 2
B-2	Called subscriber transferred	See Note 3
B-3	Subscriber line engaged	See Note 4
B-4	Congestion (encountered after changeover from A signals to B signals)	See Note 5
B-5	Number not in use	See Note 6
B-6	Subscriber line free, with call charging	See Notes 4 and 7
B-7	Subscriber line free, "non-chargeable call"	See Note 7
B-8	Subscriber line out of order	See Note 3
B-9 B-10	Spare signals for the national service	See Note 8
B-11 B-12 B-13 B-14 B-15	Spare signals for the international service	

Notes on Table 5

Note 1. — Any Group B backward signal acknowledges a group II forward signal and is always preceded by an A-3 signal which indicates that the incoming register has received all the group I forward signals it requires from the outgoing multifrequency register. See 1.3.6 of Recommendation Q.350 and the following notes on the reactions of the outgoing register to B signals.

Note 2. — Signal B-1 is always interpreted by the outgoing international register as a B-6 signal.

Note 3. — After recognizing signal B-2 or B-8, the outgoing register clears the forward circuit chain and causes the transmission of a recorded message, a special information tone or, preferably, the two alternately.

If the national incoming network cannot recognize a transferred subscriber or a subscriber line out of order, signal A-3 may be followed by signal B-5 instead of by signal B-2 or B-8, to ensure that the special information tone is sent to the caller.

Note 4. — If the national incoming network equipments can only distinguish whether the called line is clear or busy, signal A-3 shall be followed by signal B-3 when the line is occupied and by signal B-6 when it is free (or signal A-6 only shall be sent without being followed by signal B, so that the caller may hear the tones or a recorded message sent by the incoming equipments).

Note 5. — When the congestion condition is encountered at a selection stage following the changeover from A signals to B signals, signal B-4 shall be sent in the conditions specified for signal A-4 (see 1.3.4).

Note 6. — After recognizing signal B-5, the outgoing register clears the forward circuit chain and causes transmission of the special information tone.

Note 7. — After recognizing signal B-6 or B-7, the outgoing register sets up speech conditions so that a caller may hear the ringing tone.

Note 8. — Signals B-9 and B-10 are always interpreted by the outgoing international R2 register as signal B-5.

RECOMMENDATION Q.362

4.2 END OF THE EXCHANGE OF MULTIFREQUENCY SIGNALS — ACTION TAKEN BY THE REGISTERS

4.2.1 Determination of the suitable moment for terminating multifrequency signalling once a connection has been completely set up

When a connection has been completely set up by means of the R2 system, the incoming register terminates the multifrequency procedure immediately on receipt of the complete number.

The following criteria are used to determine whether the number received by the incoming register is complete:

a) analysis of the number received (see Recommendation Q.120, 1.5.5.2, a)[1];

b) electrical criteria given by the switching equipment succeeding the multifrequency register;

c) receipt of the end-of-pulsing signal (I-15);

d) the assumption, after a specified time has elapsed, that no further digits will be sent (see Recommendation Q.369, 4.8.2, footnote 3).

When a) is applied:

- if the incoming register is equipped to indicate the subscriber's line condition, signal A-3 is sent immediately on receipt of the last digit. As soon as it is known whether or nor the connection with the subscriber's line can be established, the appropriate B signal is sent;
- if the incoming register is not equipped to receive information about the subscriber's line condition or if it is not sure that the incoming register is able to collect this information before the elapse of its time-out delay (see Recommendation Q.369, 4.8.2), signal A-6 is sent immediately after reception of the last digit (no B signal will follow).

When b) is applied, it is recommended that, to avoid delay in sending the answer signal, no B signal should be sent when the subscriber's line is free, and that the setting-up of speech conditions be ensured by means of signal A-6 immediately the electrical criteria are recognized (see also 4.2.6).

When c) is applied, signal I-15 is used in accordance with Recommendation Q.107. In general, signal I-15 will be sent immediately after the last digit.

When d) is applied the A-6 signal must be sent as a pulse as soon as the specified time has elapsed. However, if the called subscriber replies before the specified time has elapsed, the A-6 pulse must be sent immediately the subscriber's reply is recognized (see also 4.2.6).

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[1] This criterion applies also when the circuit chain is extended in the national network to the exchange which serves the called subscriber—see Detailed Specifications.

4.2.2 Termination of multifrequency signalling procedures when a connection cannot be completed

A register should terminate multifrequency signalling procedures immediately any conditions preventing complete setting-up of a call have been recognized (A-4, A-15 or the appropriate B signal is sent).

4.2.3 Pulse transmission of signals A-3, A-4, A-6 or A-15

In certain conditions it may prove desirable or even necessary to send one of the signals A-3, A-4, A-6 or A-15 without prior reception of a forward signal. This can occur when the incoming register, after acknowledging the last recognized forward signal, is unable to complete the call (for example during congestion), or when the A-6 signal must be sent as specified in 4.2.1 b) and d), the last forward signal having been acknowledged. It may also be desirable to interrupt compelled signalling deliberately to avoid prolonging the transmission time of certain multifrequency signals (for example, when there is a possibility that a relatively long period may elapse between reception of the last digit and detection of the called line's condition). The average duration of such periods during the busy hour must then be limited to 3 seconds in view of the load on the carrier systems.

When the end of an A-3 signal sent in pulse form has been recognized in the outgoing register, a group II signal must be sent forward. The incoming register must acknowledge this signal by the normal compelled method by sending a B signal. On receipt of an A-4, A-6 or A-15 signal, on the other hand, no forward signal is sent by the outgoing register. The end of these backward signals must cause the dismissal of the outgoing and incoming registers (in accordance with Recommendation Q.369).

Reception of a pulse signal must cause interruption of any forward signal in course of transmission at the outgoing register. It is sometimes impossible, however, to prevent a forward signal from being sent by the outgoing register at the very moment when one of the backward signals A-3, A-4, A-6 or A-15 is sent in pulse form by the register at the incoming end. To reduce the operating difficulties which may result, the incoming register must be so designed that no forward multifrequency signal can be recognized during and after the transmission of signals A-4, A-6 or A-15 in pulse form or during 300 ± 100 ms from the start of transmission of the signal A-3 in pulse form (see Figure 9).

4.2.4 Use of forward signal I-15 in semi-automatic operation

In semi-automatic operation, calls set up to operators' positions are always terminated by transmission of the end-of-pulsing signal I-15 (see Recommendation Q.107).

Incoming registers can acknowledge receipt of the end-of-pulsing signal I-15 by sending one of the signals A-1, A-3, A-4, A-6 or A-15 in a compelled sequence. If analysis of the received number is performed, the multifrequency signalling procedure is terminated without request for the signal I-15.

If the electrical criteria given by the switching equipment succeeding the incoming register are used to derive signals A-3, A-4, A-6 or A-15, those signals are sent, in pulse form, if necessary, and then recognized by the international outgoing R2 register as acknowledging the signal I-15 and multifrequency signalling procedure is terminated in the normal way.

4.2.5 Termination of multifrequency signal exchange at transit centres

At a transit centre, the termination of multifrequency signal exchange with the outgoing centre is followed by the setting-up of speech conditions and is accompanied by release of the register.

The last forward signal received by the register at the transit centre is acknowledged by a backward signal inviting transmission of a clearly specified digit; this digit is the first forward signal sent to the next incoming register.

If the outgoing circuit seized connects with a transit centre and if international transit of the call at that centre is necessary, the signal to send the international transit call indication, A-11, must be used. This causes the outgoing international R2 register to send either one of the international transit call and echo suppressor indication signals I-12 or I-14.

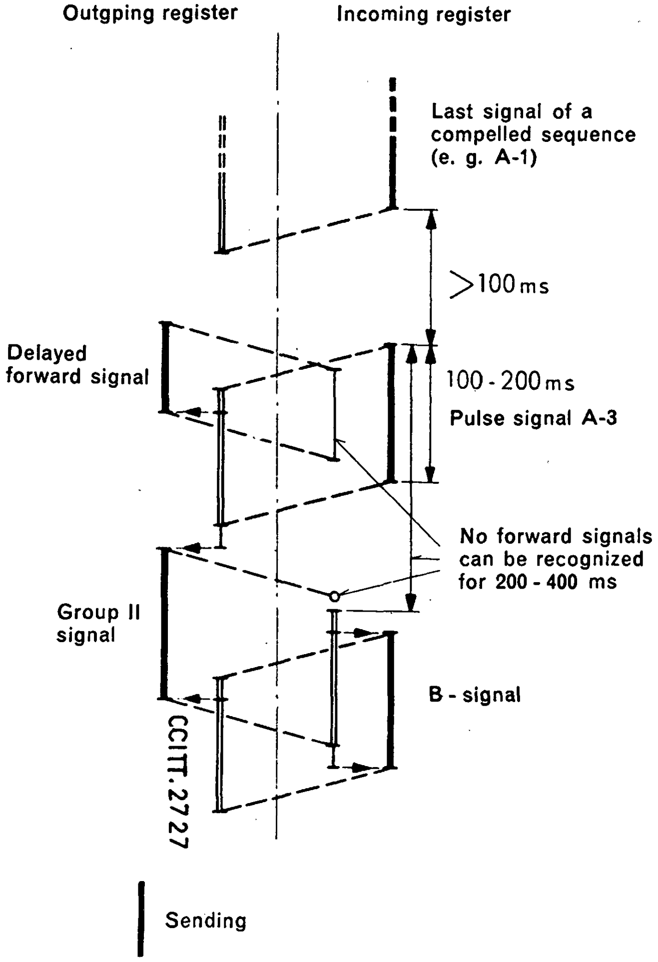

FIGURE 9. — Pulse transmission of signal A-3—Period during which no forward signal is recognized

If the outgoing circuit seized connects with an international terminal centre, the signal to send the language or discriminating digit, A-12, is used. It causes the language or discriminating digit to be sent by the outgoing international R2 register.

4.2.6 Duration of signals and time intervals between them

When a backward signal is sent in the form of a pulse of limited duration:

- the minimum delay between the end of transmission of the last compelled signal and the start of transmission of the pulse signal must be 100 ms;
- the pulse duration must be 150 ± 50 ms.

The time between the end of the pulse and the start of transmission of the subsequent answer (line) signal must not be less than 75 ms. It must not exceed 150 ms when the sending of the backward multifrequency signal is due to recognition of the called subscriber's reply (see 4.2.1).

4.2.7 Relay of multifrequency signals by a register at a transit centre

There are two possible procedures for relaying multifrequency signals by an outgoing multifrequency register (see definition 4.1.1):

a) the outgoing multifrequency register acknowledges each signal received over the incoming link by transmitting the appropriate backward signal; this operation is independent of the operations entailed in retransmitting on the outgoing link;

b) as soon as a forward signal is received on the incoming link, a signal is sent on the outgoing link; the acknowledgement signal is sent on the incoming link only when such a signal has been received on the outgoing link.

Method a) provides the more rapid transfer of information and is therefore the preferable method of relaying the information necessary for setting up the connection.

Method b) should be used for relaying information relating to the termination of multifrequency signalling procedures.

The changeover from method a) to method b) may require transmission of a pulse signal A-3, A-4, A-6 or A-15, as indicated in 4.2.3.

The procedure for disconnecting the multifrequency signal receivers and setting up speech conditions for each link, incoming and outgoing, is given in 4.8.2.

The rules stated above are applicable in particular to outgoing international R2 registers.

RECOMMENDATION Q.363

4.3 MULTIFREQUENCY SIGNALLING EQUIPMENT

Since system R2 can provide, in international traffic, end-to-end signalling from the outgoing international R2 register to the incoming R2 register at the called subscriber's local exchange (see 4.1.1), the specifications for signalling equipment take account of transmission conditions in both the international and national networks. The incoming national network may include both four-wire and two-wire circuits.

However, it is assumed in the following specifications for multifrequency signalling equipment for outgoing and incoming *international* R2 registers that the registers are directly connected by four wires to the virtual switching points of the circuits in CT3s (or international transit centres of higher category). The registers thus contain a transmitting part and a receiving part (see Figure 10).

When the outgoing R2 register is situated in a *national* exchange preceding the outgoing international exchange, which then serves as an international transit centre for signalling between R2 registers, or when the incoming R2 register is in a *national* exchange following the incoming international centre, reference should be made to Chapter III of the Detailed Specifications (see 4.6.4 in Recommendation Q.367).

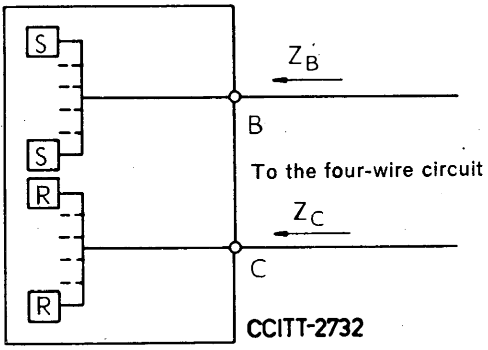

FIGURE 10. — **Multifrequency signalling equipment**

S = transmitting part
R = receiving part, including the "2-out-of-*n*" and "0-out-of-*n*" checks

RECOMMENDATION Q.364

4.4 SENDING PART OF THE MULTIFREQUENCY SIGNALLING EQUIPMENT

4.4.1 Signalling frequencies

a) forward: 1380, 1500, 1620, 1740, 1860 and 1980 Hz;

b) backward: 1140, 1020, 900, 780, 660 and 540 Hz.

Every multifrequency signal must be formed by combining any two of the six frequencies in one of the two groups. The frequency variation from each nominal frequency should not exceed ± 4 Hz.

4.4.2 Level of the transmitted signal

Combination of two of the six signalling frequencies.

A level of -11.5 ± 1 dBm should be used for each signalling frequency at the terminals B in Figure 10. The difference between the sending levels of the two frequencies making up a signal should not be more than 1 dB.

Note. — The level of the residual frequency (leak current) which might be transmitted to line must be:

a) at least 50 dB below the level -11.5 dBm of the single frequency when no multifrequency is being sent;

b) at least 30 dB below the level of either of the signalling frequencies when a multifrequency signal is being sent.

4.4.3 Harmonic distortion and intermodulation

The total power level of all frequencies due to harmonic distortion and intermodulation which might be transmitted to line in the 300-3400 Hz band must be at least 37 dB below the level of one signalling frequency.

4.4.4 Impedances

The impedance Z_B measured at the terminals of four-wire multifrequency equipment will have a nominal value equal to the nominal terminating impedance Z_T at the exchange under consideration and will be balanced to earth. When the value of Z_T is 600 ohms, Z_B must satisfy both of the following conditions:

$$\left| \frac{Z_B - 600}{Z_B + 600} \right| \leqslant 0.32$$

in the 300-3400 Hz band, and

$$\left| \frac{Z_B - 600}{Z_B + 600} \right| \leqslant 0.16$$

in the 520-1160 Hz or 1360-3000 Hz frequency band, according to the set of frequencies generated by the equipment.

All the above requirements must be met whether signalling frequencies are being sent or not.

4.4.5 Signal time tolerance

The time interval between the start of sending each of the two frequencies constituting a multifrequency signal must not exceed 1 ms.

The time interval between the cessation of sending each of the two frequencies must not exceed 1 ms.

RECOMMENDATION Q.365

4.5 RECEIVING PART OF THE MULTIFREQUENCY SIGNALLING EQUIPMENT

4.5.1 Sensitivity range

The receiving part of the multifrequency signalling equipment shall have a sensitivity range of -35 dBm to -5 dBm.

These power levels relate to the nominal impedance of the receiving part of multifrequency signalling equipment.

4.5.2 Time requirements

4.5.2.1. Time requirements have been specified for two types of multifrequency test signals (A and B) applied to the input of the receiving part of the multifrequency signalling equipment in the presence of disturbing signals as specified below.

4.5.2.2 The two types of multifrequency test signals consisting of any "2-out-of-6" combination of the six signalling frequencies are as follows:

Type A

- Each frequency differs from the nominal frequency by not more than ± 5 Hz.
- The absolute power level of each of the two frequencies of the multifrequency signal lies between −5 dBm and −20 dBm.
- The difference in level between the two frequencies is not greater than 3 dB.

Type B

- Each frequency differs from the nominal frequency by not more than ±10 Hz.
- The absolute power level of each of the two frequencies of the multifrequency signal lies between −5 dBm and −35 dBm.
- The difference in level between the two frequencies is not greater than 5 dB for adjacent frequencies or 7 dB for non-adjacent frequencies.

4.5.2.3 *The disturbing signals are:*

— in all cases:

one or more of the *n* frequencies for which the receiving part under test is designed, with a total power level of −55 dBm or less, when no multifrequency signal is being sent:

when a multifrequency signal is sent, one or more of the (n−2) remaining frequencies with a total power level 23 dB below the highest test-signal frequency level during transmission of a multifrequency signal;

— for testing the receiving part of four-wire multifrequency signalling equipment in an outgoing international R2 register: any multifrequency signal consisting of two frequencies out of the forward group of frequencies, each of these two frequencies having a level 13.5 dB above the lowest test-signal frequency level in the backward direction; an upper limit of −12.5 dBm is nevertheless specified for the level of the disturbing signal.

4.5.2.4 When test and disturbing signals as specified above are applied to the terminals C in Figure 10, the following operating time (T_0) and release time (T_R) requirements must be met when both frequencies are applied simultaneously and cut off simultaneously:

$T_0 + T_R \leqslant 70$ ms for type A test signals

$T_0 + T_R \leqslant 80$ ms for type B test signals

Note. — The recognition of faulty signals due to short-lived transient conditions can largely be avoided if a multifrequency signal is recognized only after a specified minimum time, during which two, and only two, of the individual receivers are active and if the absence of multifrequency signals is recognized only after a minimum time, during which all individual receivers are at rest. These times are included in the operating and release times T_0 and T_R.

If one of the frequencies is applied later than the other, or if one is cut off earlier than the other, or if both of these conditions are present, the sum of the operating time in relation to the slower frequency and of the release time in relation to the faster frequency must not be more than 5 ms less than what the sum of the operating and release times would be if both frequencies were applied simultaneously. (For the time lag of one frequency behind the other in application and suppression, the Detailed Specifications suggest 1 second or more—see 3.5.2.2 therein.)

When a multifrequency signal has caused the receiving part of the multifrequency signalling equipment to operate, the latter cannot release if the signal frequencies are interrupted for not more than 7 ms.

Note 1. — A method of improving the system reliability in case of interrupted signals is described in the annex to Chapter III of the Detailed Specifications.

Note 2. — With certain types of switching equipment it may prove advisable to embody devices to counteract low-frequency disturbances in the multifrequency-signalling equipment.

4.5.3 "Non-operate" and "non-recognition" requirements

The receiving part of the multifrequency-signalling equipment must not operate when the following disturbances are applied, singly or together, to its terminals:

- any combination of two pure sine waves, each with a power level of −42 dBm within the 300-3400-Hz band;
- any combination of two pure sine waves, each with a power level of −5 dBm within the 1300-3400-Hz band for the set of receivers used in the backward direction; and within the 330-1150-Hz and 2130-3400-Hz bands for the set of receivers used in the forward direction.

The receiving part of the multifrequency-signalling equipment must not recognize a signal consisting of two signalling frequencies out of the set of frequencies normally used in the direction considered, having a send level of −5 dBm0 and a duration of less than 7 ms.

4.5.4 Influence of typical transient disturbances

Typical transient disturbances, such as clicks, change of polarity, etc., generated by the switching equipment, must not change signals transferred from the receiving part of the signalling equipment to the register.

4.5.5 Impedance

The impedance Z_C measured at the terminals C in Figure 10 must meet the requirements specified for impedance Z_B in 4.4.4.

RECOMMENDATION Q.366

4.5.6 Error rate for compelled working

The test of the multifrequency signalling equipment as a whole consists in continuous, compelled transmission of multifrequency signals.

It must be ensured that all possible combinations of the forward and backward multifrequency signals have equal probability of occurrence during the test period.

The error rate is observed at the receiving part at both ends of the link and is defined, for each end, as the number of errors divided by the number of signals sent by the corresponding sending parts of the link.

It is for each Administration to define the sources of permanent and impulsive noise to be applied to the interface between the sending and receiving parts in the light of its experience and local conditions.

The compelled working may be tested, on the one hand, by using test signals of type A (see Recommendation Q.365) in the presence of noise at a power level of —40 dBm and a uniform power distribution in the 300-3400 Hz band (filtered white noise) and, on the other, by using type B test signals in the presence of noise at a power level of —45 dBm and a uniform power distribution in the 300-3400 Hz band.

The error rates under these conditions will be:

$\leqslant 10^{-5}$, for type A signals and noise at —40 dBm;

$\leqslant 10^{-4}$, for type B signals and noise at —45 dBm.

RECOMMENDATION Q.367

4.6 RANGE OF MULTIFREQUENCY SIGNALLING

4.6.1 Requirements to be met by the outgoing international R2 register

The outgoing international R2 register will always be provided with four-wire multifrequency signalling equipment and the four-wire loop will be open during multifrequency signalling (see 3.3 in the Detailed Specifications).

4.6.2 Number of international circuits

The number of international circuits switched in tandem for establishing an international connection must not exceed 4.

4.6.3 Transmission loss in four-wire international circuits

a) Nominal transmission loss at 800 Hz: 0.5 dB (Recommendation G.141, A);

b) Standard deviation of transmission loss variations with time must not exceed 1 dB (Recommendation G.151, C, a);

c) The difference between the mean value and the nominal is assumed to be 0 (as in Recommendations G.122, A, b, and G.131, A).

4.6.4 National extension circuits

When the outgoing international R2 register is situated in a *national* exchange preceding the outgoing international exchange, which then serves as an international transit centre for signalling between R2 registers, or when the incoming R2 register is in a *national* centre following the incoming international centre, reference should be made to Chapter III of the Detailed Specifications.

In principle:

a) The outgoing international R2 register must be placed in an exchange from where the incoming international exchange (CT3) in the country of destination is reached by a chain of m four-wire circuits switched in tandem, the maximum permissible value of m being 4.

b) The maximum number k of national four-wire extension circuits in the country of destination is 4.

c) The standard deviation of transmission loss variations with time in the national four-wire circuits in the country of origin and in the national four-wire extension circuits in the country of destination must not exceed 1 dB.

d) When the national circuits used in the country of origin do not have the same nominal transmission loss as the international circuits (0.5 dB), appropriate compensation of the multifrequency-signal levels must be made in both directions of transmission.

e) The nominal transmission loss at 800 Hz in the forward direction, between the virtual switching point in the incoming international exchange and any incoming multifrequency register in the country of destination must not exceed:

11.4 dB for a country using 3 national four-wire extension circuits at the most,

11.0 dB for a country using 4 national four-wire extension circuits at the most

and must never be less than:

$$-2.5 - (m \times 0.5) + (2.3 \times \sqrt{m + k})\ \text{dB}$$

where m and k have the meanings specified in a) and b) above.

4.6.5 Total attenuation distortion

It is assumed that at all frequencies within the 530-1990-Hz band the overall attenuation distortion relative to 800 Hz between the outgoing international R2 register and any incoming multifrequency register will not exceed ± 3 dB.

Nevertheless, as type B test signals (see 4.5.2 in Recommendation Q.365) allow for a 5-dB difference in level between two adjacent signalling frequencies and a 7-dB difference between two non-adjacent signalling frequencies, a 4-dB attenuation distortion of the circuit chain can be allowed for two adjacent frequencies and a 6-dB distortion for two non-adjacent frequencies, provided that the level of the weakest signalling frequency is not lower than −35 dBm at the terminals of the receiving part of the multifrequency signalling equipment.

Intermodulation

A multifrequency signalling system in conformity with the above specifications will allow satisfactory working over a circuit chain introducing intermodulation products from two signalling frequencies and falling within the 520-1160 Hz and 1360-2000 Hz bands, the level of each of such products being at least 32 dB below the highest signal frequency level.

RECOMMENDATION Q.368

4.7 ANALYSIS OF INTERREGISTER ROUTING SIGNALS

4.7.1 System R2 equipment for transit exchanges must be designed for the transfer of all information necessary for setting up the connections, including information relating to access to operators' positions.

Recommendation Q.126 on signalling system No. 4 contains all necessary information regarding the number of digits that will have to be analysed for routing purposes and these provisions apply equally to system R2. For connections which must be set up via international transit exchanges, one of the international transit indication signals, I-12, I-14 or I-11, must precede the country code. Signal I-12 or I-14 can be requested as often as required by using the interrogation signal A-11 (see Recommendation Q.361, Table 2, Note 2).

4.7.2 Procedure for identifying the outgoing international R2 centre

A multifrequency register in an international transit exchange or in a country of destination can determine the location of an outgoing international R2 register as soon as at least one forward signal has been received from that register. This is done in the following way:

— The register at the incoming end requests identification by transmitting the interrogation signal A-13. The outgoing international R2 register replies with the first digit of its country code. Each further digit of the country code is sent in reply to each subsequent repetition of signal A-13; further demands expressed through A-13 will elicit successive digits of the trunk code of the exchange where the outgoing international R2 register is situated. When all the digits required to indicate the location have been sent, the next A-13 signal must be acknowledged by the end-of-pulsing signal I-15.

The incoming register may interrupt the identification sequence by sending a backward signal other than A-13. The outgoing register must recognize this signal and acknowledge it in accordance with its meaning.

If the outgoing international R2 register, after having sent signal I-15 terminating the identification procedure, again receives signal A-13, that signal must be interpreted as a new request and identification procedure must be recommenced.

If the identification procedure is started after the digit completing the called subscriber's number has been sent, and if the called subscriber answers the call before the identification is complete, all multifrequency procedures must be immediately terminated and speech conditions must be set up as specified in 4.2.3 of Recommendation Q.362.

Note 1. — The identification procedure may be of some value for intraregional routing, accounting or other purposes. However, it is impossible to state what the ultimate use of this procedure will be and the subject requires further study.

There is thus no necessity for an outgoing international R2 register to operate as specified above. An outgoing international R2 register which does not have the identification facilities described must reply to a backward signal A-13 with a forward signal I-12 (request not accepted). The incoming register will then ask for the following digit of the address information, e.g. by sending signal A-1.

RECOMMENDATION Q.369

4.8 RELEASE OF INTERNATIONAL REGISTERS

4.8.1 Normal release conditions

a) An outgoing international R2 register must be released once it has received a backward interregister signal with an appropriate release meaning[1] or if the connection has already been released at the outgoing end.

b) An incoming international R2 register in terminal position must be released once it has sent a backward interregister signal with an appropriate release meaning or if the connection has already been released at the outgoing end.

c) An incoming international R2 register in transit position must be released in accordance with 4.2.5 or once it has sent a congestion signal or a signal B indicating that the number (or level) is not in use.

4.8.2 Abnormal release conditions

a) An outgoing international R2 register must be released and must release the forward chain in the following cases:

1) If no backward multifrequency signal is received within a period of 15 ± 3 seconds after the start of transmission of a forward multifrequency signal.
2) If the outgoing register has not resumed sending the forward multifrequency signals within a period of 24 seconds[2] following the end of transmission of a forward multifrequency signal.

Release of the register must be accompanied by transmission of a busy tone to the caller or of an equivalent signal such as will cause such transmission.

b) An incoming international R2 register must be released and must, if necessary, release the forward chain in the following cases:

— if within a period of 15[3] to 24 seconds after it has been seized, or after the end of the last forward multifrequency signal it has recognized, the incoming register has not recognized another forward multifrequency signal.

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[1] B signal for end of selection and condition of the called subscriber's line, or one of the A-6 signals for immediate setting-up of speech conditions, or congestion signal A-4 or A-15.

[2] This period of 24 seconds is a minimum. A longer time-out and a higher limit may be specified by an Administration.

[3] In some cases this minimum period may be reduced to 8 or, in exceptional circumstances, to 4 seconds. Four seconds is suitable when criterion d) in 4.2.1 of Recommendation Q.362 is applied to determine whether the number received is complete. In this case release of the incoming register must not lead to the release of the forward chain but, on the contrary, should be followed by the setting-up of speech conditions. See 2.10.2.1 in the Detailed Specifications.

In addition to release of the incoming multifrequency register and the other equipments at the incoming centre, operations will be started to cause:

- sending of a congestion signal A-4 or -A15 in pulse form;
- blocking of the incoming circuit until the clear-forward signal is received (see 2.2.4.4 of Recommendation Q.352 on abnormal signalling conditions).

Note. — Fault-recording equipment may start to operate or a delayed action alarm may alert the technical staff.

c) An outgoing international R2 register at a transit centre which operates as indicated in 4.2.7 must be released in any one of the cases mentioned in a) or b) above concerning the release of outgoing and incoming international R2 registers.

RECOMMENDATION Q.370

4.9 SETTING-UP OF SPEECH CONDITIONS

4.9.1 General

At the incoming international exchange, the circuit switches to speech conditions when the register is released after sending a backward signal A-6 indicating the setting-up of speech conditions or, by means of the appropriate B signal, the condition of the called subscriber's line.

At international transit centres, speech conditions are set up as described in 4.2.5.

At the outgoing international exchange, the circuit switches to speech conditions when the register is released on receipt of the last backward A-6 or B signal.

4.9.2 Time provisions for the setting-up of speech conditions in outgoing and incoming equipments

The following conditions regarding the duration of the various phases should be observed:

a) the multifrequency signal receivers of the outgoing register must be disconnected within 30 ms after recognition of the end of the last backward signal;

b) at the incoming exchange at least 75 ms must elapse between the end of transmission of the last backward signal and the setting-up of speech conditions;

c) the multifrequency signal receivers of the incoming register must be disconnected within 30 ms of the end of transmission of the last backward signal;

d) at the outgoing exchange speech conditions must be set up within 30 to 60 ms of recognition of the end of the last backward signal.

CHAPTER V

Interworking

RECOMMENDATION Q.380

5.1 INTERWORKING WITH STANDARDIZED SYSTEMS

In principle, the R2 system can work in conjunction with any of the signalling systems which have been standardized by the C.C.I.T.T.

The conditions for the interworking of the R2 and other C.C.I.T.T. systems have not yet been established by the C.C.I.T.T.

General information on the procedure to adopt is given in Recommendation Q.120 and in Chapter V of the Detailed Specifications.

5.2 INTERWORKING WITH NATIONAL SYSTEMS DERIVED FROM IT

The R2 system is designed for operation on international routes with 15 inter-register signals in each direction. It can, however, be adopted for interworking with the national multifrequency system derived from system R2 of an outgoing country operating with only 10 or 6 backward signals and as many forward signals as may be desired or with the national system of an incoming country operating with 10 forward signals and as many backward signals as may be desired.

For fuller information, see 1.3.4 in the Detailed Specifications.

QUESTIONS RELATIVE TO TELEPHONE SIGNALLING AND SWITCHING ENTRUSTED TO STUDY GROUP XI FOR THE PERIOD 1968-1972

Question No.	Title	Remarks
1/XI	Field trials of signalling system No. 6	To be studied by the Joint S.G. XI/S.G. XIII Working Party on "system No. 6 field trials" (FT6)
2/XI	Insertion or disablement of echo suppressors	Information to be supplied by S.G. XVI (continuation of Question 2/XI studied in 1964-1968)
3/XI	Signalling system No. 6 and future satellite operation	Linked with study of Question 20/XIII
4/XI	Signalling system No. 6 and automatic identification and removal of faulty circuits	Also of concern to S.G. IV
5/XI	Interworking between international signalling system No. 6 and national signalling systems based on system No. 6	
6/XI	The influence of stored programme control on the development of communication networks	
7/XI	Study of methods for the specification of programme logic for stored programme controlled telephone exchanges	
8/XI	Impulsive noise in an exchange	(continuation of Question 8/XI studied in 1964-1968)

IMPORTANT NOTICE

1. The Plenary Assembly having set up Special Study Group D, all questions relating to pulse code modulation (p.c.m.) have been assigned to this Study Group for the period 1969-1972.

The Chairman of Special Study Group D will contact the other Chairmen to make arrangements for liaison with the other study groups concerned as work progresses.

2. In accordance with the decision of the Plenary Assembly, notes to the effect that a question is of concern to another study group are intended primarily for the information of the members of the study group to which the question is assigned so that they may ensure the necessary co-ordination within their national Administrations.

Question 1/XI — Field trials of signalling system No. 6

In accordance with the decision of the IVth Plenary Assembly of the C.C.I.T.T., field trials will be carried out on signalling system No. 6 during study period 1969-1972. These trials will be directed by a working party, which may include members of Study Group XIII to represent the operators' point of view. The working party will thus be attached to Study Groups XI and XIII but will be relatively autonomous. It is known as Working Party FT 6 (Field Trial System No. 6).

The terms of reference of this working party are to supervise and direct the field trials, to revise the Specifications for system No. 6 where necessary and to report to Study Group XI. These terms of reference are strictly limited to the use of system No. 6 for the operational facilities defined by Study Group XIII during study period 1964-1968 and listed in the Specifications of system No. 6, which were approved by the IVth Plenary Assembly.

The conclusions of the System No. 6 Field Trials Working Party will be submitted to Study Group XI wherever they concern the Specifications and technical characteristics of system No. 6.

Note. — The field trials of signalling system No. 6, so far as they concern Study Group XIII, are covered by Question 21/XIII.

Question 2/XI — Insertion or disablement of echo suppressors

(continuation of Question 2/XI studied in 1965-1968)

In accordance with the C.C.I.T.T. Transmission Plan (Recommendation G.101), it is likely that some form of echo suppressor will be needed for the longest international connections:

- either for all connections on the group of circuits under consideration;
- or only for those connections with a certain percentage of subscribers in the country under consideration.

For a few connections it can happen that two (or more) circuits each necessitating echo suppressors will be switched together and technical considerations may make it desirable to reduce the number of echo suppressors.

What arrangements can be made, in these circumstances, in signalling and switching equipments, to permit the insertion or removal of echo suppressors when required by the transmission conditions?

Note. — The conditions relating to circuit echoes in the C.C.I.T.T. Transmission Plan are defined in Recommendation G.131, B of Volume III of the *White Book.*

ANNEX 1

(to Question 2/XI)

Reply of Study Group XI to Question 2/XI in 1968

1. Under the programme of work for Study Group XI, this question was not to be studied until the second meeting of the group in Tokyo in July 1967.

2. At the Tokyo meeting only the annexes to this question (see *White Book*, Volume VI, pp. 288-297) and one contribution by the Administration of the Federal Republic of Germany were available to Study Group XI (see Annex 2 below).

3. The Study Group XI draws attention to the principle enunciated in section 5 of the reply it prepared during the period 1961-1964 that, *as a general rule, on circuits with long propagation time, one half-echo suppressor should be inserted in the originating international centre and one in the incoming international centre.*

4. Study Group XI also agrees with Study Group XVI and considers that *the final aim should be a single type of echo suppressor (see contribution COM XVI-No. 37) with the insertion of half-echo suppressors at the two most extreme points of the connection,* where echo suppressors can be inserted on both the outgoing and the incoming sides.

Pending achievement of this final aim, the Study Group considers that, in the case of very long circuits, half-echo suppressors should be permanently associated with the circuits. When one of these circuits is switched in tandem with a second circuit also including half-echo suppressors the half-echo suppressor at the incoming end of the first circuit and the half-echo suppressor at the outgoing end of the second circuit would be disabled.

In this connection, Study Group XI refers to Recommendation Q.115, which was included in Volume VI of the *Blue Book*, in order to cover the general case of all signalling systems standardized by the C.C.I.T.T.

If Rule K in Recommendation Q.42 is to be complied with, clause b of Recommendation Q.115 should be made more restrictive and the paragraph corresponding to the three cases b i, ii and iii should be deleted accordingly.

5. The contribution submitted by the Administration of the Federal Republic of Germany (COM XI-No. 120) includes a detailed statement of the conditions to be fulfilled in order to cover all possible situations in complying with Rules A to E of Recommendation Q.42.

During the establishment of a connection, or at the latest after its completion, it must be determined whether or not echo suppressors are required. This can be done by classifying all circuits in a few groups each having propagation times within certain limits. By assessing the added group classification of the individual circuits the overall propagation time can be determined with an accuracy depending on the number of groups.

The places at which echo suppressors must be inserted can be determined by logic decision based on an exchange of information for the control of echo suppressors between the international exchanges of a connection.

The contribution of the Federal Republic of Germany envisages for this purpose four propagation time categories and four signals to characterize these propagation times together with the order of magnitude of the sum of these propagation times on the previous circuits.

The method described in this contribution would give a high flexibility in the application of future methods for the insertion and operation of the echo suppressors.

6. Study Group XI noted that in the proposals for new signalling systems signals have been reserved for the operation of half-echo suppressors.

6.1 In the case of system No. 5 *bis*, four forward X signals (the first four combinations of the 2/6 code) indicate whether it is necessary or not to insert echo suppressors and whether or not a satellite circuit is used. This X signal code includes a large number of spare signals.

6.2 System No. 6 (see Recommendation Q.254) includes an echo suppressor indicator (telephone signal mentioned in Recommendation Q.254 under 2.1.4) which, transmitted in the forward direction, indicates whether a half-echo suppressor has been inserted or not. This signal is characterized by the presence of a 1 or a 0 in bit position 7 of the second signal unit of the initial address message. Bit position 8, which is kept in reserve, will make it possible to give additional information as regards the echo suppressor indicator code and the indicator code of the category of the caller.

6.3 Both system No. 5 *bis* and system No. 6 afford the possibility of sending route monitoring signals (in the backward direction).

ANNEX 2

(to Question 2/XI)

Systematic study of conditions governing the insertion of echo suppressors and the conclusions to be drawn as regards their location

(Contribution of the Administration of the Federal Republic of Germany,
May 1967, COM XI-No. 120)

1. Introduction

Within the framework of C.C.I.T.T. Questions 5/XI (period 1960-1964) and 2/XI (period 1964-1968) the discussions have hitherto mainly been confined to the use of echo suppressors for the *complete* international telephone connection. However, no specifications have as yet been drawn up for the control of echo suppressors when interconnecting long continental and/or intercontinental circuits each of which requires an echo suppressor in any case.

The present considerations aim at the standardization of the requirements to be met by a new signalling system with regard to the control of echo suppressors. In this connection allowance has to be made for the possibilities to be introduced by the new routing plan and in part also for the conditions existing on the national sections.

In this contribution an attempt is made to give a systematic and complete survey of the arrangement of circuits in international telephone connections, which are of interest with regard to the insertion of echo suppressors, and of the possible location of echo suppressors. Based on the above, the necessity and the possibilities of using echo suppressors are investigated. Moreover, it is tried to specify principles for a general practice in the light of the "Ideal Rules" A to D laid down in Recommendation Q.42.

2. Possible combinations of circuits

As far as the insertion of echo suppressors is concerned, an international connection may comprise two types of circuits:

a) circuits which, when considered on their own, would not require an echo suppressor. They will normally not be equipped with echo suppressors;

b) circuits which by virtue of their transmission characteristics would require an echo suppressor.

TASI as well as satellite circuits fall into the latter group. Because of the limited delay on international connections, satellite circuits must always be identifiable. For TASI circuits, such an identification is only required if, because of the signalling system, special attention must be paid to their characteristics, otherwise they could be considered as normal circuits of this group.

For the four-wire circuits to be used in international connections, the propagation time is the essential distinguishing feature between the two groups.

The following combinations of circuits are possible in the establishment of international transit connections:

2.1 The connection consists solely of circuits which do not require echo suppressors. The overall propagation time of the four-wire chain necessitates, however, the use of an echo suppressor.

2.2 In addition to circuits requiring no echo suppressor, the connection comprises at least one circuit necessitating the use of echo suppressors. The circuits can be arranged in the following ways:

2.2.a) a circuit requiring no echo suppressor, at the outgoing end;

2.2.b) a circuit requiring no echo suppressor, at the incoming end;

2.2.c) circuits requiring no echo suppressors, at both ends of a connection requiring echo suppressors;

2.2.d) a circuit requiring an echo suppressor, at the outgoing end;

2.2.e) a circuit requiring an echo suppressor, at the incoming end.

2.3 The connection comprises solely circuits requiring echo suppressors.

3. Location of active echo suppressors

According to the number and type of the individual circuits of an international connection, active echo suppressors may be fitted at the following exchanges:

3.1 *At the outgoing end*

3.1.a) *at the outgoing international exchange.* This applies on condition that the propagation time of the preceding national sections does not exceed a permissible limit which has still to be fixed (according to contribution COM XV-No. 93, page 11, echo suppressors of recent design allow end delays up to 25 ms);

3.1.b) *at an outgoing national exchange*, provided the echo delay on the national sections preceding this exchange exceeds the permissible limit;

3.1.c) *at an international transit centre*, if available echo suppressors shall also be used for the country of origin and the echo delay on the preceding sections is short enough.

3.2 *At the incoming end*

3.2.a) *at the incoming international exchange*, provided the propagation time on the following national sections does not exceed a permissible limit;

3.2.b) *at an incoming national exchange*, if the echo delay on the national sections following the incoming international exchange exceeds the permissible limit;

3.2.c) *at an international transit centre*, if available echo suppressors shall also be used for the incoming country and the end delay is short enough.

4. Control information for the operation of echo suppressors

For each connection it is necessary to know which of the arrangements listed in sections 2 and 3 above applies. Dependent on the particular arrangement, the incoming and outgoing exchanges as well as the transit exchanges must obtain sufficient information enabling them to control the echo suppressors in accordance with Rules A to D or E to K of Recommendation Q.42. In forming this control information a number of factors have to be considered. Moreover, it depends upon the particular arrangement, i.e. upon the type and arrangement of the circuits and the location of the echo suppressors.

The required control information is considered below according to the location of the echo suppressors.

4.1 *Outgoing international exchange*

4.1.1 The outgoing circuit does not require any echo suppressor. The decision to provide an echo suppressor can be derived from:

4.1.1.a) the country code of the incoming country;

4.1.1.b) the country code of the incoming country and, in the case of large incoming countries, the following national digits;

4.1.1.c) the information listed in 4.1.1.a or 4.1.1.b in which case the desired direction is also considered if, for instance, the direct route does not require echo suppressors, but alternate routes necessitate their insertion;

4.1.1.d) by backward information of the international route passed (identity of the international transit centre, number of transit exchanges, propagation-time properties of the chain of circuits, satellite circuits, etc.), when echo suppressors are required while setting up the connection. In this case the proposal laid down in item a) 2 of Annex 1 to Question 2/XI (*Blue Book*, Volume III, p. 289) does not apply.

The routing in international transit centres may require the subsequent insertion of an echo suppressor at the outgoing exchange, which proves to be difficult with conventional switching equipment. However, it would also be possible to permanently fit the circuits with echo suppressors and to activate them, if required. A decision in favour of one of these possibilities must be made according to local conditions.

4.1.2 The outgoing circuit requires an echo suppressor. The outgoing exchange does not need any further information to activate the echo suppressor. However, an echo suppressor will certainly also be necessary at the incoming end (see 3.2). Corresponding information must be given by the outgoing exchange and must reach the possible points of insertion in the international part of the connection (see 3.2.a, 3.2.c).

4.1.3 If the outgoing national section is so long that an echo suppressor has already been inserted on it, the outgoing international exchange must operate in the same way as an international transit centre (see 4.2.) and by means of forward information it has to indicate that an echo suppressor is required on the incoming side of the connection.

4.2 *International transit centre*

An international transit centre should never activate echo suppressors, even if the circuits switched in tandem require an echo suppressor. The control information is passed on in both directions.

There are the following exceptions to this rule:

4.2.1 The international transit centre has to insert the echo suppressor for the immediately preceding outgoing international exchange. For this purpose the transit exchange must be able to recognize clearly that the call actually originated there and was not only through-connected.

The required information can be derived from:

4.2.1.a) a special signal sent by the outgoing exchange;

4.2.1.b) a group identification, if a particular group is used only for connections of this type;

4.2.1.c) an identification of the outgoing exchange, which would then, however, be necessary for any connection between the two exchanges concerned.

The decision to provide echo suppressors could then be made with the aid of one of the criteria according to 4.1.1.a to 4.1.1.d. Information corresponding to the relevant decision must then be transmitted to the points of insertion in the international part of the connection on the *incoming* side (3.2.a and 3.2.c).

4.2.2 The international transit centre must insert an echo suppressor for the immediately following international exchange. Here the insertion of echo suppressors can be controlled by simultaneous evaluation of the routing information and the general decision governing the insertion of echo suppressors (echo suppressor yes/no).

4.2.3 The functions of international transit centres are described in Recommendation Q.115 of the *Blue Book*. If more than one international transit centre avails itself of the facilities specified under b)i to b)iii of the above Recommendation, it is very likely that the number of echo suppressors permissible according to Rule K of Recommendation Q.42 is exceeded. In its present form Recommendation Q.115 is inconsistent with Rule K and might therefore need a revision.

When applying Rule F of Recommendation Q.42 together with the routing plan, there may be another international transit exchange between an outgoing international exchange and the international transit exchange responsible for the insertion of echo suppressors. This case should be excluded, since forming part of the necessary information according to 4.2.1.a to 4.2.1.c is rendered more difficult and ultimately it follows that such international transit centres must determine the origin of each call. Hence, we started from the assumption that instead of the incoming or outgoing international exchange only the international transit centre immediately following or preceding the incoming exchange should be responsible for the insertion of echo suppressors. The same assumption has been made in contribution COM XI-No. 100 when considering the "bis" systems ("next CT").

4.3 *Incoming international exchange*

4.3.1 The last circuit of a connection does not require an echo suppressor. The incoming exchange can determine the need for the insertion of an echo suppressor:

4.3.1.a) from particular signals transmitted in the forward direction (information about the propagation time, type of circuits, etc.);

4.3.1.b) by inviting the sending of a signal indicating the origin and by evaluating it;

4.3.1.c) by inviting the sending of the route control information and by evaluating it.

4.3.2 The last circuit of a connection requires an echo suppressor. In this case, an echo suppressor must either be inserted in the circuit or it is already included in it. It has to be ascertained whether a corresponding signal must be sent in the backward direction, if an invitation to insert an echo suppressor has not already been received in the forward direction. This applies particularly when the incoming national section requires an echo suppressor which is to be inserted in the incoming international exchange.

4.3.3 If an echo suppressor is included in the following national section, the international incoming exchange must proceed like an ordinary international transit centre.

4.4 The evaluation of the propagation times on the individual circuits provides an exact and comparatively simple means to determine the need for echo suppressors. The information about the control of echo suppressors obtained as described above can be made available to all exchanges taking part in the establishment of the connection by sending relevant signals in the forward and backward directions. Similar proposals have been made in various documents.

In this connection it must be borne in mind that even a chain of circuits as specified in paragraph 2.1 may require echo suppressors. By means of the information about the propagation time it can be determined whether or not an echo suppressor is required. For instance, the following scheme may be used for this purpose:

Propagation time	Category	Decision to insert an echo suppressor
Less than 10 ms	I	No
From 10 to 25 ms	II	No
Equal to or above 25 ms [a]	III	Yes
More than 250 ms (satellite)	IV	Yes

[a] And TASI circuits if no special TASI identification is required.

Category IV does not allow the inclusion of a (further) satellite circuit. Purely terrestrial connections do not fall into this category.

The above categories can be added according to the following scheme:

I + I = II

I + II = III

II + II = III

III + ...[1] = III

III + IV = IV

IV + ...[1] = IV

It may be possible to find more appropriate times for the above propagation-time categories. This method would allow the decision about the insertion of echo suppressors to be more closely adapted to practical requirements, even if a connection comprises only circuits which do not require echo suppressors.

The rule drawn up in contribution COM XI-No. 100, page 74 (item 2.1.1.1.a) does not cover this case and does not prevent connections with inadmissible echoes.

5. Conclusions

When applying Rules A to E of Recommendation Q.42 and making allowance for the new routing plan as well as for long national sections, the following essential features are obtained for the operation of echo suppressors on international telephone connections.

During the establishment of a connection or at the latest after its completion it must be determined whether or not echo suppressors are required. This can easily be done by assessing the added propagation times of the individual sections.

The places at which echo suppressors must be inserted can be determined by an exchange of special information for the control of echo suppressors between the international exchanges of a connection and by logic decision. This results in a greater flexibility in the application of future methods for the insertion and operation of echo suppressors.

The possibility of inserting an echo suppressor as required or of activating and disabling a permanently associated echo suppressor is necessary in order to keep the number of active echo suppressors on a connection as small as possible.

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[1] All categories other than IV; IV + IV = inadmissible route.

Question 3/XI — Signalling system No. 6 and future satellite operation

Considering

1. that the present specifications of system No. 6 incorporate point-to-point satellite operation only,

2. that methods of satellite operation yet to be defined which will ensure better exploitation of operating possibilities and greater flexibility will be required in the future;

3. that system No. 6 has some spare signal capacity;

can system No. 6 be arranged to meet the requirements for the future methods of satellite operation?

Question 4/XI — Signalling system No. 6 and automatic identification and removal of faulty circuits

Considering

1. that prompt identification of faulty international circuits, particularly in the automatic service, is desired,

2. that, as a consequence, means of automatically identifying and removing faulty circuits from service are also desired;

3. that system No. 6 has some spare signal capacity;

can system No. 6 be arranged to meet the above requirements on that part of international connections established by this system?

Note. — See the definition of international circuit in Recommendation Q.70.

Question 5/XI — Interworking between international signalling system No. 6 and national signalling systems based on system No. 6

Considering

1. that national networks may develop in a common philosophy;

2. that the common philosophy is likely to be based on network control (possibly stored programme) and may incorporate the philosophy of system No. 6 (or its equivalent);

3. that national networks may incorporate forms of network management as part of the common philosophy;

4. that as a possible consequence additional features or signals may be required on international circuits connecting such national networks;

5. that system No. 6 has some spare signal capacity;

what recommendations could be formulated to facilitate interworking between an international network employing C.C.I.T.T. signalling system No. 6 and national networks employing national signalling systems based on system No. 6?

Question 6/XI — Influence of stored programme control on the development of communication networks

Considering that:

1. processor (stored programme) control techniques are being widely applied in new national and international switching system development;

2. the use of processor control could provide a unified approach to control of the switching functions of the various types of communication networks;

3. the use of a unified processor control approach may lead to plant and operational economies;

4. there are already moves to integrate some of the various forms of digital communication networks;

5. the use of processor control is expected to provide a degree of flexibility not previously attainable economically;

6. the use of p.c.m. will allow the development of a digital voice network based on the use of integrated switching and transmission techniques which will be intimately associated with existing voice networks;

7. the characteristics of traffic and messages handled by the present communication networks are changing;

what potential does stored programme control offer for the development of the following networks:

a) voice;
b) telex;
c) data;
d) public telegraph;
e) message switching;
f) integrated switching and transmission;
g) any other forms.

Note. — This question is of concern to other Study Groups, for example Study Groups X, XIII and Special A, which will be kept informed.

Question 7/XI — Study of methods for the specification of programme logic for stored programme controlled telephone exchanges

Considering

1. that the number of Administrations introducing programme controlled exchanges in their network will increase;

2. the degree to which it is possible or desirable for Administrations to alter the operation of such exchanges;

3. the methods by which manufacturers may provide Administrations with information enabling them to make meaningful comparisons between competitive types of exchanges;

4. the advantages of a common programming language, should this prove to be feasible;

is it desirable to recommend a standard form for the presentation of the logic processes used within the exchanges?

if so and considering

5. that the form of presentation must be easy to learn, easy to interpret in relation to the needs of the operating Administration and in a form sufficiently concise for translation into the language of programmed automatic computers,

what specifications should be recommended for this standard form of presentation?

Question 8/XI — Impulsive noise in an exchange

What clauses should be provided in the specifications of national and international exchanges to ensure that impulsive noise generated in these exchanges does not disturb telephone signalling or data transmission over the general telephone network, using telephone signalling or data transmission methods recommended by the C.C.I.T.T.?

Note. — Contributions should be related to standard measuring instruments and testing methods especially to any instrument and test method which was standardized by the C.C.I.T.T. in 1968 (Recommendation H.13, *White Book*, Vol. III).

QUESTIONS ON AUTOMATIC TELEPHONE OPERATION ENTRUSTED TO STUDY GROUP XIII FOR THE PERIOD 1968-1972

Question No.	Title	Remarks
1/XIII	Effect of demand assignment satellite circuits on the International Routing Plan	Of concern to S.G.s XII and XVI from transmission viewpoint
2/XIII	International network management. Recommendations for planning and operating procedures	Of concern to S.G.s II, IV, XI and XVI
3/XIII	International network management. Recommendations for maintenance procedures	Results will be of concern to S.G. IV
4/XIII	Use of network management signals for transmission of information for maintenance purposes	Results will be of concern to S.G.s IV and XI
5/XIII	New maintenance methods	Results will be of concern to S.G. IV
6/XIII	International service co-ordination centres	Results will be of concern to S.G. IV
7/XIII	Standardization of a method of assessing service quality	Results of interest to S.G. II
8/XIII	New methods of collecting information on quality of service	Results of interest to S.G. II
9/XIII	Field trials of centralized processing of service observation results	Results of interest to S.G. II
10/XIII	Automatic service observation	Of interest to S.G.s II and XI
11/XIII	Quality-of-service tests (subscriber-to-subscriber tests)	Of interest to S.G.s II and XI
12/XIII	Establishment of a programme of inquiries among subscribers to ascertain their opinion of service quality	S.G.s II and XII to be kept informed

Question No.	Title	Remarks
13/XIII	Basic principles for the general organization of testing centres and the fault reporting service of the I.S.M.C.	
14/XIII	Comprehensive tests for signalling system No. 4	
15/XIII	Advantage to be obtained by departing from the busy-hour basis in traffic engineering	Of interest to S.G. II
16/XIII	Use of automatic traffic measuring equipment for traffic forecasts	
17/XIII	Overall grade of service for the international connections (subscriber-to-subscriber)	Of interest to S.G. XI
18/XIII	Use of computers for network planning and circuit group dimensioning	
19/XIII	Addition of a new operating facility for "transferred called subscriber" in signalling systems Nos. 5 *bis* and 6	Study Group XI to be kept informed
20/XIII	Possible operational requirements for interworking between communications satellite systems and signalling systems 5, 5 *bis* and 6	In conjunction with S.G. XI (see Question 3/XI)
21/XIII	Field trials of signalling system No. 6	Studies carried out by Joint Working Party Study Group XI/S.G. XIII "system No. 6 field trials" (FT6)

IMPORTANT NOTICE

1. Since Special Study Group D was set up by the Plenary Assembly, all questions relating to pulse code modulation (p.c.m.) have been assigned to this Study Group for the time being.

The Chairman of Special Study Group D will make arrangements with the other Chairmen for effecting liaison with the other Study Groups concerned as work progresses.

2. When a question is of interest to more than one Study Group and no Joint Study Group has been set up to deal with it, the mention of the other Study Group(s) concerned is intended for the information of the members of the Study Group to which the question has been assigned, to enable them to arrange for the necessary co-ordination *within their national* Administrations, in accordance with a decision of the IVth Plenary Assembly.

Question 1/XIII — Effect of demand assignment satellite circuits on the International Routing Plan

How should the principles of the world routing plan be modified to take into account the effect of future satellite communications and especially of demand assignment satellite circuits?

Note 1. — The future importance of the demand assignment facility seems to call for a review of the International Routing Plan in the period 1969-1972.

Note 2. — See section 4 of Recommendation Q.13 *(White Book)* which lists the precautions that the use of fixed or time pre-assigned satellite circuits renders necessary or desirable.

Note 3. — The reply made by Study Group XIII to Question 6/XIII studied in 1964-1968 is given in annex.

ANNEX

(to Question 1/XIII)

Effect of satellite communications on the world routing plan studied by Study Group XIII during the 1964-1968 period

Satellite communication will make possible the economic provision of many more direct circuit groups than would be possible by terrestrial means. These direct circuit groups will bypass the final routes that would be appropriate (whether yet provided or not) under the current world routing plan outlined in C.C.I.T.T. Recommendation E.15 or Q.13. The satellite circuits may connect two CT3s in either the same or different CT1 zones, a direct connection that is not merely permitted but even encouraged in that plan for reasons of service quality and economy.

Study Group XIII has considered whether, with this facility for the provision of direct circuit groups, satellite communication might be regarded as a means of providing attractive routings that are not covered by the principles of the world routing plan. The conclusion has been reached, however, that fixed or time pre-assigned satellite circuits can take a normal place in the world network subject to certain precautions being taken where it is possible or at least expedient to do so.

The problems presented by the provision of a demand assignment satellite network have not been considered because, without sufficient understanding and adequate experience, it is considered premature to make recommendations in this regard. However, the future importance of the demand assignment facility seems likely to be such as to call for a review of the world routing plan; and, in particular, the attention of Study Group XI should be drawn to the signalling constraints that may possibly be imposed.

The precautions that are meanwhile considered to be necessary or desirable in the use of fixed or time pre-assigned satellite circuits arise solely from the long transmission time inherent in high-altitude satellite circuits. For the same reason certain routings may be preferable to others where a choice is available.

This problem, to which some consideration is given hereafter, is dealt with in section 4 of Recommendation Q.13 of the *White Book.*

Avoiding the connection of two satellite circuits in tandem

C.C.I.T.T. Recommendation P.14 (or G.114) specifies an acceptable limit of 400 ms in propagation time save in very exceptional circumstances. It follows that two high-altitude satellite circuits, each having a propagation time of about 260 ms, should not be connected in tandem where it can be avoided. It will thus be necessary to arrange at a transit centre that no call arriving at that centre over a satellite circuit is connected onward over a second satellite circuit, unless this is required under the most exceptional circumstances. Such an arrangement of itself can be made by the Administration controlling the transit centre, without any need for special signals over the international circuit. In certain circumstances, however, this simple arrangement may be 1) unsuitable, or 2) insufficient:

1) *unsuitable*

When the Administration of the country where the call originates desires exceptionally that it be connected over two satellite circuits in tandem, because the only alternative may be over one or more h.f. radio links or because the call is required for data communication on which the long transmission delay may be acceptable *; from an examination of possible cases, Study Group XI has concluded that this requirement can be met by present signalling and switching logic, without the need for an additional "permissive" signal.

2) *insufficient*

When a call is connected over a satellite circuit to a first transit centre and then over a terrestrial circuit to a second transit centre where it is necessary to know that the call has already passed over one satellite circuit and must not be connected over another; for this purpose a signal has been specified in both signalling systems Nos. 5 *bis* and 6 to indicate that a satellite link has been taken.

Restriction of transmission delays in the international and national extensions

It would be inappropriate to regard the upper limit of 400 ms as one that could be approached at will, so long as it is not exceeded. The new Recommendation P.14 points out the need for increasing care as the propagation time exceeds about 300 ms, and every effort is needed to minimize additions to this delay through the international and national extensions.

Question 2/XIII — International network management. Recommendations for planning and operating procedures

As the C.C.I.T.T. has approved a world-wide routing plan which will be implemented with the conversion to semi-automatic and automatic working, it is recommended that the following question be studied:

What should be provided to establish international network management?

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* Signals for the identification of data calls are being studied by Special Study Group A.

a) What procedures should be provided for continuous surveillance of international and intercontinental network capacity?

b) What are the criteria for initiating network management action?

c) How should rerouting of calls during abnormal conditions be planned? This study should include consideration of the transmission effects of any plan which is adopted.

d) What organization and procedures should be recommended to control traffic flow?

e) What arrangements should be made to provide announcements in the event of serious overloading of a segment of the network?

f) What procedures should be recommended for providing operators with special instructions for use during such conditions?

g) What network management information needs to be disseminated, to what centres, and by what means?

Note 1. — The study of this question contemplates the rerouting of traffic in case of abnormal conditions. The routing of traffic over different routes would have repercussions on the settlement of accounts between Administrations. When the study of the question is sufficiently advanced, Study Group II should be informed so that it can study the implications for the financial arrangements.

Note 2. — Annex 1 reproduces the reply given by Study Group XIII in 1968 to Question 9/XIII studied during period 1965-1968.

Annexes 2 and 3 (originally annexes to this Question) examine the role to be played by network management signals in the International Routing Plan and the methods envisaged for protecting the grade of service.

ANNEX 1

(to Question 2/XIII)

Reply given by Study Group XIII in 1968 to Question 9/XIII (Network management signals) studied during the period 1965-1968

1. Study Group XIII examined several possible applications of network management signals.

2. The examination bore on the use of network management signals in the case of

- traffic surges,
- circuit group congestion, and
- faults.

Study Group XIII noted that network management signals would have a lower priority than other signals and it was considered that total delays in transferring network management signals of up to approximately three seconds per link might be acceptable. However, until the application of network management signals was more clearly defined it would be unreasonable to state precise values. Study Group XIII also agreed that the number of bits required in system No. 6 for code signals is unlikely to introduce any difficulties.

3. In examining the use of network management signals, Study Group XIII reached the following conclusions;

3.1 Some Administrations might not wish to incur the expense of generating or responding to network management signals.

3.2 For some traffic conditions the availability of status information would not be of any benefit because no alternative routing facilities exist.

3.3 The scale of differentiation between various degrees of occupancy that it is desirable to indicate is not yet certain.

3.4 Whilst network management signals might well increase the routing efficiency of the network, there was a need to obtain some information regarding the cost of plant necessary for processing and storage.

3.5 The assumptions made by Study Group XIII for network management signals are reasonable and it should make provision in the specification of signalling system No. 6 for the generation and distribution of such signals for the changing of routing.

3.6 Some additional network management signals were also foreseen for achieving the following conditions:

a) temporary change of status of a particular CT;
b) provision of transit switching at a CT3;
c) tandem connection of high-usage routes;
d) avoidance of tandem satellite links.

Whilst the availability of all these network management signals was a straightforward matter with signalling system No. 6, there was no reason why free speech or telegraph circuits should not provide such facilities in conjunction with existing signalling systems.

ANNEX 2

(to Question 2/XIII)

Network management signals in the International Routing Plan

1. The following defines network management signalling:

"A process of passing information regarding the conditions of circuit groups or equipment from one point in the network to another point, or points, in the network. The information so passed excludes information relevant to individual circuit, or individual call, requirements."

2. A continuous stream of network management signals is neither desirable nor necessary; such signals should be employed only to reflect significant changes in traffic patterns.

A status record updated from the network management signals would make it possible to ascertain the congestion conditions of circuit groups within a few seconds. The status records provide basic information for the control of traffic flow and for the planning of emergency routing in the event of serious overloading due to abnormal traffic surges or major plant interruptions.

The information might also be used to introduce oral announcements to customers and to provide instructions to operators during such abnormal conditions.

Knowledge of abnormal states of the network could also be used to print out a statement of the appropriate emergency action to be taken. The emergency action can take any of the following forms:

1) departure from the Plan by using routes involving more links than normally;

2) increased utilization of TASI;

3) use of two satellite links in tandem;

4) the utilization of remote high-usage groups of satellite circuits;

5) ability to depart from the rigid "far-to-near" sequence of choosing high-usage circuits;

6) ability to divert traffic from congested groups;

7) means of transferring time-assigned satellite circuits from one relation to another according to a fixed time or other form of control;

8) ability, with rapid signalling, to obtain routing information from other centres;

9) the possibility of avoiding relations for which the traffic in the two directions uses different routes.

Actions 4 to 9 may also be taken under normal conditions.

The development of other routing procedures in the future may well take advantage of the benefits of network management signals.

3. There has been some contradiction about the time necessary for the distribution of network management signals (see paragraph 2, Annex 1). For signalling system No. 6, 100-200 ms per link seems a reasonable estimate. For the older signalling systems, periods above a second are likely. An even greater disparity is likely in the interval after the route is selected before the call presents itself. Such differences in timing might necessitate different category boundaries.

ANNEX 3

(to Question 2/XIII)

Protection of grade of service in cases of surges of traffic

Study Group XIII examined, in 1967, the question of traffic surges produced by normal chance causes, and those produced by abnormal conditions which result in traffic levels significantly beyond those comprising a homogeneous population of traffic loads. These abnormal loads are of two kinds:

1) surges occurring *on special days* when the traffic distribution may be predictably different from normal, such as Christmas and other holidays, and for which special precautions can be taken, such as the use of spare equipment and the pre-arranged patching of circuits;

2) surges which occur *unpredictably*. Against these surges a number of precautions can be taken to ensure that the service for one traffic relation is not unduly degraded, owing to congestion, when another relation experiences a heavy surge in its offered load. Among the possible precautions are:

a) *Service protection circuits*

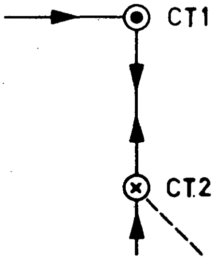
A number of circuits are reserved for the use of certain relations only. These relations are thereby "protected" since the remaining relations (plus overflow calls from the protection subgroup) have access only to the remainder of the circuits.

b) *Protective reservation equipment (P.R.E.)*

P.R.E. operates to deny the less favoured relations access to the group of final circuits when some small number, or fewer "reserved" circuits remain idle. The protected traffic has full access to all the circuits at all times. P.R.E. as normally used in the United States is non-directional and favours one category of traffic over another at both ends of a two-way circuit group.

c) *Directional reservation equipment (D.R.E.)*

D.R.E. may be installed on final routes between exchanges of different rank in a hierarchical trunking layout to give preferential treatment during congestion periods to calls bidding for circuits at the higher level exchange. This is accomplished by continuing full access to the group at the higher ranking exchange, but making all circuits appear busy at the lower ranking exchange whenever the remaining number of idle circuits is reduced to a pre-set number Y, or fewer. In this way calls which have progressed further through the routing chain are favoured for completion over calls which have penetrated the network to a shorter distance.

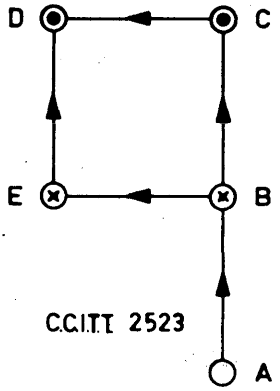


Access denied at CT2 when Y or fewer circuits in the CT2-CT1 route remain idle.

d) *Temporary change in routing*

An ability to make a temporary change in routing of the transit traffic would relieve the circuit group experiencing the traffic surge.

Thus in the diagram, traffic from A to D via B and C might find an abnormal overload on the CD link and be temporarily routed via B and E.



Comments on methods a, b, c and d

Study Group XIII recognized that the arrangements (P.R.E. and D.R.E.) described under b and c correspond to some extent to the subject matter of Question 12/XIII which envisaged the use of network management signals to inform a distant CT that, for the time being, further calls should not use the route.

It also recognized that it would be difficult to attempt to impose a rigid rule for using the first two methods (methods a and b) described above because there could be cases in which it might be advisable to give strong precedence to connections which had already engaged a number of international links. In this case the use of the third surge control scheme above (D.R.E.) might be more appropriate.

Question 3/XIII — International network management. Recommendations for maintenance procedures

What recommendations should be provided to establish international facilities status centres?

a) What steps should be taken to provide continuous review of international and intercontinental telephone network circuit availability at such a central point?

b) What steps should be taken to determine effect on service in the international telephone network of any faults, failures, or major occurrences, including those in the national network which may degrade or affect service adversely?

c) What steps should be taken to arrange for restoring circuits in the event of circuit failures including facility route failures affecting large numbers of circuits? The study should include arranging for restoration of affected facilities by providing, where possible, predetermined patching restoration layouts or facility reroutes. The study should include consideration of the transmission effects of any plan which is adopted.

d) What steps should be taken to provide continual information to the traffic forces of the current status of the circuits and switching machines for the purposes of implementing controls of traffic flow, announcements, operator instructions, etc.?

Note. — See following annex.

ANNEX

(to Question 3/XIII)

"Status Centers in the United States"

The responsibility for the provision, operation and maintenance of the circuits and equipment to provide the nationwide telephone and teletypewriter network is divided into six organizational areas, each of which is responsible for the facilities in its own territory. A "Status Center" is located at each area headquarters and one for the whole country at New York. In addition, subordinate "Status Centers" are being introduced for geographical sections within each of the six areas.

At the national centre a large map, on which is plotted all the major routes in the country is provided, and at the area centre a map of the routes in its territory.

Display boards for the more important leased channel networks show at all times the condition of components of such networks. Other illuminated displays provide space on which to record manually faults or failures of significant items of plant such as coaxial cables, microwave stations, mastergroups, supergroups, channel groups, etc. Individual overseas circuits, TASI systems and submarine cables are also shown.

The manually recorded entries show the type of facility, the time of failure, the number and type of circuits affected, the reroute used (for the circuits, not traffic), the cause of the failure, the expected time of restoration, and the actual time of restoration.

Written status reports of major route failures are prepared and reproduced in the status centre and distributed to the official responsible for the service. These in turn take any necessary action which has not already been taken by the regular maintenance organization locally. The "Status Center" is a fact-gathering organization and is not given any authority to direct restoration effort. Outside office hours, the "Status Center" calls the proper officials at home and they in turn take any necessary action.

In connection with coaxial routes and also microwave routes, spare or protection broadband channels are available to restore a failure of a broadband channel. Pre-planned reroutes via other coaxial or microwave routes using such channels are provided in all cases where such facilities are available to restore a failure of a station, a multi-tube coaxial cable, or a whole microwave route using the protection channels of other routes available. The progress of such restorations is followed by the status centres and the proper people kept informed.

The transmission of information to the area status centres and to the national status centres to keep them informed 24 hours a day is made by means of a multipoint teletypewriter circuit which operates on a two-way basis so that the status centre can query the originating station concerning a report when received. All subsequent queries are made by telephone so that the reporting circuit is left idle to receive any successive reports.

Question 4/XIII — Use of network management signals for transmission of information for maintenance purposes

Considering

1. that the receipt by remote stations of alarms on multi-circuit carrier routes may promote their enquiring of responsible International Maintenance Centres* for the details of the breakdown and thereby retard the corrective efforts of these International Maintenance Centres;

2. that considerable effort would be saved if automatic indication could be given to these remote International Maintenance Centres of the cause of a service interruption when this is known;

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* In the remote country, the International Maintenance Centres envisaged may be:

— either *International Transmission Maintenance Centres,*
— or *International Switching Maintenance Centres,*
— or *International Service Co-ordination Centres.*

Study Group XIII will have to consider to which type of centre its recommendations on the use of maintenance signals are to apply.

3. that with C.C.I.T.T. signalling system No. 6, facilities for the transmission of such information could be made available and that Study Group XIII has recognized the advantages of network management signals for the furtherance of maintenance;

4. that one utilization of the facilities of signalling system No. 6 would be for giving indications of incipient traffic congestion on different routes, at the same time noting that there is no need for network management signals, of which it is considered the maintenance signals should be a particular aspect, to depend upon the availability of each speech path, and that it is enough to communicate the information on each of the non-available (congestion condition) groups of circuits outgoing from all exchanges of the supervised network;

what information for maintenance purposes should be transmitted by means of network maintenance signals?

Question 5/XIII — New maintenance methods

Considering

1. the rapid increase in the volume of automatic and semi-automatic international traffic;
2. the proposed introduction of more specific maintenance control arrangements as recommended in Q.71 and Q.73;
3. the increasing availability of traffic simulation equipment and other performance measuring equipment;

what new maintenance methods should be recommended to enable an acceptable network performance to be achieved?

Note. — No specific suggestions on the subject could be made in 1968. However, it was then thought that introduction of the practices advocated in the revised Recommendations Q.71 and Q.73 would render it necessary to continue to study maintenance problems.

Question 6/XIII — International service co-ordination centres

What additional methods would be useful in International Service Co-ordination Centres for the performance of the functions assigned to that centre?

ANNEX

(to Question 6/XIII)

The IVth Plenary Assembly approved a new version of Recommendation Q.71 defining the role of the I.S.C.C. and a new Recommendation Q.71 *bis* outlining the functions of the I.S.C.C. It is necessary to study during the period 1969-1972 the I.S.C.C. methods which appear to be suitable for general application. In particular it will be necessary to study:

a) the methods appropriate for new types of switching, signalling and transmission equipment;

b) the extent to which computers can be used to facilitate analysis of data for I.S.C.C.s, e.g. accounting machine data such as the number of call attempts per circuit per hour and the percentage of time for which circuits on a particular traffic relation are occupied.

Question 7/XIII — Standardization of a method of assessing service quality *

Considering

1. that the method of assessing service quality in international relations between subscribers is highly desirable;
2. that, to be comparable, the values obtained in the various countries must be based on identical factors;
3. that some countries have already successfully introduced such methods at national level;
4. that each country, moreover, depends on the quality of service offered by the incoming country and is powerless to change it,

In order to maintain an acceptable overall quality in the international service between subscribers, is it desirable to develop a standard method of assessing this quality?

What method might be adopted for this purpose?

Which elements should be measured by this standard method?

Would it be desirable to recommend levels for the various elements which exert an influence on service quality?

Is it possible to consider the method whereby Administrations are invited to disseminate information on the service quality they are able to provide for incoming international traffic?

What procedure should be followed in disseminating the results obtained?

Note 1. — The elements listed in Annex 1 are recognized to be particularly important, from the point of view of the service given to subscribers, when an international connection is established.

Note 2. — A method (known as the index plans method) widely used by the A.T. & T. to evaluate the performance of its staff and to check whether appropriate facilities and equipment are used in its networks is described in Annex 2.

Note 3. — Annex 3 reproduces the conclusions formulated by Working Party XIII/4 in 1968 and the comments submitted in connection with the index plans mentioned above and described in Annex 2.

ANNEX 1

(to Question 7/XIII)

Elements of particular importance, from the point of view of the service given to subscribers, when an international connection is established

a) Unambiguous dialling procedures which are as simple as possible.

b) The lowest possible probabilities of congestion. For international circuit groups reference is made to Recommendations Q.80 to Q.84 (*Blue Book*, Volume VI). In addition it is

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* Continuation of study of point a of Question 14/XIII studied in 1965-1968.

most important that the congestion probabilities on circuit groups in the destination countries, likewise, be as low as possible to avoid unnecessary seizures of international circuits.

c) In the automatic service, the time required to establish a call to the called line should be as short as possible. In the semi-automatic service, the calling subscriber should be informed of the duration of delays if any.

d) Low rate of signalling and switching faults. The technical quality of the national network of the originating country should be maintained at as high a level as possible to permit subscribers in that country to have ready access to the international network. It is important that the incidence of signalling and switching faults in the country of destination be as low as possible (see the C.C.I.T.T. Manual on *National telephone networks for the automatic service*, Chapter IX).

e) Audible tones—The purpose of the C.C.I.T.T. Recommendations on tones is to obtain universal conformity, in order to enable the caller to recognize and discriminate, without ambiguity, between the various situations encountered, such as ringing tone, busy tone, etc. It is most desirable that the various countries observe Recommendation Q.35.

f) Transmission quality—The Recommendations in Volume III, Part I, section 1, should be observed.

g) Correct charging to the subscriber—The reliability of the charging equipment should be maintained at as high a level as possible.

h) Prompt release of the connection—At the termination of a call, both subscriber lines should be released as soon as possible.

i) The treatment of calls considered as terminating abnormally (ceased line, line out of service, etc.) should be improved, with the object of achieving conformity among countries.

j) Procedures in the event of a breakdown—In the event of a breakdown of international circuits, calls which cannot be completed should be routed to an operator or a recorded voice machine.

ANNEX 2

(to Question 7/XIII)

Index plans

The purpose of an index plan is to provide an overall assessment of performance in the process of providing service. A properly constituted index plan will indicate the general level of quality of service furnished and where this quality is not satisfactory, it will point to the segment where improvements should be made.

The various components comprising an index are each appraised in terms of a scale having 100 as the highest achievable result. In many instances this scale is simply the percentage of successes on the number of items recorded. In other cases, however, arbitrary scaled values are assigned to the recorded results. The various components are then weighted one against the other to obtain an overall index. The weighting is predetermined on a judgement basis.

A good index plan is dynamic, in the sense that as time goes on the various components comprising the index are reappraised and reweighted to place less emphasis on items that have been satisfactory for some time and where no corrective action is needed, and to place more emphasis on items on which corrective action is needed or to introduce new items into the plan.

Basic concepts of a good service measurement plan include such features as the following:

1. It should measure items of current performance where improvement is within the control of the department being measured, either directly or through joint action with other departments.
2. It should include items which bear on matters of known importance to customers.
3. It should constitute a fair basis for comparison and be acceptable to the personnel responsible for the equipment and services being measured.
4. It should establish broad standards which will serve as guides in setting objectives and yet the structure of the plan should be simple enough to be readily understood.

ANNEX 3

(to Question 7/XIII)

Comments on index plans made by Working Party XIII/4 in 1968

1. At its New York meeting in April 1966 Special Study Group B stated: "that, in principle, an index plan as described in Contribution COM XIII-No. 12 could provide an overall assessment of international service performance". At Tokyo in July 1967, Study Group XIII invited its members to submit, for the Brussels meeting, contributions on the index plan proposed by the A.T. & T. and described in Annex 2.

2. As no contribution on the index plan was submitted for the Brussels meeting of Working Party XIII/4 (May 1968), the Working Party was obliged to note that, as things stood, the C.C.I.T.T. lacked the information required to issue an opinion on the introduction of an index plan. It therefore felt it necessary at this stage:

a) to specify the provisions to be adopted to ensure that the statistical data already assembled for observations of the quality of the international telephone service could be utilized according to a logical, consistent plan in order to assess the quality of this service, even although the assessment was not as representative as it might be;

b) to propose to Study Group XIII considerations which would enable it to indicate the guiding principles for C.C.I.T.T. studies in the 1968-1972 period with a view to adopting appropriate means to obtain an overall objective picture of telephone service quality, taking into account all factors contributing to satisfactory service.

3. With regard to point 2 b above, Working Party XIII/4 agreed that a distinction must be made between:

- — the methods used to assemble statistical data, e.g. service quality observation, and
- — the methods—index plans or any other—used to obtain an overall picture of the situation from these data.

The end, of course, determines the means and both of the above-mentioned points are closely linked.

Question 8/XIII — New methods of collecting information on quality of service

Considering

1. that new designs of switching and signalling equipment should include automatic methods of providing information on quality of service;

2. that the use of the so-called artificial traffic method, whereby measurements are made on a planned pattern of test calls, is proposed for some national networks; use of the artificial traffic method avoids the need to discriminate against subscriber dialling errors. It is however necessary to exercise strict control over test programmes as well as the provision of maintenance of the remote exchange equipment. The artificial traffic method seems in 1968 to be probably the best suited for routes between countries with high mutual traffic levels.

a) What new methods of deriving information on quality of service of international traffic are available?

b) To what extent should any such new method be recommended for use as an alternative to automatic observations?

Note. — Certain Administrations considered that equipment provided for international accounting purposes could be further developed to provide information on quality of service.

Question 9/XIII — Field trials of centralized processing of service observation results

What benefits can be obtained from centralized processing of service observation results, in the light of the experience of a "field trial"?

Note. — The reply to this question should take into account the order of magnitude of the costs to be involved in a fully operational system.

ANNEX 1

(to Question 9/XIII)

Study Group XIII proposed that the centralized processing of service observation data be tried out during the study period 1968-1972. This field trial of centralized processing should be conducted by a small working party in a similar way to the organization of the tests of transmission performance (variations of equivalent of international circuits, see Question I/IV) carried out by Study Group IV. The field trial would have a twofold purpose:

1. to indicate practical methods of effecting the following:

1.1 centralized processing of service observation data;

1.2 prompt and confidential distribution of the processed results in a form convenient to the users (e.g. tables or graphs);

2. to furnish to Study Group XIII accurate statistical information on the service quality values actually obtained in the international service, to enable it to judge relative importance of the various factors affecting service quality and to serve as a kind of "test bench" for the studies relating to this Question.

ANNEX 2

(to Question 9/XIII)

Comments on the utility of centralized processing

During the study period 1964-1968, Working Party XIII/4 considered whether it would be useful to centralize the processing of data obtained from service quality observations. After a broad exchange of views on the subject, it concluded:

The main advantage of centralizing the processing of observation results is that it is the only way to assemble all information on a particular incoming international centre and on the routings in the national network of the corresponding incoming country. This assembling of information will increase the size of the sample and will therefore tend to increase the confidence level of the statistics relating to the performance of the incoming network. However this benefit will only be significant if observation procedures are standardized. Standardization is desirable in any case and it is expected that centralized processing, even during a short field trial, could help to bring about standardization more quickly as Administrations would be advised when the results of their observations on calls to other countries differed significantly from those from other sources. Centralized processing could also be of advantage in providing data on the performance of transit switching exchanges.

Insufficient information was available in 1968, regarding the costs and benefits of the centralized processing of service observations, to enable Working Party XIII/4 to make a firm recommendation regarding a permanent scheme but it was clear a field trial could be conducted without any significant increase in the costs of Administrations and the C.C.I.T.T. Secretariat. Such a field trial was expected to provide a clearer indication of the likely costs and benefits of a fully operational scheme than was available in 1968 and to provide valuable background information for the study of service observation procedures.

Question 10/XIII — Automatic service observations

Considering that

1. presently available manual observations have well-known deficiencies arising from both human and equipment errors in diagnosis, and as a consequence of the limited sample which is normally found to be economically practicable;

2. the accuracy afforded by the automatic observations is dependent upon the ability of the equipment to detect and interpret tone signals reliably as well as its capacity to discriminate between subscriber dialling errors and equipment defects. Therefore urgent attention should be given to the standardization and improvement of tones in national networks;

3. the introduction of automatic observation equipment to provide information on the service provided on incoming international routes would be valuable.

a) To what extent can automatic methods of observation be recommended for the assessment of the quality of service on:

i) international outgoing circuits;
ii) incoming international circuits?

b) What effect would the introduction of any proposed system of automatic service observation have on the volume and nature of manual observations?

Note 1. — This question will be of interest to Study Group XI at a later stage in connection with the definition of specifications for apparatus and equipment.

Note 2. — The following annex gives the comments submitted by Study Group XIII/4 in 1968 on the number of observations needed to achieve adequate reliability of service quality observations.

ANNEX

(to Question 10/XIII)

Comments of Working Party XIII/4 on the reliability of service quality observations

Working Party XIII/4 had an exchange of views at Brussels in May 1968 on the reliability of statistical measurements relating to service quality observations. Table A in section 5.3 of Recommendation Q.60 *bis* (*White Book*, Volume VI) clearly shows the amount of sampling, i.e. the number of observations required to ensure sufficient accuracy.

Since service observations must be concentrated on the deficiencies encountered, i.e. on a low percentage (which in theory should be the lowest possible percentage) of the total number of observations made (e.g. between 2% and 15% of this number), a great many observations are necessary. Whereas for the service observations required under Table 1 it was assumed that the number each month might amount to about 200, it is noted that a more reliable analysis of results might demand something like 10 times as many. As some delegates pointed out, sampling with such a high number of observations corresponds to actual practice in certain areas of the world in assessing the quality of the telephone service.

Similarly a finer analysis, involving sub-categories in order better to classify the faults encountered in setting up international automatic telephone calls, would require an even greater number of observations if the statistical results derived from observations are to be considered representative with a high degree of confidence.

It was nevertheless pointed out that, when a cumulative analysis of the results over a longer period (e.g. 6 months) is made, the assembly of a relatively small number of results, covering monthly periods, for example, may give representative statistical results if those based on monthly statistics are sufficiently stable.

Such reliability problems will have to be examined more thoroughly in the period 1968-1972, particularly as statistical theoretical studies. On the other hand, the conclusions drawn from these studies as to the number of samples required for statistically representative results may indicate in 1972 that the number of observations makes manual procedures expensive and show the need of automatic devices for measuring service quality.

Question 11/XIII — Quality-of-service tests (subscriber-to-subscriber tests)

Considering

1. the gradual extension of international fully automatic telephone traffic and the growing number of circuits between the major international centres;
2. the desirability of reducing preventive maintenance actions;
3. the need to obtain more prompt and reliable data about technical defects than is available or is likely to become available from manual observations with the size of sample considered practical for the international service;
4. the requirement for a high quality of service on all international connections including those using long national extensions;
5. on the other hand the difficulties, such as different tones arising from the use of different switching systems, etc., experienced in making automatic test calls.

To what extent should test calls of the subscriber-to-subscriber type be made:

1. manually, or
2. automatically

for fault location purposes?

What arrangements should be made for the provision of answering (slave) equipments in distant networks?

What types of faults should be recognized by the equipment?

Note 1. — Reference is made to Question 8/XIII.

Note 2. — In the study of subscriber-to-subscriber test calls it is pointed out that:

a) accounting agreements,
b) national patterns of international traffic,
c) the number of calls necessary to obtain statistically significant results are to be taken into consideration.

Question 12/XIII — Establishment of a programme of inquiries among subscribers to ascertain their opinion of service quality

Considering

1. that this subject was already studied during the period 1964-1968 under Question 14/XIII-f;
2. the particular importance of knowing the opinion of subscribers when information is needed about the service quality offered to them;

what would be achieved by using customer interviews to determine customers' opinion of service quality?

And, if found practicable, how should such customer interviews be arranged?

ANNEX

(to Question 12/XIII)

Reply given by Working Party XIII/4 (Brussels, May 1968) to point f of Question 14/XIII studied in 1965-1968

1. At its Tokyo meeting, Study Group XIII asked for contributions on the interview programme to determine customer evaluation of the quality of service. In the contributions submitted in response to this request by the United Kingdom (COM XIII-No. 100) and the Federal Republic of Germany (COM XIII-No. 103), the opinion is expressed that "it is more practical to carry out service quality observations than to question subscribers" (Federal Germany) and "no support can be given to the institution of a regular programme of customer interviews; when specific needs for surveys arise, each case (example, enquiry made about the use of long delay introduced by echo suppressors by Study Group XVI) would be considered on its merits" (United Kingdom).

2. Interview programmes for customers could be considered for the three following aspects:

2.1 to determine difficulties experienced by telephone customers and to prepare instructions,

2.2 for maintenance,

2.3 for service quality information.

3. Questionnaires for interviewing customers seem particularly useful to determine the difficulties experienced by the customers and to establish pertinent instructions for them.

This problem of instruction for customers making international and national calls was studied in 1965-1968 by the Human Factors Working Party of Study Group XIII (Working Party XIII/1, Chairman Mr. Karlin), which has since been attached to Study Group II by the IVth Plenary Assembly.

4. It is noted that this kind of interview would not be very useful for day-to-day maintenance purposes as the information collected will arrive rather late, but it could be used for appraisal of the general quality of maintenance.

5. Regarding quality of service, interviews with customers could give some indications on several aspects that need improvement in the quality of service. In this connection a questionnaire, prepared by Working Party XIII/1 at its meeting at Geneva, 6-10 May 1968, was examined and the following item seems to provide details of that kind:

"(at end of the interview, categorize the answers in terms of the items below):

10.1 Low volume.

10.2 Noise or hum.

10.3 Distortion.

10.4 Variation in level, cutting on and off.

10.5 Crosstalk.

10.6 Echo.

10.7 Complete cut off.

10.8 Other (describe)."

Question 13/XIII — Basic principles for the general organization of testing centres and the fault reporting service of the I.S.M.C.

Considering

that Recommendation Q.71 provides for an international transmission maintenance centre and an international switching maintenance centre for the organization of maintenance in the automatic service;

that the basic principles for the organization of maintenance for an international transmission maintenance centre are described in Recommendations M.7, M.11, M.12 and M.13;

that parallel Recommendations should be drawn up to define the organization of maintenance for the international switching maintenance centre;

that Recommendation Q.78 confines itself to describing the general organization of maintenance in an I.S.M.C.;

how should testing and fault reporting be organized from the switching point of view?

What are the responsibilities of the I.S.M.C. as regards the location and clearance of faults from the switching point of view?

Note. — Annexes 1, 2 and 3 reflect the conclusions reached by Working Party XIII/4 on supervision of operation and maintenance in May 1968.

ANNEX 1

(to Question 13/XIII)

Testing centre

(Conclusions formulated by Working Party XIII/4 in May 1968 and presented as draft Recommendation Q.78 bis*)*

1. *Test access points*

i) Recommendation Q.70 gives the definition of an international circuit used for telephone service. "Access points" are required to enable lining-up and subsequent maintenance operations to be performed on such a circuit.

ii) Recommendation Q.75 (M.64 of the *White Book*), part B, paragraphs 1 a, 1 b and 1 c describes the access points needed on telephone circuits, these points being referred to as "line access points", and "circuit access points", and recommends that these access points should be provided and used for various tests or measurements.

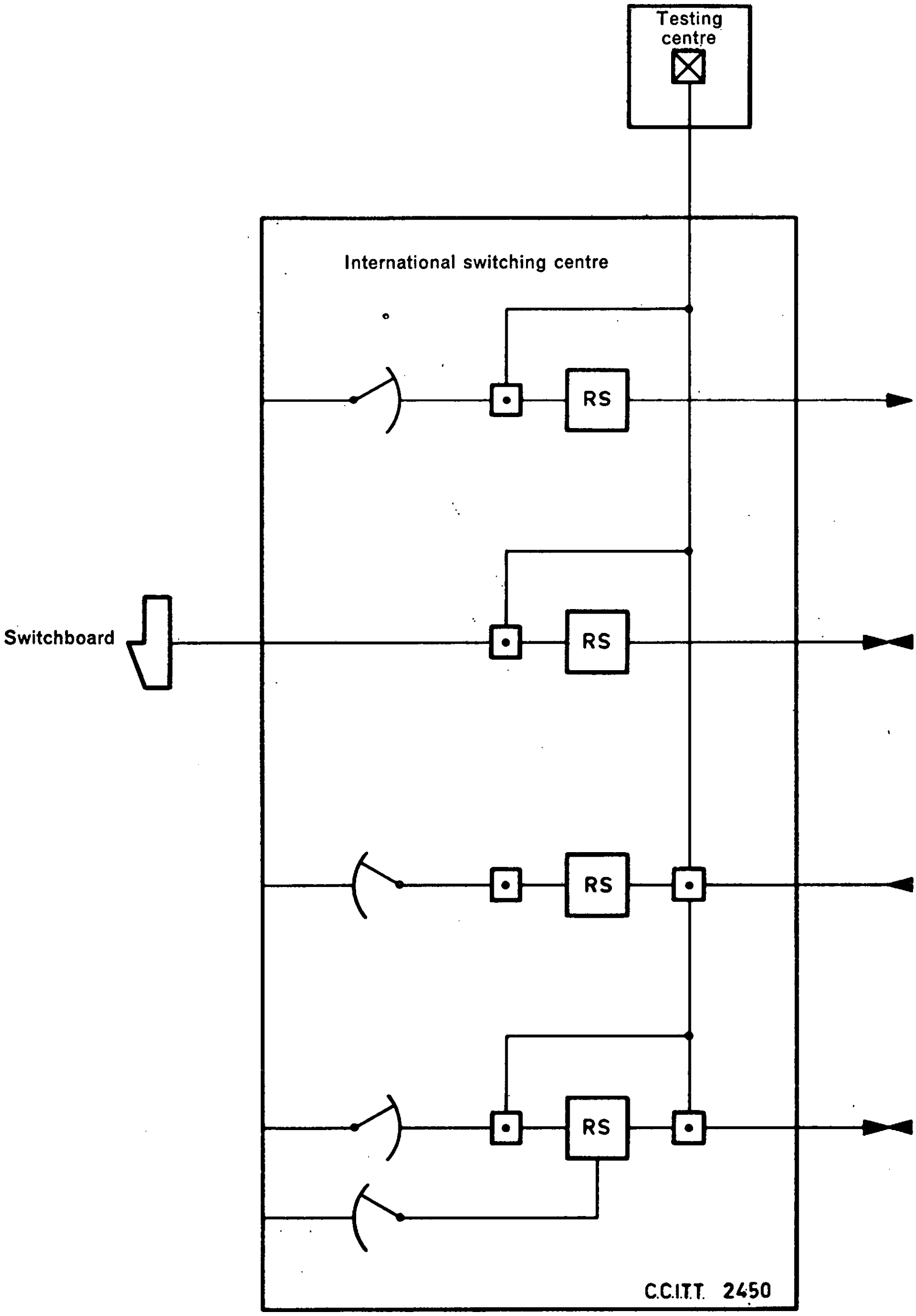
iii) The testing centre should have "circuit access points" for all circuits in the telephone service.

2. *Measuring and testing equipment*

2.1 The basic types of measuring equipment needed in the testing centre comprise:

i) equipment for signalling tests and measurements,

ii) equipment for switching tests and measurements,



RS = relay set

▣ = circuit access point

FIGURE 1. — Schematic diagram of access to the testing centre

iii) signal generators (fixed and variable frequency oscillators and calibrated sending units);

iv) level measuring sets.

In addition the following equipment is required, depending upon the arrangements existing at the centre:

i) automatic transmission measuring and testing equipment,

ii) calibration units,

iii) psophometers.

2.2 The implementation of the world-wide transmission and switching plans make it necessary for international equipment and signalling systems to be maintained to a very high degree of accuracy.

To this end, testing and measuring equipment provided for maintenance should wherever possible conform to the specifications of the C.C.I.T.T. Where no C.C.I.T.T. specification is available, the best order of accuracy and stability should be provided, consistent with cost and type of measurement to be made.

3. *Responsibilities*

3.1 Each testing centre should be responsible for the maintenance of the telephone circuits routed through this centre.

3.2 The signalling and switching testing centre will, within its area of operation, assume responsibilities similar to those of the associated repeater station. These responsibilities are described in Recommendation M.8 (*White Book*, Vol. IV) as follows:

> " *Responsibilities of control stations*
>
> 1. A circuit control station is responsible for both directions of transmission; group, supergroup, etc. control stations are responsible for the incoming direction of transmission only.
>
> 2. Each control station is reponsible for ensuring that the circuit, link, or line with which is it concerned is set up and maintained to the required standards. In particular it is responsible for:
>
> a) controlling lining-up measurements to within the recommended limits and keeping records of reference measurements (initial measurements);
>
> b) ensuring that routine maintenance measurements are carried out on the due dates, using the specified methods and in such a way that interruptions to service are limited to the shortest possible duration;
>
> c) ensuring that the stations concerned take action when a fault occurs, and controlling the various tests or investigations necessary in clearing the fault. A fault-reporting procedure should be established among the control stations, the I.T.M.C. and the operating service or private user. It must be possible to report faults discovered at any time of day or night;
>
> d) recording, on forms provided for the purpose, all incidents which arise, giving the time of occurrence of the incident, the exact location, if known, the action taken, if any, and the time of restoration to service;
>
> e) informing the I.T.M.C. of any condition which might affect the operation of the circuits under its control;
>
> f) seeking the authority of the control I.T.M.C. for any action which will take a circuit, or circuits, out of service;
>
> g) knowing what are the possibilities of rerouting any faulty circuits, groups, etc. "

3.3 This testing centre is called the Control Testing Centre.

4. *Functional diagram*

Figure 1 shows an example of the basic routing and testing access on all classes of telephone circuits.

ANNEX 2

(to Question 13/XIII)

Fault report point

(Conclusions formulated by Working Party XIII/4 in May 1968 and presented as draft Recommendation Q.78 ter)

1. Fault reporting

1.1 *General*

For the maintenance of international telephone circuits it is necessary to have a recognized point to which faults on the circuits terminating at the international centre shall be reported. In the particular case of automatic circuits, the principles given in Recommendation Q.73 are also applicable.

1.2 *Control of fault-clearance on circuits*

Initial circuit fault reports may arrive at the fault report point at either end of the circuit, but it is always the responsibility of the end receiving the report to ensure that the fault reports it receives are passed to the other end.

The control testing centre assumes responsibility for control and fault clearance (see Recommendation Q.78 *bis*, point 3, 2nd paragraph).

2. Sources of fault reports

In general, fault reports will be received from the following sources:

i) staff at the switching centre for faults arising from:
   - local alarms;
   - routine maintenance and functional tests;

ii) maintenance staff at the international transmission maintenance centre (I.T.M.C.);

iii) traffic staff at the international operating centre(s). Reports from this source will concern public telephone circuits;

iv) staff of the international service co-ordination centre (I.S.C.C.) responsible for the analysis of service quality;

v) corresponding international switching maintenance centres, in other countries;

vi) from services concerned with the national switching network of the country.

3. Responsibilities of a fault report point

3.1 The general responsibilities of a fault report point associated with an I.S.M.C. will depend on the decisions taken by each Administration regarding the division of responsibilities between the I.S.M.C. and the I.S.C.C. (see Recommendation Q.73). In general, the I.S.C.C. will tend to concentrate on long-term aspects and on the analysis of data to assist in locating obscure faults whereas the I.S.M.C. will tend to concentrate more on day-to-day attention to faults which can be located easily.

3.2 It will be necessary to ensure that the following points are covered:

i) receiving and recording fault reports from the sources given in section 2;

ii) withdrawing faulty circuits from service;

iii) sending fault reports to the particular testing staff for the location and clearance of the fault;

iv) providing the information and co-operation needed to deal with enquiries by traffic and maintenance staff and the fault report point at the other end;

v) notifying the point of origin of a fault report when the fault has been cleared and arranging for the return of the circuit to service;

vi) ensuring that faults are cleared as soon as possible;

vii) keeping fault and circuit records up to date;

viii) making an analysis of faults as may be necessary;

ix) investigating repeated faults;

x) advising the international service co-ordination centre of faults affecting automatic circuits.

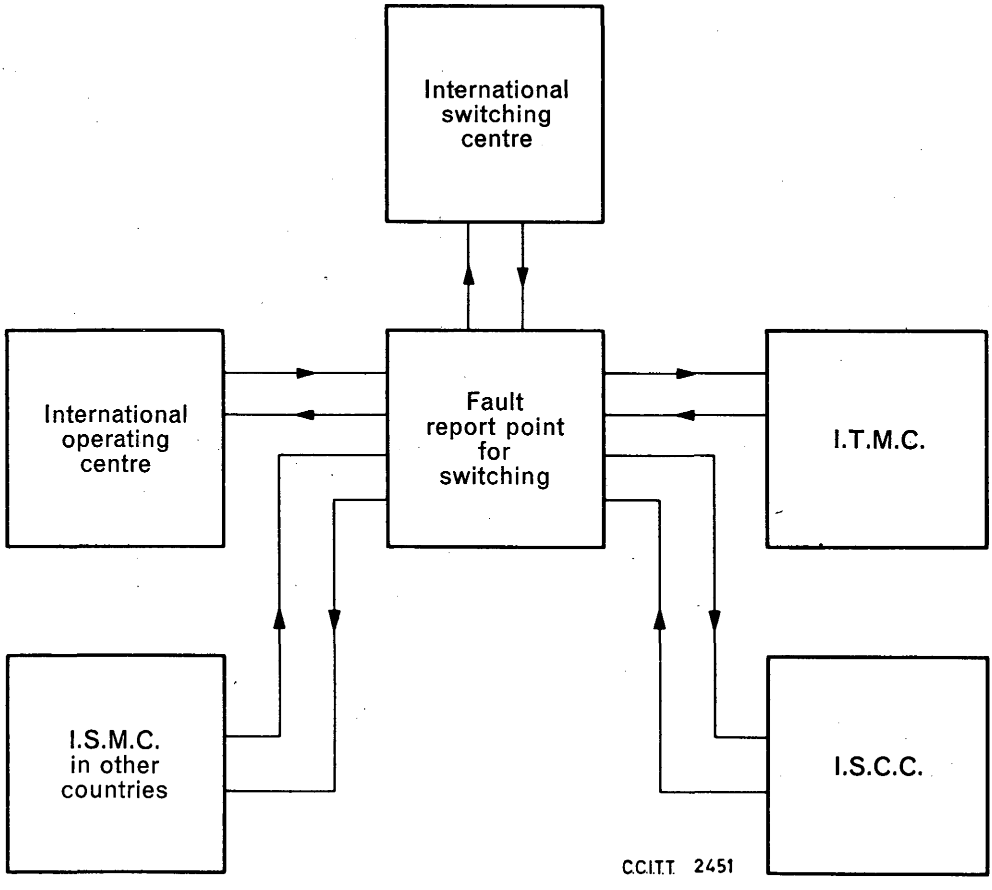


FIGURE 2. — Fault report flow

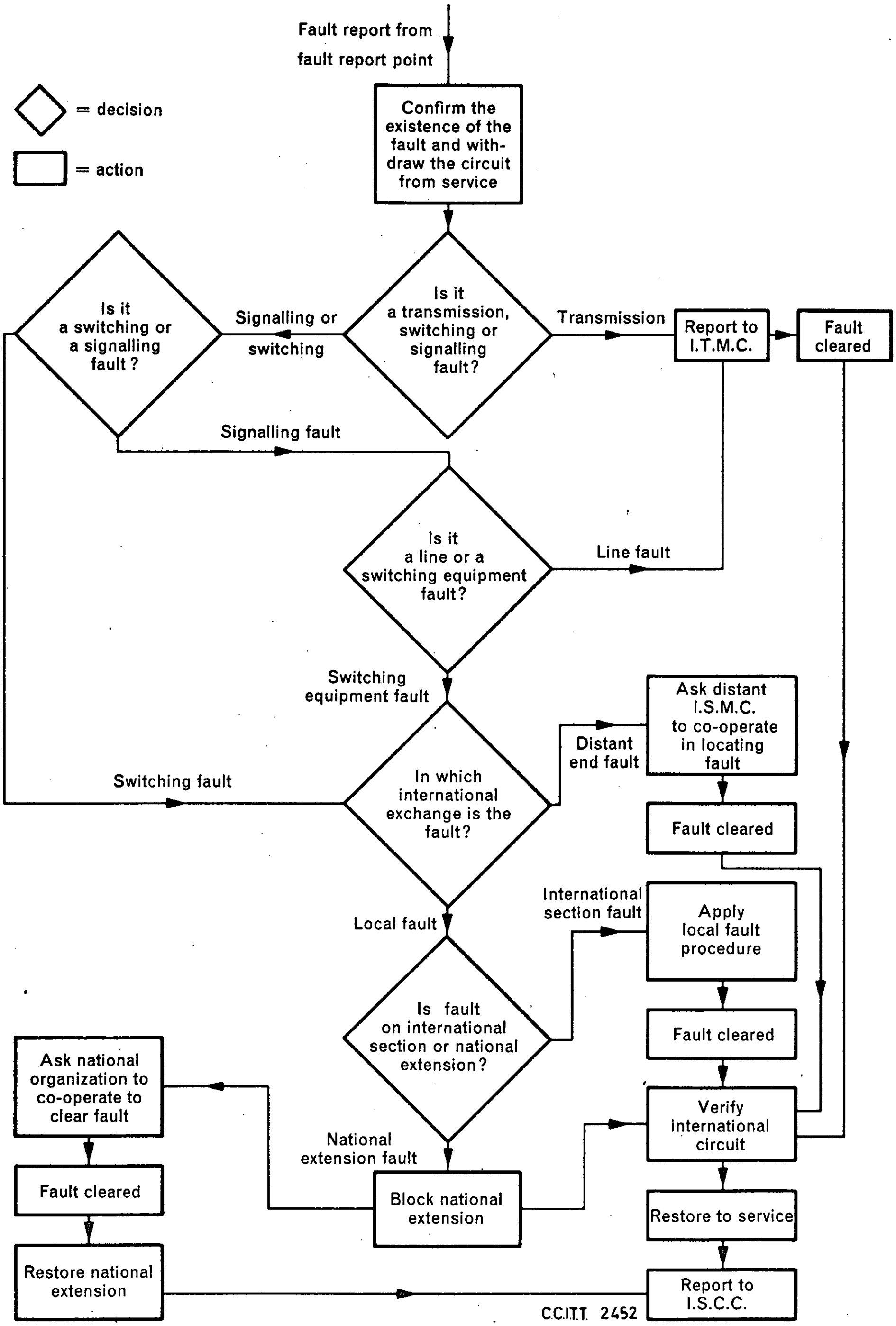


FIGURE 3. — **Possible action for fault clearance**

4. Service circuits

Service circuits are set up between various centres as may be necessary, in accordance with Recommendation M.10, Volume IV of the *White Book* (Recommendation M.12 in the *Blue Book*).

The arrangements for terminating service circuits at any I.S.M.C. are determined by the technical services of the Administrations according to their requirements.

A fault report point should be given access to the service circuits available. In addition, service circuits should be provided as required between the fault report point and centres such as the international transmission maintenance centre, I.S.C.C., etc.

5. Functional diagram

Figure 2 shows an example of the flow of fault reports to and from the fault report point.

ANNEX 3

(to Question 13/XIII)

Responsibilities in locating and clearing faults

(Conclusions formulated by Working Party XIII/4 in May 1969
and presented as draft Recommendation Q. 79)

1. Faults will be reported to a "fault report point" in an international switching maintenance centre (I.S.M.C.) in accordance with Recommendation Q78*ter*.

2. Figure 3 shows action that might be taken in locating and clearing faults. Being only an example, the figure does not attempt to show all possible ways of dealing with a fault, but the example should be an aid to the location and clearance of various faults.

Question 14/XIII — Comprehensive tests for signalling system No. 4

What should the comprehensive tests forming part of the manual tests for system No. 4 consist of?

Note 1. — These tests form the subject of Recommendation Q.139, paragraph 5.7.4.

Note 2. — Recommendation Q.163, paragraph 4.3.4 describes such tests for system No. 5.

Question 15/XIII — Advantage to be obtained by departing from the busy-hour basis in traffic engineering

Considering

1. that there is evidence of significant departure in practice from the general assumption of statistical equilibrium, as applied to international telephone traffic;

2. the difficulties of establishing the busy hour for a particular traffic relation, especially for cases with time differences between originating and terminating countries;

3. that the maximum traffic does not occur at exactly the same time every day;

4. that other hours of the day can carry traffic of a magnitude near to the busy-hour traffic;

5. the need to derive the maximum statistical information from traffic measurements taken over a number of hours which include the busy hour;

what advantage would be obtained by departing from the busy-hour concept in traffic engineering?

REFERENCES

1. Contributions and temporary documents of period 1964-1968:
   a) Contribution COM XIII-No. 27 (Helsinki Telephone Company);
   b) Contribution COM XIII-No. 42 (Australia);
   c) Contribution COM XIII-No. 44 (Report on the Meeting in New York, 25 April-3 May 1966, page 5, item 3.3);
   d) Temporary Document No. 2 of the Tokyo Meeting: (Helsinki Telephone Company), excluding question on page 6;
2. Papers presented at the Fifth International Teletraffic Congress (New York, 1967):
   a) A. ELLDIN: Dimensioning for the dynamic properties of telephone traffic.
   b) S.A. KARLSSON: The dimensioning of telephone traffic routes from measured integrated peak traffic.

Question 16/XIII — Use of automatic traffic-measuring equipment for traffic forecasts

Considering

that it is expected that equipment for measuring traffic is likely to become more and more automatic;

that such equipment is likely to be in day-to-day operation;

How can such traffic measurements be best used in forecasting general growth trends?

Note. — See *Blue Book,* Volume VI, pp. 399-403.

Question 17/XIII — Overall grade of service for international connections (subscriber-to-subscriber)

Considering

that the economic provisioning of the national and international parts of an international connection are interrelated;

that an overall grade of service value of between 1% and 2% is recommended for the international part of the connection;

that the efficient use of the international circuits represents an important consideration in determining the overall grade of service values for the national parts of an international connection;

that the non-coincidence of the busy hours of different circuit groups may have a large influence on the overall grade of service;

that separate values might be advisable for the national outgoing and incoming parts of the connection;

what overall grade of service values should be recommended for the national parts of an international connection?

What range of value can be expected for the overall international connection (subscriber-to-subscriber)?

Question 18/XIII — Use of computers for network planning and circuit group dimensioning

Considering that

1. Administrations have ready access to computers either locally or to that owned by the I.T.U.;
2. traffic measurement techniques have been established which provide statistics in a suitable form for machine processes;
3. there is adequate dimensioning information available for use by computers;
4. it is desirable that the results of processing should be on a comparable basis for bilateral agreements and for the Plan Committees;

a) what practices should be recommended in the application of computers for network planning and dimensioning?

b) what recommendations should be made for the collection and analysis of data?

Note. — The primary objective should be the production, if feasible, of computer flow-charts suitable for use by the Secretariat, as well as by Member countries, in calculating traffic and circuit estimates by computer, for purposes of the Plan Committees.

ANNEX

(to Question 18/XIII)

Several Administrations, operating companies and manufacturers already have extensive experience in the use of computers for network design and associated problems, and although independent action in the early stages of development is highly desirable it is felt that an exchange of views, at least, on the use of computers is now appropriate. Further, it is thought that early consideration should be given to how computers may best be used in the future to aid in the design and management of the international network, even while the techniques themselves have still to be fully designed and tested.

The manual solution of a complex problem necessarily requires simple and approximate methods but even so may involve a great deal of skilled manpower. Although, in assessing factors relating to costs, etc., manual methods may produce results that are sufficiently accurate, considering the difficulty in formulating assumptions that accurately describe the nature of telephone traffic, it seems reasonable to expect that the more sophisticated techniques that can be employed with automatic data processing will prove beneficial. This is especially the case in a rapidly expanding system involving very large capital investments.

In the past, much emphasis has been given to developing manual methods based on the "queueing theory" section of operational research, taking into account the behaviour of telephone traffic, but more recent attention has been given to "inventory analysis" technique to take into account the perhaps more important practical considerations of batch ordering, dead times between demand and supply, re-order costs, etc. Computers may well provide the most practicable means of combining both approaches. The large storage capacity of magnetic tape handlers might also enable the forecasting process to be incorporated in a comprehensive computer procedure.

For many applications it has been found more efficient to devise new techniques for computer processing rather than merely to reproduce previous manual methods, assuming that these are considered to be satisfactory and it is recommended that the Study Group XIII should first give attention to this aspect.

There are a number of references on methods for dimensioning networks, for example:

WILKINSON, R.I.: Theories for toll traffic engineering in the U.S.A.; *B.S.T.J.* 35 (1956).

RAPP, Y.: Planning of a junction network in a multi-exchange area. I — General principles; *Ericsson Tech.* 20 (1964).

P.O. Trunking Reports Nos. 60, 61 and 62 (United Kingdom Administration).

FUKUI, Keuro: Processing by computers for network planning and design; *N.T.T. Technical Publication D*—No. 8 and *J.T.R.* 1967, Volume 9, No. 4.

Reference should be made in particular to Annex 3 of Chapter VI of the Manual on Automatic Local Networks published by the C.C.I.T.T. on completion of the work of GAS 2 in 1964-1968 and the Bibliography to Chapter VI (see pages 13 to 16 of the General Bibliography at the end of the Manual).

Question 19/XIII — Addition of a new operating facility for "transferred called subscriber" in signalling systems Nos 5 *bis* and 6

Note. — The operating facilities for signal transmission in the backward direction in systems Nos. 5 *bis* and 6 do not cover sufficiently the situation of a transferred called subscriber. In the case where a subscriber's number has been changed it would be most desirable to invite the calling party to get in touch with his information service in order to prevent any further attempts by him to reach the called subscriber by the old number.

Question 20/XIII — Possible operational requirements for interworking between communications satellite systems and signalling systems Nos. 5, 5 *bis* and 6

Considering

1. that in present operation of communications satellite systems a number of circuit routes are carried from an originating CT on a multi-destination carrier within the satellite system for further onward routing on a CT to CT basis;

2. that demand assignment of satellite circuits may be implemented by means of communications satellites, and it is understood that engineering operating tests of a demand assignment system on the satellite system are currently under way;

3. that demand assignment of satellite circuits could provide direct circuits between CTs for which traffic does not justify full-time direct circuits with the improved service and possible economic advantages encouraging an early and general use of demand assignment satellite circuits;

4. that it is desirable to make possible the economical provision of circuits for use in the automatic service, in particular for small traffic relations;

a) what additional operational requirements must the signalling system No. 6 meet in order to provide:

- for interworking with satellite systems operating in the demand assignment mode, or
- for interworking in a different manner from that used at present with satellite systems operating in a multi-destination carrier mode?

b) what additional operational requirements must the signalling systems Nos. 5 and 5 *bis* meet in order to provide for interworking with satellite systems operating in the demand assignment mode?

Note. — This question is to be studied in conjunction with Study Group XI (Question 3/XI).

ANNEX

(to Question 20/XIII)

Methods of operating satellite circuits

(Information abstracted from the annex to Document COM XIII-No. 94, 1964-1968)

The following is a summary of the main features of multi-destination techniques of routing circuits and demand assignment of circuits.

1. *Multi-destination carrier operation* is a method of using the satellite that economizes in the use of radio equipment and satellite bandwith. The same RF carrier is used to serve a number of telephony channels destined to different CTs. All the GO telephony channels of satellite circuits of a country should be transmitted on as small a number of carriers as possible; preferably, one. The carrier is received by the earth stations which serve the CTs that are to receive the channels borne by the carrier.

The desired channels for a particular CT are normally selected at the earth station serving that CT. And then only these channels are routed onward to the CT. The return channels are handled in a similar manner to establish a complete two-way circuit.

2. *Demand assignment of satellite circuits* is a method of operation whereby a circuit is established between two CTs only when it is necessary to set up a demand telephone connection between two CTs. To set up this demanded telephone connection the actual signalling system used is an integral part of the demand assignment system.

The originating CT must indicate to the demand assignment system the terminal points of the demand assignment circuit to be established.

3. The application of the Nos. 5, 5 *bis* and 6 signalling systems to the demand assignment mode of operation and of the No. 6 signalling system in its different manner of interworking with satellite systems to the multi-destination carrier mode may require modification in the satellite system as well as in the signalling systems.

4. The figures which follow illustrate:

Figure 1 — point-to-point operation of the No. 6 system through the satellite system;

Figure 2 — point-to-multipoint operation of the satellite system;

Figure 3 — demand assignment of satellite circuits showing multipoint control channel.

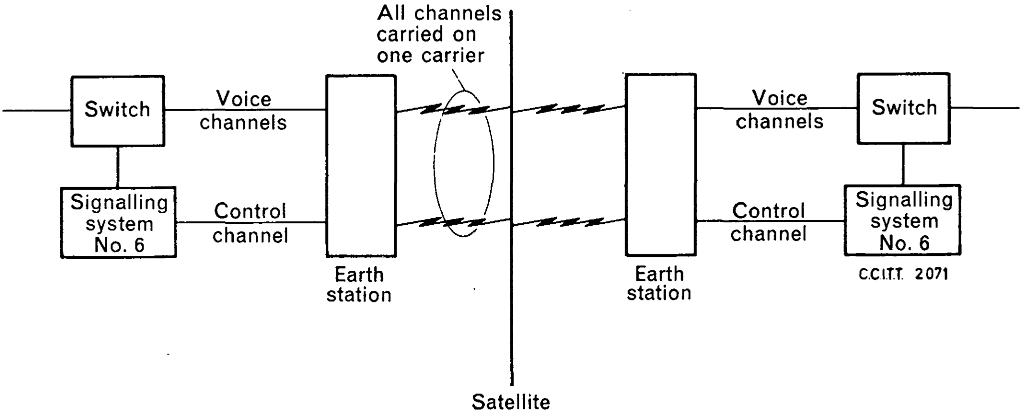


FIGURE 1. — **Pre-assigned circuits. One or more common control channels per route working on a point-to-point basis**

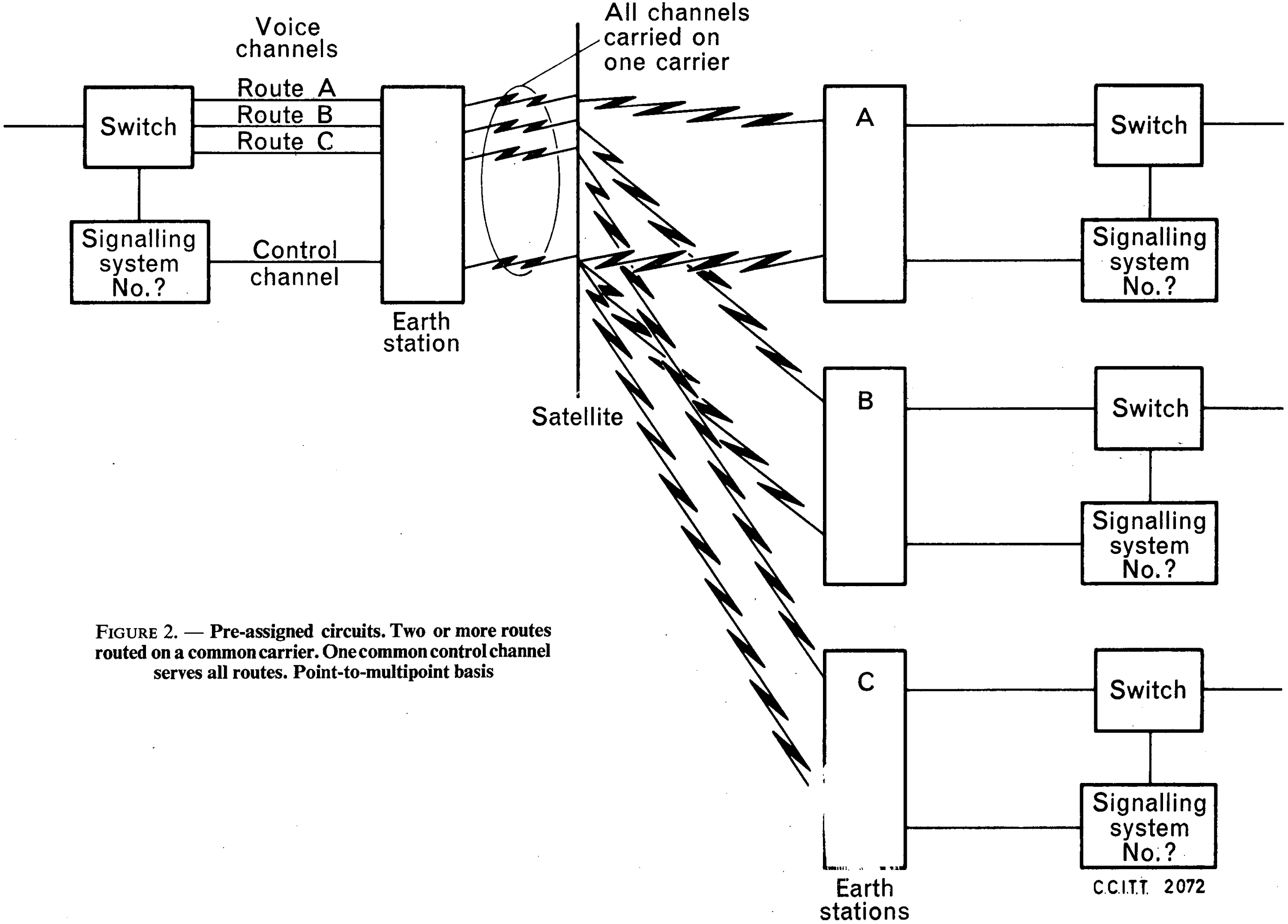


FIGURE 2. — **Pre-assigned circuits. Two or more routes routed on a common carrier. One common control channel serves all routes. Point-to-multipoint basis**

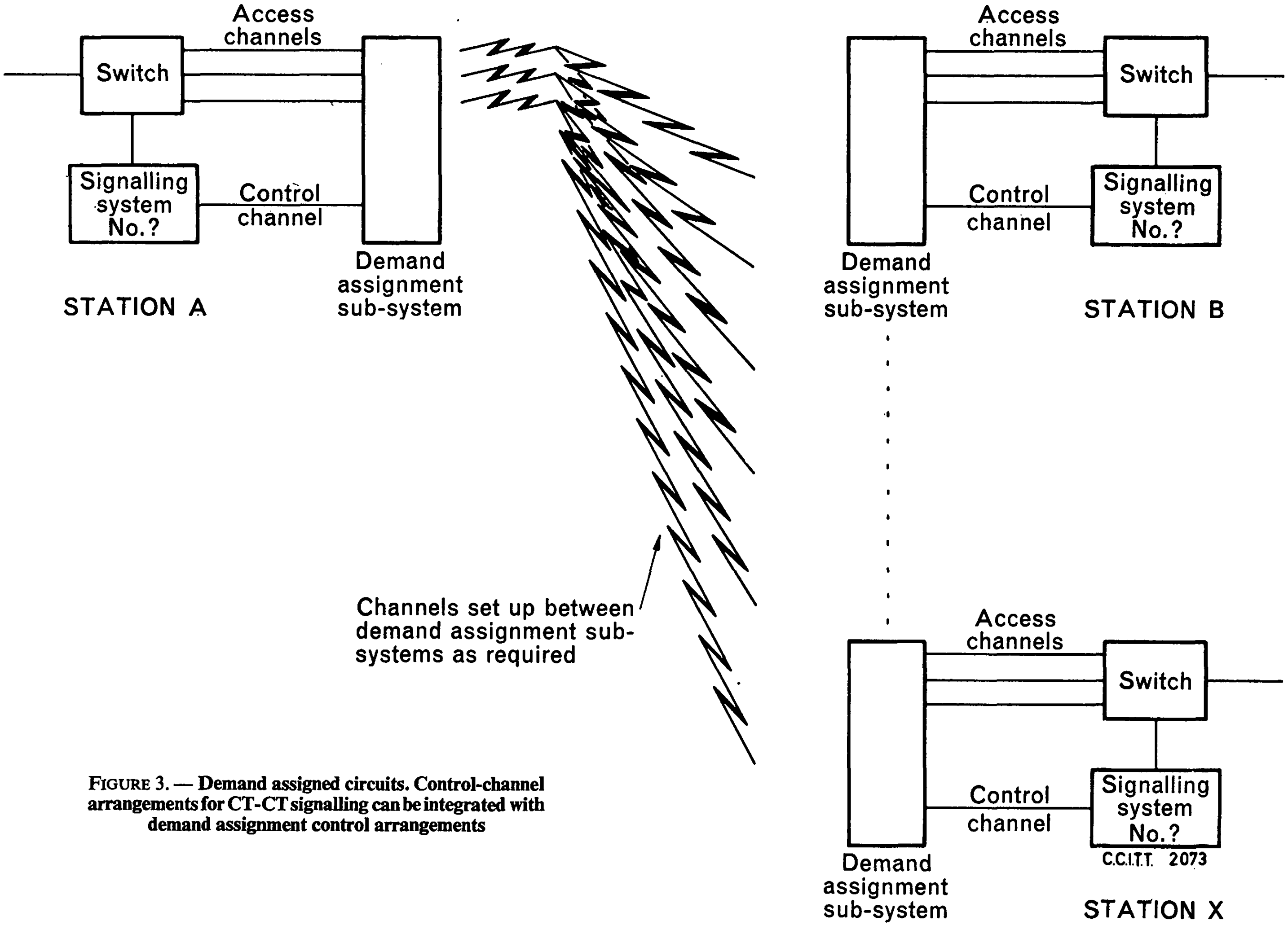


FIGURE 3. — **Demand assigned circuits. Control-channel arrangements for CT-CT signalling can be integrated with demand assignment control arrangements**

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1. PUENTE, J. G.: *A PCM-FDMA demand assigned satellite multiple access experiment*, published by American Institute of Aeronautics and Astronautics, New York, as A.I.A.A. Paper No. 68-451.
2. COMSAT: Contribution C.C.I.T.T. COM XIII-No. 94. Satellite operation and signalling system No. 6.
3. LUTZ, S. G.: A traffic study of multiple access satellite communications based on Atlantic system model, *Telecommunications*, July 1968.
4. MORITA, M.; FUKAMI, T.; YAMOTO, S. *et al.*: Star system, *NEC Research and Development Journal*, No. 8, October 1966.
5. SEKIMOTO, T. and PUENTE, J.: A time division multiple access experiment, Professional Group Communications Technology, *IEEE*, October 1968.

Question 21/XIII — Field trials of signalling system No. 6

1. In accordance with the decision taken by the IVth Plenary Assembly of the C.C.I.T.T. on a proposal by Study Group XI, signalling system No. 6 is to undergo field trials during study period 1969-1972. A working party will be responsible for the organization and direction of the trials. The terms of reference of this working party, which will enjoy the appropriate degree of autonomy, are to supervise and direct the field trials, to revise the specifications for system No. 6 where necessary and to report to Study Group XI. Its terms of reference are strictly limited to the use of system No. 6 for the operational facilities which were defined by Study Group XIII in 1964-1968 and are contained in the Specifications approved by the IVth Plenary Assembly.

2. In line with the proposals made by Study Group XIII, the Plenary Assembly decided that this working party could include members of Study Group XIII to represent the operators' point of view.

3. The working party's conclusions will be submitted to Study Group XIII whenever they have any bearing on the operational conditions of the signalling system.

DOCUMENTARY PART

SUPPLEMENTS

SUPPLEMENTS CONCERNING THE WORK OF STUDY GROUP XI

SUPPLEMENT No. 1

REPORT ON THE ENERGY TRANSMITTED BY CONTROL SIGNALS AND TONES

This report dates from 1956. It was used for designing signalling system No. 3 and signalling system No. 4.

1. The problem

In 1956, the C.C.I.F. endeavoured:

a) to calculate the energy of control signals for international signalling and of national tones which may be transmitted on an international circuit in automatic working (subscriber-to-subscriber) in the international network;

b) bearing in mind the limit in Recommendation Q.15 for the overall energy that can be transmitted for signalling on an international circuit, to see whether an increase in the permissible power for control signals and/or a limitation of the sent power of national tones should be proposed;

c) to indicate to what extent administrations should be recommended to use the principles established in reply to *b)* above as the basis for signalling in national networks.

2. Operating assumptions

In the calculations, it was assumed from *experience in automatic trunk operation in the national networks of various administrations* that in international automatic operation there would be about 20 calls per circuit in the busy hour including:

12 successful calls,
1 call with no reply by the called subscriber, and
7 calls for which the line or the called subscriber was busy.

3. Calculation of control signal energy

With these assumptions, the following figures were obtained:

- a total energy, for both directions of transmission, of 21 000 microwatts × seconds during the busy hour, for system No. 3, and
- a value which is slightly below half of the above, for system No. 4.

4. Assumptions relative to national tones

The maximum national tone *level* specified, on the basis of the information available in 1956, is —0.2 neper (absolute power level (referred to 1 milliwatt) at a zero relative level point). Moreover, allowances should be made for the fact that an additional attenuation of 0.4 neper is always inserted in the international connection during the period in which tones may be sent. A level of −0.6 neper or a power of 300 microwatts, at a zero relative level point, was therefore considered as a maximum.

As regards the cadences of tones, it was noted that, according to Tables 3 and 4 on pages 25 and 26 of the C.C.I.F. *Green Book*, Volume V,

- in almost all cases, the length of the tone period of busy tone is not greater than the length of the silent period,
- for all the countries mentioned (except for Spain and the Paris network), the most unfavourable ringing tone conditions will be a tone period having a duration of one-third that of the silent period.

It was finally assumed for the calculation that the duration of connection of the various tones was:

- 10 seconds of ringing tone in the case of a successful call,
- 60 seconds of ringing tone if there is no reply,
- 10 seconds of busy tone under engaged conditions.

5. Calculation of the energy transmitted for the national tones

The calculated total sending duration of tones in the busy hour is shown in the following table:

	Duration of tones per call (in seconds)	Number of calls	Total duration of tones (in seconds)	Ratio of tone period to silent period	Total sending duration (in seconds)
Successful calls	10	12	120	1/3	30
No reply.	60	1	60	1/3	15
Engaged	10	7	70	1/1	35

Total = 80 s

Thus, in the busy hour and in the most unfavourable conditions, a total energy of

$$300\ \mu W \times 80\ s = 24\,000 \text{ microwatts} \times \text{seconds}$$

is obtained.

This is the value for the direction in which the tones are transmitted (backwards, as far as operation is concerned), i.e. it is applicable to both directions of transmission.

In the special case of the Paris network the durations corresponding to the first two lines of the table should be doubled and the total sending duration would be increased to 125 seconds; as the tone level is much lower than −0.6 neper in this case, the maximum value calculated above would not be reached.

6. Calculation of the energy transmitted in the international service for control signals and national tones

A calculation of the energy of control signals in standardized systems (paragraph 3 above) shows that, when system No. 3 is used in the automatic international service, the value to be expected for the combination of both directions of transmission is about 21 000 microwatts × seconds.

In the case of system No. 4, the energy of the control signals is appreciably less.

Hence, if the calculated energy for national tones assuming the most unfavourable conditions, say 24 000 microwatts × seconds, is added to the higher of the two calculated values (i.e. 21 000 microwatts × seconds for system No. 3), a total energy (for the two directions of transmission) of 45 000 microwatts × seconds is obtained, which is much lower than the value of

$$2 \times 36\,000 = 72\,000 \text{ microwatts} \times \text{seconds}$$

defined in Recommendation Q.15.

However, this does not mean that the level of the signalling pulses can be raised, since the choice of this level was based on crosstalk considerations.

SUPPLEMENT No. 2

TASI CHARACTERISTICS AFFECTING SIGNALLING

During a normal telephone conversation each party usually speaks for only about 40% of the time (speech activity), 60% of his channel time being idle. TASI (Time Assignment Speech Interpolation) is an equipment which rapidly switches channels to talkers on a time-shared basis to make use of the otherwise idle channel time and thus permits a greater number of simultaneous calls than would otherwise be possible with the available channels in the cable.

TASI interpolates to associate a trunk (circuit) with a transmission channel when speech is detected on a trunk at one end and is required to be transmitted, over a channel, to the same trunk at the other end. The trunk/channel association is ceased, and the channel made available to other trunks when the cessation of a burst of speech is detected.

When the interpolation begins and a free channel is available, but not yet associated, a time (the initial clip) elapses before detection of the speech (or signal) by the TASI speech detector and trunk/channel association at each end. Should the TASI system be heavily loaded, a free channel may not be immediately available. In this situation a time (extended clip) in addition to the initial clip elapses before trunk/channel association.

To reduce the number of times clipping occurs, the TASI speech detector is given a hangover, maintaining trunk/channel association, to bridge the shorter gaps in speech, and thus reduce the interpolation. This feature permits the transmission of a sequence of short-pulse short-gap signals without signal clipping.

As signals must be detected by the TASI speech detector before transmission over the TASI system and as the total clip (initial clip + extended clip) reduces the duration of the received signal, TASI affects signalling.

The characteristics of TASI affecting signalling may be summarized as follows:

1. TASI speech detector sensitivity: —40 dbm0 (—4.6 Nm0);

2. To minimize speech activity on the RETURN channel due to reflection from the GO channel, the TASI speech detector on the RETURN channel is desensitized in the presence of speech on the GO channel. This also applies to signalling. Thus in situations where simultaneous forward and backward signalling is required, the level of the backward signalling must be such as to take account of a reduction of some 15 dB (1.7 Np) in the sensitivity of the speech detector at the end receiving the forward signal:

3. Nominal duration of speech detector hangover;

a) 50 ms for input signals of 50 ms or less,

b) 240 ms for input signals greater than 50 ms;

4. Nomination duration of clip of a signal (including the 5 ms response time of the TASI speech detector):

a) initial clip: 18 ms,

b) total clip when TASI is heavily loaded and a free channel is not immediately available, expressed as a probability that a signal will be clipped for a certain time or longer:

Total clip	Number of TASI systems in series on one circuit		
	1	2	3
125 ms	1/100	1/20	1/10
250 ms	1/700	1/40	1/60
500 ms	1/15 000	1/5000	1/1500

A total clip of 500 ms was assumed for the No. 5 system design, and the duration (850 ± 200 ms) of the forward-transfer pulse line signal concerned includes a 500-ms TASI prefix for TASI trunk/channel association;

5. A maximum duration of gaps between short-pulse signals has been determined to maintain continuous operation of the speech detector and thus continuous trunk/channel association. The maximum allowable duration of the gaps is twice the pulse duration over the pulse range 10 to 60 ms and over the operate level range of the speech detector.

This assumes prior energization of the speech detector to give the 240 ms hangover (see item 3 *b* above) before the short-pulse short-gap signalling is applied.

The register short-pulse short-gap multifrequency signalling adopted for the No. 5 system takes advantage of this continued speech detector operation and is transmitted without a TASI prefix, reliance being placed on the trunk/channel association due to the seizing signal.

SUPPLEMENT No. 3

INFORMATION RECEIVED ON NATIONAL

Tables 1 and 2 hereafter give the data on national voice-frequency

TABLE 1. — **Europe**

	Germany (Federal Republic)		Algeria	Austria	Denmark	Spain	France	Great Britain		Ireland	
Frequency (Hz) . .	3000	(2280)*	2000	2280	3000	2500	2280	600-750 separate	2280	2040-2400 compound	2280
Tolerance at the generator terminals (Hz)	±7.5	±6	±6	±6	±3	±3	±3	±3	±6	±6	±6
Frequency variation possible at the entry to the international circuit (Hz) . . .	±15	±15	±12	±15	±8	±15	±6	±5	±8	—	—
Splitting time (milliseconds)	20	20	15 then 35 with attenuated 18 dB	30	35	10	35	140 or 400 320	35	60	35
Absolute level of the power of signals at the point of zero relative level (decibels)	−8	−8	−6	−6	−8	−6	−6	+3	−6	−9	−6
	* for narrow-band circuits										

VOICE-FREQUENCY SIGNALLING SYSTEMS

signalling systems for European countries and extra-European countries

and Mediterranean Basin

Italy	Morocco	Norway	Netherlands	Poland	Portugal		Sweden	Switzerland	Czechoslovakia	Tunisia	U.S.S.R.		Yugoslavia
2040-2400 compound	2280	2400	2400-2500 separate	2280	2400	2040-2400 compound *	2400 (for 2 wires: 2200 and 2400)	3000	2280	2280 500-20	1200-1600 separate and compound	2100 or 1600	2280
±6	±3	±2	±2	±6	±6	±6	±6	±3	±6	±5	±5	±5	±6
±15	±10	—	±5	±8	±15	±15	±11	±6	±15	—	±15	±15	—
40-60	25-35	35	30-55	45	35-40	40-60	35-40	70	150 then 130 with filter	66-34	40 before reply, 150 after reply	50-75	—
−9	−6	−6	+3.5	−6	−9	−9	−6	−3.5	−6	−6	−4	−6	−6

* standardization considered

TABLE 2. — **Extra-**

	Argentina	Australia		Canada	Cuba	East African Post and Tele-comm. Admin. (Kenya, Uganda and Tanzania)	United States of America
Frequency (Hz). . .	2040-2400 compound 500	600-750 sep-arate	2280	2600 (for 2 wires: 2400-2600)	2150	2040-2400 separate and compound	2600
Tolerance at the generator terminals (Hz)	±6	±5	±6	±5	±3	±6	±5
Frequency variation possible at the entry to the international circuit (Hz) . . .	±15	±15	±15	±15	±15	—	±15
Splitting time (milli-seconds)	60	160-210	35	35 maximum	60	30-40	35 maximum
Absolute level of the power of signals at the point of zero relative level (decibels)	−9	0	−6	−8 and after attenuation −20	−10	−9	−8 and after attenuation −20

European countries

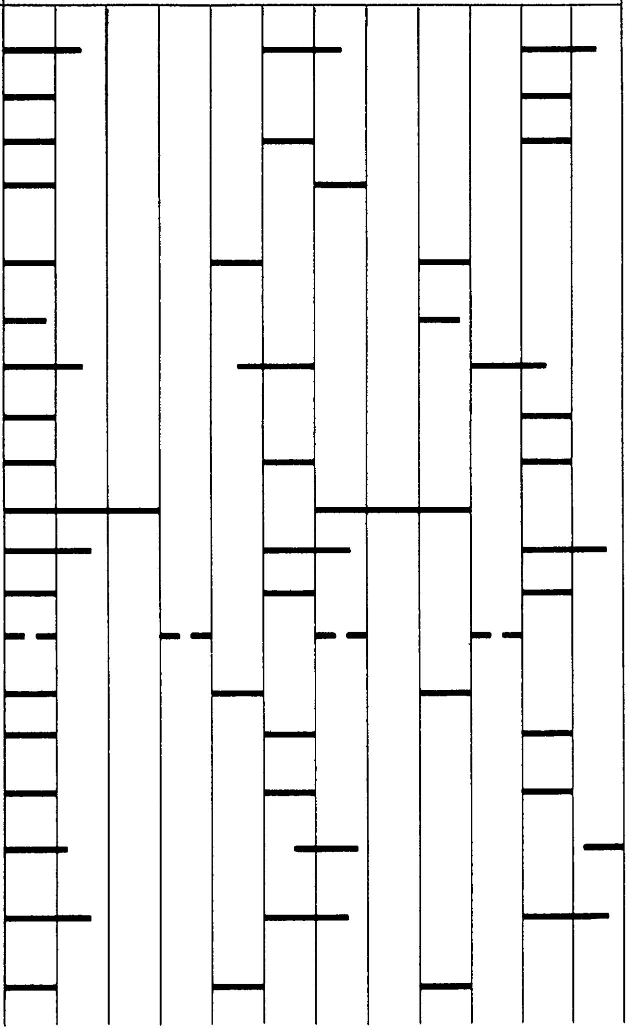
Mexico	India	New Zealand		Rhodesia		South Africa (Rep. of)		Syria	Thailand
2400	2400	600-750	2280	3250 Tone-on-idle signalling	2280*	600-750 separate	2280	2040-2400 compound standardization proposed =2280	2280
±5	±2	±3	±3	±7.5	±6	±2	±6	±6	±6
±15	±10	—	—	—	—	—	—	—	±8
35 maximum	25 filter loss at 2400 Hz → 50 dBm	160-210	20-30	filter loss at 3250	2280 → 30 dBm	50	70	70	35 max.
−8 and after attenuation −20	−10	−6	−6	−14	−14	−7	−11 ±1	−11±1	−6

* For narrow-band circuits

SUPPLEMENT No. 4

VARIOUS TONES USED IN NATIONAL NETWORKS

TABLE 1. — RINGING TONE

Country	Frequency (Hz)	EUROPEAN COUNTRIES AND MEDITERRANEAN BASIN
ALGERIA	25 or 50	
GERMANY (F. R.)	In few cases 450 or 425 in future	
AUSTRIA	450	
BELGIUM	450 Exceptionally 450 × 25[1]	
DENMARK	450	
SPAIN	400	
FINLAND	At present 400 or 450 In future 425 ± 25	
FRANCE Paris	425	
FRANCE Paris and Province	425	
GREECE	450	
IRELAND	400 / 450	
ISRAEL	400 ± 8 400 ± 8 or 450 ± 9	
ITALY	400/450	
LEBANON	435	
MOROCCO	25 + harmonics or 450/50 or 450	
NORWAY	400 or 450	

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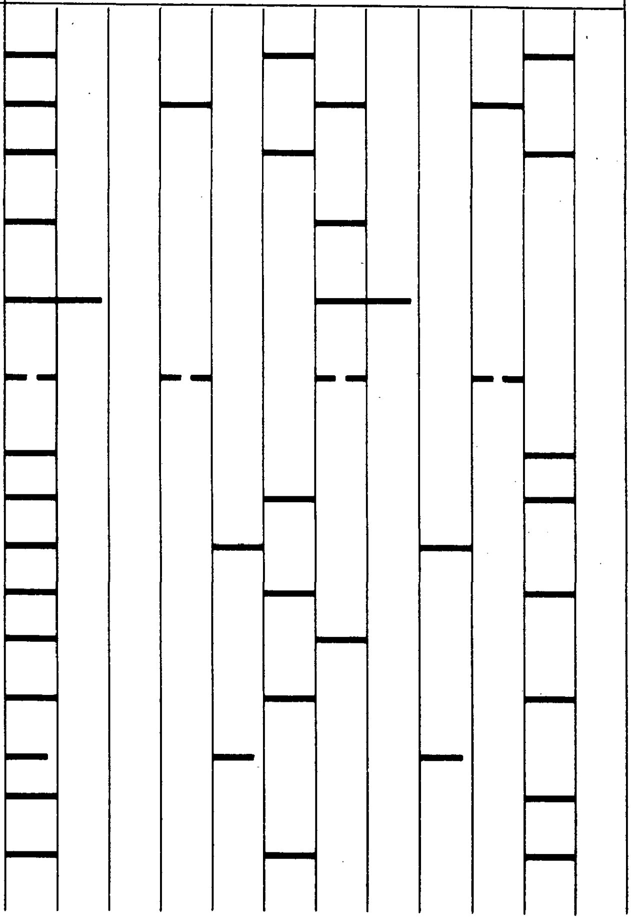
[1] The frequency is between 400 and 450.

TABLE 1. — RINGING TONE (continued)

Country	Frequency (Hz)	EUROPEAN COUNTRIES AND MEDITERRANEAN BASIN
NETHERLANDS	425 or 450 or 25 + harmonics[2] or 260[3]	
POLAND	400	
PORTUGAL	400	
ROUMANIA	$16^{2}/_{3}$ or 450/25 or 450/50	
UNITED KINGDOM	400+450 400×25 $400 \times 16^{2}/_{3}$	
SWEDEN	425	
SWITZERLAND	400	
SYRIA	450/50	
CZECHOSLOVAKIA	450	
TUNISIA	400±80	
U.S.S.R.	450±50 at present 425±25 in future	
YUGOSLAVIA	450 or at present 25×450 in future	



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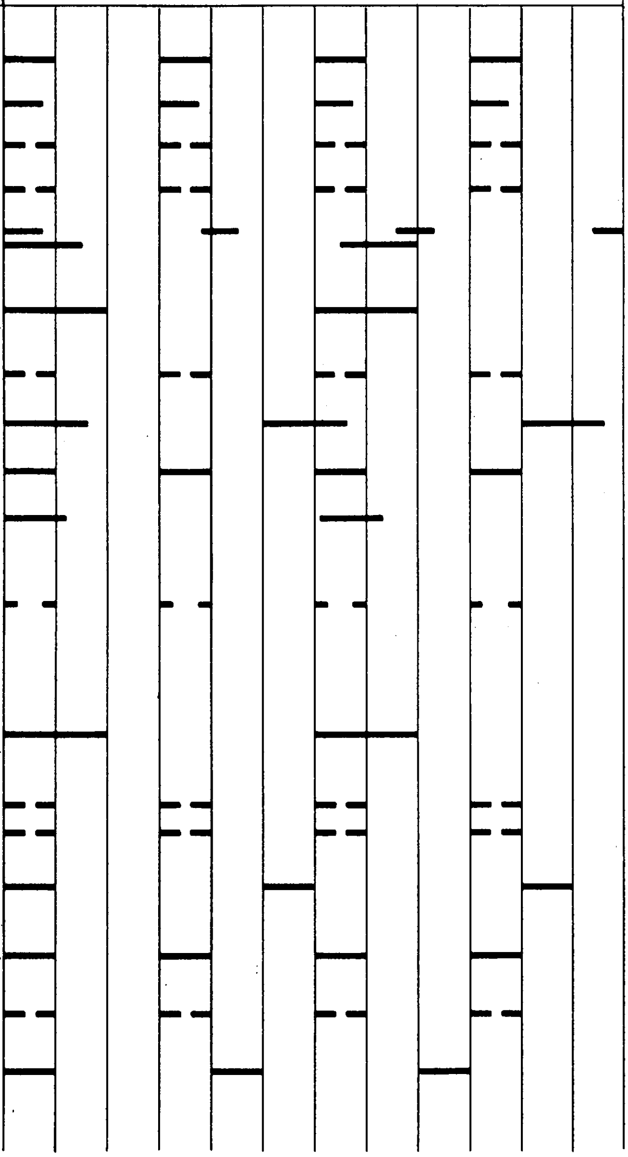
[2] It will be deleted in 1980.

[3] It will be deleted in 1972.

TABLE 1. — RINGING TONE (continued)

Country	Frequency (Hz)	EXTRA-EUROPEAN COUNTRIES
ARGENTINA	25+400 $\times 16^{2}/_{3}$ 25	
AUSTRALIA	400×17	
BOTSWANA	400/450	
BRAZIL	400 or 450	
CANADA	420×40 or 440 [1]+480 [1]	
CHILE	$16^{2}/_{3}$	
IVORY COAST	50	
CUBA	420+40	
EL SALVADOR	425	
EAST AFRICAN P. and T. Adm. (KENYA, UGANDA and TANZANIA)	133+17 or 400+17 or 400 + 450	
UNITED STATES	420×40 or 440 [1]+480 [1]	
INDIA	$133+16^{2}/_{3}$ $400+16^{2}/_{3}$	
INDONESIA	435 or 450	
JAPAN	$400 \times 16^{2}/_{3}$ $350 \times 33^{1}/_{3}$ [2]	
JORDAN	$400+16^{2}/_{3}$	
KUWAIT	400	



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[1] Precise tone—frequencies ± 0.5% of nominal values.

[2] Partially used at old-type exchanges.

TABLE 1. — RINGING TONE (continued)

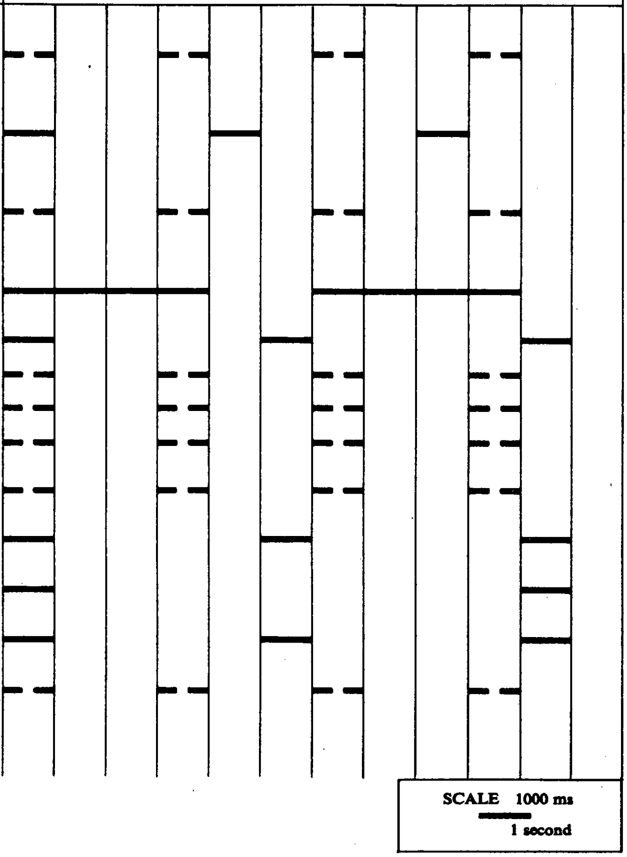
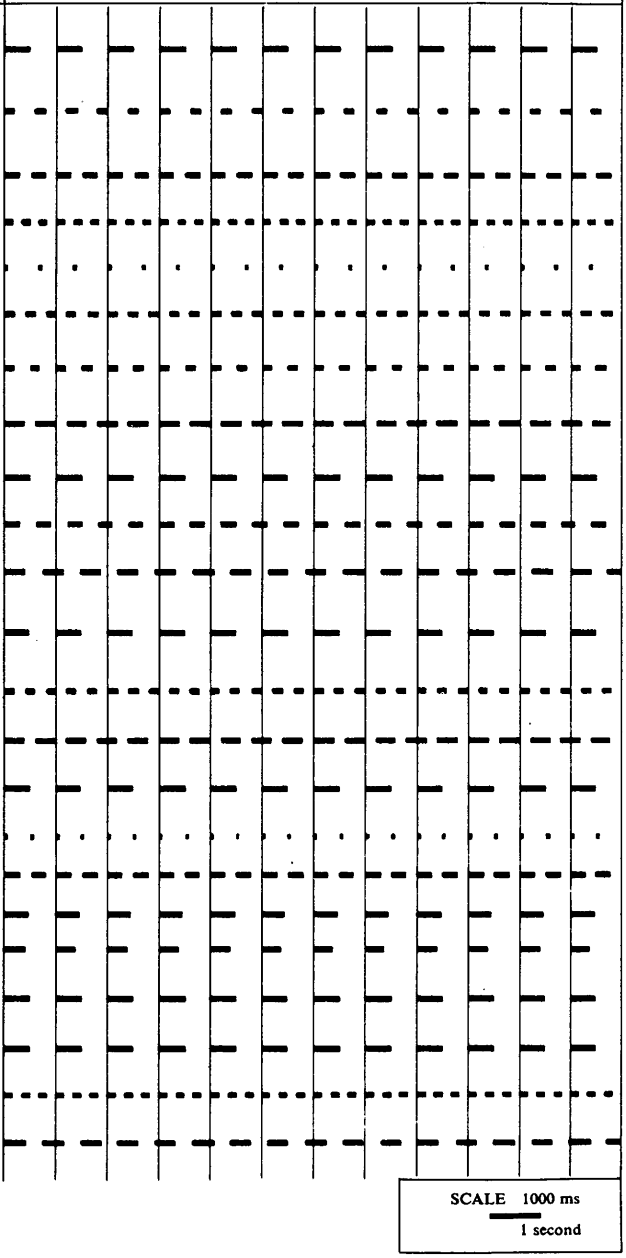
Country	Frequency (Hz)	EXTRA-EUROPEAN COUNTRIES
MALAWI	400 133	
MAURITANIA	50	
NEW ZEALAND	$400+16\frac{2}{3}$ 400+25 400+450	
NIGERIA	133+17	
PAKISTAN	450 $400+16\frac{2}{3}$	
SINGAPORE	$400\times16\frac{2}{3}$ 400×24	
SOUTH AFRICA (Rep. of)	400+33	
THAILAND	400	
URUGUAY	450+25 at present 450 in future	
ZAMBIA	$133\frac{1}{3}$ or 400+450	

TABLE 2. — BUSY TONE

Country	Frequency (Hz)	EUROPEAN COUNTRIES AND MEDITERRANEAN BASIN
ALGERIA	450	
GERMANY (F. R.)	At present [1] 450 or 425	
AUSTRIA	450	
BELGIUM	450	
DENMARK	450	
SPAIN	400	
FINLAND	At present: 400 or 450 In future: 425±25	
FRANCE	425	
GREECE	450	
IRELAND	400	
ISRAEL	400±8 400±9	
ITALY	400 or 450	
LEBANON	435	
MOROCCO	400 or 450	
NORWAY	400 or 450	
NETHERLANDS	425 or 450 or 260 [2] 425 (planned)	
POLAND	400	
PORTUGAL	400	
ROUMANIA	133 or 450	
UNITED KINGDOM	400	



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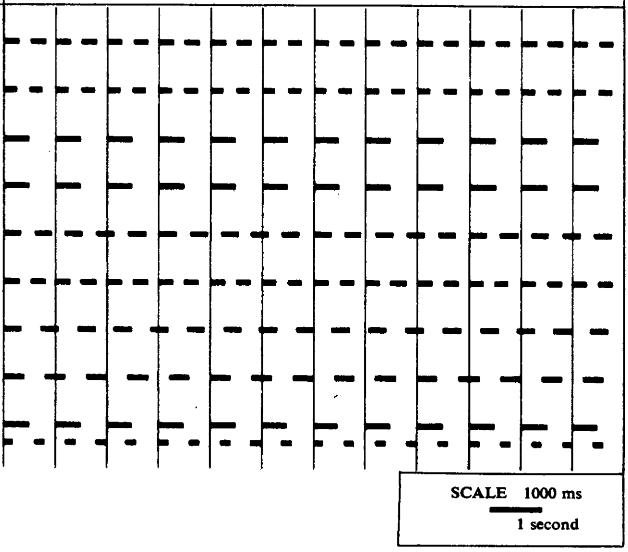
[1] In future, 425 Hz (congestion—0.25 second on, 0.25 second off—and subscriber busy—0.50 second on, 0.50 second off).

[2] To be deleted in 1972.

TABLE 2. — **BUSY TONE** (continued)

Country	Frequency (Hz)	EUROPEAN COUNTRIES AND MEDITERRANEAN BASIN
SWEDEN	**425**	
SWITZERLAND	**400** (standardized) **450** [1]	
SYRIA	**450**	
CZECHOSLOVAKIA	**450**	
TUNISIA	**400±80**	
U.S.S.R. [2]	**450±50** at present **425±25** in future	
YUGOSLAVIA	**450**	



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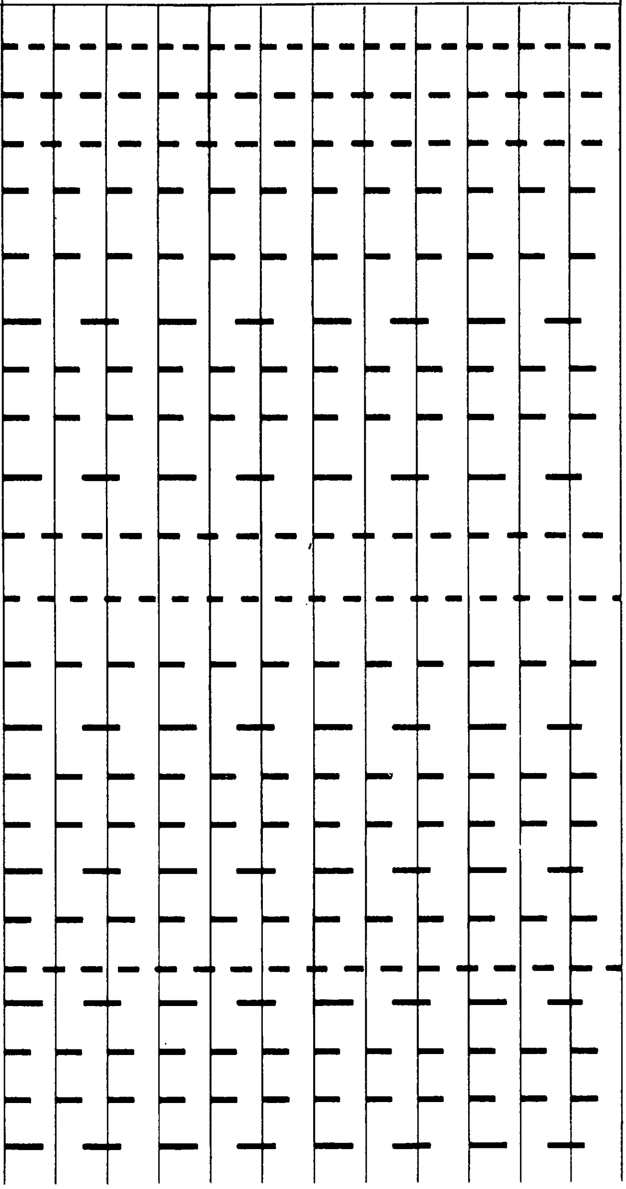
[1] Obsolete equipment still in service.

[2] A signal of the same frequency and periodicity is used to indicate both a busy line and a busy subscriber.

TABLE 2. — BUSY TONE (continued)

Country	Frequency (Hz)	EXTRA-EUROPEAN COUNTRIES
ARGENTINA	400 × 450 × 360	
AUSTRALIA	400	
BOTSWANA	400	
BRAZIL	400 or 450	
CANADA	600 × 120 or 480[1] + 620[1]	
CHILE	400	
IVORY COAST	450	
CUBA	600+120	
EAST AFRICAN P. and T. Adm. (KENYA, UGANDA and TANZANIA)	400	
EL SALVADOR	425	
UNITED STATES	600 × 120 or 480[1] + 620[1]	
INDIA	400	
INDONESIA	435 or 450	
JAPAN	400	
JORDAN	400	
KUWAIT	400	
MALAWI	400	
MAURITANIA	600	
NEW ZEALAND	400	
NIGERIA	400	

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[1] Denotes new precise tone plan. Frequencies ± 0.5 % of nominal values.

TABLE 2. — **BUSY TONE** (continued)

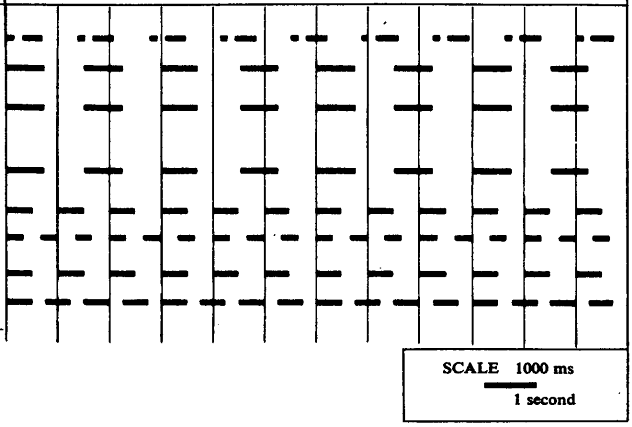
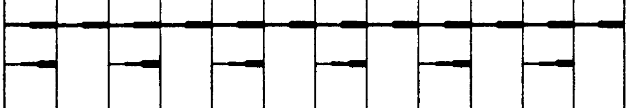
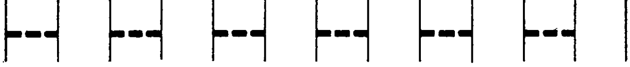
Country	Frequency (Hz)	EXTRA-EUROPEAN COUNTRIES
PAKISTAN	**450** **400**	
SINGAPORE	**400**	
SOUTH AFRICA (Rep. of)	**400**	
THAILAND	**400** **450**	
ZAMBIA	**400**	

TABLE 3. — OTHER TONES
(Reference, information, number unobtainable, congestion tones *)

Country	Frequency (Hz)	EUROPEAN COUNTRIES AND MEDITERRANEAN BASIN
GERMANY (F. R.)	950/1400/ 1800	
AUSTRIA Information tone	950/1400/ 1800	
BELGIUM Congestion tone	450	
Information tone	900/1380/ 1860	
DENMARK Information tone	450	
SPAIN Information tone	400	
Spare level	400	
FINLAND	950/1400/ 1800	
FRANCE Routing or transfer tone [1]	425	
IRELAND	400	
ISRAEL	1000/1400/ 1800 ±2% [2]	
LEBANON	435	
MOROCCO Waiting tone	450	
Pre-metering tone	450	
NETHERLANDS Special information tones	150/450 or 950/1400/ 1800	
Congestion tone (planned)	425	
POLAND Congestion tone	400	
Information tone	950/1400/ 1800	

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* It may be advantageous to provide the intervention of an assistance operator at the incoming international exchange in the event of receipt of these tones.

[1] In principle, this tone is not retransmitted outside the French network. However, it may be retransmitted in the case of calls arriving at Paris via distant transit connections in the French network and for some nearby international relations. The French Administration is considering designing a device to put an end to this.

[2] Alternating with a recorded announcement.

TABLE 3. — **OTHER TONES** (continued)

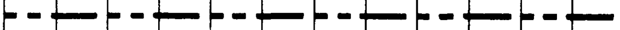
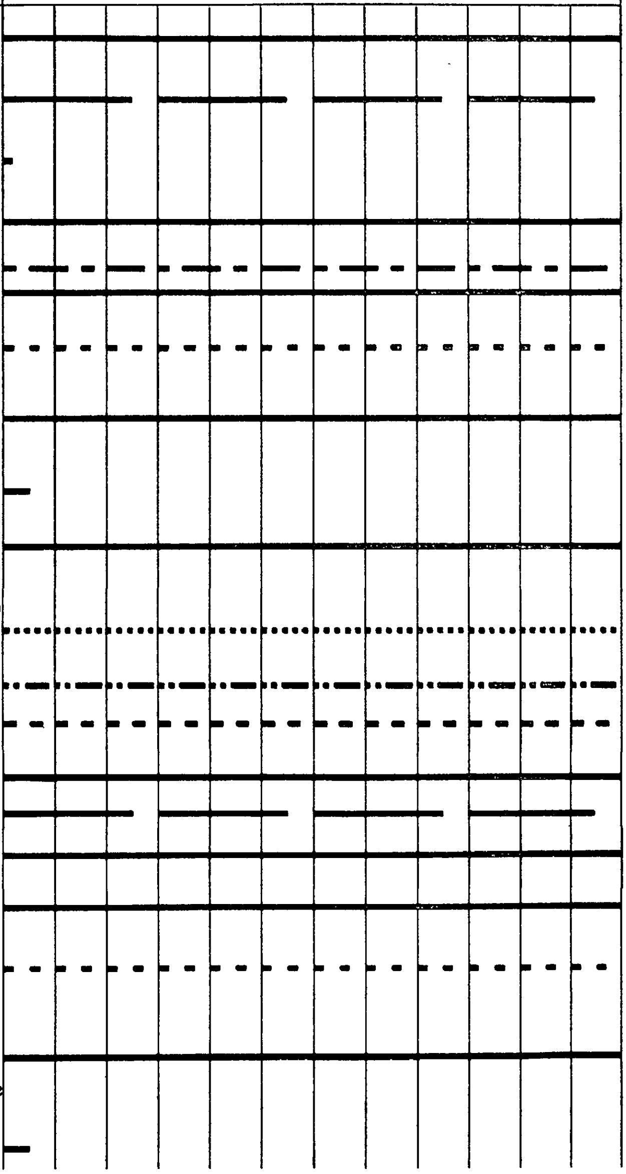
Country			Frequency (Hz)		**EUROPEAN COUNTRIES AND MEDITERRANEAN BASIN**
PORTUGAL	Number unobtainable		**400**		
ROUMANIA	Number unobtainable .		**400 × 133 or 450**		
	Information tone		**950/1400/ 1800**		
UNITED KINGDOM	Number unobtainable . . .		**400**		
	Pay tone. . .		**400**		
	Equipment engaged . . .	**400**		Normal level	
				Reduced level	
SWEDEN	Information tone .		**425**		
	Congestion tone .	**425**		Normal level	
				Reduced level or fully suppressed	
SWITZERLAND	Information tone		**950/1400/ 1800**		
SYRIA	Re-call tone		**450**		
	Number unobtainable		**450**		
	Dead level		**450**		

TABLE 3. — OTHER TONES (continued)

Country		Frequency (Hz)	EXTRA-EUROPEAN COUNTRIES
ARGENTINA	Dial tone . . .	400 × 450 × 360	
AUSTRALIA	Number unobtainable	400	
	Recording tone[1] . . .	1400±100	
BOTSWANA	Number unobtainable . . .	400	
BRAZIL	Information tone . Dial tone	400 or 450	
CANADA	Reorder (congestion) tone. . . .	600 × 120 or 480[2] + 620[2]	
	Dial tone	600 × 120 or 350[2] + 440[2]	
	Reorder warning tone	1400[3]	
CHILE	Dial tone.	$33\frac{1}{3}$ or 400 × $33\frac{1}{3}$	
	Waiting tone . . .	(1100+900) × 10	
CUBA	Number unobtainable .	520	
	Congestion tone . . .	600+120	
EAST AFRICAN P. and T. Adm. (KENYA, UGANDA and TANZANIA)	Number unobtainable	400 400	
	Dial tone	33 or 50	
EL SALVADOR	Dial tone .	425	
UNITED STATES	Reorder (congestion) tone . .	600 × 120 or 480[2]+620[2]	
	Dial tone	600 × 120 or 350[2] + 440[2]	
	Reorder warning tone . .	1400[3]	



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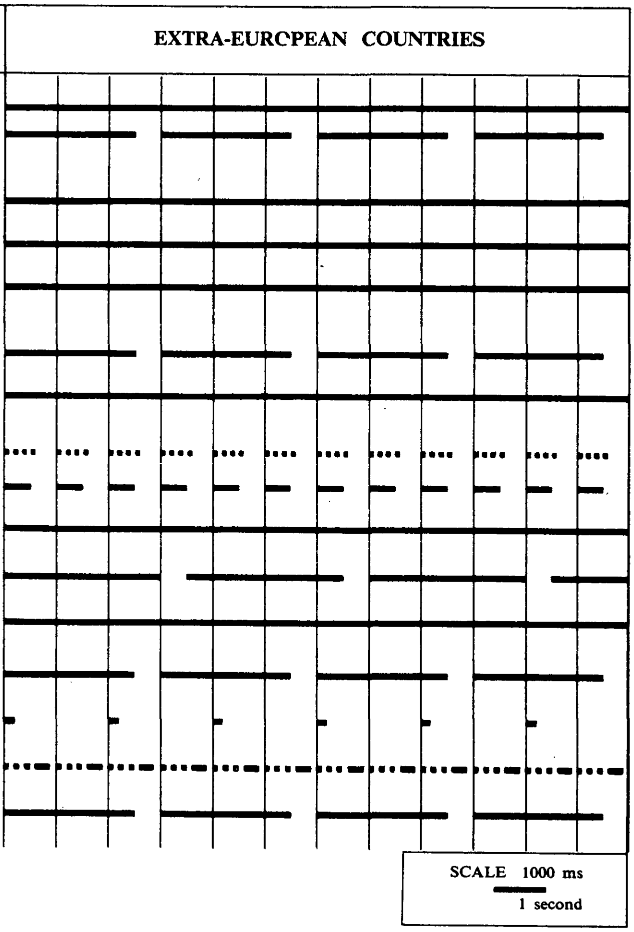
[1] Applied for 0.200 second every 15 seconds.

[2] Denotes new precise tone plan. Frequencies ± 0.5% of nominal values.

[3] Applied for 0.500 second every 15 seconds.

TABLE 3. — OTHER TONES (continued)

Country		Frequency (Hz)
INDIA	Number unobtainable	400 400
JORDAN	Number unobtainable	400
KUWAIT	Dial tone	33
	Number unobtainable	400
MALAWI	Number unobtainable	400
MAURITANIA	Dial tone	600
NEW ZEALAND	Number unobtainable	400
	Congestion tone	900
NIGERIA	Dial tone	33
	Number unobtainable	400
SINGAPORE	Number unobtainable	400
SOUTH AFRICA (Rep. of)	Number unobtainable	400
	Call office pay tone	900
THAILAND	Number unobtainable	400
ZAMBIA		200



The following countries replied to the C.C.I.T.T. enquiry, but have no special tones:

ALGERIA, ITALY, JAPAN, TUNISIA, URUGUAY, U.S.S.R., YUGOSLAVIA.

SUPPLEMENT No. 5

NORTH AMERICAN PRECISE AUDIBLE TONE PLAN

Table 1 is a description of a new audible tone plan which is currently being installed in the North-American network and which is expected to:

1. achieve uniformity in the quality of audible tones,
2. minimize customer confusion as to meaning of audible tones,
3. enable machine recognition of audible tones for purposes of service observing, etc.

Basically, the new plan provides four frequencies that are used singly or in combination with varying cadences to form the audible tone signals shown in Table 1, and some other special purpose, limited use signals.

TABLE 1

Use	*Frequencies* [1] *(Hz)*				*Power per frequency at exchange where tone is applied*	*Cadence*
	350	*440*	*480*	*620*		
Dial tone	●	●			–13 dBm0	Continuous
Busy tone			●	●	–24 dBm0	0.5 s "on" 0.5 s "off"
Re-order tone			●	●	–24 dBm0	0.2 s "on" 0.3 s "off", or 0.3 s "on" 0.2 s "off"
Audible ringing tone		●	●		–19 dBm0	2 s "on" 4 s "off"

[1] Frequency limits are ± 0.5% of nominal.

SUPPLEMENT No. 6

TREATMENT OF CALLS CONSIDERED AS "TERMINATING ABNORMALLY"

Country of destination	Ceased line	Line out of service	Changed number	Line connected to absent subscribers service	Faulty line	Spare numbers (no subscriber)	Spare level or spare code	Congestion in the inland automatic system
Algeria	Operator or ringing tone Recorded announcement proposed		Busy tone	Operator	Operator or busy tone or ringing tone			Busy tone
Germany (Federal Republic)	Special information tone, alone or with a recorded announcement (use according to Q.35, 5.1, cases a and c, Volume VI, *White Book*)			Operator	Ringing tone or busy tone	Ringing tone (alone, without any other indication)	Special information tone, alone or with a recorded announcement (use according to Q.35, 5.1, cases a and c, Volume VI, *White Book*)	Busy tone
Argentina	Ringing tone		Normally, operator; exceptionally, ringing tone	—	Ringing tone		Busy tone	
Australia	Operator, recorded announcement or check number tone		Operator or recorded announcement		Ringing tone, try again tone or recorded announcement	Check number tone, ringing tone or recorded announcement	Recorded announcement or check number tone	Try again tone or recorded announcement

N.B. In Australia, busy tone is now known as try again tone whilst number unobtainable tone is known as check number tone.

Country of destination	Ceased line	Line out of service	Changed number	Line connected to absent subscribers service	Faulty line	Spare numbers (no subscriber)	Spare level or spare code	Congestion in the inland automatic system
Austria	Operator or busy tone or special information tone, the latter if necessary also at the initiative of the operator	Busy tone or special information tone	Operator or recorded announcement or busy tone or special information tone; the latter may also be transmitted during the intervals of the announcement or if necessary at the initiative of the operator	Operator or recorded announcement or special information tone to be transmitted during the intervals of the announcement or at the initiative of the operator	Ringing tone or busy tone	Busy tone or special information tone	Busy tone	
Belgium	Operator (information tone complemented by recorded announcement proposed)		Operator for individual cases; recorded announcement in case of transfer of groups of subscribers	Operator	Ringing tone. In certain cases information tone complemented by recorded announcement	Ringing tone	In principle, no indication; special tone in certain networks (information tone complemented by recorded announcement proposed)	Recorded announcement incoming to Brussels. At other points on the trunk network where congestion can be expected, the sending of information tone complemented by recorded announcements is proposed

Country of destination	Ceased line	Line out of service	Changed number	Line connected to absent subscribers service	Faulty line	Spare numbers (no subscriber)	Spare level or spare code	Congestion in the inland automatic system
Canada	Operator or recorded announcement *			Service usually provided by persons not in the employ of the Telephone Company	Operator or busy tone	Operator or recorded announcement		30 or 120 impulsions per minute tone or recorded announcement
Chile Telephone Company	Ringing tone	Ringing tone or recorded announcement	Operator or recorded announcement	Service not provided	Ringing tone or busy tone	Ringing tone	Busy tone	
Ivory Coast	Regular ringing tone or operator			Service not provided. Ringing tone	Ringing tone or busy tone	Busy tone or re-call of an operator		
Cuba	Ringing tone		Operator for individual cases; operator or recorded announcement in case of transfer of groups of subscribers	Service not provided	Ringing tone or busy tone	Ringing tone	Number unobtainable tone or congestion tone	No tone is provided

* In many cases, the recorded announcement is followed by cut-through to an operator.

Country of destination	Ceased line	Line out of service	Changed number	Line connected to absent subscribers service	Faulty line	Spare numbers (no subscriber)	Spare level or spare code	Congestion in the inland automatic system
Denmark	Information tone or ringing tone, or operator or recorded announcement			Operator or recorded announcement	Ringing tone	Information tone or ringing tone	Information tone	Busy tone
Spain	Special tone		Operator or recorded announcement	Service not provided	Busy tone or ringing tone	Ringing tone	Special tone	
United States	Operator or recorded announcement *			Service usually provided by persons not in the employ of the Telephone Company	Operator, busy tone or ringing tone	Operator or recorded announcement		Re-order (congestion) tone or recorded announcement
East African P. & T. Ad. (Kenya, Uganda and Tanzania)	Number unobtainable tone		Operator		Number unobtainable tone			Busy tone

* In many cases, the recorded announcement is followed by cut-through to an operator.

Country of destination	Ceased line	Line out of service	Changed number	Line connected to absent subscribers service	Faulty line	Spare numbers (no subscriber)	Spare level or spare code	Congestion in the inland automatic system
Finland	Ringing tone or operator or recorded announcement	Ringing tone or busy tone or recorded announcement	Operator or recorded announcement or ringing tone	Operator or recorded announcement	Ringing tone or busy tone	Ringing tone or busy tone	No special indication; busy tone in some cases. Information tone or recorded announcement will probably be introduced	Busy tone. In certain cases no tone
France	Operator or recorded announcement			Operator	Operator or recorded announcement	Operator or recorded announcement or busy tone		Busy tone or recorded announcement
India	Number unobtainable tone		Operator or recorded announcement or number unobtainable tone	Service not provided	Number unobtainable tone			Busy tone
Ireland	Number unobtainable tone		Operator	Service not provided	—	Number unobtainable tone		Busy tone
Italy	Busy tone or ringing tone		Operator or recorded announcement	Operator	Busy tone or ringing tone	Busy tone		

Country of destination	Ceased line	Line out of service	Changed number	Line connected to absent subscribers service	Faulty line	Spare numbers (no subscriber)	Spare level or spare code	Congestion in the inland automatic system
Japan	—	Busy tone or ringing tone	Operator or recorded announcement	Service not provided	Recorded announcement or operator	Operator or recorded announcement	Recorded announcement	Busy tone or recorded announcement
Lebanon	Ringing tone (recorded announcement proposed)			Operator	Ringing tone (recorded announcement proposed)	Ringing tone	Special tone	Busy tone
Norway	Operator or recorded announcement			Operator	Ringing tone		Information tone or no tone	No tone or busy tone
New Zealand	Number unobtainable tone	Busy tone or ringing tone	Operator	Service not provided	Busy tone or ringing tone	Number unobtainable tone		Congestion tone
Netherlands	Information tone			Operator or information tone	Information tone or ringing tone		Information tone or busy tone	Busy tone
Poland	Ringing tone						Special tone or busy tone	

Country of destination	Ceased line	Line out of service	Changed number	Line connected to absent subscribers service	Faulty line	Spare numbers (no subscriber)	Spare level or spare code	Congestion in the inland automatic system
Portugal	Busy tone or number unobtainable tone	Busy tone or number unobtainable tone	Operator or busy tone for individual cases; recorded announcement in case of groups of subscribers	Service not provided	Ringing tone or busy tone	Busy tone or number unobtainable tone	Operator or busy tone or number unobtainable tone	Busy tone
Southern Rhodesia	Operator or number unobtainable tone	Number unobtainable tone	Operator or recorded announcement	Service not provided	Number unobtainable tone			Busy tone or recorded announcement
Roumania (P. R.)	"Spare line tone" or operator			Service not provided	Busy tone or ringing tone	"Spare line tone" or operator		—
United Kingdom	Operator or number unobtainable tone	Number unobtainable tone	Operator or recorded announcement	Call answered by an operator or a private answering service or a call transferred to another subscriber	Number unobtainable tone			Busy tone or recorded announcement

Country of destination	Ceased line	Line out of service	Changed number	Line connected to absent subscribers service	Faulty line	Spare numbers (no subscriber)	Spare level or spare code	Congestion in the inland automatic system
South Africa (Rep. of)	Number unobtainable tone		Operator or recorded announcement	Operator	Ringing tone or busy tone	Number unobtainable tone		Busy tone
Sweden	Operator or re-call tone				Ringing tone or busy tone or no tone	Operator or re-call tone or no tone		Congestion tone or no tone
Switzerland	Operator or recorded announcement			Operator	Ringing tone		Busy tone	
Syria	Ringing tone. Operator (proposed)	Number unobtainable tone	Operator or ringing tone	Ringing tone. Operator (proposed)	Ringing tone		"Barred level" tone	—

SUPPLEMENTS CONCERNING THE WORK OF STUDY GROUP XIII

SUPPLEMENT No. 7. — Table of the Erlang loss formula
(Erlang No. 1 formula, also called Erlang B formula).

SUPPLEMENT No. 8. — Curves showing the relation between the traffic offered and the number of circuits required according to Recommendations Q.81, Q.82 and Q.84.

SUPPLEMENT No. 7

TABLE OF THE ERLANG LOSS FORMULA
(Erlang No. 1 formula, also called Erlang B formula)

Loss probabilities: 1%, 3%, 5%, 7%.

Formula:

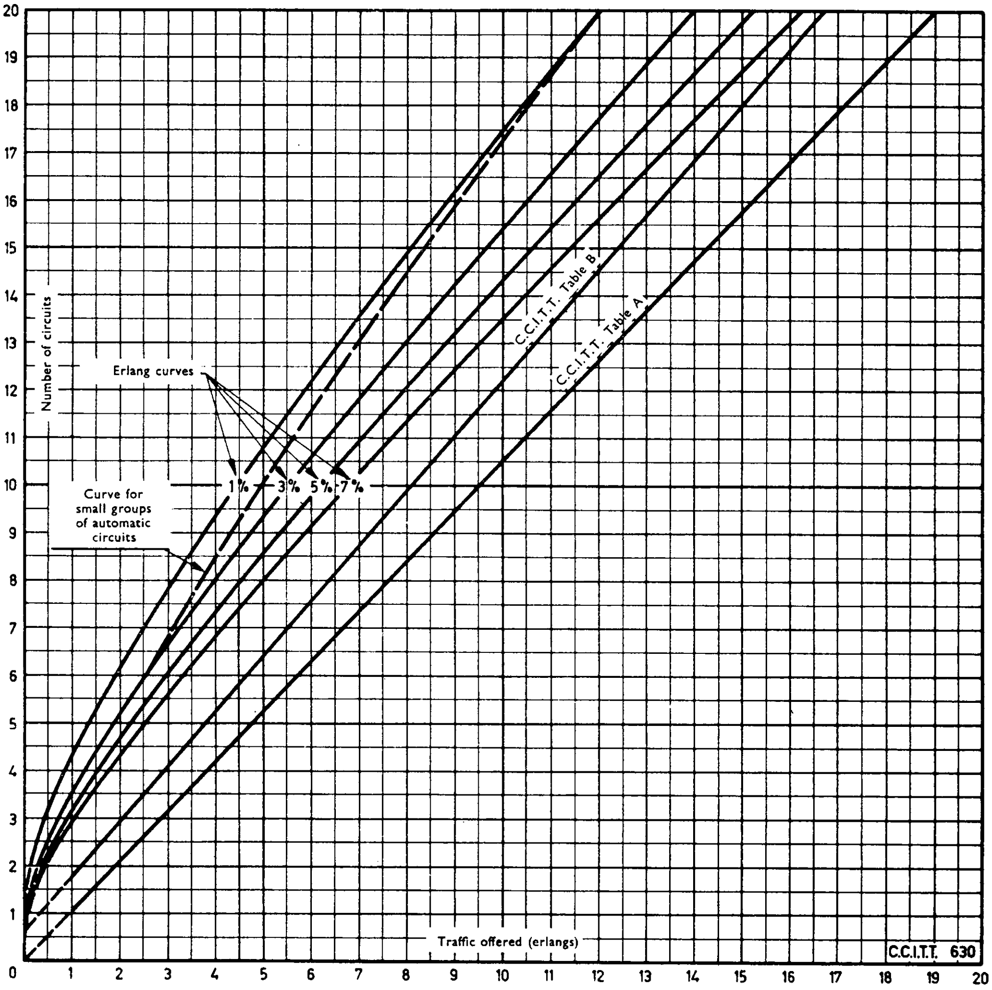
let p = the loss probability
y = the traffic offered (in erlangs)
n = the number of circuits

$$E_1, n\,(y) = p = \frac{\dfrac{y^n}{n!}}{1 + \dfrac{y}{1} + \dfrac{y^2}{2!} + \ldots + \dfrac{y^n}{n!}}$$

n	$p = 1\%$	$p = 3\%$	$p = 5\%$	$p = 7\%$	n	$p = 1\%$	$p = 3\%$	$p = 5\%$	$p = 7\%$
1	0.01	0.03	0.05	0.08	51	38.80	42.89	45.53	47.72
2	0.15	0.28	0.38	0.47	52	39.70	43.85	46.53	48.76
3	0.46	0.72	0.90	1.06	53	40.60	44.81	47.53	49.79
4	0.87	1.26	1.53	1.75	54	41.50	45.78	48.54	50.83
5	1.36	1.88	2.22	2.50	55	42.41	46.74	49.54	51.86
6	1.91	2.54	2.96	3.30	56	43.31	47.70	50.54	52.90
7	2.50	3.25	3.74	4.14	57	44.22	48.67	51.55	53.94
8	3.13	3.99	4.54	5.00	58	45.13	49.63	52.55	54.98
9	3.78	4.75	5.37	5.88	59	46.04	50.60	53.56	56.02
10	4.46	5.53	6.22	6.78	60	46.95	51.57	54.57	57.06
11	5.16	6.33	7.08	7.69	61	47.86	52.54	55.57	58.10
12	5.88	7.14	7.95	8.61	62	48.77	53.51	56.58	59.14
13	6.61	7.97	8.84	9.54	63	49.69	54.48	57.59	60.18
14	7.35	8.80	9.73	10.48	64	50.60	55.45	58.60	61.22
15	8.11	9.65	10.63	11.43	65	51.52	56.42	59.61	62.27
16	8.88	10.51	11.54	12.39	66	52.44	57.39	60.62	63.31
17	9.65	11.37	12.46	13.35	67	53.35	58.37	61.63	64.35
18	10.44	12.24	13.39	14.32	68	54.27	59.34	62.64	65.40
19	11.23	13.11	14.31	15.29	69	55.19	60.32	63.65	66.44
20	12.03	14.00	15.25	16.27	70	56.11	61.29	64.67	67.49
21	12.84	14.89	16.19	17.25	71	57.03	62.27	65.68	68.53
22	13.65	15.78	17.13	18.24	72	57.96	63.24	66.69	69.58
23	14.47	16.68	18.08	19.23	73	58.88	64.22	67.71	70.62
24	15.29	17.58	19.03	20.22	74	59.80	65.20	68.72	71.67
25	16.13	18.48	19.99	21.21	75	60.73	66.18	69.74	72.72
26	16.96	19.39	20.94	22.21	76	61.65	67.16	70.75	73.77
27	17.80	20.31	21.90	23.21	77	62.58	68.14	71.77	74.81
28	18.64	21.22	22.87	24.22	78	63.51	69.12	72.79	75.86
29	19.49	22.14	23.83	25.22	79	64.43	70.10	73.80	76.91
30	20.34	23.06	24.80	26.23	80	65.36	71.08	74.82	77.96
31	21.19	23.99	25.77	27.24	81	66.29	72.06	75.84	79.01
32	22.05	24.91	26.75	28.25	82	67.22	73.04	76.86	80.06
33	22.91	25.84	27.72	29.26	83	68.15	74.02	77.87	81.11
34	23.77	26.78	28.70	30.28	84	69.08	75.01	78.89	82.16
35	24.64	27.71	29.68	31.29	85	70.02	75.99	79.91	83.21
36	25.51	28.65	30.66	32.31	86	70.95	76.97	80.93	84.26
37	26.38	29.59	31.64	33.33	87	71.88	77.96	81.95	85.31
38	27.25	30.53	32.62	34.35	88	72.81	78.94	82.97	86.36
39	28.13	31.47	33.61	35.37	89	73.75	79.93	83.99	87.41
40	29.01	32.41	34.60	36.40	90	74.68	80.91	85.01	88.46
41	29.89	33.36	35.58	37.42	91	75.62	81.90	86.04	89.52
42	30.77	34.30	36.57	38.45	92	76.56	82.89	87.06	90.57
43	31.66	35.25	37.57	39.47	93	77.49	83.87	88.08	91.62
44	32.54	36.20	38.56	40.50	94	78.43	84.86	89.10	92.67
45	33.43	37.16	39.55	41.53	95	79.37	85.85	90.12	93.73
46	34.32	38.11	40.54	42.56	96	80.31	86.84	91.15	94.78
47	35.22	39.06	41.54	43.59	97	81.24	87.83	92.17	95.83
48	36.11	40.02	42.54	44.62	98	82.18	88.82	93.19	96.89
49	37.00	40.98	43.53	45.65	99	83.12	89.80	94.22	97.94
50	37.90	41.93	44.53	46.69	100	84.06	90.79	95.24	98.99

SUPPLEMENT No. 8

CURVES SHOWING THE RELATION BETWEEN THE TRAFFIC OFFERED AND THE NUMBER OF CIRCUITS REQUIRED



Relation between the traffic (in erlangs) offered and the number of circuits required in the case of:

- the C.C.I.T.T. Tables A and B (Recommendation E.510 and Q.85)
- the Erland formula ($p = 1\%, 3\%, 5\%$ and 7%)
- the curve for small groups of automatic circuits (see Annex to Recommendation E.520 and Q.87)

FIGURE 1. — **Number of circuits between 1 and 20**

Relation between the traffic (in erlangs) offered and the number of circuits required in the case of the Erlang formula for (p = 1%, 3%, 5% and 7%)

FIGURE 2. — **Number of circuits between 1 and 100**