THE INTERNATIONAL TELEGRAPH AND TELEPHONE CONSULTATIVE COMMITTEE

(C.C.I.T.T.)

FIFTH PLENARY ASSEMBLY

GENEVA, 4-15 DECEMBER 1972

GREEN BOOK

VOLUME VI - 1

Telephone signalling and switching

GENERAL CONTENTS OF VOLUME VI

GENERAL RECOMMENDATIONS ON SIGNALLING AND SWITCHING

(Recommendations Q.1 to Q.96)

Published by

THE INTERNATIONAL TELECOMMUNICATION UNION

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CONTENTS OF THE C.C.I.T.T. BOOKS
APPLICABLE AFTER THE FIFTH PLENARY ASSEMBLY (1972)

GREEN BOOK

Volume I
- — Minutes and reports of the Vth 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 1973-1976.
- — Summary table of Questions under study in the period 1973-1976.
- — Recommendations (Series A) on the organization of the work of the C.C.I.T.T.
- — Recommendations (Series B) relating to means of expression.
- — Recommendations (Series C) relating to general telecommunication statistics.

Volume II-A
- — Recommendations (Series D) and Questions (Study Group III) relating to the lease of circuits.
- — Recommendations (Series E) and Questions (Study Group II) relating to telephone operation and tariffs.

Volume II-B — Recomendations (Series F) and Questions (Study Group I) relating to telegraph operation and tariffs.

Volume III — Recommendations (Series G, H and J) and Questions (Study Groups XV, XVI, Special Study Groups C and D) relating to line transmission.

Volume IV — Recommendations (Series M, N and O) and Questions (Study Group IV) relating to the maintenance of international lines, circuits and chains of circuits.

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 equipment.

Volume VII — Recommendations (Series R, S, T, U) and Questions (Study Groups VIII, IX, X, XIV) relating to telephone technique.

Volume VIII — Recommendations (Series V and X) and Questions (Study Group VII and Special Study Group A) relating to data transmission.

Volume IX
- — Recommendations (Series K) and Questions (Study Group V) relating to protection against interference.
- — Recommendations (Series L) and Questions (Study Group VI) relating to the protection of cable sheaths and poles.

Each volume also contains, where appropriate:
- — Definitions of specific terms used in the field of this volume.
- — Supplements for information and documentation purposes.

CONTENTS

SERIES Q RECOMMENDATIONS

[1] Q Recommendation is an extract of the G series Recommendation.

[1] Q Recommendation is an extract of the G series Recommendation.

PART X

SIGNALLING SYSTEM No. 5

PART XI

INTERWORKING OF SYSTEMS No. 4 AND No. 5

Recommendation | Page

PART XII

SIGNALLING SYSTEM No. 5 *bis*

PART XIII

INTERWORKING OF SYSTEM No. 5 *bis* WITH SYSTEMS No. 4 AND No. 5

PART XIV

SIGNALLING SYSTEM No. 6

(Note: See page 415 for *detailed* Table of Contents)

Recommendation | Page

PART XV

SIGNALLING SYSTEM R1

PART XVI

SIGNALLING SYSTEM R2

INTRODUCTION

1. The Recommendations in Volume VI of the *Green Book* are in agreement with Series E of the C.C.I.T.T. Recommendations (Volume II-A of the *Green 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 *Green 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.

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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 $\pm$ 2%, interrupted at a frequency of 20 Hz $\pm$ 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 or an absolute power level of zero (with a tolerance of $\pm$1 decibel) which corresponds to an average power for the interrupted signalling current of 0.5 milliwatt, with a tolerance of $\pm$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 900 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 aboslute 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:

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

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 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 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 time 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 [1]

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.

[1] The substance of this Recommendation also appears in Recommendation E.144 in Volume II.A of the *Green Book*.

Recommendation Q.6 [1]

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;

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 (formely called " two-frequency system ") standardized by the C.C.I.F. in 1954;

[1] The substance of this Recommendation also appears in Recommendation E.145 in Volume II.A of the *Green Book.*

— 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 R1 (Regional system No. 1, formerly called the North American System), standardized by the C.C.I.T.T. in 1968;

— System R2 Regional System No. 2 formerly called the MFC Bern System 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 IV, Part V (New Delhi, 1960). [1]

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.

[1] See an amendment in Part VIII of this volume.

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 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.

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 the same line signalling as System No. 5, i.e. two " in-band " signalling frequencies (2400 and 2600 Hz) for the link by link transmission of those signals.

Uses, in both forward and backward direction, 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 [1].

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).

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.

[1] The specifications of System No. 5 *bis* provide the possibility of using common interregister signalling equipment on relations using System No. 5 and on those using System No. 5 *bis*.

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 this Volume.

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 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 this Volume.

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.

Volume II-A | **Volume VI**

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 groups 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:

Bruxelles 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 ".

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.

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

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 Bruxelles	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 AND DIALLING PROCEDURES 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]:

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 two digits of the national (significant) number should be analyzed 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 R.

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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.

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 $11\text{-}n$ (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;

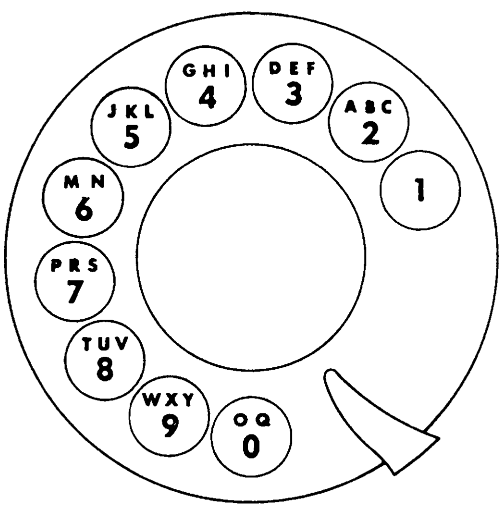
b) to supply, at the time of opening this automatic service, a booklet of instructions containing the conversion table to the main subscribers to the international service;

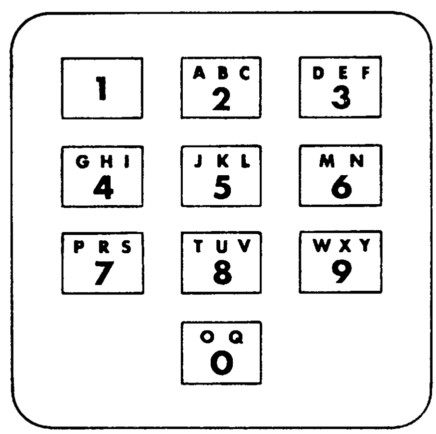
4.3 It would also be desirable, in countries with letters in the telephone numbers, that subscribers with considerable international traffic should be asked to show on their letter-heads, next to their telephone number, the international number with figures only. (See Recommendation E.162.)

5. **Rotary dials** (see Figure 1/E.161/Q.11)

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 keysets) used by international operators for semi-automatic operating in Europe have this arrangement of letters and figures.





C.C.I.T.T. 637 A

FIGURE 1/E.161/Q.11.

FIGURE 2/E.161/Q.11.

On the North American dials and 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 Figure 2/E.161/Q.11)

6.1 *10 button sets* (see Figure 2/E.161/Q.11)

6.1.1 *Arrangement and numbering*

The standard arrangement and numbering for push-buttons corresponding to the digits 1 to 0 is as shown in the figure below:

1	2	3
4	5	6
7	8	9
	0	

C.C.I.T.T. 4693 A

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

Where a need exists within an Administration for a 5×2 array for use on special telephone apparatus, the array should be as shown in the figure below:

1	**2**
3	**4**
5	**6**
7	**8**
9	**0**

C.C.I.T.T. 4693 B

Note. — User dialling performance on this special array is slightly inferior to that on the standard array given above.

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[1], 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 (see Figure 2/E.161 and Q.11).

6.1.2 *Symbols*

The symbols for these buttons are the digits 1 to 0 as indicated in the figures in 6.1.1. These buttons are to be known as button 1, button 2, etc.

6.2 *12 button sets*

6.2.1 *Arrangement*

In the 12 button set the standard arrangement shown in 6.1.1 is extended by two additional buttons, one to the left and the other to the right of the button 0, thus making a pattern of 4 horizontal rows of three buttons each forming a 4×3 array.

Two buttons may also be added to the 5×2 array shown in 6.1.1. These should be located below and in line with buttons 9 and 0, thus making a 6×2 array.

6.2.2 *Symbols*

On the 4×3 array the symbol on the button which is immediately to the left[2] of the button 0 and which, according to Recommendation Q.23, is used to transmit the frequency pair 941 Hz and 1209 Hz, should have a shape easily identified as the general shape shown in Figure 3/E.161 and Q.11.

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[1] Thus, for example, on the North American dials and keysets the digit 0 is not associated with the letters O and Q, but with the word " operator ", the letter O being associated with the digit 6.

[2] On the 6×2 array, the corresponding button is located below button 9.

The symbol will be shown as the " star "[1] as translated in the various languages.

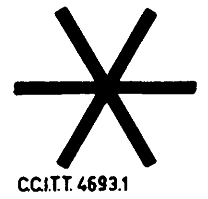

FIGURE 3/E.161/Q.11.

On the 4×3 array the symbol on the button which is immediately to the right[2] of the button 0 and which, according to Recommendation Q.23, is used to transmit the frequency pair 941 Hz and 1477 Hz, should conform in shape to the specifications given in Figures 4 or 5. This symbol shall consist of four lines of equal length (b), forming two pairs of parallel lines. One pair is horizontal while the other is vertical or inclined to the right at an angle α of 80° as shown in Figure 5. It will be seen that the two pairs of parallel lines overlap. The ratio a/b, where " a " is the overlap, shall be between 0.08 and 0.18.

The preferred values are:

— in Europe[3]
  $\alpha = 90°$ with $a/b = 0.08$

— in North America[3]
  $\alpha = 80°$ with a/b close to the upper limit of 0.18.

The symbol will be known as the " square " or the most commonly used equivalent term in other languages[4].

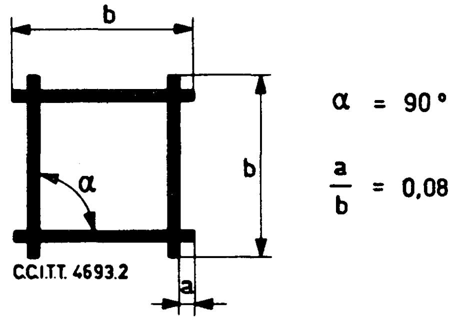

FIGURE 4/E.161/Q.11.

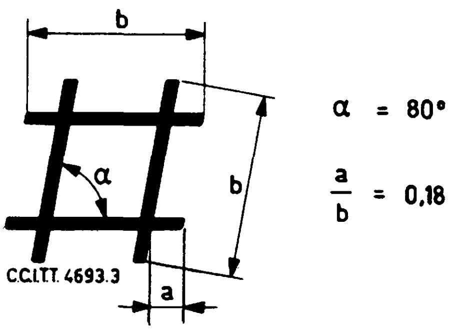

FIGURE 5/E.161/Q.11.

[1] In France, the term " asterisk " may also be used for this symbol.

[2] In the 6×2 array, the corresponding button is located below the button O.

[3] No information is available at the present time as to which of these values would be preferred in other continents.

[4] In some countries an alternative term, (e.g. " number sign ") may be necessary for this purpose, unless further investigation indicates that " square " is suitable for the customers.

The additional buttons with these symbols will be placed as shown below:

For the standard 4×3 array

1	2	3
4	5	6
7	8	9
*	0	#

For the 6×2 array

1	2
3	4
5	6
7	8
9	0
*	#

C.C.I.T.T. 4693 C

6.3 *16 button sets*

6.3.1 *Arrangement*

In the 16 button set, the 4×3 array shown in 6.2.2 is extended by four additional buttons placed to the right in such a way as to form a 4×4 array.

6.3.2 *Symbols*

On the 4×4 array, the symbols on the additional buttons are A, B, C and D[1]. (The reasons for the choice of these four symbols are explained in Annex 1 to this Recommendation.)

A is the symbol for the button to the right of button 3 and is used to transmit the frequency pair 697 Hz and 1633 Hz[2].

B is the symbol for the button to the right of button 6 and is used to transmit the frequency pair 770 Hz and 1633 Hz[2].

C is the symbol for the button to the right of button 9 and is used to transmit the frequency pair 852 Hz and 1633 Hz[2].

D is the symbol for the button to the right of button # and is used to transmit the frequency pair 941 Hz and 1633 Hz[2].

In order to avoid any possibility of auditory confusion in transmitting these letters over international telephone lines the phonetic equivalents

Amsterdam Baltimore Casablanca Denmark

or

Alfred Benjamin Charles David

as already used in international telephone working, are recommended for identifying the letters A, B, C, D.

[1] If letters still appear on buttons 1-0 of the push-button set when 16 button sets are introduced, Administrations may choose to use the lower case letters a, b, c, d rather than the upper case letters until such a time as it is possible to remove the alphabetic characters from buttons 1-0.

[2] These are the frequency pairs specified for the right hand column as indicated in Recommendation Q.23.

The additional buttons with these symbols will be placed as shown below[1]:

1	2	3	A
4	5	6	B
7	8	9	C
*	0	#	D

C.C.I.T.T. 4693 D

6.4 *Design of symbols*

Symbol size and the line thickness should be appropriate to provide optimal recognition.

6.5 *Use of colours*

The question of standardization of button and symbol colour for international purposes is still under study. In the meantime, colours different from the digit buttons and symbols should not be used[2, 3].

7. Prefixes and codes

7.1 *International prefix*[4]

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*[4]

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*;

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[1] Some Administrations may wish to provide spatial separation for special reasons between buttons A, B, C, D and the other 12 buttons.

[2] Where exceptionally, for national purposes, Administrations use colour for the * and # symbols which is different from that used for the digit symbols, they should be red and blue respectively.

[3] Further study may show whether some form of perceptual separation, such as colour or size is required between the buttons A, B, C, D and the other twelve buttons.

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

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 in Annex 2 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.

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 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.

7.3.3 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).

7.3.4 The use and printing of symbols and separators in national and international telephone numbers is detailed in Recommendation E.162.

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

ANNEX 1

(to Recommendation E.161/Q.11)

Method used in selecting the symbols for buttons 13 to 16 of the 16 push-button keysets

During its Montreal meeting in June-July 1970, Study Group II agreed that a study had to be undertaken forthwith in order to choose suitable symbols for buttons 13 to 16 of the 16 push-button set.

The matter was considered urgent because at that time 16 button telephone sets were commercially available and various manufacturers had expressed an interest in their production. Standardization of the symbols was immediately needed to guide manufacturers before a large number of unstandardized sets was produced, that is, using different symbols or symbols that do not satisfy elementary human factor rules.

Push-button sets, it was noted, could be used not only for communications between subscribers but also for other purposes, e.g. for end-to-end data transmission. A large number of possible applications is envisaged. Many telephone and data applications, or functions, are not yet known but are likely to appear in the future when 16 button sets are introduced. These considerations led the C.C.I.T.T. to decide that the symbols for the buttons 13 to 16 should not have any special meaning related to the functions of the button.

A variety of symbols was considered during the studies made from 1970 to 1972. However, it appeared that only a set of four letters of the Latin alphabet satisfied most of the requirements mentioned in the appendix to Recommendation E.162, " Desirable properties of diallable symbols ". Briefly, these symbols should be as far as possible:

1. distinct from other diallable symbols;
2. widely known by name;
3. reproducible;
4. C.C.I.T.T.—I.S.O. compatible;
5. made up of a single character;
6. abstract;
7. immediately recognizable as a diallable character.

A test programme was designed in 1970 to find the most suitable set of four letters. This included a study of auditory and visual confusion between letters and the existing digits and symbols for the buttons 1 to 12. Eight countries participated in the auditory test and eight in the visual confusion test. In addition, configuration (layout) tests were performed in seven countries.

The countries participating in the auditory confusion test were: Australia, Denmark, Finland, Federal Republic of Germany, Japan, Sweden, United Kingdom (Post Office) and the United States of America(A.T.& T.).

The countries participating in the visual confusion test were: Canada, Denmark, Finland, Federal Republic of Germany, Italy, Sweden, United Kingdom (Post Office), and the United States of America (A.T. & T.).

The countries participating in the configuration (layout) tests were: Canada, Japan, Federal Republic of Germany (Siemens), Netherlands (PTT/IPO), Sweden, United Kingdom (Post Office), and the United States of America (A.T. &. T.).

The results of the configuration test showed a small decrement in the dialling performance with a 16 button set as compared to a standard 12 button set which, however, is not statistically significant. In this test, buttons 13 to 16 were labelled A, B, C and D.

The results of the three types of tests were examined together with considerations of other desirable properties of the symbol set, e.g.:

1. simplicity for the user;
2. a logical sequence;
3. ease of recognition in as many countries as possible;
4. possibility of extending the set of symbols.

It was agreed that the labels A, B, C and D were the most satisfactory from a general point of view.

ANNEX 2

(to Recommendation E.161/Q.11)

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; their classification when they have a three-digit code, being initially made on the basis of the first two digits.

" Territories " which have been given a country code, but the telecommunications of which come under the international jurisdiction of other States, are normally arranged in the order in which they come in the code list of the relevant 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.

Note 1.—This list is reproduced in the Plan Book of the World Plan Committee which is responsible for keeping it up to date.

Note 2.—" 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 is responsible.

REVISED LIST OF COUNTRY CODES INCORPORATING AMENDMENTS AGREED UPON BY THE WORLD PLAN COMMITTEE, MEXICO CITY 1967; VENICE 1971

World numbering ZONE 1

(Integrated country codes)

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

World numbering ZONE 2

Egypt (Arab Republic of)	20	Congo (People's Rep. of the)	242
Morocco (Kingdom of)	21 [a]	Zaïre (Rep. of)	243
Algeria (Algerian Dem. and Pop. Rep.)	21 [a]	Angola (3)	244
Tunisia	21 [a]	Portuguese Guinea (3)	245
Libyan Arab Republic	21 [a]	Sudan (Democratic Republic of the)	249
Gambia	220	Rwanda (Republic of)	250
Senegal (Republic of the)	221	Ethiopia	251
Mauritania (Islamic Republic of)	222	Somali Democratic Republic	252
Mali (Republic of)	223	Afars and Issas (Fr. Ter.) (1)	253
Guinea (Republic of)	224	Kenya	254
Ivory Coast (Republic of the)	225	Tanzania (United Rep. of) (mainland)	255
Upper Volta (Republic of)	226	Uganda	256
Niger (Republic of the)	227	Burundi (Republic of)	257
Togolese Republic	228	Mozambique (3)	258
Dahomey (Republic of)	229	Zanzibar (Tanzania)	259
Mauritius	230	Zambia (Republic of)	260
Liberia (Republic of)	231	Malagasy Republic	261
Sierra Leone	232	Reunion (France)	262
Ghana	233	Rhodesia	263
Nigeria (Fed. Rep. of)	234	Territory of South-West Africa	264
Chad (Republic of the)	235	Malawi	265
Central African Republic	236	Lesotho (Kingdom of)	266
Cameroon (United Rep. of)	237	Botswana (Republic of)	267
Cape Verde Islands (3)	238	Swaziland (Kingdom of)	268
St. Thome and Principe (3)	239	Comoro Islands (1)	269
Equatorial Guinea (Republic of)	240	South Africa (Republic of)	27
Gabon Republic	241		

Spare codes 28, 29, 246, 247, 248

[a] *Subdivisions of the integrated country codes*

— Algeria: 213, 214 and 215;
— Libyan Arab Republic: 218 and 219;
— Morocco: 210; 211 and 212 (212 in service);
— Tunisia: 216 and 217.

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	Germany (Federal Republic of)	49
Hungarian People's Republic	36	Gibraltar (5)	350
German Democratic Republic	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

World numbering ZONE 5

Honduras (British) (5)	501	Chile	56
Guatemala	502	Colombia (Republic of)	57
El Salvador (Republic of)	503	Venezuela (Republic of)	58
Honduras (Republic of)	504	Bolivia	591
Nicaragua	505	Guyana	592
Costa Rica	506	Ecuador	593
Panama	507	French Guiana (France)	594
Peru	51	Paraguay	595
Mexico	52	Surinam (Netherlands)	597
Cuba	53	Uruguay (Oriental Republic of)	598
Argentine Republic	54	Netherlands Antilles (Netherlands)	599
Brazil	55		

Spare codes 500, 508, 509, 590, 596

World numbering ZONE 6

Malaysia	60	Papua New Guinea (Australia)	675
Australia (Commonwealth of)	61	Tonga	676
Indonesia (Republic of)	62	Solomon Islands (5)	677
Philippines (Republic of the)	63	New Hebrides (5)	678
New Zealand	64	Fiji	679
Singapore	65	Wallis and Futuna (1)	681
Thailand	66	American Samoa (4)	684
Guam and Trust Territory of the Pacific Islands (4)	671	Gilbert and Ellice Islands (5)	686
		New Caledonia (1)	687
Portuguese Timor (3)	672	French Polynesia (1)	689

Spare codes 69, 670, 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	Khmer Republic	855
Viet-Nam (Republic of)	84	Laos (Kingdom of)	856
Hongkong (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 Arab Republic	967
Pakistan	92	[a]	968[a]
Afghanistan	93	Yemen (People's Dem. Rep. of) (Aden)	969
Sri Lanka (Ceylon)	94	[a]	971[a]
Burma (Union of)	95	Israel (State of)	972
Lebanon	961	[b]	973[b]
Jordan (Hashemite Kingdom of)	962	[a]	974[a]
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			

[a] See I.T.U. notifications 992, 995 and 998.

[b] It is pointed out that the use of the code 973 has been the subject of bilateral agreements published in I.T.U. notifications 984, 990 and 992.

Volume II-A | **Volume VI**

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*[1].

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.

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

[1] The use of rerouting is not envisaged in the International Routing Plan.

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.

(See Annex 1 for some brief explanatory notes on the International Routing Plan.)

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 its 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.

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).

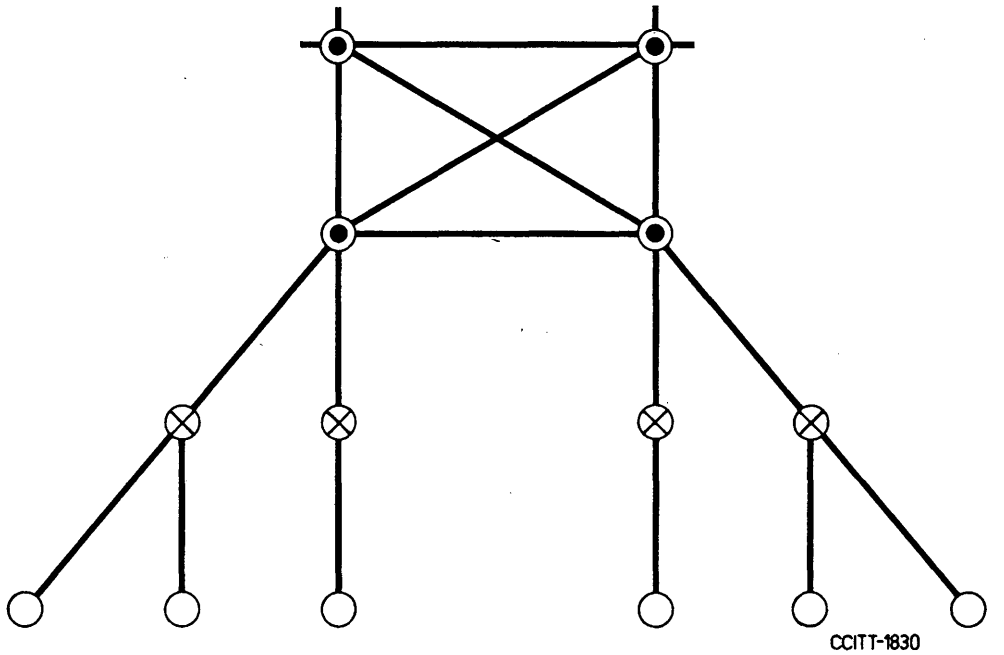

FIGURE 1/E.171/Q.13. — **Theoretical final route structure (backbone structure) of the international telephone network.**

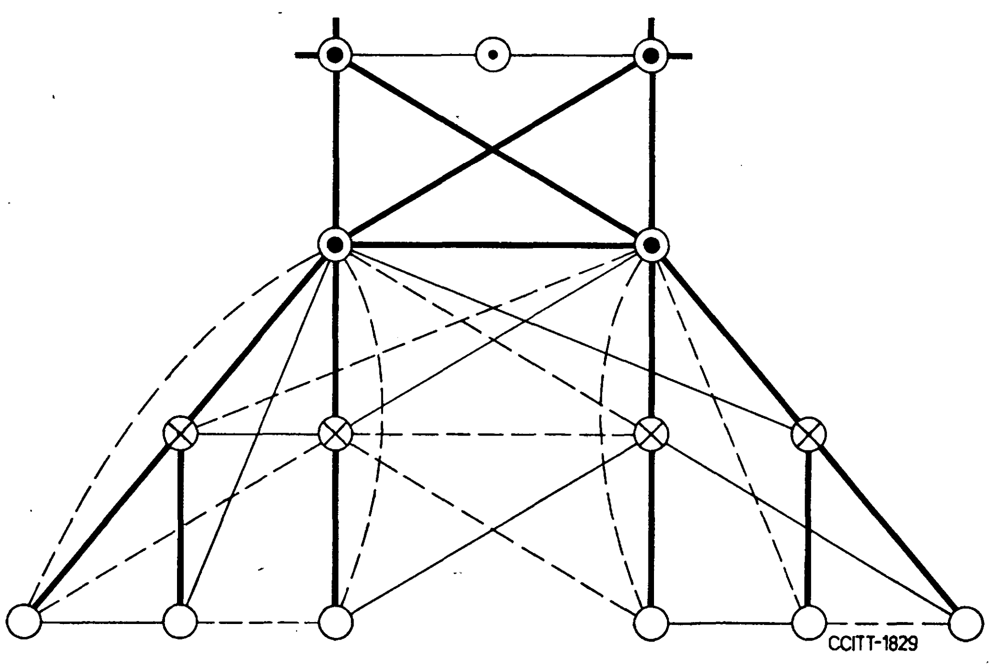

FIGURE 2/E.171/Q.13. — **Example of actual structure of the international telephone network.**

◉	CT1 = First category transit centre	▬▬	Theoretical final route
⊗	CT2 = Second category transit centre	——	Actual final route (low loss probability circuit group)
○	CT3 = Third category transit centre		
⊙	CTX = (CT of unspecified category)	— — —	High-usage route (high-usage circuit group)

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/E.171/Q.13.

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 six 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 six.

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 five 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 six 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. However, the transmission delay associated with such circuits, taken in conjunction with the acceptable limits specified in Recommendation Q.41[1] 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.

[1] 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.

4.2.2 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.

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.

4.4 *Use of demand assignment*

4.4.1 A demand assigned circuit (e.g. SPADE; see Annex 2 for detailed description) includes three signalling links[1]). These are:

a) from the outgoing CT to the earth station;

b) between earth stations;

c) from an earth station to an incoming CT.;

Information relating to the use of standardized C.C.I.T.T. signalling systems for a or c is given in Recommendation Q.7.

4.4.2 To route via a demand assignment system, the outgoing CT is governed in its operation by its ability to utilize congestion information.

1) When congestion information from the demand assignment system can be utilized by the outgoing CT, then normal routing rules apply.

2) When congestion information cannot be utilized, the outgoing CT can route calls only as programmed. When calls are routed into the demand assignment system in this manner, two possibilities are recommended:

a) dimension all access and satellite links in the demand assignment system on the final probability basis; and/or

b) arrange for alternative routing and/or internal rerouting within the demand assignment system in accordance with arrangements agreed upon by the Administrations involved. [2]

[1] According to the provisional agreement of C.C.I.T.T., for transmission planning purposes the whole speech path between two CTs via the two access links and the satellite link is considered equivalent to a single circuit. A change in this provisional agreement may influence the provisions of Section 4.4 of Recommendation Q.13.

[2] See Recommendation Q.48 (figure and text) for detailed description of these arrangements for alternate routing and internal rerouting.

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 3a and 3b 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 3c and 3d from CT A to CT B.

5.2.6 Calls may be routed over direct or traverse 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 3e 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 3f illustrates this rule, which applies to both traffic flow directions.

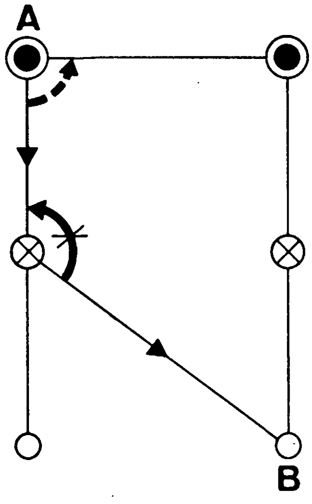

Figure a.—See 5.2.4.

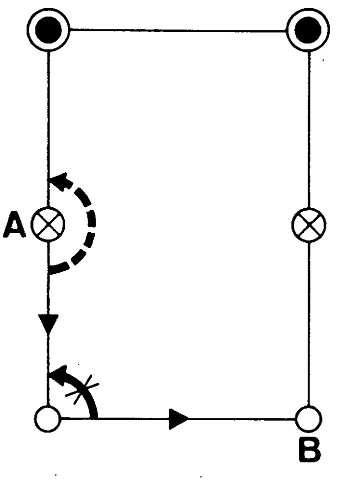

Figure b.—See 5.2.4.

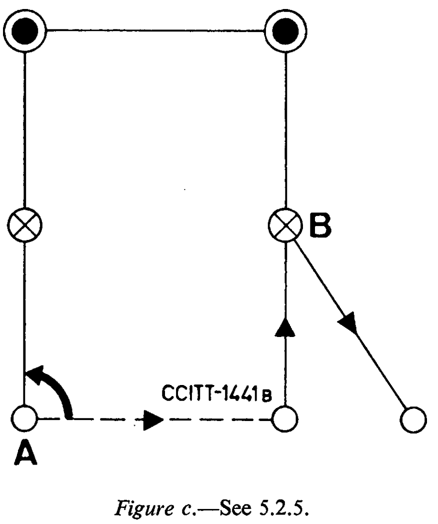

Figure c.—See 5.2.5.

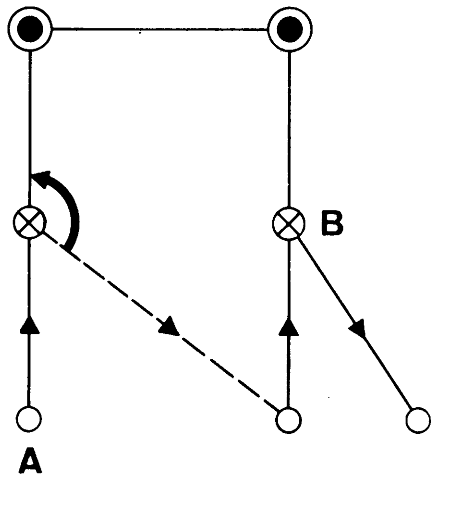

Figure d.—5.2.5.

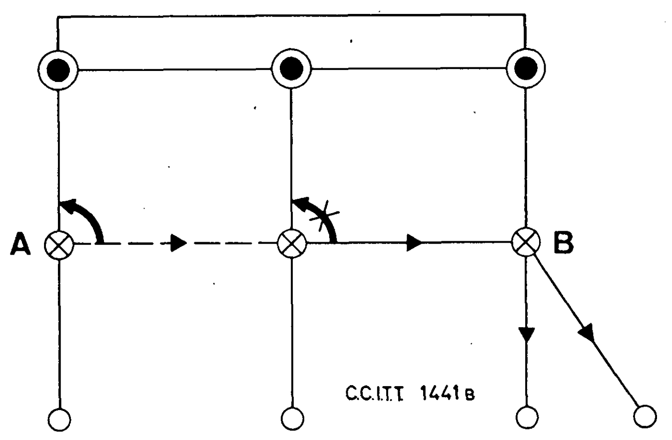

Figure e. — See 5.2.6.

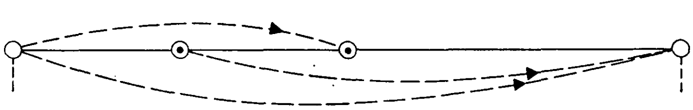

Figure f. — See 5.2.7.

FIGURE 3/E.171/Q.13. — **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 circuitgroup)

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

Overflow

Possible overflow

Overflow not allowed

ANNEX 1
(to Recommendation E.171/Q.13)

Explanatory notes on the routing plan

The following explanatory notes on the routing plan are provided as a basis for general familiarity with the plan for conditions which do not require a detailed knowledge of the complete Recommendation E.171/Q.13.

1. The designation of CTs, as CT1, CT2 or CT3, indicates the magnitude of functional requirements, and the routing arrangements for orderly procedures and economic network operation. It does not imply seniority of status of CTs.

2. Each CT, whether a CT1, CT2 or CT3, interconnects the national network (or part of it) and international circuits. Each CT thus performs a CT3 function.

3. While a CT1 may function as a CT3, in addition, a CT1 also routes the relevant concentrated traffic to and from the CT2s directly connected to that CT1. Similarly, while a CT2 may function as a CT3, in addition a CT2 also routes the relevant concentrated traffic to and from the CT3s directly connected to that CT2. These requirements arise in order to carry out the transit switching of international circuits according to the theoretical final routing structure of the plan.

4. A centre is designated by the most involved function it performs.

A CT1 is more costly than a CT2 or a CT3 because of the equipment to interconnect directly with all other CT1s by means of expensive low loss probability circuit groups and thus because of the greater number of circuits required for the transit switching of traffic. This has the consequences of greater:

- maintenance requirement;
- number of signalling equipments;
- interworking problems (e.g. between different signalling systems);
- accounting problems.

A CT2 is more costly than a CT3 because of the relatively greater number of circuits required. The consequences stated above for a CT1 also arise in a CT2 to a relative degree.

5. The size of each centre is determined by the volume of international traffic and by the number of circuits between that country and others.

As much traffic as economically possible is routed over direct circuits to destination countries, such direct circuits may be:

- high usage, which necessitates overflow to the low loss probability network; or
- low loss probability, in which case overflow does not apply.

As an alternative to direct circuits, traffic which can be more economically combined at an intermediate transit exchange is directed along the low loss probability final route. Overflow from the final route does not apply.

6. The routing plan takes account of the need for it to develop independently of the numbering plan and the rules for charging and accounting. This independence promotes freedom for evolution of all such associated plans by reducing the complexity of necessary coordination. Nevertheless, it should be recognized that some mutual interactions exist among these plan(s) and rules and this should be kept in mind.

ANNEX 2
(to Recommendation E.171/Q.13)

Single channel per carrier PCM multiple access demand assignment equipment (SPADE) system

The SPADE system is a single channel per carrier system employing PCM-4 phase-PSK modulation which has been developed for operation on the INTELSAT satellite communication system.

A chosen satellite RF band of 36 MHz is divided to form a " pool " of individual frequencies on the basis of assigning a single voice channel to each RF carrier.

The system is fully variable allowing any pair of channels to be selected on demand by any of a maximum of 49 stations in the network to form circuits in a demand assignment pool of approximately 400 circuits. Each station terminal uses a demand assignment signalling and switching unit (DASS) for the assignment of channels based on continually updated channel allocation status data provided via a common signalling channel (CSC). Consequently, the system does not require to be controlled by a central station.

In addition the DASS performs the necessary interface functions between the SPADE signalling system and the particular international signalling systems used by the countries concerned.

The signalling aspects of the SPADE system have been designed in accordance with Recommendation Q.48.

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 [1]

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.

The reference to " the busy hour " in Section 1 of this Recommendation is to indicate that the limit (of −15 dBm0) applies when transmission systems and telephone exchanges are at their busiest so that the various factors concerning occupancy and activity of the various services and signals are to be those appropriate to such busy conditions.

It is not intended to suggest that an integrating period of one hour may be used in the specification of the signals emitted by individual devices connected to transmission systems. This could lead to insupportably high short-term power levels being permitted which give rise to interference for durations of significance to telephony and other services.

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.

[1] This Recommendation is, basically, an extract of Recommendation G.223 in Series G (Line transmission, Volume III of the *Green Book*) of the C.C.I.T.T. Recommendations.

Hence, the maximum *energy* which may be transmitted by all the signals and tones [1] during the busy hour is:

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

Note 2.—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/C was therefore set for study during the 1968-1972 study period to deal with all aspects of the problem.

At this point in time there is not sufficiently firm information to justify an alteration to the value of the *conventional* load per channel of −15 dBm0 (32 μWO) long-term mean, currently recommended.

Indeed the steps envisaged by Administrations to control and reduce the levels of non-speech signals indicate that the situation could be contained despite the increase in the non-speech services.

The economic aspects of changing (in particular increasing) the conventional load per channel would need to be thoroughly investigated before a change could be recommended.

Nevertheless there are sufficient indications that the study of all relevant factors must continue. Accordingly, the question has been retained.

As regards the subdivision of the 32 μW into 10 μW signalling and tones and 22 μW speech and echo, carrier leaks, and telegraphy, again there is no evidence which would justify proposals to alter this subdivision.

As a general principle, it should always be the objective of Administrations to ensure that the *actual* load carried by transmission systems does not significantly differ from the *conventional* load assumed in the design of such systems.

[1] See Supplement No. 1 in the documentary part of Volume VI for a calculation of the energy transmitted for the national tones and signals.

Recommendation Q.16 [1]

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 channels filters.

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

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

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 necesarry 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 II-A and II-B 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 Zürich 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 nonetheless 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.

The allocation of frequencies to the various digits and symbols of a push-button set appears in Figure 1/Q.23.

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

7.1 each transmitted frequency must be within $\pm$ 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).

High group frequencies (Hz)

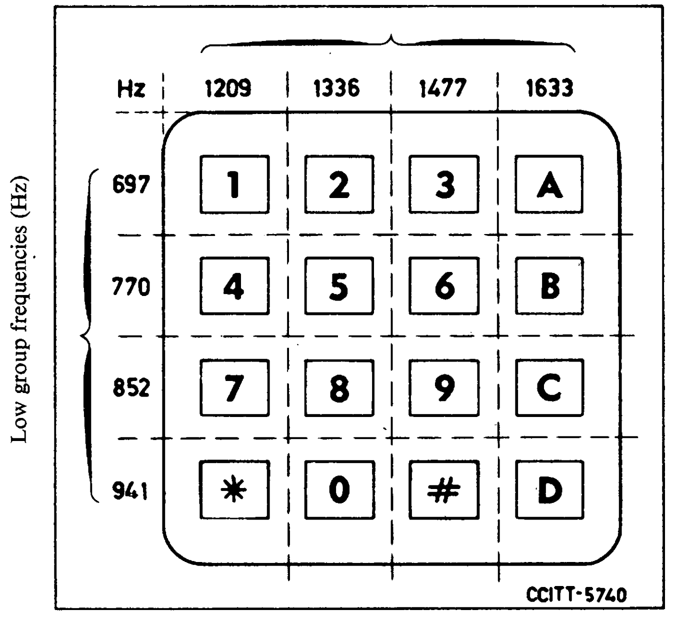

FIGURE 1/Q.23 — **Allocation of frequencies to the various digits and symbols of a push-button set.**

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 3.4.1 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 3.4.1 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.202;)

— measuring the call duration (see Recommendation Q.51).

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 [1]. 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:

1) power supply noise,

2) noise generated in the speech path circuit,

3) noise induced in the speech path circuit.

[1] 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 nternal impedance).

1.2 *Supply leads*

The interference in the speech circuits if 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, spring 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 of 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/Q.32, 2/Q.32 and 3/Q.32.

FIGURES 1/Q.32, 2/Q.32 and 3/Q.32. — **POSSIBLE METHODS FOR REDUCING THE RISK OF INSTABILITY**

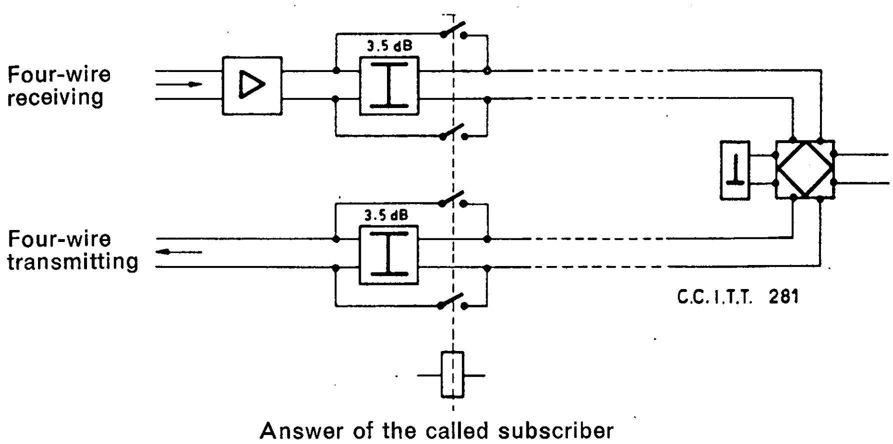

FIGURE 1/Q.32. — *Method a:* **Inserting an attenuator in each channel of the four-wire chain of the connection.**

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

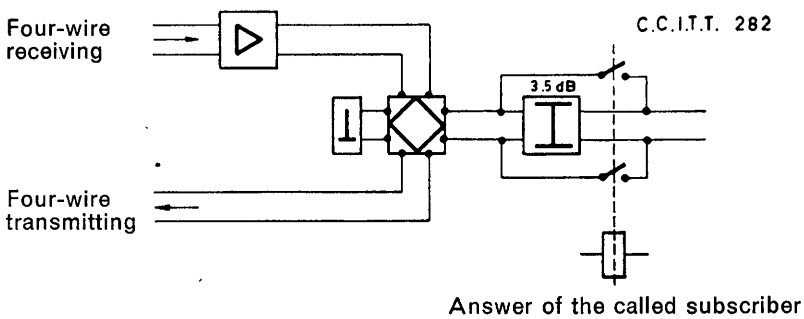

FIGURE 2/Q.32. — *Method b:* **Inserting an attenuator in the two-wire extension of the connection.**

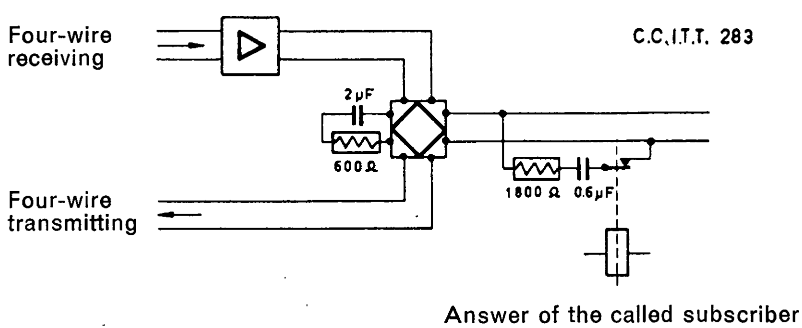

FIGURE 3/Q.32. — *Method c:* **Bridging a terminating impedance across the two-wire extension of the connection.**

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 *Green Book*, Volume III, it is considered sufficient to arrange for the stability [1] of the four-wire 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.

Recommendation Q.33

PROTECTION AGAINST THE EFFECTS OF FAULTY TRANSMISSION ON GROUPS OF CIRCUITS

Although certain signalling systems may have the capability to provide an indication when an individual circuit is faulty, in order to maintain the required availability of the public network, it is considered necessary to provide alarm facilities to alert maintenance staff when a group of circuits provided by multiplex transmission system is faulty.

It is considered desirable if the faulty circuits could be removed from service automatically and restored to service automatically when the fault condition no longer exists.

Failure of an FDM system can possibly be indicated by means of pilot supervision.

Failure of a PCM system is indicated at both ends by the loss of frame alignment (or multiframe alignment as appropriate); see Recommendations Q.46 and Q.47.

These failure indicators provide the means whereby the circuits affected can be removed from service and restored automatically by the switching control of an international exchange.

[1] 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.

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Volume II-A | **Volume VI**

PART I | PART II

CHAPTER VI | 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. [2]

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.

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

[2] Recommendation E.181 specifies the information which could be given to subscribers to facilitate recognition of foreign ringing and busy tones.

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/E.180 and Q.35 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).

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.

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

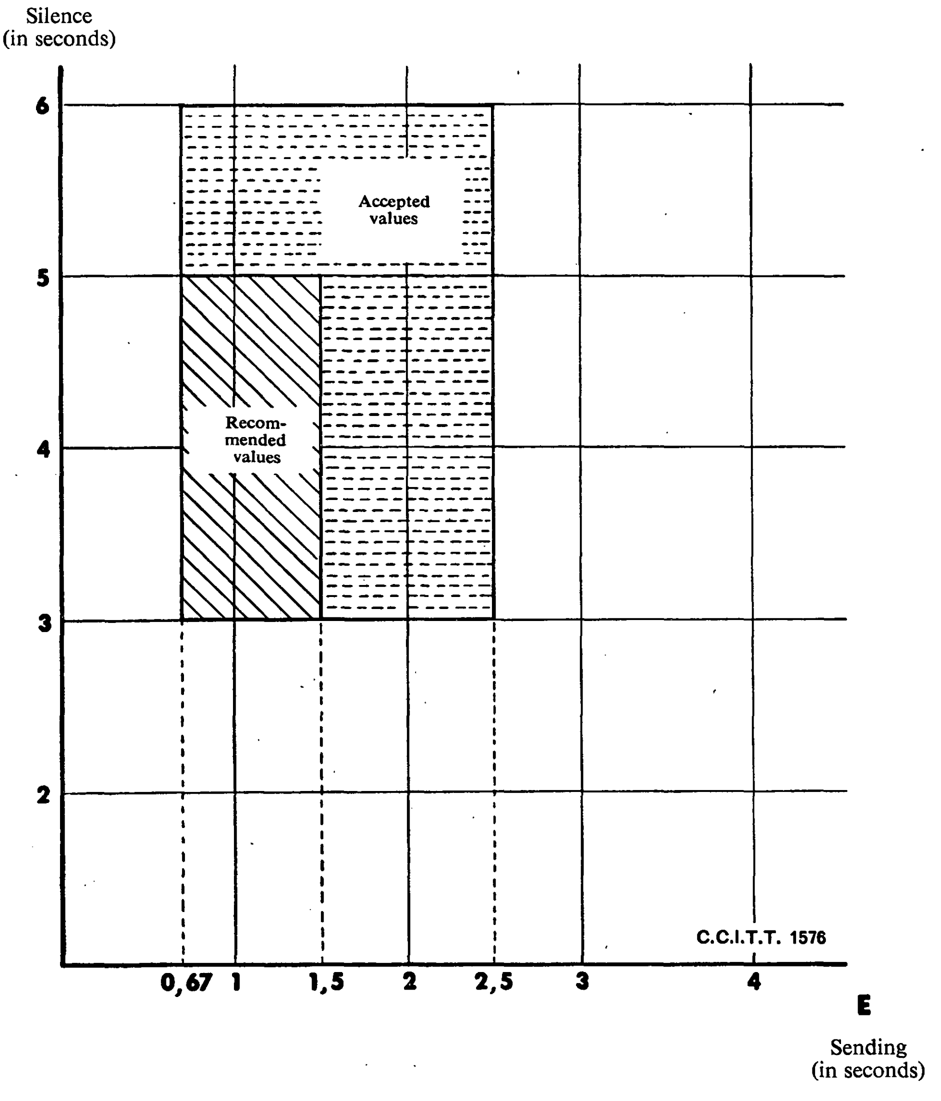

FIGURE 1/E.180/Q.35. — **Ringing tone.**

Frequency:

— recommended interval: 400-450 Hz

— accepted interval: 340-500 Hz

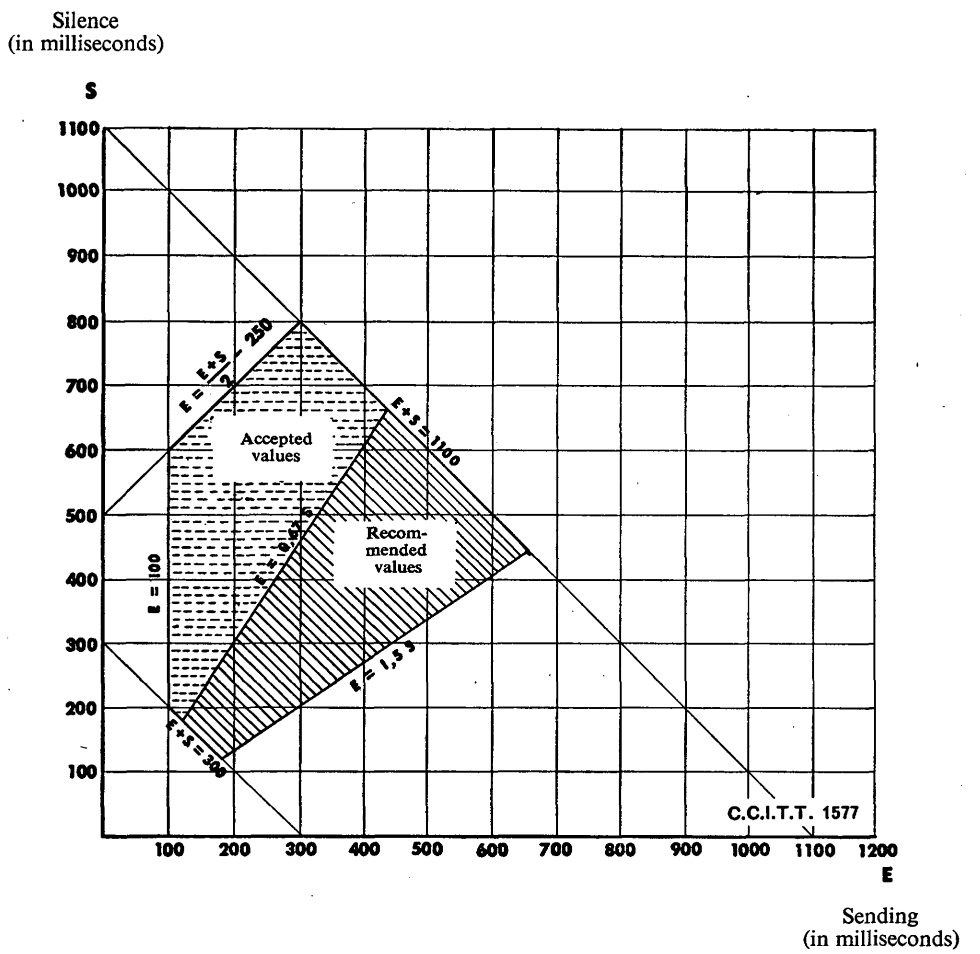

FIGURE 2/E.180/Q.35. — **(Subscriber) busy tone and (equipment or circuit group) congestion tone.**

Frequency:

— recommended interval: 400-450 Hz

— accepted interval: 340-500 Hz

Figure 2/E.180 and Q.35 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;

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 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:

$$950 \pm 50 \text{ Hz}; \quad 1400 \pm 50 \text{ Hz}; \quad 1800 \pm 50 \text{ Hz},$$

sent in that order.

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

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 sseconds 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.

CHAPTER VI

General characteristics for international telephone connections and international telephone circuits

1.0 *General*

Recommendation Q.40 [1]

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. *Green 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/Q.40.

— *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 terminal exchanges and to the subscribers.

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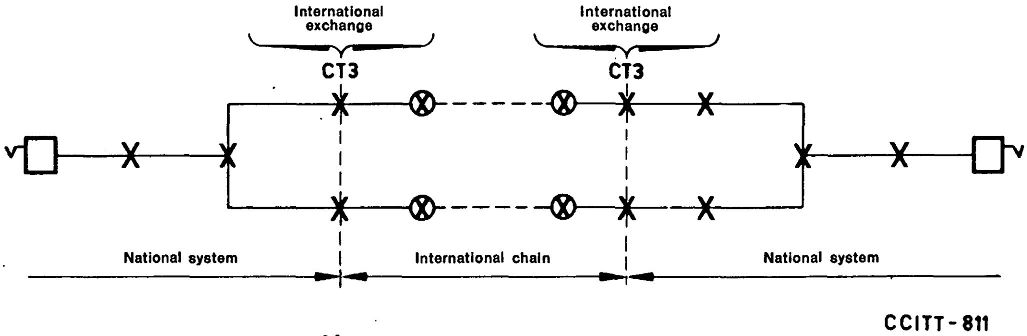
[1] This Recommendation is an extract of Recommendation G.101 in series G (Line transmission, Volume III of the *Green Book*) of the C.C.I.T.T. Recommendations.

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



X Switching exchange

⊗ International transit centre (CT1 and CT2)

FIGURE 1/Q.40. — **Definition of the constituent parts of an international connection.**

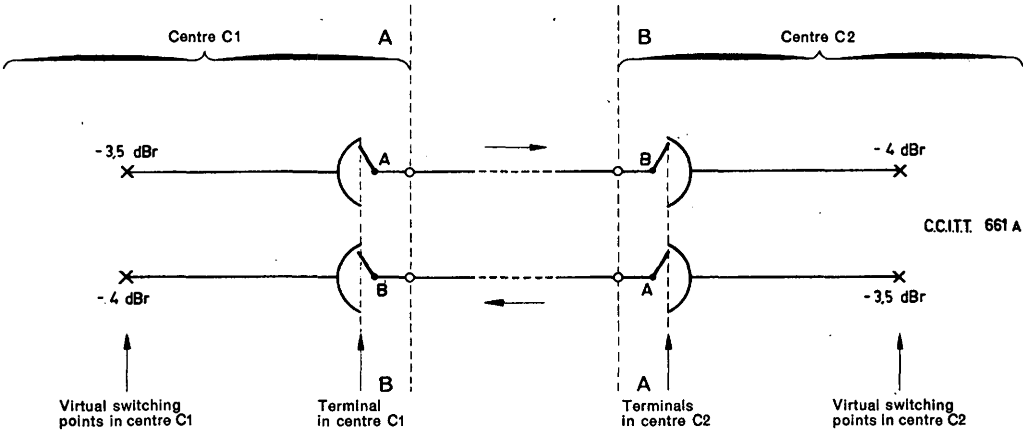


FIGURE 2/Q.40. — **Definitions for an international circuit.**

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/Q.40; 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 1000 km or, exceptionally, 1500 km, the country concerned is considered as of average size. In such countries, in most cases, not more than three national circuits are interconnected on a four-wire basis between each other and to international circuits. These circuits should comply with the recommendations of paragraph 1.2 of Recommendation G.141, *Green 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, *Green Book*, Volume III).

Note.—The abbreviation " a four-wire chain " (see Figure 3/Q.40) 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, all of which may 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 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, *Green 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,

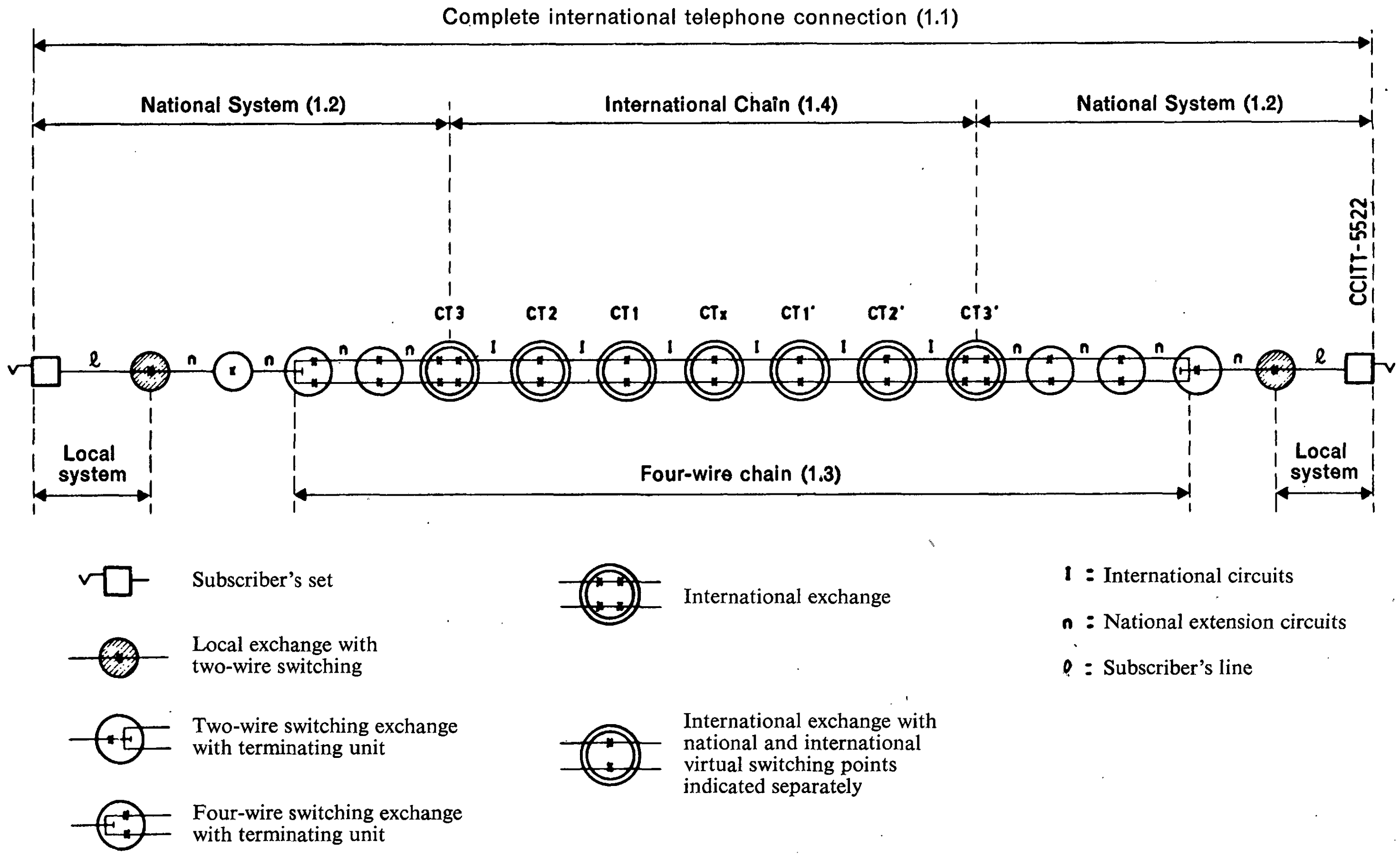


FIGURE 3/Q.40. — **An international connection to illustrate the nomenclature adopted.**

Note.—The arrangements shown for the national systems are examples only. The numbers given in brackets refer to the sub-section of Section 1 (of Volume III, part 1) in which recommendations may be found relevant to that part of the connection. In addition, the circuits making up this chain must individually meet the requirements of sub-section 1.5.

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/Q.40. Certain exceptional routings, moreover, involve a seventh international circuit.

c) *Hypothetical reference connections*

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

1.1 *General characteristics of a complete international telephone connection*

Recommendation Q.41 [1]

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 *Green Book*).

The C.C.I.T.T. therefore *recommends* the following limitations on mean one-way propagation times [2] 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.

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*

. . . .

[1] This Recommendation is an extract of Recommendation G.114 in series G (Line transmission, Volume III of the *Green 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.

[2] Means of the times in the two directions of transmission.

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)

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 14 000 km altitude	110 ms
Satellite at 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 4.

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, *Green 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 [1]

STABILITY AND ECHO (ECHO SUPPRESSORS) [2]

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*

. . . .

b) *Echo suppressors*

The preferred type of echo suppressor is a terminal, differential, half-echo suppressor operated from the far end [3]. 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, *Green Book*, Volume III. The characteristics of the short delay echo suppressor are given in the *Blue Book*, Volume III, Recommendation G.161, B.

[1] This Recommendation is an extract of Recommendation G.131 in Series G (Line transmission, Volume III of the *Green 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.

[2] See also Recommendation Q.115.

[3] Definitions of Recommendation G.161 (Volume III of the *Green 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.

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).

Compatibility with signalling systems for the switched telephone service is ensured by Recommendation Q.115.

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.

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.

However, each half echo-suppressor should be located sufficiently near to the respective subscribers for the end delays not to exceed the maximum value recommended in Recommendation G.161 B.b. For countries of average size, this will normally mean that the originating and terminating half-echo suppressors will be in the countries of origin and destination of the call.

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

[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.

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.

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.)

Where a terminating international exchange is accessible from an originating international exchange by more than one route, and:

a) at least one route requires echo suppressors, and at least one route does not; and

b) the originating exchange is unable to determine which route is to be used,
echo suppressors should be connected in all cases.

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 [1].

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

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

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

[2] See Annex 3 to Question 2/XI, studied in 1965-1968 (pages 295 to 297, *Blue Book*, Volume VI).

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. Where method 1 above is used, due regard must be paid to the last sentence of section B.a above. Methods of achieving the required reduction of circuit losses are under study by the C.C.I.T.T. 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 [1]

TRANSMISSION LOSSES, RELATIVE LEVELS

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.

Note 1.—See the definitions in section 2. The position of the virtual switching points is shown in Figure 2 of Recommendation Q.40 and in Figure 1 in Recommendation G.122.

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.

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.

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

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 (Q.15).

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*

The C.C.I.T.T. 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. Interconnection 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.

Recommendation Q.44 [1]

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, *Green 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

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

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 specification 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.

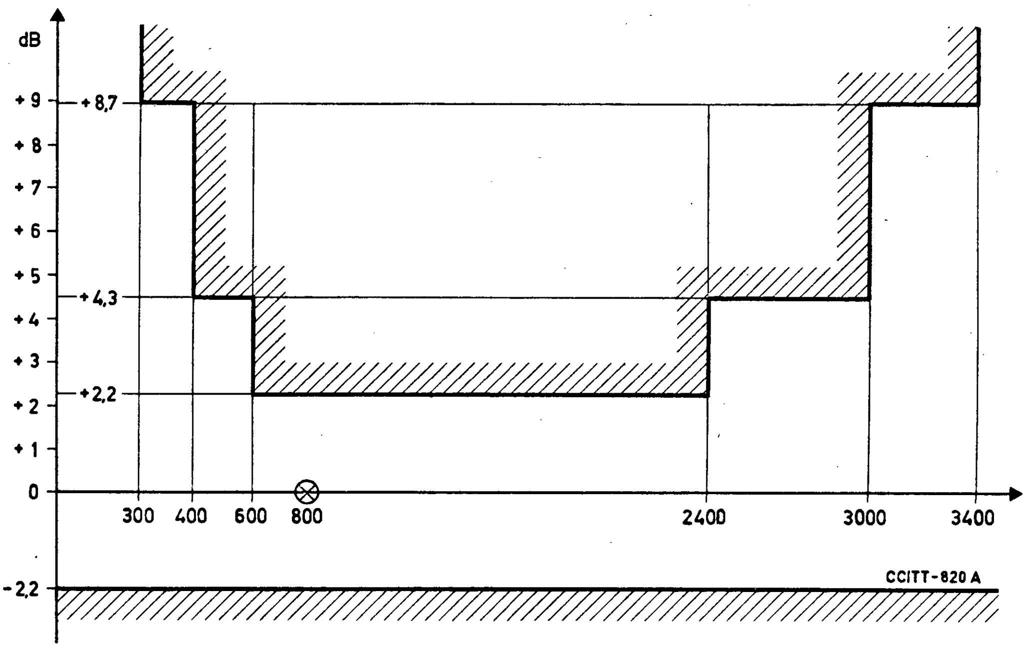


FIGURE 1/Q.44. — Diagram No. 1 of Volume III. — **Permissible attenuation variation with respect to its value measured at 800 Hz(objective for world-wide chain of 12 circuits in terminal service).**

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/Q.45).

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).

A connection through the international exchange is shown by 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.

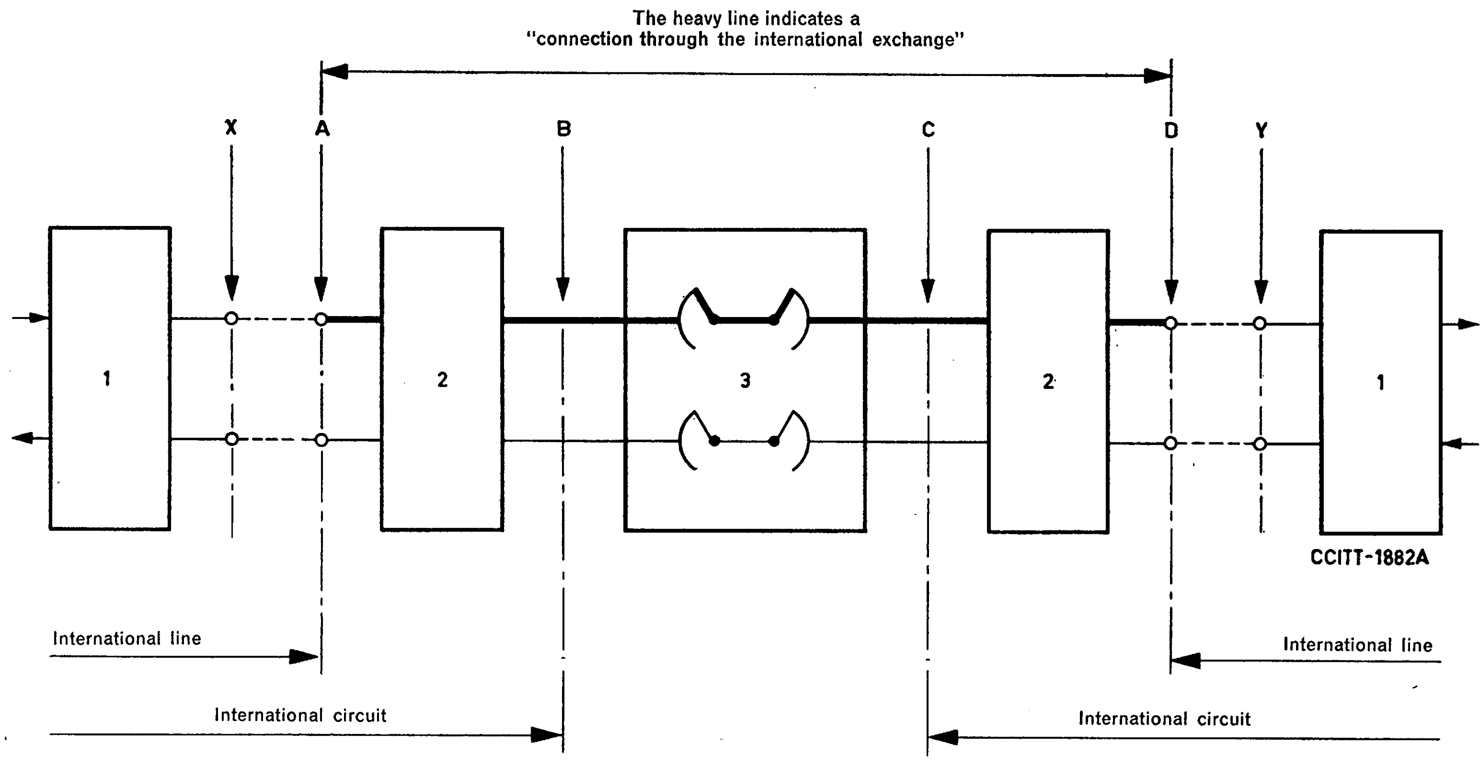
The switching equipment input point associated with a receive channel may be such that the nominal relative level is different from -4.0 dBr. Let this nominal relative level be R [1].

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 [1].

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 $R-S+T$.

[1] 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.



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/Q.45.

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*

Ideally, the net switching loss of an international exchange would always 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/Q.45.

In this arrangement:

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

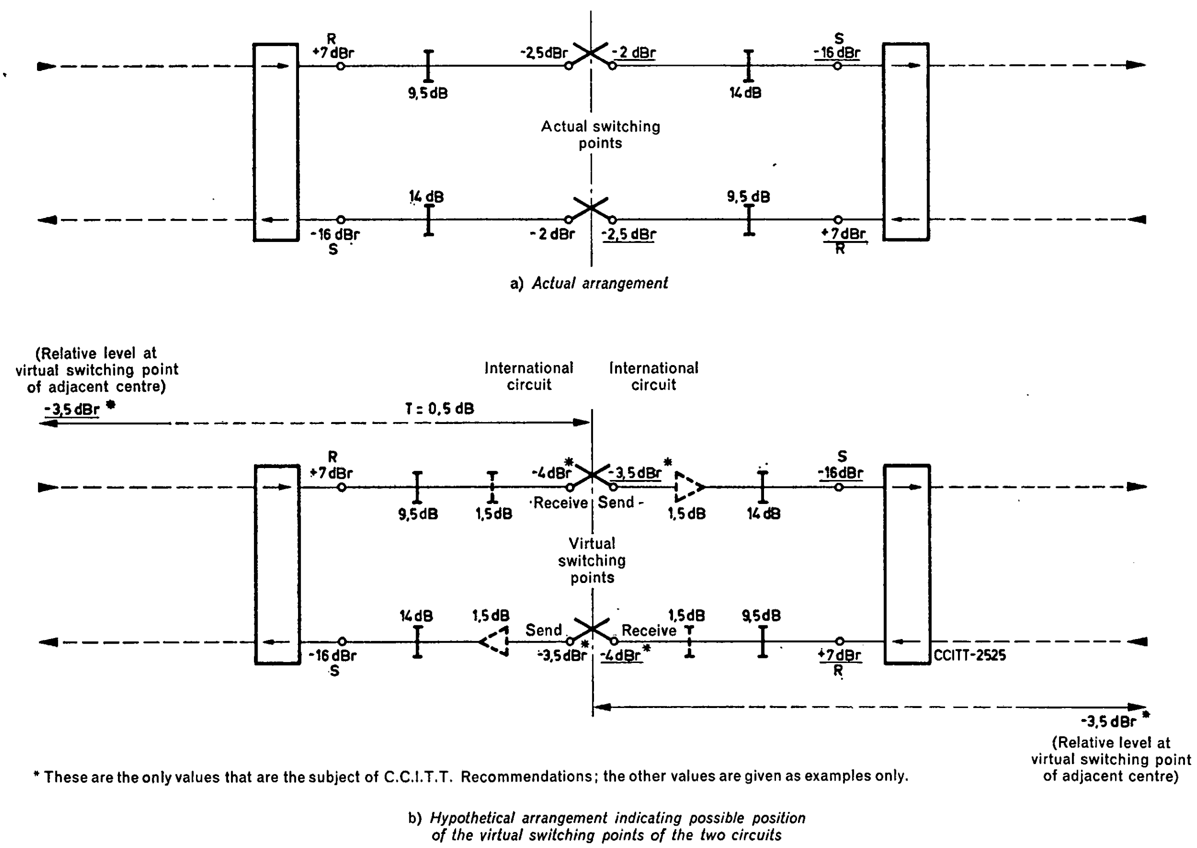


FIGURE 2/Q.45. — **Example showing a simplified representation of a transit connection in an international exchange with actual arrangement and possible location of virtual switching points.**

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:

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

In practice, different connections established by the switching equipment will introduce different values of net switching loss so that a distribution of net switching losses will arise. The mean value of this distribution should be very close to zero but does not need to be specified.

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/Q.45). 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. For purposes of calculation a value of 0.2 dB may be assumed.

In order to conform to this value, it is considered sufficient that, for purposes of design and acceptance testing, the difference between the losses at 800 Hz of the shortest and longest paths from point B to point C in no case exceeds 0.8 dB. For a practical assessment of the average value of net switching loss, the contribution from the switchblock can be taken as the mean of the maximum and minimum values of loss between points B and C.

These values apply for connections routed directly, and once only, through the switchblock. Due to the fact that the switchblock contains only switches and associated cabling, the actual loss between points B and C in any case can only have positive values.

If special re-entrant trunking arrangements are used, requiring the connection to pass through the switchblock twice (this may be a convenient way to extend the availability of the switching network or to introduce additional equipment, e.g. echo suppressors), the maximum loss and loss dispersion will be increased. In view of this, the re-entrant technique should not be used to such an extent as to increase significantly the mean net switching loss of the exchange.

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 [1] 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

[1] 1000 Hz is an acceptable alternative reference frequency.

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 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.

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 mean *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).

Note.—The busy-hour is defined in the I.T.U. list of terms, term 17.47.

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 *Impulsive noise*

In any four-wire international exchange, the busy-hour mean impulsive noise counts should not exceed five counts in 5 minutes at a threshold level of −35 dBm0.

Figure 3/Q.45 shows the maximum number of impulsive noise counts acceptable on a 5 minute period.

Annex 1 (to Recommendation Q.45) describes the procedure to be followed for impulsive noise measurements.

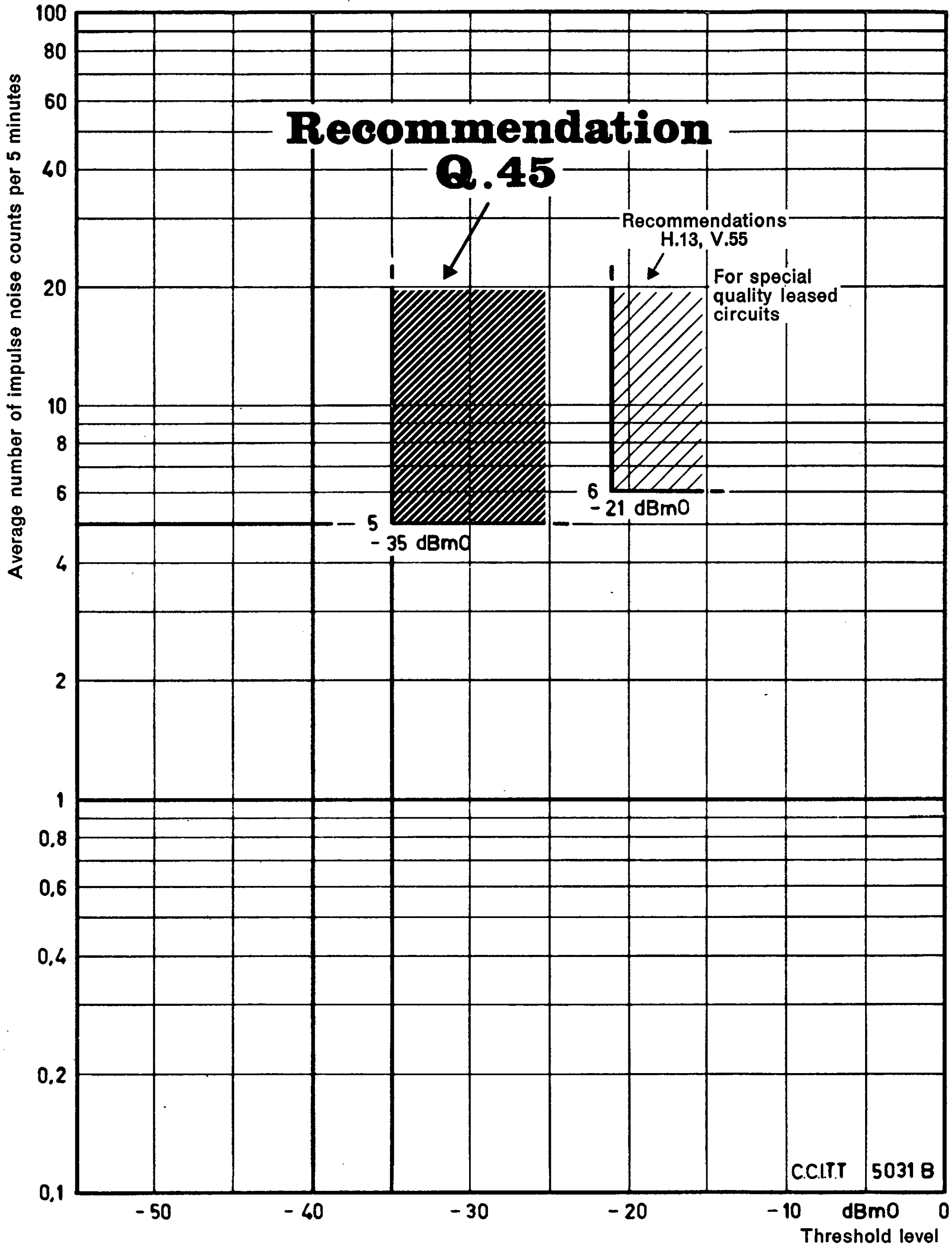


FIGURE 3/Q.45. — **Impulsive noise requirements for four-wire exchanges.**

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 multifrequency 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.

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 u/U measured as shown on Figure 4a/Q.45 or Figure 4b/Q.45 and is expressed in decibels as the reciprocal of this ratio in transmission units.

The diagrams of Figures 4a and 4b 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 4a or Figure 4b 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 4a and Figure 4b.

7. 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.

FIGURE 4a and 4b/Q.45. — **MEASUREMENT OF THE DEGREE OF UNBALANCE TO EARTH**

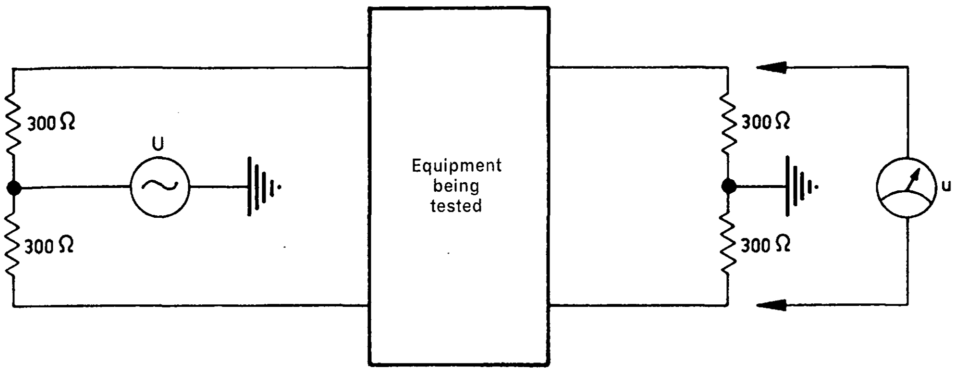


FIGURE 4a/Q.45.

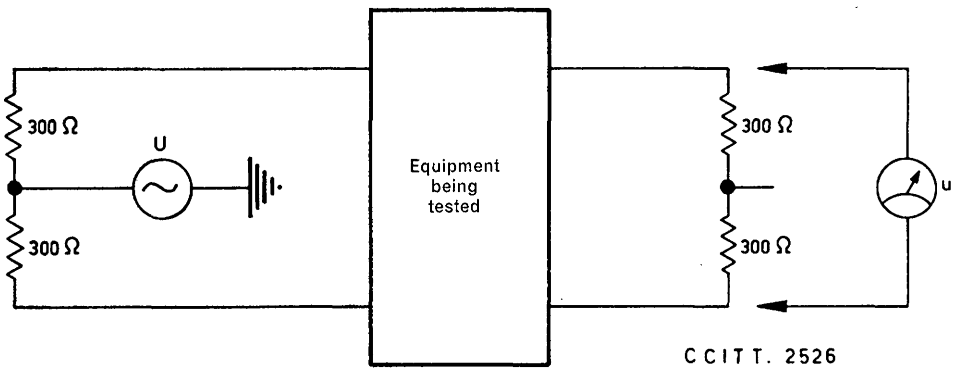


FIGURE 4b/Q.45.

ANNEX

(to Recommendation Q.45, point 5.3)

Procedure for impulsive noise measurements

1. A test circuit should be formed by setting up a connection across the switching unit and terminating the connection on one side of the exchange by the appropriate closing impedance and on the other by the impulse measuring device in parallel to the closing impedance. Those terminating points should be points A and D in the diagram of Figure 1/Q.45 (or equivalent points) to include the switching equipment of the exchange. Where it is the desire of an Administration, measurements may be made at points X and Y if precautions are taken to ensure that the results apply only to the automatic switching equipment, signalling equipment, echo suppressors, relay sets, pads and cabling of the exchange.

2. The measurements should be made using the device specified in Recommendation H.13 (V. 55). The 600-3000 Hz filter network described in paragraph h of Recommendation H.13 (V.55) should be in the circuit.

3. The measurements should be made at times when the probability of noise occurring is at its highest.

4. The time of observation for each test should be five minutes.

Note.—The number of different test circuits set up across the exchange for measuring should take into account the size and complexity of the switching unit and should be a number sufficient to represent the various possible types of calls and routes through the exchange.

See also Supplement 7 (Measurements of impulsive noise in a four-wire telephone exchange) in the documentary part of this Volume.

Volume III | **Volume VI**

SECTION 7 | FIRST PART

CHAPTER VII

PCM multiplex equipment and utilization of C.C.I.T.T. signalling systems on PCM links

Introduction

Two primary PCM multiplex equipments are recommended by the C.C.I.T.T., viz:

- a primary PCM multiplex equipment operating at 2048 kbit/s, which is described in Recommendation G.732; and
- a primary PCM multiplex equipment operating at 1544 kbit/s, which is described in Recommendation G.733.

Recommendations G.732 and G.733 are reproduced as Recommendations Q.46 and Q.47.

Recommendation G.732 (Geneva, 1972) — **Recommendation Q.46 (Geneva, 1972)**

CHARACTERISTICS OF PRIMARY PCM MULTIPLEX EQUIPMENT OPERATING AT 2048 KBIT/S

1. General characteristics

1.1 *Fundamental characteristics*

The encoding law used is the A-law as specified in Recommendation G.711. The sampling rate, load capacity and the code are also specified in that Recommendation.

The number of quantized values is 256.

Note.—The inversion of bits 2, 4, 6 and 8 is covered by the encoding law and is applicable only to voice channel time slots.

1.2 *Bit rate*

The nominal bit rate is 2048 kbit/s. The tolerance on this rate is $\pm$ 50 parts per million (ppm).

1.3 *Timing signal*

It should be possible to derive the transmitting timing signal of a PCM multiplex equipment from an internal source, from the incoming digital signal and also from an external source.

2. Frame structure

2.1 *Number of bits per channel time slot*

8, numbered from 1 to 8.

2.2 *Number of channel time slots per frame*

32, numbered from 0 to 31. The number of bits per frame is 256, and the frame repetition rate is 8000 Hz.

2.3 *Channel time slot assignment*

2.3.1 Channel time slots 1 to 15 and 17 to 31 are assigned to 30 telephone channels numbered from 1 to 30.

2.3.2 The allocation of the bits of channel time slot 0 is given in Table 1 below.

TABLE 1

ALLOCATION OF BITS IN CHANNEL TIME SLOT 0

	Bit number							
	1	2	3	4	5	6	7	8
Time slot 0 containing the frame alignment signal	Reserved for international use (Note 1)	0	0	1	1	0	1	1
		Frame alignment signal (see 2.4)						
Time slot 0 not containing the frame alignment signal	Reserved for international use (Note 1)	1 (see 2.4)	Transmission of international alarm (see 3.2)	Reserved for national use (Note 2)				

Note 1.—The use will be defined at a later stage. For the moment these bits are fixed at " 1 ".

Note 2.—The bits allocated for national use may not be used internationally. On the digital path crossing the border they are fixed at " 1 ".

2.3.3 Channel time slot 16 is assigned to signalling as covered in section 4. The use of this channel time slot for other purposes may be specified separately.

2.4 *Frame alignment signal*

As shown in Table 1 above, the frame alignment signal occupies positions 2 to 8 in channel time slot 0 of every other frame.

The frame alignment signal is:

0011011.

In order to avoid simulation of the frame alignment signal by bits 2 to 8 of channel time slot 0 in frames not containing the frame alignment signal, bit 2 in those channel time slots is fixed at 1.

2.5 *Loss and recovery of frame alignment*

Frame alignment will be assumed to have been lost when three or four consecutive frame alignment signals have been received with an error.

Frame alignment will be assumed to have been recovered when the following sequence is detected:

— for the first time, the presence of the correct frame alignment signal;

— the absence of the frame alignment signal in the following frame;

— for the second time, the presence of the correct frame alignment signal in the next frame.

Note.—To avoid the possibility of a state in which no frame alignment can be achieved due to the presence of an imitative frame alignment signal, the following procedure may be used:

When a valid frame alignment signal is detected in frame n, a check should be made to ensure that a frame alignment signal does not exist in frame n+1, and also that a frame alignment signal exists in frame n+2. Failure to meet one or both of these requirements should cause a new search to be initiated in frame n+2.

3. Fault conditions and consequent actions

3.1 The PCM multiplex equipment should detect the following fault conditions:

— loss of frame alignment;

— failure of codec (if codec monitor is provided);

— absence of received timing signal;

— failure of main power supply;

— frame alignment signal error rate.

When provided, monitoring of the codec should be arranged logically.

The detection of a failure of the received timing signal is required only when this fault does not result in an indication of either loss of frame alignment or failure of the codec.

3.2 *Loss of frame alignment or failure of codec*

When loss of frame alignment occurs or a codec failure is detected (or when the received timing signal is absent) at multiplex equipment A of a link A-B, the following action should be taken:

3.2.1 *At local end A:*

a) Provide a local alarm.

b) Suppress transmission on the telephone channels in the receive direction.

c) In those frames not containing the frame alignment signal, change bit 3 of channel time slot 0 from the state " 0 " to the state " 1 " in the direction of transmission A to B.

d) In the case of channel associated signalling, within a time of 6 ms apply the signalling condition corresponding to state " 1 " on the line to all the signalling channels received from multiplex equipment B.

e) In the case of common channel signalling indicate to the signalling equipment that loss of frame alignment or codec failure has occurred.

f) Indicate to the switching equipment that loss of frame alignment or codec failure has occurred so that circuits can be removed from service.

3.2.2 *At distant end B:*

When the condition mentioned in paragraph 3.2.1 c is received at distant end B, the following action should be taken:

a) Provide a local alarm, if required.

b) Indicate to the switching equipment that loss of frame alignment, or codec failure has occurred at local end A so that circuits can be removed from service.

3.3 *Failure of main power supply*

When a failure of the main power supply is detected the following action should be taken.

a) Provide a local alarm.

b) Indicate to the switching equipment that the main power supply has failed so that circuits can be removed from service.

3.4 *Error rates*

When the probability of error detected in the frame alignment signal exceeds 1 in 10^4 bits, a local alarm should be given.

Note.—The method of determining the probability of error and the confidence limits require further study. Other actions to be taken when this fault condition is detected require further study.

3.5

SUMMARY TABLE OF FAULT CONDITIONS AND CONSEQUENT ACTION

Fault condition	Actions at local end A				Transmission to distant end	Actions at distant end B		
	Alarm	Transmission on channels suppressed	Indication to signalling equipment	Indication to switching equipment		Indication to signalling equipment	Indication to switching equipment	Alarm
Loss of frame alignment or Failure of codec [a] or Absence of received timing signal [a]	Yes	Yes	Yes	Yes	Bit 3 of channel time-slot 0 without frame alignment signal	No	Yes	Yes
Failure of main power supply	Yes	No	No	Yes	No	No	No	No
Frame alignment signal error rate	Yes	Under study	Under study	Under study	Under study	Under study	Under study	Under study

[a] See paragraph 3.1.

4. Signalling

The use of channel time slot 16 is recommended for either common channel or channel associated signalling.

The detailed requirements for the signalling organization of particular signalling systems will be included in the specifications for those signalling systems.

4.1 *Common channel signalling*

Channel time slot 16 may be used for common channel signalling up to a rate of 64 kbit/s. The arrangements for the use of channel time slot 16 for common channel signalling are not yet specified in detail. The method of obtaining signal alignment will form part of the particular common channel signalling specification.

4.2 *Channel associated signalling*

This paragraph contains the recommended arrangement for use of the 64 kbit/s capability of channel time slot 16 for channel associated signalling.

4.2.1 *Multiframe structure*

A multiframe comprises 16 consecutive frames (whose structure is given in paragraph 2.2) and these are numbered from 0 to 15.

The multiframe alignment signal is 0000 and occupies digit time slots 1 to 4 of channel time slot 16 in frame 0.

4.2.2 *Allocation of channel time slot 16*

When channel time slot 16 is used for channel associated signalling it provides a 64 kbit/s path which is subdivided into lower rate paths using the multiframe alignment signal as a reference.

Details of the bit allocation are given in Table 2 below.

This bit allocation provides four 500 bit/s signalling channels designated a, b, c and d for each telephone channel. With this arrangement the signalling distortion of each signalling channel introduced by the PCM transmission system, will not exceed ± 2 ms.

TABLE 2

ALLOCATION OF CHANNEL TIME SLOT 16

Channel time slot 16 of frame 0	Channel time slot 16 of frame 1		Channel time slot 16 of frame 2		Channel time slot 16 of frame 15	
0000 xyxx	*abcd* channel 1	*abcd* channel 16	*abcd* channel 2	*abcd* channel 17	*abcd* channel 15	*abcd* channel 30

x = spare bit to be made 1 if not used.
y = bit used to indicate loss of multiframe alignment (see paragraph 4.2.3.1).

When bits b, c or d are not used they should have the value:

$b = 1$
$c = 0$
$d = 1$

It is recommended that the combination 0000 of bits *a*, *b*, *c* and *d* should not be used for signalling purposes for channels 1-15.

4.2.3 *Loss and recovery of multiframe alignment*

Multiframe alignment should be assumed to have been lost when two consecutive multiframe alignment signals have been received with an error.

Multiframe alignment should be assumed to have been recovered as soon as the first correct multiframe alignment signal is detected.

4.2.3.1 *Action to be taken and alarms at local end A*

As soon as loss of multiframe alignment is detected at local end A of a PCM system, the following action should be taken:

- within a time of 6 ms the signalling condition corresponding to a 1 on the line should be applied to all the signalling channels received from distant end B of the PCM system;
- within a time of 6 ms an alarm should be given by the part of the PCM equipment detecting the loss of multiframe alignment, for possible use in the signalling equipment at local end A;
- as soon as possible, bit 6 of channel time slot 16 in frame 0, will be given the value 1 in the direction of transmission A to B. This same bit must have the value 0 when the signalling equipment at local end A is in multiframe alignment.

4.2.3.2 *Action to be taken and alarms at distant end B*

When it is recognized at distant end B that bit 6 in channel time slot 16 of frame 0 has taken the value 1 indicating a loss of multiframe alignment at end A, then the following actions should be taken at end B:

- the signalling condition corresponding to state 1 on the line should be applied, within a time of 6 ms to all the signalling channels received from end A;
- within a time of 6 ms an alarm should be given by the part of the PCM equipment recognizing the fault condition, for possible use in the signalling equipment at end B.

4.2.3.3 *Recovery of multiframe alignment*

The times specified above for the actions to be taken in the event of loss of multiframe alignment at the local or distant ends, apply equally to the operations which must be accomplished when multiframe alignment has been recovered.

5. Interfaces

Analogue: see Recommendation G.712.
Digital: Under study.

Recommendation G.733 (Geneva, 1972) **Recommendation Q.47 (Geneva, 1972)**

CHARACTERISTICS OF PRIMARY PCM MULTIPLEX EQUIPMENT OPERATING AT 1544 KBIT/S

1. General characteristics

1.1 *Fundamental characteristics*

The encoding law used is the μ-law as specified in Recommendation G.711. The sampling rate, load capacity and the code are also specified in that Recommendation.

The number of quantized values is 255. Two character signals are reserved for zero value (1 1 1 1 1 1 1 1 and 0 1 1 1 1 1 1 1).

In some networks the all-zero character signal (0 0 0 0 0 0 0 0) is eliminated to avoid loss of timing information to the digital line, resulting in 254 quantized values.

1.2 *Bit rate*

The nominal bit rate is 1544 kbit/s. The tolerance on this rate is $\pm$ 50 parts per million (ppm).

1.3 *Timing signal*

It should be possible to derive the transmitting timing signal of a PCM multiplex equipment from an internal source, from the incoming digital signal and also from an external source.

2. Frame structure

2.1 *Number of bits per channel time slot*

8, numbered from 1 to 8.

2.2 *Number of channel time slots per frame*

24, numbered from 1 to 24.

One bit per frame is added for a frame alignment signal and for a multiframe alignment signal or signalling.

The number of bits per frame is 193, and the frame repetition rate is 8000 Hz.

2.3 *Channel time slot assignment*

2.3.1 Channel time slots 1 to 24 are assigned to 24 telephone channels numbered 1 to 24.

2.3.2 Allocation of the frame alignment signal and S-bit (for multiframe alignment or signalling) is given in Table 1 below.

TABLE 1

ALLOCATION OF THE FRAME ALIGNMENT SIGNAL AND S-BIT

Frame number	Frame alignment signal (see 2.4)	Multiframe alignment signal or signalling
1	1	
2		S
3	0	
4		S

2.3.3 The assignment of the S-bit is covered in section 4.

2.4 *Frame alignment signal*

The frame alignment signal occupies the first bit position of every other frame.

This signal is:

1 0 1 0 1 0 . . .

2.5 *Loss and recovery of frame alignment*

The frame alignment signal should be monitored to determine if frame alignment has been lost. Frame alignment should be recovered after a valid alignment signal is available at the receiving terminal equipment.

3. Fault conditions and consequent actions

3.1 The PCM multiplex equipment should detect the following fault conditions:

— loss of frame alignment;
— failure of codec, if possible;
— failure of main power supply.

When provided, monitoring of the codec should be arranged locally.

3.2 *Action following detection of a fault condition*

When a fault condition has been detected at local end A, the following action should be taken:

3.2.1 *At local end A*

An alarm should be given by PCM multiplex equipment A after the appropriate period required to assure that channels will be disconnected only due to a true interruption of the received digital line signal.

3.2 2 *At distant end B*

When a fault condition is detected at local end A, the following measures may be instituted:

— PCM multiplex equipment A may transmit a signal in its digital line signal by forcing bit 2 in every channel time slot to the value zero in the direction of transmission A to B.

— In some networks where channel associated signalling is employed, local end A may transmit a distant end alarm signal by modifying the S bits as described in paragraph 4.2.1.

— When the alarm signal from A is detected in PCM multiplex equipment B, an alarm should be produced at B, in order to indicate the loss of frame alignment at the distant end A, except in the case where the PCM multiplex equipment at end B has itself lost frame alignment.

3.2.3 *Use of the alarm to automatically remove circuits from service*

The alarm described in 3.2.1 and 3.2.2 above should be used at both end A and end B to automatically remove the associated circuits from service and to restore them to service when frame alignment has been recovered.

3.2.4 *Rapid indication of loss of frame alignment*

An indication should be given to the signalling system No. 6 equipment (digital version which is under study) by the PCM multiplex equipment detecting a loss of frame alignment (equipment A only) within 3 milliseconds (provisionally). This indication will serve the same function as that provided by the data carrier failure alarm in the analogue version (see Recommendation Q.275).

4. Signalling

4.1 *Common channel signalling*

The pattern of the S-bit may be arranged to carry common channel signalling at a rate of 4 kbit/s or a submultiple of this rate.

4.2 *Channel associated signalling*

Based on agreement between the Administrations involved, channel associated signalling is provided for intra-regional circuits according to the following arrangement which provides two independent signalling channels designated A and B.

4.2.1 *Multiframe structure*

A multiframe comprises 12 frames as shown in Table 2. The multiframe alignment signal is carried on the S-bit, as shown in that Table.

TABLE 2

MULTIFRAME STRUCTURE

Frame number	Frame alignment signal	Multiframe alignment signal (S-bit)	Bit number(s) in each channel time slot: For character signal	Bit number(s) in each channel time slot: For signalling	Signalling channel
1	1		1-8		
2		0	1-8		
3	0		1-8		
4		0	1-8		
5	1		1-8		
6		1	1-7	8	A
7	0		1-8		
8		1	1-8		
9	1		1-8		
10		1	1-8		
11	0		1-8		
12		0	1-7	8	B

When the S-bit is modified to signal the loss of frame alignment alarm as indicated in Section 3.2.2., the S-bit in frame 12 is changed from " 0 " to " 1 ".

4.2.2 *Loss of multiframe alignment*

Loss of multiframe alignment is assumed to have taken place when loss of frame alignment occurs.

4.2.3 *Allocation of signalling bits*

Frames 6 and 12 are designated as signalling frames.

The eighth bit in each channel time slot is used in every signalling frame to carry the signalling associated with that channel.

4.2.4 *Minimization of quantizing distortion*

In the signalling frame only seven bits are available for encoding of voice frequencies. In order to minimize the quantizing distortion, the decoder output values are shifted slightly. All even numbered decoder output values, y_n, are changed to be equal to the next higher decision value, i.e. x_{n+1}. All odd numbered decoder output values y_{n+1} are changed to be equal to the same numbered decision value, i.e. x_{n+1}, as shown in Figure 1.

When suppression of the " all zero " character signal is required, the value of the seventh bit is forced to be " 1 " when all the other bits of the character signal have the value " 0 ".

5. Interfaces

Analogue: See Recommendation G.712.
Digital: See Recommendation G.703, Table 1.

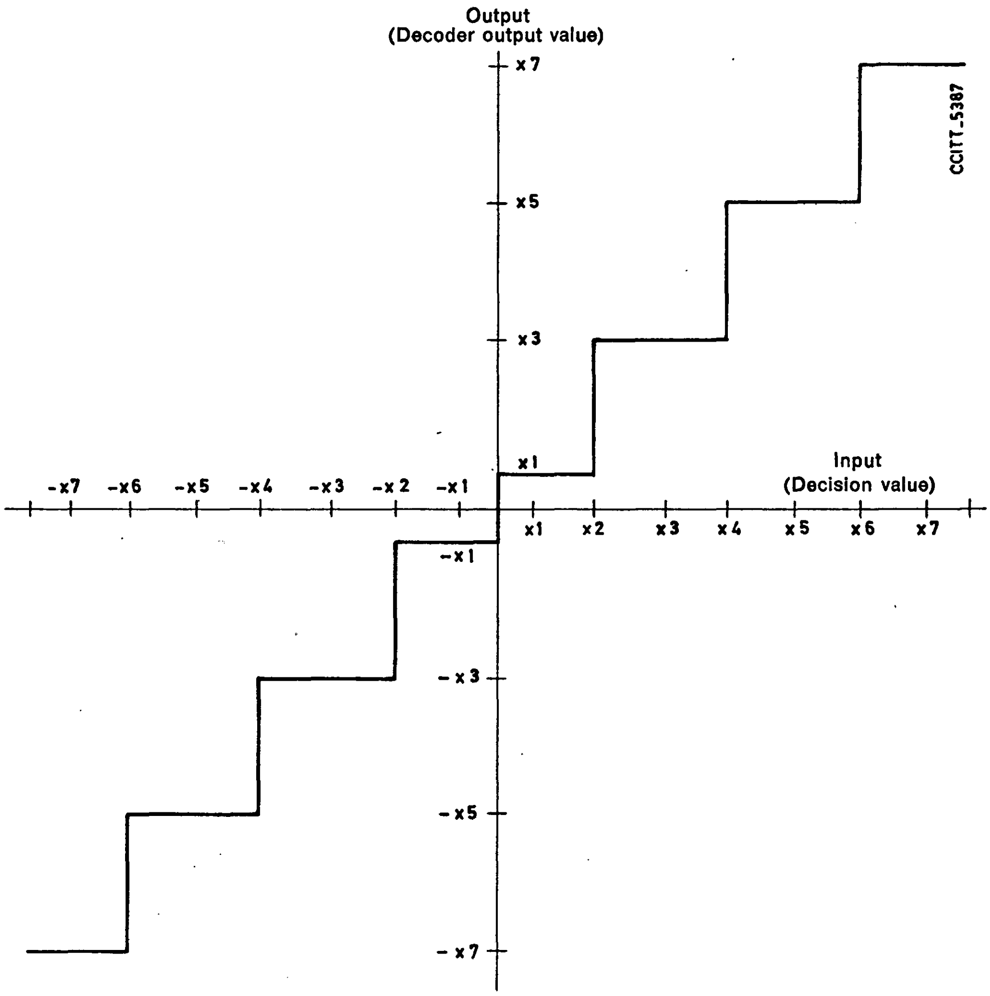


FIGURE 1/G.733/Q.47. — **Seven bit codec transfer characteristic.**

CHAPTER VIII

Signalling for satellite systems

Recommendation Q.48

DEMAND ASSIGNMENT SIGNALLING SYSTEMS

(see also at the end of this Volume, Supplement 8, on this subject)

1. The term " demand assignment " (abbreviated as DA) should be taken as meaning that the assignment is on a per call basis.

Note.—Satellite circuits with demand assigned multiple access are those circuits which may be set up by assignment of a satellite link to operate between specified earth stations when the actual demand arises.

The origin, destination, or both of the satellite link can be varied. The link is assigned to set up the required telephone circuit according to the call.

This defines the following concepts:

1) variable destination satellite link;
2) variable origin satellite link;
3) fully variable satellite link (the origin and destination of which may both be varied).

The Recommendation covers, when applicable, fully variable and variable destination types of DA systems.

2. The DA signalling system shall be capable of interworking with all curfently standardized C.C.I.T.T. signalling systems and shall have the capacity to carry all the telephony signals currently provided by these C.C.I.T.T. signalling systems and shall in addition provide reserve capacity.

Any currently standardized C.C.I.T.T. signalling system shall be able to be applied to any access link. Different C.C.I.T.T. signalling systems may be applied to the various access links at the same time.

3. Account should be taken of the fact that particular earth stations may have special signalling requirements to suit the CTs using these earth stations (e.g. joint use of an earth station by a number of CTs, long distances between CT and earth station, CTs with access to more than one earth station).

4. The DA signalling system shall be an integrated signalling system used both for:

a) signalling for setting up the DA speech circuit; and
b) transfer of the information flow for telephony.

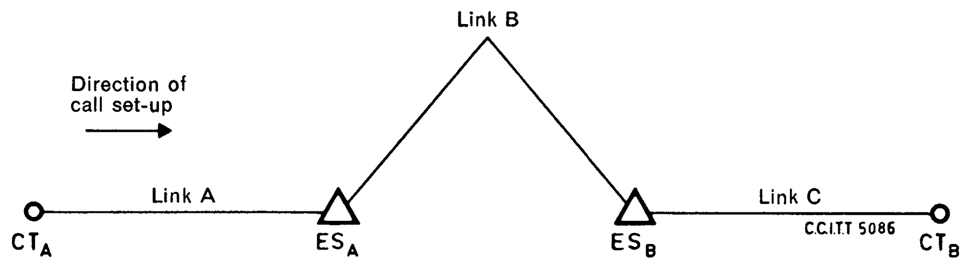
5. The DA signalling system shall be capable of transmitting address information in both the *en bloc* and the overlap mode of operation. The transmission of address information by the outgoing DA system terminal should be such as to result in minimum delay to these signals in the DA system.

The manner of transmitting signals over the DA signalling system shall be independent of the type of signalling system to be encountered in the access link at the far end.

Accordingly, the interworking arrangements described in Table 1 are recommended. (For definitions of " *en bloc* " and " *en bloc* overlap " see the definitions in Recommendation Q.151.)

TABLE 1

INTERWORKING ARRANGEMENTS FOR DA SIGNALLING SYSTEMS



	Case 1	
En bloc — system No. 6	En bloc	En bloc — system No. 5 En bloc — system No. 6
	Case 2	
En bloc — system No. 6	En bloc	Overlap — system R2
	Case 3	
En bloc — system No. 5	En bloc-overlap or en bloc	En bloc — system No. 5 En bloc — system No. 6
	Case 4	
En bloc — system No. 5	En bloc-overlap or en bloc	Overlap — system R2
	Case 5	
Overlap — system No. 6 Overlap — system R2	Overlap	En bloc — system No. 5
	Case 6	
Overlap — system No. 6 Overlap — system R2	Overlap	Overlap — system No. 6 Overlap — system R2

6. The DA signalling system shall send out address digits from ESB to CTB in the correct order, that is, the order of dialling.

7. Means shall be provided for preventing spillover of signals between successive calls, which use the same satellite channel through the DA signalling system.

8. The DA signalling system should be capable, for the sequence " re-answer signal—clear back signal " of correctly extending to CTA, from ESA, the last state representing the final position of the called party's switch hook.

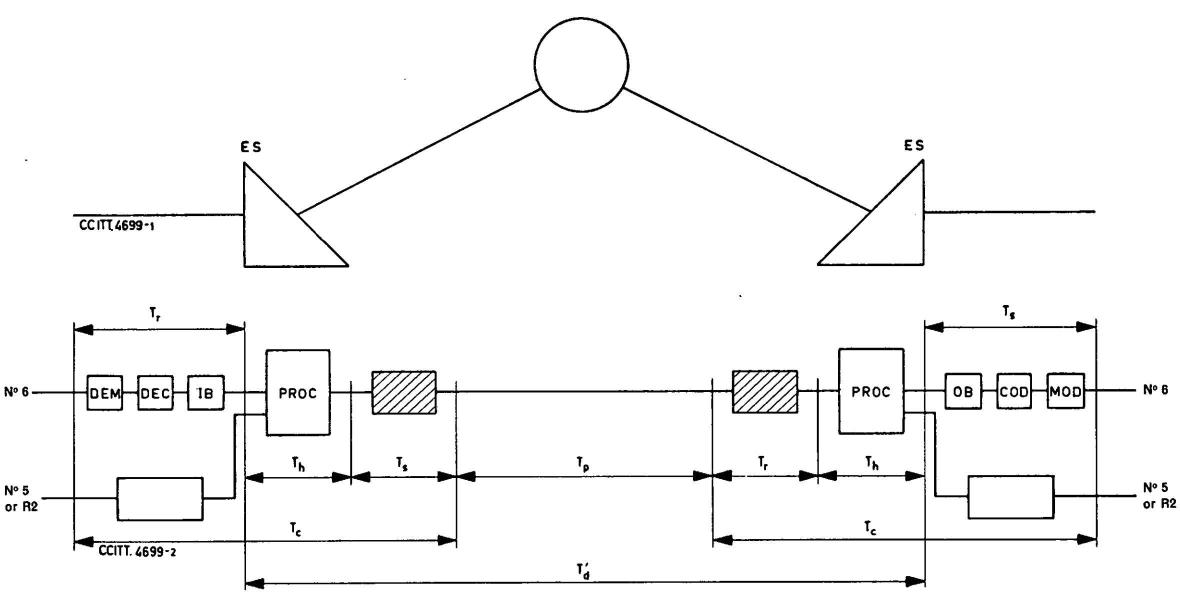
9. The message structure of the demand assignment signalling system should be such that one message will contain all the information necessary for one event (e.g. answer signal for one particular circuit). Single unit and multi-unit messages should be catered for. Each signal unit should contain both information and check bits.

10. All time-outs for both normal and abnormal conditions in the DA signalling system should be designed according to the recommendations concerning the relevant C.C.I.T.T. signalling systems.

11. Signal transfer time through the DA signalling system should be fast. While no firm time requirements in regard to the various components of signal transfer time have been established, design objectives in terms of average and 95% level values for the signal transfer time (T_d) for answer signals, other one-unit messages and the initial address message are given. These figures are to viewed as reasonable objectives and not as firm requirements.

11.1 *Signal transfer time in the DA signalling system*

A signal transfer time in the DA signalling system is specified. This signal transfer time is called T_d' in the diagram of Figure 1.



$$T_d' = 2T_h + T_s + T_r + T_p = T_h + T_c + T_p$$

FIGURE 1/Q.48. — **Functional signal transfer time diagram.**

T_d' = Signal transfer time in DA signalling system.

For other symbols, see Recommendation Q.252.

To facilitate the calculation of the total signal transfer time of the DA system, it is assumed that the times T_r as well as T_s respectively of the terrestrial and satellite transmission links are equal.

The value $T_d = T_d' - T_p$ should be used as the design objective for the DA signalling system. The values of T_d calculated for the design of the system are shown in Table 2.

Note.—These figures have to be interpreted as reasonable estimates and not as firm requirements.

TABLE 2

VALUES OF SIGNAL TRANSFER TIMES FOR DESIGN OF A DA SIGNALLING SYSTEM

Design objectives for T_d

$T_d = T_d' - T_p$

	Type of message	Answer	Other one-unit message	IAM of 5 SU
T_d in ms	AV.	52	85	145
	95% level	85	175	235

For calculation use the following relations:

$$T_d = 2T_h + T_s + S_r = T_c + T_h \quad (1)$$

$$T_{d\,(AV)} = T_{c\,(AV)} + T_{h\,(AV)} \quad (2)$$

$$T_{d\,(95\%)} = T_{d\,(AV)} + \sqrt{(\Delta T_c)^2 + (\Delta T_h)^2} \quad (3)$$

where:

$$\Delta T_c = T_{c\,(95\%)} - T_{c\,(AV)} \quad (4)$$

$$\Delta T_h = T_{h\,(95\%)} - T_{h\,(AV)} \quad (5)$$

For basis of calculation, see Recommendation Q.287 (Annex).

12. *Dependability requirements*

The requirements specified for system No. 6 (Recommendation Q.276, section 6.6.1) are recommended as the objectives for the DA signalling system.

12.1 *Signal transfer dependability* (Recommendation Q.276, sections 6.6.1 b and c)

“ 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, and

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. ”

12.2 *Error correction by retransmission* (Recommendation Q.276, section 6.6.1 a)

Although the bit error rate in the DA signalling system has not been determined, the design of the system should be made such that a design objective “ not more than one in 10^4 signal units carrying telephone information is allowed to be delayed as a consequence of error correction by retransmission. ”

12.3 *Interruption of the signalling service* (Recommendation Q.276, section 6.6.1 d)

System No. 6 requirements are:

The “ 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. ”

Since the speech circuits and the signalling channel in the DA system normally will be interrupted simultaneously, it is understood that the above figures are related to the signalling equipment and not to the transmission media common to both the signalling channel and the speech circuits.

CHAPTER IX

AUTOMATIC TESTING EQUIPMENT

Recommendation Q.49

(The specification for ATME No. 2, which appears in Recommendation 0.22 of Volume IV, is however reproduced below as Recommendation Q.49 for the convenience of users of Volume VI.)

SPECIFICATION FOR THE C.C.I.T.T. AUTOMATIC TRANSMISSION MEASURING AND SIGNALLING TESTING EQUIPMENT ATME No. 2

1. *General*

The C.C.I.T.T. automatic transmission measuring and signalling testing equipment (ATME No. 2) is intended to make transmission measurements and signalling system functional tests [1] on all categories of international circuits terminating in exchanges with 4-wire switching.

The ATME No. 2 will consist of two parts, namely:

1) directing equipment at the outgoing end, and
2) responding equipment at the incoming end.

The responding equipment will be available in the following forms:

1) a signalling system functional testing *and* transmission measuring device (Type a),
2) a signalling system functional testing device (Type b).

It is not possible for the signalling system functional testing devices as found in Types a and b to check the busy flash signal. For this purpose a separate test call must be established using an appropriate test code. Arrangements will therefore be provided to force the transmission of the busy flash signal over the circuit under test by the incoming international exchange equipment. This may be carried out by examination of the test code in the exchange equipment or by the provision of a separate responding equipment. The busy flash signal should be transmitted as the result of a simulation of exchange or circuit congestion. For the purposes of this specification, the equipment providing this busy test arrangement shall be referred to as responding equipment Type c.

Responding equipment Type a is always required. Type b is optional; when used in addition to Type a, it is expected to provide an economical means for making more frequent signalling tests without occupying the transmission measuring equipment. Type c responding equipment is required in cases when the signalling system used on the circuits to be tested provides a busy flash line signal.

For both-way circuits, directing and responding equipments are required at both ends for making signalling system functional tests. For transmission measurements over both-way circuits, the outgoing

[1] The concept of " functional tests " excludes marginal testing.

TABLE 1

COMMAND SIGNALS FROM DIRECTING EQUIPMENT TO RESPONDING EQUIPMENT

Code No.	Interpretation
1	Measure absolute power level at 800 (or 1000) Hz (sent level 0 dBm0)
2	Measure absolute power level at 400 Hz } with a sent level indicated by the 800 Hz (or 1000 Hz) measurement command signal
3	Measure absolute power level at 2800 Hz } with a sent level indicated by the 800 Hz (or 1000 Hz) measurement command signal
4	Measure psophometric noise power (no TASI locking tone applied) [a]
5	Measure psophometric noise power (with TASI locking tone applied)
6	Measure absolute power level at 800 (1000) Hz (and subsequent level measurements in the programme with a sent level of −10 dBm0)
11	Used instead of forward transfer when this signal is not provided
13	Reverse the direction of measurement
14	(Reserved for national use)
15	End of transmission measurement programme

[a] Applies to circuits on routes which do not incorporate a TASI system and are not equipped with echo-suppressors.

TABLE 2

SIGNALS FROM RESPONDING EQUIPMENT TO DIRECTING EQUIPMENT

Code No.	Interpretation
1-10	Digits 1,. . . . . 9, 0 (measurement results information)
11	+ prefix for transmission measurements)
12	− (prefix for transmission measurements)
9	+ (prefix to indicate measurement tone interruption)
7	− (prefix to indicate measurement tone interruption)
8	+ (prefix to indicate measurement tone instability)
6	− (prefix to indicate measurement tone instability)
13	Command acknowledgement
11 (3 times)	(" out of range at the upper end " printed out as " +++ ")
12 (3 times)	(" out of range at the lower end " printed out as " −−− ")
15	Recognition of faulty multi-frequency signal

end is normally that which is the responsibility of the control station, and the incoming end is that which is the responsibility of the sub-control station. However, these may be interchanged by mutual agreement.

The equipment shall be of modular construction in order that only those features desired by the using Administrations need be included. The present specification already takes account of operating over circuits using C.C.I.T.T. signalling systems Nos. 3, 4, 5, 5 *bis*, 6, R1 and R2 It is believed that it may also ultimately be possible to use it over circuits employing other types of signalling systems.

Results of measurements shall be recorded only at the outgoing end, that is by the directing equipment. However, arrangements can be made by the Administrations involved, to send the results of the measurements by mutually acceptable means to the Administrations in charge of the incoming end and other points as desired.

2. *Kinds of measurements and tests*

Transmission measurements of the following kinds will be made in both directions of transmission:

- absolute power level measurement at 800 (or 1000) Hz;
- absolute power level measurement at 400, 800 (or 1000) and 2800 Hz (loss/frequency distortion);
- noise measurements.

In addition to tests of the normal signalling functions required in the process of setting up the test call, line signals such as the following will also be tested:

- clear back,
- forward transfer,
- busy flash (this requires a separate test call).

The equipment will be designed in such a way that further measurements and tests can be incorporated at a later date.

3. *Equipment for making transmission measurements and processing the results*

The directing and responding equipments shall each be provided with features for making absolute power level and noise measurements, as described below. In addition, the directing equipment shall have the capability of receiving the results of the measurements made by both the directing and responding equipments, making the necessary adjustments to these results, as discussed below, and converting the results to the proper form for transmission to the output device. The output device is also considered to be part of the directing equipment. (See Tables 1 and 2.)

3.1 *Absolute power level measurements*

a) *Sending end*

At the access point at the input to the path to be measured there will be connected a *sending equipment* which will send a tone of the appropriate frequency and level as specified in paragraphs 6.3 and 8.1.

b) *Measuring end*

At the access point at the output from the path to be measured there will be connected a measuring device whose specifications are given in paragraphs 6.3 and 8.1.

The measuring device shall provide results in the form of a deviation, expressed in dB, from the nominal absolute power level of the circuit at the virtual switching point at the receiving end. This assumes that for the responding equipment (see paragraph 3.3), the relative level at the receiving end virtual switching point is −4 dBr. A level higher than nominal shall be indicated as positive " + " and a level lower than nominal shall be indicated as negative " — ". The transmission parameters of the switched access path between the virtual switching point and the measuring device shall be allowed for (see C.C.I.T.T. *Green Book*, Vol. IV, Recommendation M.64, Part B).

If the equipment is capable of detecting an interruption or a condition of instability experienced during a measurement (see paragraph 10.5) the result shall be indicated as shown in Table 2.

3.2 *Noise measurements*

a) *Sending end*

At the access point at the input to the path to be measured there will be connected a 600 ohms terminating resistance of a TASI locking tone in accordance with 6.4.19 or 6.4.20 and 8.3.

b) *Measuring end*

At the access point at the output from the path to be measured, there will be connected a noise measuring device whose specifications are given in paragraph 8.2.

The noise measuring device shall provide results in terms of absolute power level with psophometric weighting referred to 0 level (dBm0p) assuming for the responding equipment that the relative level at the receiving end virtual switching point is −4 dBr (see paragraph 3.3). The transmission parameters of the switched access path between the virtual switching point and the noise measuring device shall be allowed for (see C.C.I.T.T. *Green Book*, Vol IV, Recommendation M.64, Part B).

3.3 *Adjustment of results*

Circuits that may be used in international transit connections are operated with a nominal loss of 0.5 dB, that is, the relative level at the receiving virtual switching point is −4.0 dBr. However, circuits which are not intended to be used in international transit connections may be operated with nominal losses greater than 0.5 dB (see Recommendation G.131-Ba, *Green Book*, Volume III).

The results of measurement of absolute power level deviations and noise sent by the responding equipment to the directing end will assume a −4.0 dBr virtual switching point for all circuits. Thus, a measured value corresponding to −5.0 dBm at the virtual switching point will always be transmitted to the directing equipment as a deviation of −1.0 dB. Where a circuit is operated with a nominal loss greater than 0.5 dB, i.e. the actual relative level at the virtual switching point is more negative than −4.0 dBr, the directing equipment shall apply the appropriate correction to the results of the measurement of absolute power level deviation and noise received from the responding equipment.

3.4 *Output*

The output shall be recorded by suitable means, to be decided by the Administration concerned. For absolute power level measurements at 800 (or 1000) Hz the results shall be presented, with the appropriate algebraic sign, as deviations from the nominal absolute power level at the virtual switching point. The results of measurements at 400 and 2800 Hz shall be presented as deviations from the measured absolute power level at 800 (or 1000) Hz. Results of noise measurements shall be expressed in dBm referred to 0 level (dBm0p).

An example is given below for measurements made by the responding equipment.

Frequencies	Absolute power level at the receiving virtual switching point at responding equipment	Deviation transmitted from responding equipment to directing equipment (a relative level of −4.0 dBr at the virtual switching point is assumed)	Presentation	
			For circuit with nominal loss of 0.5 dB	For circuit with nominal loss other than 0.5 dB, say 1.5 dB
At 800 Hz	−3.7 dBm	+0.3 dB	+0.3	+1.3
At 400 Hz	−4.4 dBm	−0.4 dB	−0.7	−0.7
At 2800 Hz	−4.6 dBm	−0.6 dB	−0.9	−0.9
Absolute noise power at receiving virtual switching point at responding equipment		Value transmitted from responding equipment to directing equipment (a relative level of −4.0 dBr at the virtual switching point is assumed)		
−46 dBm		−42 dBm0p	−42	−41

Distinct indications will be given under the following conditions:

a) the absolute power level deviation exceeds the assigned maintenance limit;

b) the noise power value is outside the assigned maintenance limit;

c) the absolute power level deviation is so great that the circuit is rendered unfit for service;

d) the noise power value is so great that the circuit is rendered unfit for service;

e) failure to complete the test call;

f) failure to meet the requirements of the signalling tests.

In cases e and f the point in the programme at which a given failure occurs should be indicated.

The form that the output should take has not been specified, and international agreement on this point does not appear to be necessary, except concerning the following print-out conventions: [1]

Absolute power level or noise power too high to be measured . . . . +++
(print-out interpretation of three code 11 signals)

Absolute power level or noise power too low to be measured . . . . ———
(print-out interpretation of three code 12 signals)

Interruption in measurement tone during absolute power level measurement . . . . 9 XX or 7 XX [2]

Instability during absolute power level measurements . . . . 8 XX or 6 XX [2]

If directed by the input programme, the date and time (to the nearest minute) shall be recorded.

The possibility shall be included to provide a complete record of the results of all measurements and signalling tests and the identification of all circuits which could not be measured or tested because the circuit was occupied or because the responding equipment could not be reached. A different indication shall be given for each of the latter two categories.

In addition a shortened record should be obtainable which omits information concerning circuits which were within maintenance limits and on which no instability or interruption was indicated.

---

[1] See Table 2 and paragraph 10.5.

[2] XX represents the results of the measurement.

3.5 *Re-measurement and re-test arrangements*

Arrangements are required to provide an input data record for circuits which were occupied on initial measurement or test and for circuits on which the responding equipment could not be reached. This input data record should be capable of expansion to include all circuits except those which are found to be within maintenance limits and on which no instability or interruption was indicated. The input data record shall be in such a form that it may be used to control the directing equipment so as to permit the re-examination of these circuits in any grouping as desired by the using Administration.

4. *Method of access*

4.1 In general, access arrangements will conform to Recommendation M.64, Part B, paragraph 1.b of the *Green Book*, Volume IV.

4.2 *Outgoing international exchange*

Access to the circuit for test at the outgoing international exchange will be on a 4-wire basis as shown in Figure 1/Q.49 such that:

a) all line signalling equipment to be tested is included,

b) as much as possible of the international circuit will be measured, in accordance with the recommendation referred to in 4.1.

4.3 *Incoming international exchange*

Access to the responding equipments at the incoming international exchange will be gained via the normal exchange switching equipment on a 4-wire basis as shown in Figure 1/Q.49.

4.4 *Address information*

The following address information will be used to gain access to the responding equipments at the incoming international exchange.

4.4.1 *Address information sequence*

i) *Signalling systems C.C.I.T.T. Nos. 3 and 4*

a) terminal seizing signal,

b) code 13,

c) code 12,

d) digit 0,

e) two digits which will be associated with the particular testing or measuring device (see 4.4.2),

f) code 15.

ii) *Signalling system C.C.I.T.T. No. 5*

a) KP1,

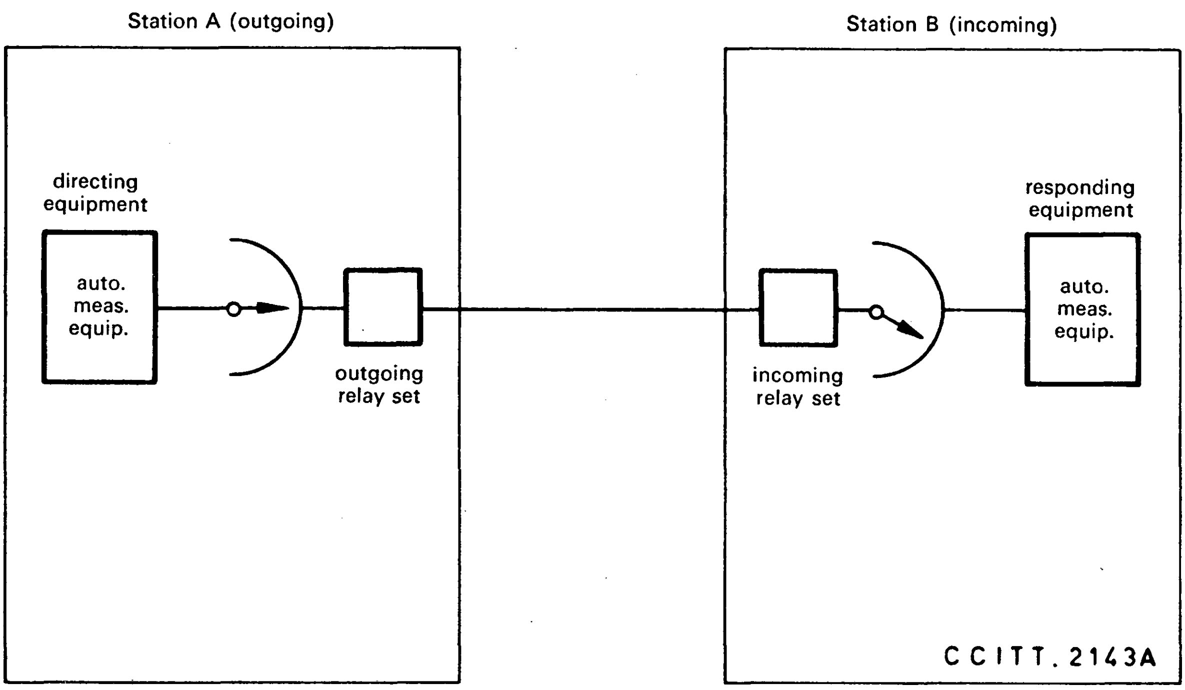
b) digit 7 (non-allocated language digit),

c) code 12,

d) digit 0,

e) two digits which will be associated with the particular testing or measuring device (see 4.4.2),

f) ST.



Note. — The connection between the directing equipment and the international circuit should be such that all line signalling equipment is included and allows as much as possible of the international circuit to be measured. The connection at the incoming international exchange between the international circuit and the responding equipment is made using the normal exchange switching equipment. It is recognized that there may be one or more switching stages involved at the outgoing and incoming international exchanges.

FIGURE 1/Q.49. — **Recommended method of access for automatic transmission measurements and signalling tests.**

iii) *Signalling system C.C.I.T.T. No. 5* bis

a) XI_1 or XI_1I_2 or $XI_1I_2I_3$, [1]

b) digit 7 (non-allocated language digit),

c) code 12,

d) digit 0,

e) two digits which will be associated with the particular testing or measuring device (see 4.4.2),

f) ST.

iv) *Signalling system C.C.I.T.T. No. 6*

The initial address message format for access to testing devices is given in Recommendation Q.295.

The X digit allocation should be as follows:

a) signalling system testing and transmission measuring device (called Type a) 1

b) signalling system testing device (called Type b) [2] 2

v) *Signalling system C.C.I.T.T. R1*

a) KP,

b) digits to be agreed upon between the Administrations concerned,

c) ST.

vi) *Signalling system C.C.I.T.T. R2*

a) Code I-13,

b) Code I-13,

c) two digits which will be associated with the particular testing or measuring device,

d) Code I-15.

4.4.2 *Test codes for C.C.I.T.T. signalling systems Nos. 3, 4, 5, 5* bis *and R2*

i) Signalling system testing and transmission measuring device, called Type a —61,

ii) Signalling system testing device, called Type b —62,[2]

iii) Signalling system " busy flash signal " testing device, called Type c — 63 (except in system R2).

5. *Operating principles*

It shall be possible to perform any one, two or more of the measurements and tests mentioned in paragraph 2 on the same circuit under the control of the directing equipment without releasing the connection except when the busy flash test is performed.

5.1 When the directing equipment has indicated to the responding equipment the kind of measurement to be made, the measurement is first made at the directing equipment with the responding equipment sending a measurement tone or providing a 600 ohms termination (or TASI locking tone). The directing equipment then sends the measurement tone or provides a 600 ohms termination (or TASI locking tone) while the responding equipment makes the measurement.

5.2 Directing equipment which has access to circuits equipped with echo-suppressors must be provided with arrangements to transmit the echo-suppressor disabling tone specified in 8.3. Arrangements

[1] The " X " digit is to be selected from Table 1 in Recommendation Q.211 as appropriate for the circuit under test.

[2] If a Type b device is not provided in an exchange it should be possible to gain access to the Type a device using the code provided for the signalling system testing device Type b.

must be included in the directing equipment to provide for the transmission of this tone only on circuits equipped with echo-suppressors. These features may be omitted in equipments which do not have access to such circuits, but provision must be made to add them when required.

5.3 Directing and responding equipment which has access to circuits on routes incorporating a TASI system or to circuits equipped with echo-suppressors must be provided with means for transmitting the TASI locking tone as specified in paragraph 8.3. Means are required in the directing equipment to transmit this tone only on such routes or circuits. If these features are not provided initially, arrangements must be made so that they can be added when required.

6. *Signalling system testing and transmission measuring procedure*

6.1 *Establishment of connection and signalling test sequence*

6.1.1 When the outgoing circuit is seized, the appropriate address information is transmitted in accordance with the specification for the signalling system in use (see paragraph 4.4).

6.1.2 When access is gained to the responding equipment, the answer signal will be transmitted. If the responding equipment is occupied, a busy indication will be returned to the directing equipment in accordance with normal signalling arrangements for the circuit and for the access arrangements concerned. If the busy indication is received, this will be recorded by the directing equipment and the circuit released. See para 3.4.

6.1.3 If no signal is received by the directing equipment within 10 to 20 seconds of transmission of the address information, then a fault will be recorded and the circuit released.

6.1.4 When the answer signal is received by the directing equipment and transmission measurements are desired with a responding equipment Type a, transmission measurement cycles may take place as described in paragraph 6.4. These cycles will end with the " end of transmission measuring programme " signal (Code 15) transmitted by the directing equipment, followed by the acknowledgement signal (Code 13) transmitted by the responding equipment in accordance with the normal responding sequence.

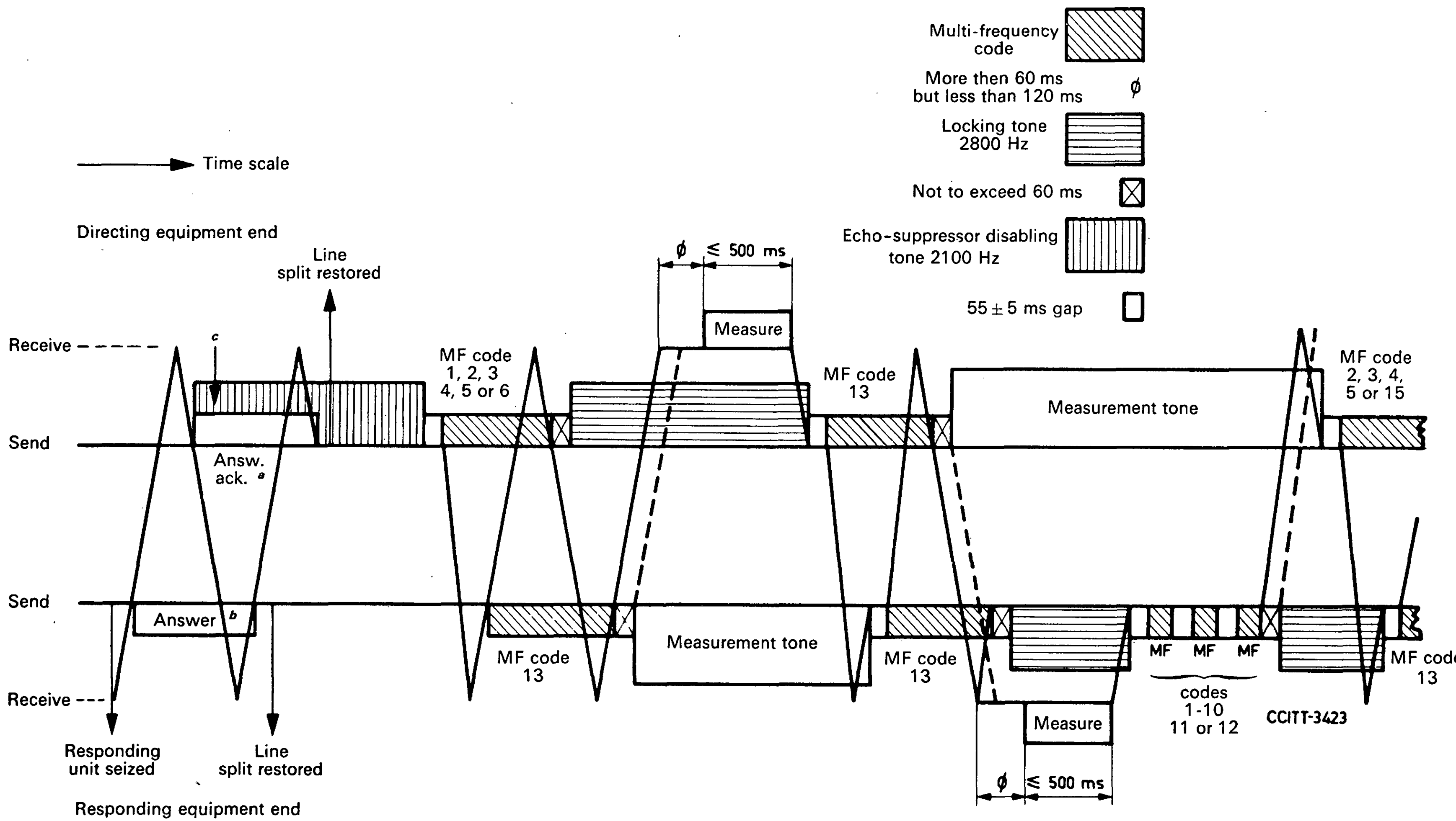
6.1.5 When the answer signal is received by the directing equipment, and transmission measurements are not desired, or if the responding equipment is of Type b, or if the transmission measurement cycles have been completed and a complete signalling functional test is required, the directing equipment will transmit the forward transfer signal, or if this signal is not provided, the Code 11 signal.

a) *Forward transfer signal provided*

If the transmission measurements have been made, a forward transfer signal will be transmitted 500 ± 100 ms after the end of the transmission measuring programme signal. If transmission measurements have not been made or if Type b equipment is used, the transmission of the forward transfer signal will be initiated 500 ± 100 ms after the receipt of the answer signal by the directing equipment.

b) *Forward transfer signal not provided*

If transmission measurements have been made the Code 11 signal will be transmitted after the end of the transmission measuring programme signal. The directing equipment will transmit the TASI locking tone between the Code 15 and Code 11 signals on circuits equipped with echo-suppressors to ensure that they remain disabled. When the acknowledgement to the Code 15 signal is recognized by the directing equipment the Code 15 command signal will be disconnected and the TASI locking tone will be connected within 60 ms. When the end of the command acknowledgement signal is recognized by the directing equipment the TASI locking tone will be removed and the Code 11 command signal will be connected 55 ± 5 ms after the disconnection of the TASI locking tone. If transmission measurements have not been made or if Type b equipment is used, the transmission of the Code 11 signal will be preceded by transmission of the echo-suppressor disabling tone as specified in paragraphs 6.4.1 to 6.4.3 When the



Responding equipment end [a] C.C.I.T.T. No. 5 (and No. 5 *bis*) answer acknowledgement line signal.

[b] C.C.I.T.T. No. 4, No. 5 (and No. 5 *bis*) answer line signal

[c] In C.C.I.T.T. system No. 6 the sending of the echo-suppressor disabling tone will start after reception of the answer signal (via the common signalling channel).

FIGURE 2/Q.49. — **Typical ATME signalling sequence.**

acknowledgement to the Code 11 signal (return of Code 13) is recognized by the directing equipment, the Code 11 command signal will be disconnected.

6.1.6 If shortened signalling functional tests alone are desired, the directing equipment will initiate a clear-forward signal on receipt of the answer signal if transmission measurements have not been made, or on receipt of the acknowledgement signal (Code 13) following the end of transmission measuring programme signal when transmission measurements have been made.

6.1.7 When a complete signalling functional test is carried out the receipt of a forward transfer signal will initiate the transmission of a clear-back signal followed by the re-answer signal 500 ± 100 ms after the clear-back signal. For systems without a forward transfer signal or where the forward transfer signal is not provided (see 6.1.5 above), the receipt of a Code 11 signal will initiate the transmission of a clear-back signal 500 ± 100 ms after the command acknowledgement signal. The transmission of a re-answer signal will follow 500 ± 100 ms after the end of the clear-back signal (the 500 ms gap between the clear-back and re-answer signals can allow a TASI circuit to release the TASI channel). If the clear-back signal is not received by the directing equipment within 5 to 10 seconds of sending the forward transfer signal or the Code 11 signal, or if the re-answer signal is not received 5 to 10 seconds after the receipt of the clear-back signal, a fault will be recorded and the circuit released.

When the re-answer signal is recognized the directing equipment will initiate a clear-forward signal.

6.1.8 When the clear-forward signal is transmitted (in accordance with 6.1.6 or 6.1.7), a check should be made that the outgoing circuit has been released and is available for future use. If the outgoing circuit is not fully released within 5-10 seconds of transmission of the clear-forward signal, a fault will be recorded. It should be noted that the test for the release of the circuit may not be possible on certain designs of equipment.

6.2 *Busy-flash test*

The busy-flash signal may be tested by establishing a call using the address code specified in paragraph 4.4, to force transmission of a busy-flash signal by the incoming exchange equipment. On receipt of the busy-flash signal the circuit will be released.

If the busy-flash signal is not received within 10-20 seconds of transmission of the address information then a fault will be recorded and the circuit released.

Note. — There is no need to make such a test in C.C.I.T.T. signalling system No. 6 or in system R2.

6.3 *Transmission measuring procedure and exchange of information between directing and responding equipments*

The signalling sequence for each individual measurement cycle is specified in section 6.4 and the frequencies and codes in Tables 1, 2 and 3. An example of the signalling sequence for a cycle involving the measurement of absolute power level is shown in Figure 2/Q.49. The signalling scheme adopted for the command signals between directing and responding equipments consists of multi-frequency signals transmitted in compelled sequence; results are transmitted from the responding equipment to the directing equipment by means of multi-frequency pulse-type signals.

In the future it may be necessary to perform measurements with a tone level of −10 dBm0 in addition to the 0 dBm0 tone level now specified. In these circumstances a signal will be sent to inform the responding equipment of the measurement level to be used. (See Table 1 and paragraph 8.1.) It should be noted that the sensitivity of the measuring equipment must be arranged to accommodate both levels.

The signal sender and signal receiver chosen are those specified for the C.C.I.T.T. No. 5 inter-register signalling system and the equipment used should be as specified in the C.C.I.T.T. *Green Book*, Volume VI, Recommendations Q.153 and Q.154.

TABLE 3

FREQUENCY ALLOCATION AND CODES

Code No.	Frequencies (compound) Hz
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
10	1300+1500
11	700+1700
12	900+1700
13	1100+1700
14	1300+1700
15	1500+1700

6.4 *Description of transmission measuring cycles*

6.4.1 When the indication that the answer signal has been received is passed to the directing equipment, the echo-suppressor disabling tone will be transmitted from the directing equipment for 2 seconds ± 250 ms.

Note 1. — This period takes into account the delay necessary for connection to a TASI channel, the time necessary for the assured disablement of the echo-suppressor, the long propagation time likely to be experienced on satellite circuits and the delays attributable to the functioning of the signalling system. For circuits not using a line-signalling system involving an answer acknowledgement signal (such as signalling systems Nos. 3 and 4) it will be sufficient to send a disabling tone for at least 400 ms. If, however, the circuit to be tested is not equipped with echo-suppressors (see paragraph 5), the procedure in 6.4.1 will be omitted.

Note 2. — The specifications for the echo-suppressor disabling tone and the TASI locking tone are given in paragraph 8.3.

6.4.2 When the echo-suppressor disabling tone is removed, the directing equipment will transmit a multi-frequency command signal to the responding equipment. The interval between cessation of the tone and transmission of the command signal will be 55 ± 5 ms. If, however, the disabling tone has not been sent (see paragraph 5) the multi-frequency command signal will be sent within 60 ms, following the indication that the answer signal has been received.

6.4.3 When the command signal is received by the responding equipment a multi-frequency command acknowledgement signal will be transmitted.

6.4.4 When the command acknowledgement signal is recognized by the directing equipment, the command signal will be disconnected and the TASI locking tone, if it is to be sent (see paragraph 5), will be connected within 60 ms.

6.4.5 When the cessation of the command signal is recognized by the responding equipment the command acknowledgement signal is disconnected and the measurement tone is connected within 60 ms.

6.4.6 The time required for the directing equipment to detect the cessation of the command acknowledgement signal and connect the measuring equipment will be not less than 60 nor more than 120 ms.

6.4.7 The level measurement should be completed within 500 ms after connection of the measuring equipment. When the measurement is completed, the measuring equipment will be disconnected and the TASI locking tone mentioned in paragraph 6.4.4, if present, will be disconnected.

6.4.8 Following disconnection of the TASI locking tone mentioned in paragraph 6.4.7, a multi-frequency command signal will be connected. The interval between the tone and the signal will be 55 ± 5 ms. If, however, the TASI locking tone was not sent, the command signal will be connected 55 ± 5 ms after the measuring equipment has been disconnected.

6.4.9 When the multi-frequency command signal is recognized by the responding equipment, the measurement tone will be removed and a multi-frequency command acknowledgement signal will be transmitted. The interval between cessation of the measurement tone and the commencement of the multi-frequency command acknowledgement signal will be 55 ± 5 ms.

6.4.10 The recognition of the command acknowledgement signal by the directing equipment will cause the disconnection of the command signal and the connection of the measurement tone within 60 ms of the end of the command signal.

6.4.11 When the cessation of the multi-frequency command signal is detected by the responding equipment, the command acknowledgement signal will be disconnected and the TASI locking tone, if provided in the responding equipment, will be connected within 60 ms of the end of the command acknowledgement signal.

6.4.12 The time required for the responding equipment to detect the cessation of the command signal and connect the measuring equipment will not be less than 60 nor more than 120 ms.

6.4.13 The measurement should be completed within 500 ms after the connection of the measuring equipment. When the measurement is completed, the measuring equipment will be disconnected.

6.4.14 When the responding equipment is ready to transmit measurement results information to the directing equipment, the TASI locking tone mentioned in paragraph 6.4.11 will be disconnected if it has been sent. The first multi-frequency pulse to be used for the transmission of results will follow after an interval of 55 ± 5 ms from the disconnection of the TASI locking tone. If the locking tone was not sent, the first multi-frequency pulse will be sent within 60 ms after disconnection of the measuring equipment.

6.4.15 Measurement result information will be transmitted as three multi-frequency pulses in the form of a prefix followed by two digits of codes 1 to 10 as appropriate (see Table 2). The last two digits will be sent in order of significance (most significant digit first). The pulse-length will be 55 ± 5 ms and the interval between pulses 55 ± 5 ms.

6.4.16 If the responding equipment is provided with a TASI locking tone this tone will be applied within 60 ms after the third multi-frequency pulse has been sent.

6.4.17 When the third multi-frequency pulse is recognized by the directing equipment, the measurement tone will be disconnected. A multi-frequency command signal will be sent by the directing equipment after an interval of 55 ± 5 ms from disconnection of the measurement tone. If the responding equipment has sent the TASI locking tone mentioned in 6.4.16, this tone will be disconnected on recognition by the responding equipment of the multi-frequency command signal sent by the directing equipment. The responding equipment must send the command acknowledgement signal 55 ± 5 ms after cessation of the TASI locking tone. If the multi-frequency command signal sent by the directing equipment is the start of a new measurement cycle the new test sequence will proceed from the point described in paragraph 6.4.4 and will consist of a repetition of the sequence in paragraphs 6.4.4 to 6.4.17.

6.4.18 If the foregoing test sequence completes the transmission measuring programme, the multi-frequency command signal mentioned in paragraph 6.4.17 will be the " end of programme signal ".

6.4.19 In the case of noise measurements on routes not incorporating a TASI system or on circuits not equipped with echo-suppressors the measurement tone mentioned in paragraphs 6.4.5, 6.4.9, 6.4.10 and 6.4.17 must be replaced by a 600-ohm terminating resistor.

6.4.20 In the case of noise measurements carried out on routes incorporating a TASI system or on circuits equipped with echo-suppressors the measurement tone mentioned in 6.4.5, 6.4.9, 6.4.10 and 6.4.17 must be replaced by the TASI locking tone.

6.4.21 In the case of noise measurements, the responding equipment is informed of the necessity for the TASI locking tone mentioned in 6.4.20 by the multi-frequency command signal, " measure psophometric noise power (with TASI locking tone applied) " (see Table 1).

6.5 *End of programme procedure*

When transmission measurement is complete the remainder of the operations will be continued in accordance with paragraphs 6.1.4 through 6.1.8, insofar as they apply.

6.6 *System supervision*

6.6.1 Each multi-frequency signal must consist of two, and only two, frequencies. If one or more than two frequencies are received by the directing equipment, the measurement is recorded as faulty and the connection is released. If one or more than two frequencies are received by the responding equipment it shall be arranged to return code 15 in place of the command acknowledgement signal code 13. The directing equipment will then recognize the signal, record the measurement as a fault and release the connection.

6.6.2 In the transmission of measurement results, the code signals must comprise three, and only three digits. When this is not the case, the measurement is recorded as faulty, and the connection is released.

6.6.3 Arrangements must be provided at the directing equipment to monitor the full duration of the programme. In addition to the time out requirements given in other parts of this specification if at any time the programme fails to progress for a period of 20-40 seconds then the test is recorded as faulty and the connection is released. An alarm may be given to the maintenance staff.

7. *Programming*

The directing equipment will be programmed by manual means and by punched tape or cards or magnetic tape at the option of the using Administration or operating agency. Information to be supplied to the directing equipment will consist of the following:

1) the identification of the circuit to be tested;

2) the kind of circuit (TASI, echo-suppressor equipped, etc.) and the kind of signalling system;

3) sufficient address information to identify the particular type of responding equipment at the incoming international exchange;

4) the transmission measurements to be made, the nominal values, and the assigned maintenance limits;

5) whether the results are to be recorded by the output equipment;

6) indication whether or not the date and time of the test should be recorded by the output equipment;

7) whether there should be a shortened record as described in paragraph 3.4.

8. *Specifications for transmission measuring apparatus and for disabling tones and locking tones*

The following specifications apply over a temperature range of + 5°C to + 50°C.

8.1 *Measuring device*

Sending equipment:

Frequencies: 400 ± 5 Hz, 800 ± 9 Hz (or 1000 ± 11 Hz) and 2800 ± 14 Hz,

Absolute power level sent: 0 dBm0 ± 0.1 dB (or −10 dBm0 ± 0.1 dB, see 6.3),

Purity of output: ratio of total output to unwanted signal at least 40 dB,

Impedance: 600 ohms balanced,

Balance with respect to earth at least 46 dB between 300 and 3400 Hz[1, 2],

Return loss: at least 30 dB (at each of the above-mentioned frequencies).

Receiving equipment:

Frequency range: 390-2820 Hz,

Impedance: 600 ohms balanced,

Balance with respect to earth: at least 46 dB between 300 and 3400 Hz, and below 300 Hz increasing such that at least 60 dB at 50 Hz is obtained[1, 2],

Return loss: at least 30 dB at each of the above sending equipment frequencies,

Measuring range: from −9.9 dB to + 5.1 dB relative to the nominal absolute power level of the −4.0 dBr receiving virtual switching point. It should be borne in mind that the nominal value of absolute

[1] Pending the general adoption of a method for measuring the balance with respect to earth, the method to be used is left for agreement between the constructor of the equipment and the Administration concerned.

[2] Any interface equipment provided to meet the signalling requirements of the exchange, or for purposes of controlling functions within the ATME No. 2, must be considered as part of the ATME No. 2 for the purpose of determining the balance to earth.

power level at the receiving virtual switching point will depend on the absolute power level at the sending end which may be 0 dBm0 or −10 dBm0 (see 6.3),

Accuracy (absolute): at 800 (or 1000) Hz, ±0.2 dB: at 400 and 2800 Hz, ±0.2 dB referred to the 800 (or 1000) Hz value,

Resolution (smallest measurement step): 0.1 dB.

8.2 *Noise measuring apparatus*

Weighting: psophometric with requirements as specified in Recommendation P.51, Volume V, *Green Book*.

2800 Hz suppression: when noise measurements are made on circuits involving a TASI system or on circuits equipped with echo-suppressors, a stop filter for 2800 Hz must be inserted before carrying out the noise measurement. The requirements for the filter are given in Figure 3/Q.49. When measuring white noise with psophometric weighting the insertion of the filter in the noise measuring circuit shall not cause a difference from the reading without the filter of more than 1 dB.

Method of detection: the method of detection shall be such that if white Gaussian noise, or a sine wave of any frequency between 390 and 2820 Hz is applied at the input in the absence of the 2800 Hz stop filter mentioned above, for a period of 375 ± 25 ms, the output indication will be the same in each case, within ± 1 dB, as that given by the C.C.I.T.T. psophometer when the same white Gaussian noise or sine wave is applied at its input for a period of 5 seconds.

Measuring interval: 375 ± 25 ms,

Impedance: 600 ohms balanced.

Balance with respect to earth: at least 46 dB between 300 and 3400 Hz, and below 300 Hz increasing such that at least 60 dB at 50 Hz is obtained [1, 2],

Return loss: at least 30 dB from 40 to 5000 Hz,

Measuring range: −30 to −65 dBm0p,

Accuracy: ± 1 dB at calibrating frequency from −30 to −55 dBm0p. Between −55 dBm0p and −65 dBm0p an accuracy of ± 2 dB is allowed, but ± 1 dB remains desirable,

Resolution (smallest measurement step): 1 dB.

8.3 *Disabling and locking tones*

— Echo-suppressor disabling tone:
  Frequency: 2100 Hz ± 15 Hz
  Level: −12 dBm0 ± 1 dB

— TASI locking tone:
  Frequency: 2810 Hz ± 14 Hz
  Level: −10 dBm0 ± 1 dB
  Impedance: 600 ohms balanced
  Balance with respect to earth at least 46 dB between 300 and 3400 Hz[1, 2];
  Return loss: at least 30 dB from 300 to 3400 Hz.

9. *Calibration*

9.1 *Built-in calibration*

The accuracy desired from the ATME makes necessary calibration equipment of laboratory-type accuracy. Such accuracy is seldom provided by normal maintenance equipment available to repeater station staff. Hence, built-in calibration features should be provided. Due regard should be paid to the ease of maintenance, and adequate access facilities should be provided.

[1, 2] See footnote under paragraph 8.1.

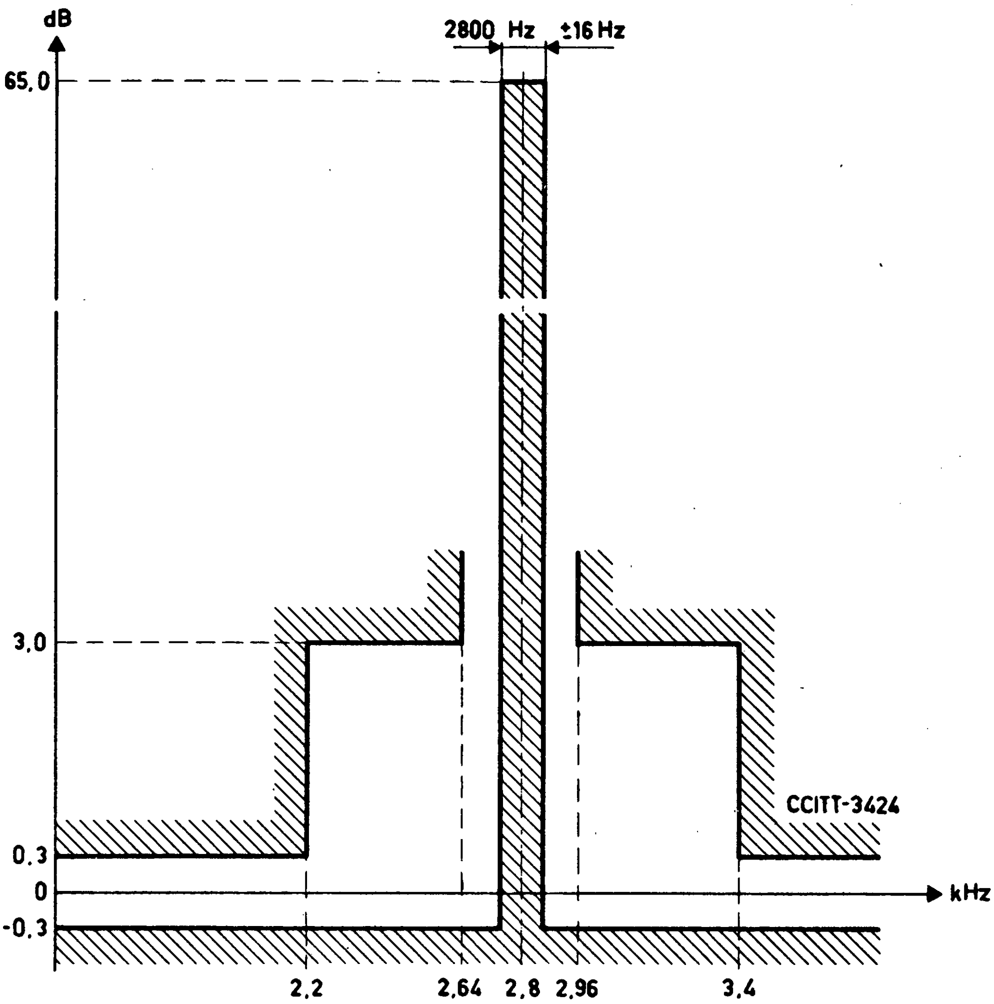


FIGURE 3/Q.49. — **Performance requirements for 2800 Hz stop-filter.**

The difference between the loss frequency characteristic with the 2800 Hz stop-filter inserted and the loss frequency characteristic without the filter shall conform to the following limits:

30 Hz to 2.2 kHz and 3.4 kHz to 20 kHz	difference not greater than ± 0.3 dB
2.2 kHz to 2.64 kHz 2.96 kHz to 3.4 kHz }	difference not greater than + 3.0dB or — 0.3 dB
2.8 kHz ±16 Hz	difference greater than 65 dB

(The characteristic with the filter inserted relative to the characteristic without the filter should not enter the hatched areas of the above figure.)

9.2 *Self-check*

The responding and directing equipments shall each incorporate a local self-checking facility on the transmission measuring unit which will bring in a local alarm and disable the unit when it is out of tolerance. This self-check should be applied at least daily. If they so wish, user Administrations may incorporate arrangements for making this self-check automatically.

10. *Optional arrangements*

10.1 *Automatic start*

In the long term, the operation of the ATME without any attention by technical personnel will be desirable. The addition of timed automatic start facilities to the ATME is required when unattended operation of the ATME is intended.

10.2 *Timed automatic selection of particular circuits or groups of circuits*

It may be desirable to select for test a particular circuit, or group of circuits, at specified times according to a prearranged programme, for example, noise measurement during busy and non-busy hours.

10.3 *Automatic repeat attempt*

It may be desirable to incorporate an automatic repeat test facility for circuits which have been rejected as faulty. The arrangement should permit an " automatic repeat attempt " of the relevant test cycle immediately following the first test.

10.4 *Switching pad test*

It is desirable to test the operation and accuracy of switched pads which may be used in international circuits. Normally, transmission measurements will be made with the pads in the " transit condition " (pads in). An optional arrangement should be provided to permit transmission measurements to be made with the pads at either or both ends switched out, under direction of the input programme. While it is possible to have the directing equipment remove the pads at its end of the circuit, it appears necessary to use different test codes to control the pads at the other end. Information concerning such codes will be issued separately and at a later date. In any case, when the pads are switched out, the directing or responding equipment will insert pads of equal nominal value in the measuring path.

10.5 *Interruption and instability during level measurements*

It may be desirable to detect an interruption or a condition of instability during the level measuring interval at the directing and/or the responding equipments. If such indications are available they will always be recorded by the directing equipment (see paragraph 3.4).

10.6 *Non-availability of responding equipment*

It may happen that, as a result of a failure at the responding end, all attempts made at the directing end to set up a call with a particular responding equipment will be unsuccessful—there may be no reply or the busy tone may be received. As this state of affairs could seriously affect the carrying out of a measurement programme as planned, it would appear to be desirable to ensure either:

- that this situation should give rise to an alarm signal if the directing equipment is operating under supervision;
- or that the directing equipment should be able automatically to select an alternative measurement programme if it is operating without supervision.

PART III

MEASUREMENT AND RECORDING OF CALL DURATIONS FOR ACCOUNTING IN INTERNATIONAL TELEPHONY

CHAPTER I

Measuring and recording call durations

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 duration 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 duration of automatic calls must be capable of detecting the two moments mentioned above and of measuring the interval between them.

1.2 When 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. [1]

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.

[1] In Recommendation E.250, paragraph 4.1.4., (Volume II.A) holding time is not recommended because of the wide variations between chargeable time and holding time in different relations and in different call types, which makes the use of holding time inappropriate for remunerating Administrations of countries of destination.

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 duration

All records of call duration 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 [1] (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 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.

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

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.

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

By way of example, Figure 1/Q.51 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;

c) for registers in groups ii and iv, equipment for analyzing 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.

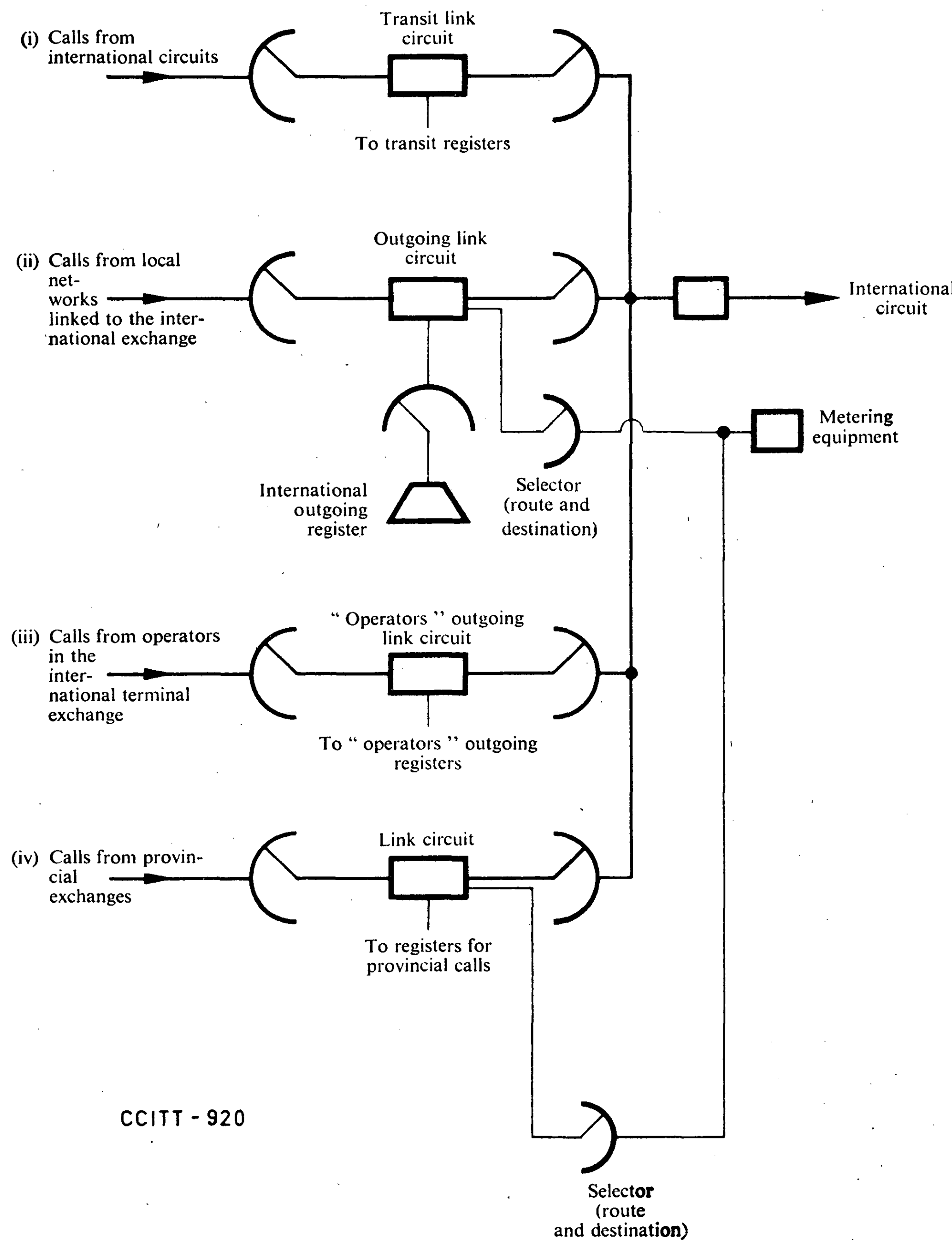


FIGURE 1/Q.51 — **Diagram giving an example of traffic distribution in an international exchange.**

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.81.)

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.

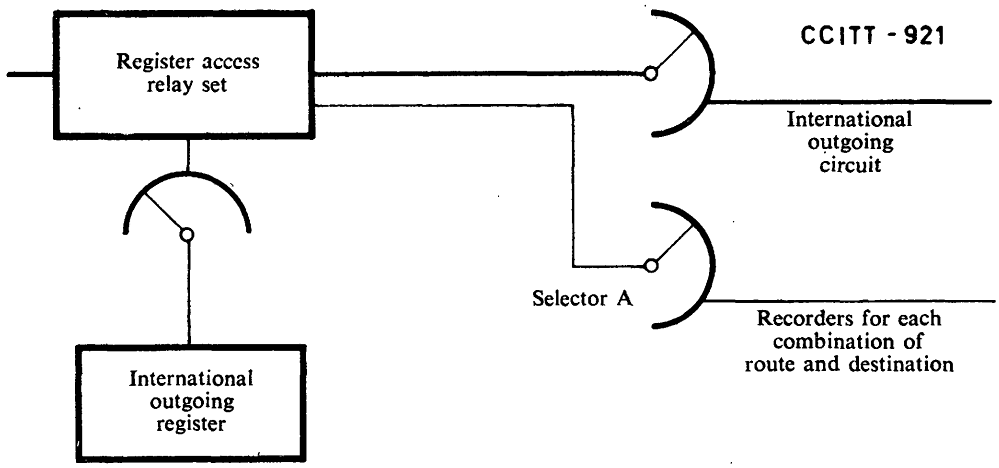


FIGURE 1/Q.52

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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Volume II-A	**Volume VI**
PART IV	PART IV
CHAPTER II	CHAPTER I

INTERNATIONAL NETWORK MANAGEMENT

Recommendation E.410	**Recommendation Q.55**

INTERNATIONAL NETWORK MANAGEMENT. RECOMMENDATIONS FOR PLANNING AND OPERATING PROCEDURES

1. *General considerations*

In recent years the demand for international telephone service has increased substantially. This demand has been met by advances in both technology and operating techniques. The growth of traffic has also required the development of larger transmission systems to provide economically the capacity to meet the recommended grades of service.

Now, with the continuing increase of automatic service, control over traffic offered to the international network will decrease, since an operator will no longer be involved in establishing the connection. When abnormal traffic peaks occur, or there are interruptions and failures of switching or transmission systems, the capability to manage the traffic flow must be available. Traffic congestion at one office, if uncontrolled, can spread and degrade the level of service throughout the international telephone network.

It may ultimately be desirable to have international network management on a worldwide basis. However, at this time there are reservations about the creation of a new international body to establish international network management. For the present it is suggested that it would be best left to the discretion of Administrations to agree bilaterally or multilaterally on the degree to which they would like to cooperate in introducing network management. The methods used, the experiences encountered and the benefits derived would then be of considerable value in developing more advanced international network management.

2. *Definition of network management*

Network management is the function of supervising a communications network to ensure maximum utilization of the network under all conditions. Supervision requires monitoring, measuring and, when necessary, action to control the flow of traffic.

3. *Objective of network management*

The objective of network management is to provide service protection and maximize the number of paid conversations by fully utilizing available equipment and facilities during normal and abnormal periods.

Network management still requires that the network in operation should be adequately engineered to meet normal volumes of traffic, the requirement for which is described in C.C.I.T.T. Recommendations Q.13, Q.85, Q.87, Q.88, Q.89, Q.95 and Q.95 *bis*.

4. *Gains that can be derived from network management*

4.1 Best possible service to the subscriber during abnormal periods by limiting the spread of congestion.

4.2 Continuity of essential services during breakdown and abnormal periods.

4.3 Maximum utilization of serviceable equipment under normal and breakdown conditions.

4.4 Improvement of traffic flow information.

5. *Classification of network management actions*

5.1 The need for the control of traffic may be generated by:

a) the failure of an international or national transmission system (see note),

b) congestion in a CT,

c) the failure of a CT,

d) congestion in a national network,

e) heavy traffic caused by any unusual condition.

Note. — All appropriate actions to restore a failed transmission system should be considered concurrently with traffic control actions. Under certain circumstances it may also be possible as an exception to augment trunks or circuits between switching centres by use of special facility arrangements such as the expansion of circuits in TASI systems or the use of two satellite links in tandem.

5.2 Network management actions fall into one of two broad categories:

— *Protective actions*, designed to remove from the network those calls having a low probability of successful completion. Such calls should be cancelled as close to their origin as possible, thus making more of the network available to calls with a higher probability of success. A correlated principle underlying protective actions is to improve the probability of completion for those calls which have progressed furthest into the network. This type of action would be taken in response to congestion in common control-switching systems, on final routes, or both.

— *Expansive actions* are those actions which are taken to make available lightly loaded facilities to traffic experiencing congestion on its normal routes.

Examples of *protective actions* are:

a) Cancellation of alternate routing via congested common control switching machine. This action must be taken in response to machine (common control) load indications which are transmitted to the switching centres involved.

b) Directionalization of international two-way trunk groups to favour traffic leaving the international network over that which is entering. This action is taken in response to network-congestion indications and is a function of trunk-group loads.

c) Partial cancellation of first-routed traffic in congested switching machines. This action is similar to item a where the machine is loaded with first-routed traffic.

d) Cancellation of alternate routing via congested final routes. This action could be taken in response to trunk and/or machine load information.

e) Recorded announcements to subscribers and special operator instructions. A recorded announcement may be provided at the originating end to advise operators (or subscribers) to take appropriate action during serious overloading of a segment of the network. A recorded announcement might be initiated at the originating CT upon receipt of a network-management signal and the language or languages of the originating country may be used (see note). The local management of the traffic operating personnel may also provide special instructions by means of locally generated announcements and/or verbal instructions. (Local switchboard indicators are sometimes used to request operators to listen to pertinent announcements.)

Note. — The attention of the "Human Factors" Working Party of Study Group II is directed to this proposal to recommend the use of locally applied recorded announcements as a means of notifying subscribers of difficulties in the use of the international service. Realizing that studies are being conducted on announcement methods and their effect on the use of the international services by foreign visitors, this Working Party is requested:

— to consider the use of recorded announcements as compared to tone indications, or other methods;

— to consider the types of recorded announcement which may be employed.

Expansive actions are principally rerouting from routes that are congested to others having spare capacity. Therefore, it may be desirable to alter normal routing procedure in response to abnormal traffic loads. This action requires extensive trunk-load information. To ensure that the quality of transmission is maintained when rerouting is required, the provisions of Recommendation E.171/Q.13 should apply.

Protective or expansive actions may fall into one of the following categories:

1) Prearranged by mutual agreement.

2) Initiated by the outgoing Administration at the time, e.g. suppression of traffic.

3) Negotiated by the Administrations involved at the time.

6. *Criteria* [1]

Data should be available in the network management data base for trouble conditions which can adversely affect engineered service levels. As a minimum requirement the following should be supervised:

6.1 *Switching centre equipment* to permit an exchange of switching centre status information between directly connected switching centres and, as a second priority, between any other centres where such information would be useful.

6.2 *All final routes.*

6.3 *Selected high-usage routes:* High-usage routes whose overflow traffic in case of overload would seriously congest the final route.

Bid [2] counters and overflow bid counters should be provided to determine the amount of circuit group congestion. These counters should be read during periods of heavy traffic previously established by office trends and during periods of abnormal conditions. In addition, visual indications—such as All Trunks Busy

[1] See Question 4/XIII.

[2] A *bid* is an attempt to obtain a circuit in a circuit group. A bid may be successful or unsuccessful in seizing a circuit in that group.

—on final and selected high-usage routes should initiate the reading of bid and overflow bid counters. To attain uniformity in the reporting and analysis of data, bid and overflow readings can be computed into the following relationships:

a) *Percentage overflow* indicates the relationship between the total quantity of bids offered to a circuit group, in a specified period of time, and the quantity of bids not finding a free circuit.

$$\frac{\text{Overflow bids}}{\text{Bids}} \times 100 = \text{Percentage overflow}$$

b) *Bids per circuit per hour* (BCH)

BCH is an indication of the average number of bids per circuit at each end of an international circuit group. Its purpose is to quickly identify the direction of the traffic pressure in a form that is easily discernible.

$$\frac{\text{Bids per hour}}{\text{Quantity of working circuits}} = \text{BCH}$$

c) *Seizures*[1] *per circuit per hour* (SCH)

SCH is an indication of the number of times, in a specific time interval, that each circuit in an international circuit group is seized. This information, when compared with coincident percent overflow and bids per circuit per hour (BCH) data, provides an indication of the reasonableness of the seizure rate, i.e. the proportion of bids which result in seizures. Circuit-group seizure rate can be pre-established by examining average holding time and other pertinent engineering data.

$$\frac{\text{Seizures per hour}}{\text{Quantity of working circuits}} = \text{SCH}$$

Decisions to initiate a network management action should be based on a system of continuous measurement of sufficiently rapid sampling and combinations of the above relationship. A data-collection system could function as frequently as every second on common control equipment. There is no apparent reason to record all of these data when conditions are normal and normal practice could be to record the nth sample. However, if a possible approach to a congestion condition was indicated, it is suggested that the sample be recorded and made available to the network management centre. The criteria defining the possible start of a congestion can be:

i) *Final circuit groups.* When the traffic intensity on the group reaches the prescribed figure for the specified grade of service on the route.
Data from bid and overflow counters taken at intervals of one quarter hour can be used for this determination.

ii) *Selected high-usage circuit groups.* When the proportion of overflow reaches the prescribed level. Data from bid and overflow bid counters taken at intervals of one quarter hour can also be used for this determination.

iii) *Switching equipment.* Where possible, the length of the queue waiting for access to common control equipment should be sampled in preference to straight-forward equipment occupancy. Other equipment should be supervised on the basis of equipment occupancy or the number of call arrivals per unit of time.

The actions or negotiations leading to traffic controls may be taken upon the receipt of appropriate network management signals (or notification by other means of communication) at the outgoing end. It is expected that these network management signals will normally be transmitted from the incoming end (at which point the congestion manifests itself) to the outgoing end but possibly in the reverse direction as well. Such actions may include the possibility of appropriate recorded announcements at the outgoing end to control the flow of traffic.

[1] A *seizure* is a bid for a circuit in a circuit group which succeeds in obtaining a circuit in that group.

Administrations should give consideration to the assignment of responsibility for negotiated traffic controls to a single location for a given international relationship.

7. *Network management signals*

A variety of network management signals may be transmitted to centres which may apply traffic controls to alleviate congestions or react to failures. The signals involved need only be transmitted to a selection of centres with CT status. Further retransmission within the national network should be at the discretion of Administrations. These signals may be transmitted on a common channel-signalling system, but may also be provided by other means of communication, to indicate the need or desirability of a traffic-control action. The network management signal involved could be arranged to indicate degrees and types of difficulties so as to communicate the need for one or more automatic traffic control actions or the possibility of one or more negotiated traffic-control actions. The specific number of signals to be used must depend on their availability and the additional development of network management.

The transfer of the initial message and the subsequent message which cancels the initial message should each be suitably acknowledged.

Typical network management signals may include the following information:

1. Codes to identify the origin and destination points involved.

2. Date and time of the data.

3. Trunk group occupancy, bid and overflow data: This information is used principally for the rerouting contemplated as the principal expansive action in paragraph 5. It may also be used for the protective actions, but in this case it is used locally and need not necessarily be transmitted anywhere.

4. Common control equipment occupancy or queue length indications: This information is used for both protective actions and expansive controls described in paragraph 5.

5. Measurement of seizure rate (e.g. proportion of attempts which result in seizures): Estimates of their magnitudes can be obtained from realizable measurements such as bids per circuit per hour (BCH) and seizures per circuit per hour (SCH) described in paragraph 6. These data can be used for protective actions.

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Volume II-A	**Volume VI**
PART IV	PART IV
CHAPTER III	CHAPTER II

CHECKING THE QUALITY OF THE INTERNATIONAL TELEPHONE SERVICE

Recommendation E.420 **Recommendation Q.60**

CHECKING THE QUALITY OF THE INTERNATIONAL TELEPHONE SERVICE. GENERAL CONSIDERATIONS

The methods of measuring the quality of service are as follows:

1. Service observations;
2. Test calls (simulated traffic);
3. Customer interviews.

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 1, 2 and 3 in Recommendations E.422/Q.61, E.423/Q.62, and E.424/Q.63.

Table 1 in Recommendation E.422/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 2 in Recommendation E.423/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 3 in Recommendation E.424/Q.63 is used to record the results of test calls undertaken especially when the observations shown in Table 1 make it clear that the percentage of faults is too high.

The use of customer interviews as a method of measuring telephone service quality is the subject of Recommendation E.425/Q.64.

Recommendation E.421 **Recommendation Q.60 bis**

SERVICE QUALITY OBSERVATIONS

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.

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 was considered in 1968 that the need for automatic observations would increase in view of the heavy cost associated with manual or semi-automatic observations on the rapidly expanding international network. It was also considered that automatic observations would 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]

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.

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[1] Item 3.7 of Table 1.

[2] Item 4.4 of Table 1.

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).

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.

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.

[1] For definitions of test access points see Recommendation M.64. See also Recommendation M.11.

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.

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%).

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 if there is 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 six weeks[2].

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].

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**

OBSERVATIONS ON 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 M.64, Part B.

Should certain Administrations wish to observe incoming traffic, too, the outcome of such observations could be entered in a similar form.

b) These observations should be conducted according to Recommendation E.421/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:

[1] I.S.C.C. = International Service Coordination Centre (see Recommendation Q.72).

[2] See Question 9/XIII.

How to fill in Table 1

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.

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, and 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].

---

[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.

TABLE 1

OBSERVATIONS ON 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 ______________ to ______________

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	6	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.

Recommendation E.423 **Recommendation Q.62**

OBSERVATIONS ON TRAFFIC SET UP BY OPERATORS

(See Table 2)

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

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 manoeuvres 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.

4. The number of effective calls observed considered in cateogry 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

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	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"				

TABLE 2 (*continued*)

8. Time-to-answer by operators	Total number of calls answered and unanswered		Calls answered				Calls unanswered (abandoned calls)					
			under 15 seconds		in 15 to 30 seconds		after 30 seconds		within 30 seconds		after 30 seconds	
Operators:	Number	Mean waiting time in seconds	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 Comments.

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 four 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.

d) *Subscriber-to-subscriber type test call*

A subscriber-to-subscriber type test call is a test call from a test equipment having the characteristics of an average subscriber line in one national network to a similar equipment in the national network of a distant country.

Test calls types 1, 2, 3 and subscriber-to-subscriber 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 periods.

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.

Subscriber-to-subscriber type test calls can be made by agreement of the I.S.C.C.s in the countries concerned.

Normally, unless there is a specific agreement between the Administrations concerned, subscriber-to-subscriber type test calls would be considered for fault location after:

1. verifying that there are no evident faults in the international switching centres involved that would cause the poor quality of service or subscriber complaint being investigated;
2. verifying that type 1 or type 2 test calls have been made on the international circuits that might have been involved;
3. verifying that there are no evident faults in the national network from the outgoing exchange to the international centre in the originating country;
4. verifying that there are no evident faults in the national network in the distant country, from the international centre to the called exchange.

When subscriber-to-subscriber type test calls are made, the I.S.C.C.s in the two countries should consider such factors as:

1. the expected nature of the fault;
2. international accounting agreements;
3. the need for making the calls in the busy hour;
4. the possibility of causing or aggravating congestion at the time the calls are made.

The responding equipments used for subscriber-to-subscriber type test calls could be those used for maintenance of the national networks.

2. *Results of test calls* (see Table 3)

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.

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]
Sub-to-Sub[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.)

[a] Delete whichever is inapplicable.

Recommendation E.425 **Recommendation Q.64**

INQUIRIES AMONGST USERS OF THE INTERNATIONAL TELEPHONE SERVICE

One method of measuring telephone service quality is to conduct inquiries amongst users to ascertain their opinions of and actual experience with various aspects of the service they use. These inquiries are usually made by means of questionnaires, which are designed to isolate the basic sources of user difficulty which may arise when making a call, from the means of obtaining the dialling information, setting up the call and any subsequent aspects, e.g. transmission quality.

To permit comparison and studies of the findings of these inquiries at the international level, it is considered desirable that all countries should use the same types of questionnaire.

It is therefore recommended that the following two types of questionnaire should be used:

a) Questionnaire for national subscribers dialling international calls. (See Annex 1.)

b) Questionnaire for visitors from other countries dialling national or international calls. (See Annex 2.)

It is intended that the questionnaires will be completed by staff specially instructed for the interview and not by the telephone user being interviewed. To ensure that this practice will be followed, together with others designed to secure uniformity of use, notes on the intended use are associated with the questionnaires.

The questionnaire for foreign visitors has been arranged so that it can be used for either national or international calls. It has been specifically related to the "last call" made by the visitor in order to obtain reasonably precise information; only the last few questions relate to the more general or cumulative experience of the telephone user. This does not preclude the use of the form for obtaining the same information on a general experience basis providing the interviewer is suitably instructed and completed questionnaires are annotated in a distinct manner and separated from the "last call" questionnaires.

As the main object of the questionnaires is to provide data which can be compared on an international basis, and used to resolve human factor difficulties, the questions asked will not completely meet the service and marketing department requirements of any one country. Administrations are asked to accept this limitation and to use the questionnaires as presented.

Note. — The data arising from replies to certain questions in these forms are also essential to the work of Study Groups XII (Assessment of service transmission quality) and XIII (Subscribers' opinion of service quality).

ANNEX 1

(to Recommendation E.425/Q.64)

INQUIRIES AMONGST USERS

Questionnaire for national subscribers dialling international calls

(For details of use, see associated notes following the questionnaire)

Interviewed by Visit ☐

Telephone ☐

Code		YES	NO
1.0	*Do you dial international calls to other countries yourself?* (If no) — ask *why not* and after answer terminate interview.	☐	☐
1.1	Reason .... (If yes) — proceed to questions below.		
	In regard to the last international call you dialled:		
2.0	*What country did you dial direct?*		
3.0	*Can you give me the town or telephone number you dialled?* Insert information		
	a) *Was the call to a private number?*	☐	☐
	b) *Was the call to a company? (Business subscriber)*	☐	☐
	c) *Did you dial direct to an extension in a PBX?*	☐	☐

Code		
4.0	*How long ago?*	
4.1	— less than 24 hours	☐
4.2	— one to seven days	☐
4.3	— more than seven days	☐

Code		YES	NO
5.0	*Did you have any difficulty in obtaining the telephone number for this call?*	☐	☐

Code		International prefix	Country code	Trunk code	Subscriber number
5.1	*Where did you get the number?*				
5.2	— official telephone directory	☐	☐	☐	☐
5.3	— special (pre-printed) telephone directory	☐	☐	☐	☐
5.4	— personal list	☐	☐	☐	☐
5.5	— letterhead	☐	☐	☐	☐
5.6	— information operator	☐	☐	☐	☐
5.7	— friends or business associates	☐	☐	☐	☐
5.8	— memory	☐	☐	☐	☐
5.9	— other (specify)........				

Code				*YES*	*NO*
6.0		*Did you have any difficulty in knowing how to make the international call?*		☐	☐ If no, go to 7.0
		(If yes) — *What difficulty?*			
6.1		— knowing the procedure for making a call	☐		
6.2		— knowing the international prefix	☐		
6.3		— knowing the country code	☐		
6.4		— knowing the trunk code	☐		
6.5		— knowing whether the addressee's number can be dialled	☐		
6.6		— trunk prefix wrongly included	☐		
6.7		— other (specify)........................			
7.0	a)	*Did you have to dial the international number more than once?*		☐	☐ If no, go to 8.0
		(If yes) — *Why?*			
7.1		Could not understand or was unsure of the tone or voice announcement received. (If this item is marked, proceed to b, c, d and e below).	☐		
7.2		— dialled incorrectly	☐	If any of these items are marked leave out b, c, d and e and proceed to f.	
7.3		— busy tone; engaged	☐		
7.4		— no reply; no answer	☐		
7.5		— heard nothing after dialling	☐		
7.6		— other (specify)........................			
7.7	b)	*Did you hear:*			
7.8		— *a tone?*	☐		
7.9		— *a voice announcement?*	☐		
7.10		— *both?*	☐		
7.11	c)	*Did the tone and/or announcement come in*			
7.12		— *during dialling?*	☐		
7.13		— *after dialling?*	☐		
7.14	d)	*Could you describe the tone or tell me what the announcement said?*			
7.15	e)	*What did you decide to do when you heard that tone and/or voice announcement?*			
7.16		— dialled again	☐		
7.17		— called the operator	☐		
7.18		— other (specify)........................	If marked go to 8.0		

Code			*YES*	*NO*
7.19	f) *How long did you wait before dialling again?*			
7.20	— less than one minute	☐		
7.21	— one to five minutes	☐		
7.22	— more than five minutes	☐		
8.0	*Did the person who answered use a language you did not understand?*		☐	☐
	(If yes) — *What did you do about it?*			
8.1	— disconnected and dialled the operator	☐		
8.2	— flashed the operator	☐		
8.3	— dialled again later	☐		
8.4	— other (specify)..			
9.0	*Which of these four words comes closest to describing the quality of the connection during conversation?*			
9.1	— *excellent*	☐		
9.2	— *good*	☐		
9.3	— *fair*	☐		
9.4	— *poor*	☐		
10.0	*Did you or the person you were talking to have any difficulty in talking or hearing over that connection?* (If answer is "yes" probe for nature of difficulty, but without suggesting possible types of difficulty, and copy down answers verbatim: e.g. "*Could you describe the difficulty a little more?*")		☐	☐
	(At end of inerview, categorize the answers in terms of the items below):			
10.1	— Low volume	☐		
10.2	— Noise or hum	☐		
10.3	— Distortion	☐		
10.4	— Variations in level, cutting on and off	☐		
10.5	— Crosstalk	☐		
10.6	— Echo	☐		
10.7	— Complete out off	☐		
10.8	— Other (specify)			

Could you give the following additional information

Code			*YES*	*NO*
11.0	*Type of telephone set used?*			
11.1	— rotary dial	☐		
11.2	— push button	☐		
11.3	— repertory dialler (type)	☐		
11.4	— coin box	☐		
11.5	— loud-speaking telephone	☐		
12.0	*Approximately how many international calls do you make per month?*			
12.1	— 1 or less	☐		
12.2	— 2 to 5	☐		
12.3	— 6 to 10	☐		
12.4	— 11 or more	☐		
13.0	*How many different countries did you call during the preceding month?*	☐		
13.1	*Approximately how many different international numbers do you call?*			
13.2	— 1 to 5	☐		
13.3	— 6 to 10	☐		
13.4	— 11 to 19	☐		
13.5	— 20 or more	☐		
14.0	*Are there any other comments you would like to make about international subscriber dialling?* (Specify)			
15.0	*What do you find most difficult in dialling international calls?* (Specify)			
16.0	*Are you:*			
16.1	a) *a business subscriber?*		☐	☐
	(If yes)			
16.2	— *the person in a firm mainly responsible for telecommunications?*	☐		
16.3	— *the PBX operator?*	☐		
16.4	— *a secretary?*	☐		
16.5	— *an extension user? (Other than 16.2)*	☐		
16.6	b) *a residential subscriber?*		☐	☐
16.7	c) *other user?* (Specify)			

ANNEX 2
(to Recommendation E.425/Q.64)

Questionnaire for visitors from other countries dialling national or international calls

(For details of use see associated notes following the questionnaire)

Code

1.0 *In which country do you live?* ....

1.1 *In which country do you make most of your telephone calls?*

....

		YES	NO
2.0	*Have you visited our country before?*	☐	☐
		If no, go to 3.0	

How many times?

2.1	— once	☐
2.2	— 2 to 5 times	☐
2.3	— more than 5 times	☐

3.0 *Do you understand our language?*

3.1	— well	☐
3.2	— fair	☐
3.3	— not at all	☐

4.0 *Did you yourself dial any telephone calls in this country?* ☐ ☐

If yes, go to 5.0

(If no), ask *why not* and terminate interview, indicate reason below.

4.1	— did not know how to make a call	☐
4.2	— no need to make a call	☐
4.3	— my calls were placed by somebody else	☐
4.4	— other reasons	

5.0 *Was this visit the first time you had experience with this country's telephone system?* ☐ ☐

6.0 *Approximately how many calls did you dial during this visit?*

		National	*International*
6.1	— 1	☐	☐
6.2	— 2 to 5	☐	☐
6.3	— 6 or more	☐	☐

Code

Code		National	International
7.0	*Was the last call you dialled a national or international call?*	☐	☐

7.1 (If international) — *To which country did you make the call?*

(Specify) ....

7.2 *How long ago is it since you made this call?*

7.3	— less than 24 hours	☐
7.4	— one to seven days	☐
7.5	— more than seven days	☐

8.0 *Where did you get the number?*

8.1	— official telephone directory	☐
8.2	— special (pre-printed) telephone directory	☐
8.3	— personal list	☐
8.4	— letterhead	☐
8.5	— information operator	☐
8.6	— friends or business associates	☐
8.7	— memory	☐
8.8	— other (specify)..................	

		YES	*NO*
9.0	*Did you have any difficulty in knowing how to make a call?*	☐	☐
		If no, go to 10.0	

(If yes) — *What difficulty?*

9.1	— knowing the procedure for making the call Go to 9.5 if the call is national	☐
9.2	— knowing the international prefix	☐
9.3	— knowing the country code	☐
9.4	— trunk prefix wrongly included	☐
9.5	— knowing the trunk code	☐
9.6	— knowing whether the addressee's number can be dialled	☐
9.7	— obtaining information for addressee's number	☐
9.8	— other (specify)..................	

Code		YES	NO
10.0	a) *Did you have to dial the number more than once?*	☐	☐ (If no) go to 11.0
	(If yes) — *Why?*		
10.1	— could not understand or was unsure of the tone or voice announcement received. (If this item is marked proceed to b, c, d and e below.)	☐	
10.2	— dialled incorrectly	☐	If any of these items are marked, leave out b, c, d and e.
10.3	— busy tone; engaged	☐	
10.4	— no reply; no answer	☐	
10.5	— heard nothing after dialling	☐	
10.6	— other (specify)		
10.7	b) *Did you hear:*		
10.8	— *a tone?*	☐	
10.9	— *a voice announcement?*	☐	
10.10	— *both?*	☐	
10.11	c) *Did the tone and/or announcement come in:*		
10.12	— *during dialling?*	☐	
10.13	— *after dialling?*	☐	
10.14	d) *Could you describe the tone or tell me what the announcement said?* (Specify)		
10.15	e) *What did you decide to do when you heard that tone signal and/or voice announcement?*		
10.16	— dialled again	☐	
10.17	— called operator	☐	
10.18	— other (specify)		
11.0	*When the call was established, did the person who answered use a language you did not understand?*	☐	☐ If no, go to 12.0
	(If yes) — *What did you do about it?*		
11.1	— disconnected and called the operator	☐	
11.2	— flashed the operator	☐	
11.3	— dialled again later	☐	
11.4	— other (specify)		

Code

12.0 *Which of these four words comes closest to describing the quality of the connection during conversation?*

12.1 — *Excellent* ☐
12.2 — *Good* ☐
12.3 — *Fair* ☐
12.4 — *Poor* ☐

13.0 *Did you or the person you were talking to have any difficulty in talking or hearing over that connection?* *YES* ☐ *NO* ☐

(If answer is "yes" probe for the nature of difficulty, but without suggesting possible types of difficulty and copy down answers verbatim) e.g. "*Could you describe the difficulty a little more?*"

(At end of interview, categorize the answers in terms of items below):

13.1 — low volume ☐
13.2 — noise or hum ☐
13.3 — distortion ☐
13.4 — variations in level, cutting on and off ☐
13.5 — crosstalk ☐
13.6 — echo ☐
13.7 — complete cut off ☐
13.8 — other (specify)..

14.0 *Have you used a coin telephone in our country?* ☐ ☐

14.1 (If yes) *Did you have any difficulty in knowing how to use it?* (If yes, probe non-directively to determine the nature of the difficulty.) (Specify).. ☐ ☐

....

15.0 *Have you used our directory to look up a number or for information on the use of the telephone?* ☐ ☐

15.1 (If yes) *Did you hare any difficulty finding what you wanted?* If yes, prob non-directively to determine the nature of the difficulty.) (Specify) ☐ ☐

....

16.0 *Are there any other comments or suggestions you would like to make about the telephone service in this country?*

16.1 — *In general?* (Specify) ....

....

16.2 — *Based on your first few calls?* (Specify)..

....

NOTES ON INTENDED USE OF QUESTIONNAIRES

1. *General*

These notes apply to both types of questionnaire, i.e.:

a) Questionnaire for national subscribers dialling international calls.

b) Questionnaire for visitors from other countries dialling national or international calls.

Both questionnaires have been designed for face to face interviews or for interview by telephone. *They are not of a suitable form* to be passed direct to a telephone user by hand or by post for them to fill in personally.

2. *Use of questionnaires*

With the above in mind the following points should be adhered to in order that valid comparisons may be made at an international level.

1) The interviews will need to be conducted by a trained interviewer capable of clearly understanding the various technical terms used in the sub-sections in order to categorize the interviewer's replies, which may be very simply or vaguely expressed. In certain questions he or she may need to probe for clarity without suggesting or prompting answers.

2) In the event of the questionnaires having to be translated *for use by the interviewer* into languages other than English, French or Spanish, i.e. those languages for which the C.C.I.T.T. Secretariat will already hold copies of the questionnaires, care must be exercised to avoid any change of meaning of the questions.

3) In conducting the interview the order of questions and the precise wording should be followed, i.e. the interviewer should avoid re-expressing a question in his own words.

4) It is intended that *only the questions in italics* should be asked by the interviewer. The sub-sections in type are to be used by the interviewer to categorize the answers.

5) As far as possible all the questions should be asked; however in the rare event of embarrassment occurring, for example with the use of questions 1.0 and 1.1 on the foreign visitor questionnaire, these should be omitted.

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Volume IV | **Volume VI**

PART I | **PART V**

SECTION 3.3 | **CHAPTER I**

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 | **Recommendation 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.

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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.

Circuit and automatic equipment maintenance includes:

a) the carrying out of setting-up measurements and adjustments [1];

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.

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.

controlled maintenance [2]

A method to sustain a desired quality of service by the systematic application of analysis techniques using centralized supervisory facilities and/or sampling to minimize preventive maintenance and to reduce corrective maintenance.

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 [3]

A test made to indicate whether a quantity would fall within or outside a pair of limits or boundaries.

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[1] 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.

[2] See Supplement No. 1.4 of Volume IV of the *Green Book* for a controlled maintenance method.

[3] Such a test might be made to ascertain the margin of security in actual operating conditions.

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

— *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 **Recommendation 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 Cooperation 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/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 *Green Book*, Volume IV (for transmission) and in Volume VI (for switching).

The international service coordination 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.

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.

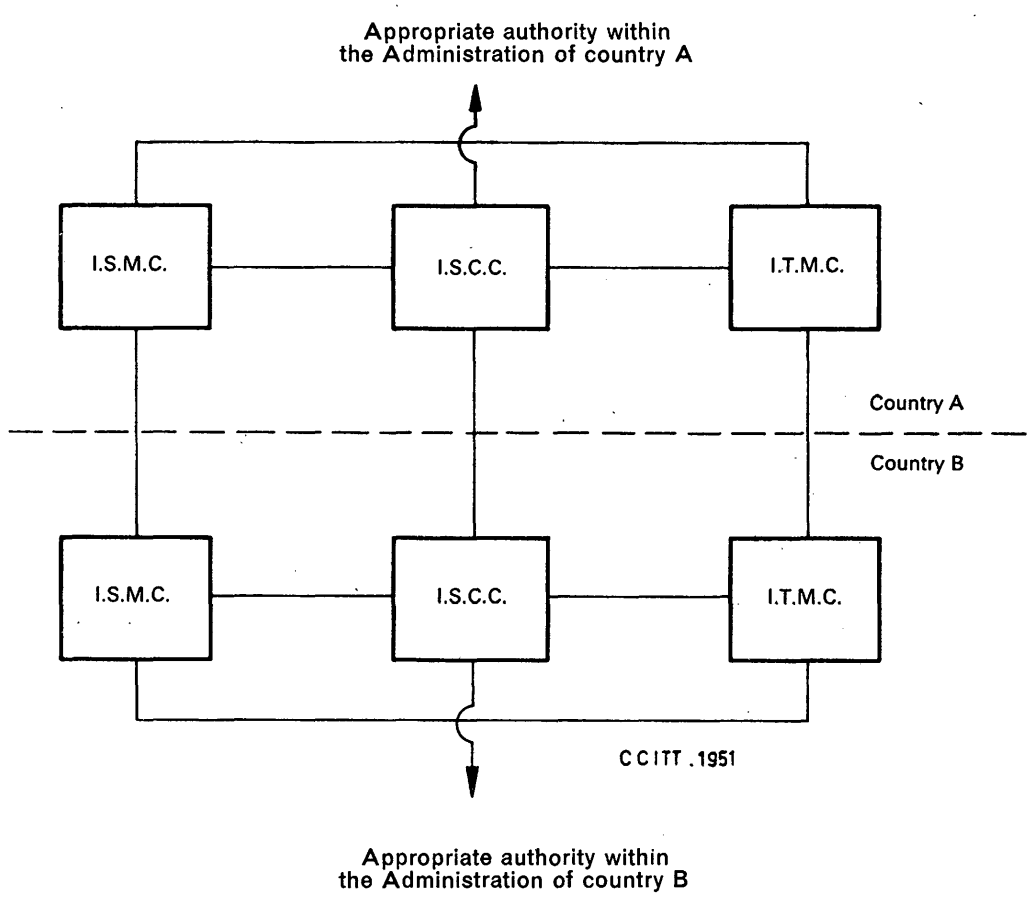
2.5 These three centres are known in C.C.I.T.T. Recommendations as:

— International transmission maintenance centre (I.T.M.C.)

— International switching maintenance centre (I.S.M.C.)

— International service coordination centre (I.S.C.C.)

(see Figure 1/M.71/Q.71).



I.T.M.C. = International transmission maintenance centre
I.S.M.C. = International switching maintenance centre
I.S.C.C. = International service coordination centre

FIGURE 1/M.71/Q.71.

Recommendation M.71 ***bis*** **Recommendation Q.71** ***bis***

STATUS AND RESTORATION OF THE INTERNATIONAL AUTOMATIC SERVICE

(Provisional Test) [1]

1. General

This Recommendation defines a set of functions to be fulfilled by staff or equipment in one or more central point(s) for collecting data and disseminating information concerning non-availability of telecommunication systems which affect the international automatic services. These functions are indicated for guidance of Administrations who wish to designate a point or points to carry out such functions. These functions can be combined partly or entirely with functions already carried out by existing units or handled by a separate entity. It is left to the Administration concerned to decide whether to keep the functions separate or combine them in a manner to suit the Administration. As a guide the following functions are suggested.

2. Functions concerning information on major breakdown

2.1 Information concerning major breakdowns or special circumstances in the *international* network which would materially affect international traffic, whether incoming, outgoing or transit should be collected.

2.2 Information concerning major breakdowns or special circumstances in the *national* network which would materially affect *international* traffic should be collected. These parameters should be established by the Administration concerned. This information should be made available to other interested parties as quickly as possible, and as appropriate.

2.3 The probable duration of a major breakdown should be determined. It should also be determined whether the traffic load is such that service is likely to be affected.

2.4 Information pertaining to restoration activities should be ascertained.

2.5 During a major breakdown information pertaining to the failure and restoration activities should be collected in order to answer questions from centres not involved in the actual repair work regarding the progress of restoration.

3. Functions concerning restoration plan

3.1 The restoration plan for international telecommunication systems should be examined to determine the extent to which a restoration is possible.

3.2 In the event of a major breakdown, ensure that the appropriate restoration plan is being implemented by the responsible parties.

3.3 If no restoration plan exists or, for some reason, an existing plan cannot be implemented, suitable alternatives should be suggested to the responsible authorities in the light of the information available.

3.4 Information should be collected pertaining to:

a) the progress made in implementing the plan;
b) changes in plans already being implemented;
c) fault clearance; and
d) restoration of normal conditions.

[1] This is a provisional Recommendation because the matter needs further thorough study in the 1973-1976 study period. The influence on the other services has to be studied, especially in the light of the proposed new wording of Question 9/IV.

4. Functions concerning traffic

4.1 During periods of abnormal conditions, when necessary, reports should be furnished to the operating authorities. These should include progress reports in cases of prolonged disruption.

4.2 Traffic operating personnel should be advised when a major breakdown occurs so that suitable instructions may be given about changes in operating procedures, etc.

4.3 There may also be a requirement for notifying, through the appropriate authorities, other international centres of the action which has been taken so as to ensure that necessary changes in operating procedures, etc., are made.

Recommendation M.72 **Recommendation Q.72**

INTERNATIONAL SERVICE COORDINATION CENTRE (I.S.C.C.)

1. The appropriate service, which will analyze information from various sources in regard to international network performance at each international centre or in complex arrangements for more than one international centre, is the international service coordination centre (I.S.C.C.).

There are advantages in having only one I.S.C.C. in each Administration. However, if an Administration finds it necessary to have more than one I.S.C.C. it is desirable to designate a single I.S.C.C. as the operative one for a group of international centres concerned with a given relation, to make it unnecessary for another Administration to contact more than one I.S.C.C. It is recognized that in certain cases it may be impractical in some Administrations to apply this principle of a single I.S.C.C. for a given relation. Such I.S.C.C.s should be interconnected and the Administration may nominate one of the I.S.C.C.s (or other central organization) to process and coordinate the activities of the various I.S.C.C.s as required.

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 analyze information from various sources such as the items listed in paragraph 5 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 cooperate 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 analyze information as quickly as possible, using all the means at the disposal of the Administration;

4.6 To cooperate with the I.S.C.C.s of other countries in order to coordinate action in case of service defects and congestion existing in the part of the network depending on those I.S.C.C.s.

5. The I.S.C.C. should receive all information necessary for the evaluation and supervision of the quality of the international service. It is recommended that the following items be considered:

— Regular call failure reports from operators and subscribers;
— Traffic service observations for preparation of Recommendation Q.61, Table I and Table II;
— Traffic service observations undertaken for specific purposes;
— Results of manual and automatic test calls;
— Reports from I.S.C.C.s of other Administrations and also from I.T.M.C.s and I.S.M.C.s of its own Administration;
— Summary information from group reference pilots;
— Information from automatic supervision of switching equipment;
— Information that all circuits on a route are busy;
— Summary information from international accounting equipment;
— Information from special circuit and circuit group surveillance equipment;
— Periodic data from traffic measuring equipment, e.g. loading in Erlangs, percentage occupancy and overflow intensities;

In addition, maintenance centres may wish to pass summaries of transmission measurements to their own I.S.C.C.(s).

It is necessary for the I.S.C.C. to receive all information as quickly as possible and it should therefore be provided with the facilities listed in Recommendation Q.71 (M.71), paragraph 2.3.

6. The I.S.C.C. must also have the following documentation:

— 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. 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.

8. 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.

[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.

Recommendation M.73 **Recommendation Q.73**

MAINTENANCE METHODS

1. General

In order to meet the service demands of a progressive and rapidly expanding international full automatic telephone network with the best possible quality of service, it is essential that all factors adversely affecting the quality of service should be detected and service restored as quickly as possible. This objective recognizes the fact that perfect performance is unattainable and that beyond a certain point, costs can rise sharply out of proportion to service quality gain.

When choosing a suitable maintenance method or a combination of methods one should consider:

— the reliability of the plant to be maintained;

— the availability of testing and supervisory facilities as well as the availability and quality of manpower in the maintenance organization;

— the availability of facilities in the plant that indicate the existence and frequency of disturbances₂

— the availability of arrangements for automatic remedial action;

— the availability of automatic means to process and analyze operational data received from the plant;

— that the objective is to ensure a satisfactory overall service quality (subscriber-to-subscriber) in the international connection, giving equal importance to the national and international parts of the chain that constitute the connection.

It is recognized that a combination of maintenance methods may be applied.

Reference is made to Supplement No. 1.4 in Volume IV of the C.C.I.T.T. *Green Book.*

2. Preventive maintenance methods

2.1 *Functional tests*

2.1.1 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.

2.1.2 Functional tests are carried out locally, or from either end of an international circuit to the other.

2.1.3 The organization of the programme for carrying out functional tests locally is left to the discretion of the Administration responsible for the international exchange.

2.1.4 Overall functional tests on an international circuit are such that they can be made from one end of the circuit without cooperation 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.

2.2 *Circuit limit tests*

2.2.1 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.

2.2.2 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.

2.2.3 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.

2.3 *Limit tests on the constituent parts of a circuit*

2.3.1 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.

2.3.2 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.

2.3.3 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.

2.3.4 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.

2.4 *Maintenance measurements*

2.4.1 *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.

2.4.2 *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.

2.4.3 *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. *Green 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.

3. Corrective maintenance methods

These methods may apply to certain parts of the plant where it is possible to locate and clear faults solely after they have affected the service. Corrective maintenance, if exclusively practised in the entire plant, can create unsatisfactory service conditions due to extreme variations in functional quality and can cause very irregular application of maintenance effort.

The application of exclusively corrective maintenance methods would presuppose such system design that even if breakdowns of single units or parts of the plant occur, they should have a minor effect on the service quality offered the subscribers.

4. Controlled maintenance methods

Whereas it has been the practice to undertake programmes of preventive maintenance procedures together with day-to-day corrective maintenance procedures, recent equipment development has made it possible to introduce new maintenance methods. Modern systems can provide immediate information of irregularities and of abnormal conditions. Although preventive maintenance gives a comparatively good service, the number of defects caused by interference of preventive operations may be considerable.

A maintenance method utilizing the supervising facilities now available may enable the maintenance organization to reduce considerably preventive routines in the maintenance work. Preventive routines may then be replaced by methods of continuous supervision of the function of the plant and by means which check continuously the performance of the equipment and give signals to the maintenance staff when the quality of service is below a present acceptance limit. Alternatively, when facilities for continuous supervision are not available, a sampling technique could be introduced to determine the number of routine tests necessary to gain a reasonable assurance that all equipments are in proper order.

Introduction of a system of maintenance control of this kind will necessitate a certain degree of centralization of administrative and technical means in the maintenance organization. Rapid and informative indication of the state and performance of the international and concerned parts of the national network is required from the maintenance point of view at strategic points in the network.

Various information of operational conditions in the plant can be utilized for maintenance supervision purposes, such as:

— traffic data;

— accounting data;

— maintenance data;

— service performance data.

Such data may be analyzed manually but could also be processed by computers, allowing for a more extensive analysis, for instance, to compare performance statistics with preset standards which are set for particular routes, circuits, etc. Information held in the computer store may be extracted on-line and could be made directly available to those maintenance and management centres where it is required.

Application of computer processing as described necessitates a high degree of centralization, but also other factors support a centralized maintenance organization such as the increasing use of network management signals. The introduction of processor controlled switching and digital transmission systems is also expected to increase the possibilities to apply remote controlled and centralized maintenance supervision methods in the future.

Relevant recommendations with regard to the establishment of centres for:

— analysis of information on the international network performance; and

— for supervision of maintenance in the international automatic service;

are given in Volume IV and Volume VI.

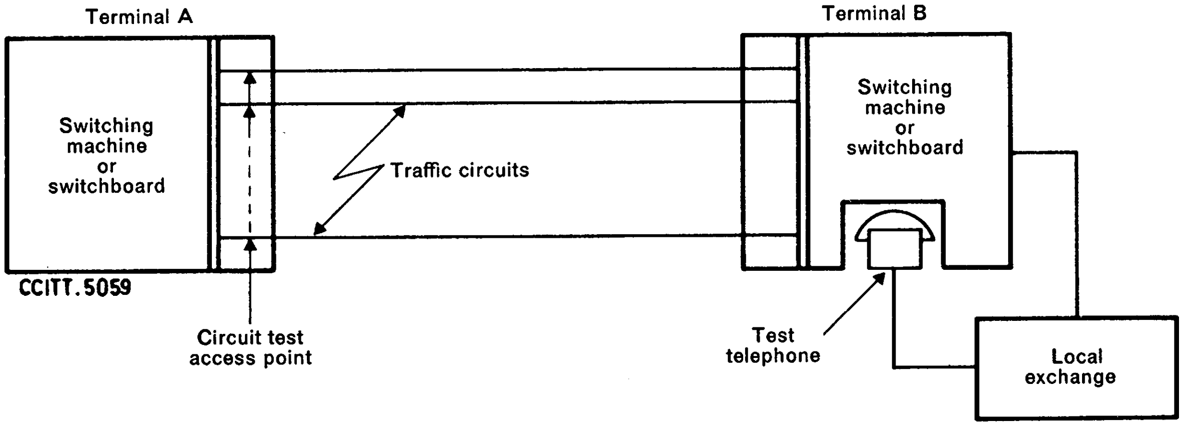
Recommendation M.73 *bis* **Recommendation Q.73 *bis***

SUBJECTIVE TESTING

Public network circuits may be tested subjectively to reveal gross faults by systematic test calls from circuit terminal A to a telephone located at circuit terminal B. Such test calling may be done independently of all other tests or combined with functional signalling tests as described in the " second method " in Recommendations Q.139 and Q.163 for signalling systems 4 and 5, respectively. Such test calls may be classed as " Type 3 test calls " as defined in Recommendation Q.63 (E.424). They may be applied on a periodic basis for systematically checking each trunk in a group for excessive echo, clipping, loss, noise, distortion and crosstalk. Any fault suspected as a result of this subjective check should be investigated in the normal manner. When " Type 3 test calls " are used in this manner, a test telephone is assumed to exist at the distant international centre. The test telephone is connected to a local exchange not located at the same point as the international centre so as to permit a realistic appraisal of the service quality. The test should be initiated at the outgoing terminal for one-way circuits and at both terminals sequentially on both-way circuits. Such test calls for checking service quality should be scheduled with the distant international centre during light load periods.

Another method of subjective testing that may be alternatively considered involves " Type 1 test calls ", as defined in the above recommendations. It permits systematic evaluation from terminal A to a location at terminal B which would not consist of a test telephone but rather a test location at terminal B that is not associated with a local exchange. Such an arrangement might not be as effective in detecting echo control problems (since the simulation of a normal connection would be less realistic) but might be useful when the first technique suggested above is impractical due to local conditions.

In order to obtain the greatest value from such tests it might be advantageous to apply them in association with the tests prescribed in Recommendation M.61 and with " in-station " tests such as those for maintenance of echo suppressors.



[1] If possible, not located at the same point as terminal B so as to develop a realistic return loss.

FIGURE 1/M.73 *bis*/Q.73 *bis*. — **Use of a " Type 3 test call " for systematic circuit evaluation.**

Recommendation M.74 **Recommendation 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 coordination centre staff.

2. Reporting service defects to the international service coordination centre

As a general rule, the international service coordination centre should receive fault reports from the following sources:

a) operators;

b) customers;

c) service observation staff;

d) other international service coordination 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 coordination 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 coordination centre of their own country.

3. Action to be taken by the international service coordination centre

If, as a result of analysis, the general location of a fault is clear, the international service coordination centre will refer details of its findings to the appropriate service which will endeavour to locate the fault and advise the international service coordination centre of the results achieved.

If the analysis does not give a clear indication of the location of a fault, the international service coordination centre may request the service that it deems most appropriate to undertake an investigation without delay to locate the fault.

Recommendation Q.75 [1]

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.

[1] See also Recommendation M.64, Part B.

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 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.

CHAPTER II

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	Monthly or more often in accordance with Recommendation Q.139, 5.7.2	Monthly and in accordance with Q.139, 5.7.3	Yearly and in accordance with Q.139, 5.7.4
	Automatic	Daily and to be specified in a new Recommendation		
No. 5	Manual	Monthly or more often in accordance with Recommendation 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 Recommendation 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.

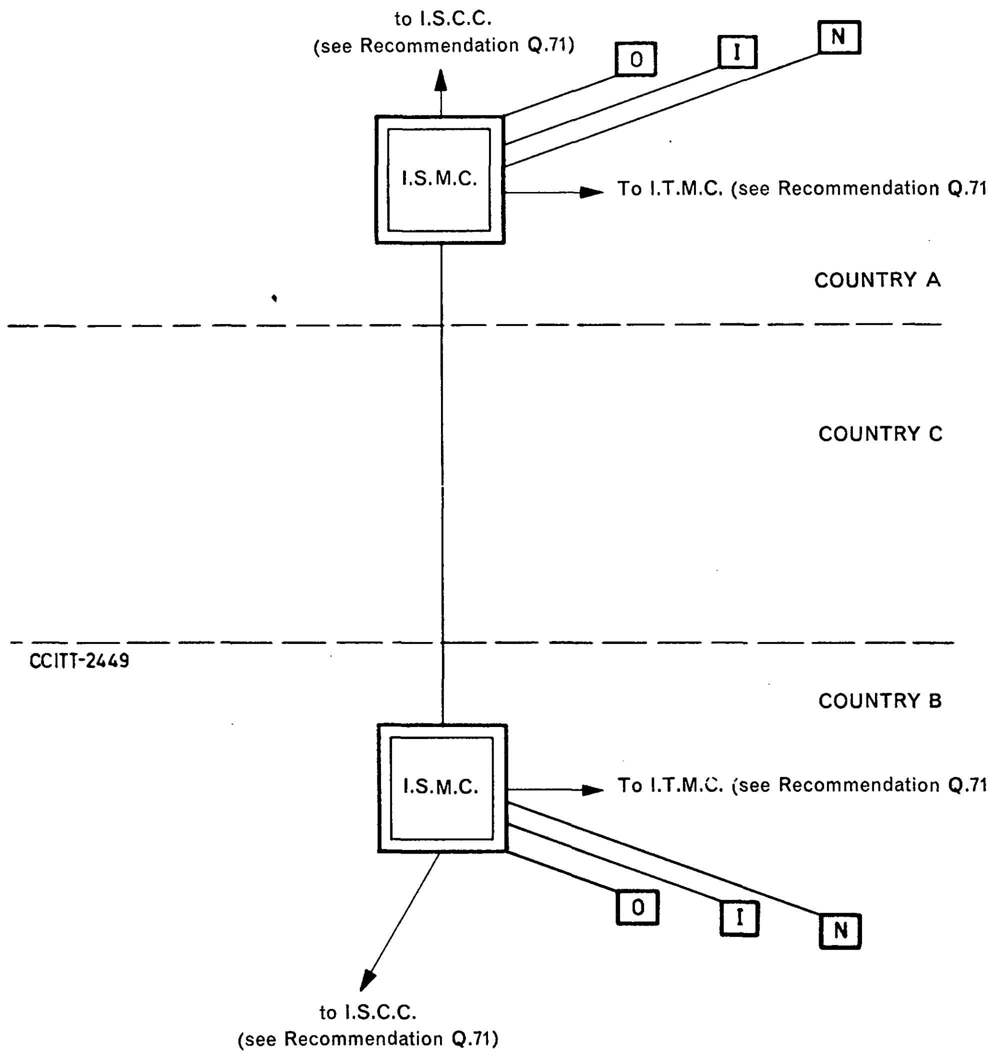
1.2 The size and complexity of the maintenance organization will depend on the particular case and the particular country concerned. In some instances it may be possible to carry out all functions from a single centre; in others each function may be carried out from separate locations or alternatively 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 cartered 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.



Legend

I.S.M.C. = International switching maintenance centre
I.T.M.C. = International transmission maintenance centre
I.S.C.C. = International service coordination 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/Q.78. — **Interrelations of I.S.M.C. and associated services.**

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 coordinate 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 Recommendations Q.78 *bis*, Q.78 *ter* and Q.79.

i) a " testing centre " responsible for setting up, lining up and subsequent maintenance of the signalling and switching equipment 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.

Recommendation Q.78 *bis*

TESTING CENTRE IN AN I.S.M.C.

1. Definition of an I.S.M.C. testing centre

One of the basic features of the I.S.M.C. is the testing centre which is responsible for the initial adjustment and subsequent maintenance to agreed standards, of the signalling and switching equipment in the international exchange with which the I.S.M.C. is associated.

2. Test access points

2.1 Recommendation Q.70 gives the definition of an international automatic circuit used for telephone service. " Access points " as recommended in Recommendation M.64 of the C.C.I.T.T. *White Book* are required to enable initial adjustment and subsequent maintenance operations to be performed on such a circuit.

2.2 The I.S.M.C. testing centre should have " circuit access points " (as described in Recommendation Q.75) for all circuits in the telephone service in order to conduct signalling and switching tests that require the use of a circuit. These access points will also need to be used by the circuit testing centre (see Recommendation M.11 in Volume IV).

3. Measuring and testing equipment (signalling and switching)

3.1 The basic types of equipment needed by an I.S.M.C. for the testing of international public telephone circuits, are as follows:

3.1.1 Equipment for signalling tests.

3.1.2 Equipment for switching tests.

3.3.3 Signal encoders consisting of:

a signal generator with facilities to vary frequency, amplitude and timing within defined limits, in conjunction with:

a test call generator, so that test calls, using nominal or marginal signals, can be generated.

3.1.4 *Signal decoders*

A device capable of responding to incoming signals such as to indicate whether or not the received signals are within limits.

3.1.5 *Signal displays*

A device capable of displaying the signals, line or register, transmitted or received by a circuit. The display should preferably be in digital form.

3.1.6 *Signal timers*

A device capable of measuring the length of and interval between line and register signals, transmitted or received over a circuit.

3.1.7 Signal level measuring device.

3.1.8 Signal distortion measuring device.

3.1.9 Signal recording device, for permanent records of line and register signals.

3.2 The implementation of the world-wide transmission and switching plans makes 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 the type of measurement to be made.

4. Responsibilities and functions

4.1 The testing centre should be responsible for the maintenance of switching and signalling equipment associated, directly and indirectly, with all circuits terminated in the exchange. (It is recognized that in some Administrations the responsibility for line signalling maintenance is assigned to the I.T.M.C.)

4.2 To carry out these responsibilities it is necessary for the centre to perform the following functions:

4.2.1 Arrange for the setting up and adjustment of all signalling and switching equipment associated directly and indirectly with circuits in the exchange, keeping accurate records of initial and subsequent measurements.

4.2.2 Ensure that routine maintenance tests as recommended in Recommendations Q.76 and Q.77 as well as any other appropriate Q Recommendations are carried out on the prescribed dates, in such a way that service interruptions are kept to a minimum.

4.2.3 Maintain and accurately calibrate traffic recording devices and other equipment available at the centre, as these are important aids to maintenance, forecasting and network management.

4.2.4 Ensure that, when a possible signalling or switching fault is reported to it, action is taken to conduct the various tests in cooperation with other centres where necessary in order to confirm the existence of and the broad location of the trouble, and to advice the circuit control station within its own Administration (or terminal subcontrol if such be the case) or other centres as may be appropriate at any time of the day or night.

4.2.5 Ensure that full use is made of local test procedures before calling upon the assistance of other centres.

4.2.6 Keep accurate records of all incidents which arise, giving the time of occurrence, the exact location, the cause, the action taken and the time of restoration to service.

4.2.7 Inform the appropriate centre of any faults or difficulties arising at the switching centre which might affect the quality of service.

4.2.8 Seek the authority of the circuit control station [1], within its own Administration (or terminal sub-control if such is the case), where it is found necessary to withdraw a circuit or circuits from service. In the case where a circuit fault can cause a major failure of a group of circuits it should withdraw the circuit from service and then advise the circuit control station within its own Administration (or terminal sub-control, if such is the case).

4.2.9 Cooperate with other centres as required.

4.2.10 Take prompt action to enable circuits to be restored to service by advising the circuit control station within its own Administration (or terminal sub-control if such is the case) as soon as a circuit has been cleared of faults.

Recommendation Q.78 *ter*

FAULT REPORT POINT IN AN I.S.M.C.

1. Fault reporting

1.1 *General*

For the maintenance of international telephone circuits, switching systems and signalling systems, it is necessary to have recognized points to which faults shall be reported (see Recommendation Q.74/M.74).

The I.S.M.C. shall have such a point and shall act on these faults reported to it at any time of day or night according to a procedure specified by each Administration.

[1] The term " circuit control station " designates that location which controls the placement and removal of a circuit in service and other functions as defined in the *Green Book*, Volume IV.

1.2 *Control of fault clearance*

When a fault report or report of service difficulty is received by an I.S.M.C. fault report point, action should be taken to identify the fault or difficulty.

Where as the result of the initial action taken the fault is proved to be on or to affect a circuit, such a fault should be reported to the circuit control station [1] within its own Administration (or terminal sub-control, if such be the case).

Where as a result of the initial action taken the fault is proved to be in the automatic equipment, local procedures will be followed.

Where the initial action taken indicates the possibility of a fault in the next international exchange, or in any subsequent international circuit or exchange, cooperation from the staff at the next international exchange should be obtained in order to effect a broad location of the fault.

Where any automatic aids to fault location are available at the next international exchange, these should be used to the full before calling upon the assistance of the staff at the centre concerned.

Where the trouble is proved beyond the next international exchange, the I.S.M.C. in that centre centre should take over the responsibility for the location and clearance of the fault.

For the responsibilities of signalling and switching test centres see Recommendation Q.78 *bis*, paragraph 4.

2. Sources of fault reports

In general, fault reports will be received from the following sources:

2.1 Staff at the switching centre for faults arising from:

— local alarms and supervisory devices;

— routine maintenance and functional tests.

2.2 Maintenance staff at the international transmission maintenance centre (I.T.M.C.).

2.3 Traffic staff at the international operating centre(s).

2.4 Staff of the international service coordination centre (I.S.C.C.).

2.5 I.S.M.C.s in other countries.

2.6 Services concerned with the national network of the country.

3. The responsibilities and functions of a fault report point

3.1 The general responsibilities of a fault report point for switching and signalling will depend on the decisions taken by each Administration regarding the division of responsibilities between the I.S.M.C., the I.T.M.C. and the I.S.C.C. (see Recommendation Q.71).

3.2 The functions of the fault report point are as follows:

3.2.1 Receiving and recording fault reports from the sources given in section 2.

[1] The term " circuit control station " designates that location which controls the placement and removal of a circuit in service and other functions as defined in the *Green Book*, Volume IV.

3.2.2 Arranging for the withdrawing from service of faulty equipment which is under its own control.

3.2.3 Requesting the circuit control station [1] within its own Administration (or terminal sub-control if such be the case) to arrange for the withdrawing of faulty circuits from service.

3.2.4 Providing the information and cooperation needed to deal with inquiries by traffic and maintenance staff and the fault report point at the other end.

3.2.5 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.

3.2.6 Ensuring that faults are cleared as soon as possible.

3.2.7 Keeping fault and circuit records up to date.

3.2.8 Investigating repeated faults.

3.2.9 Advising the I.S.C.C. of the faults affecting the automatic service.

3.2.10 Making an analysis of equipment faults as may be necessary.

4. Service circuits

Service circuits are normally set up between fault report points and maintenance centres as necessary in accordance with Recommendation M.12, and between maintenance centres of the same type in different countries in accordance with Recommendation Q.71, M.71.

Recommendation Q.79

RESPONSIBILITIES IN LOCATING AND CLEARING FAULTS

1. Faults will be reported to a fault report point in an international switching maintenance centre (I.S.M.C.) in accordance with Recommendation Q.78 *ter*.

2. The figure shows action that might be taken in locating and clearing faults. As it is 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.

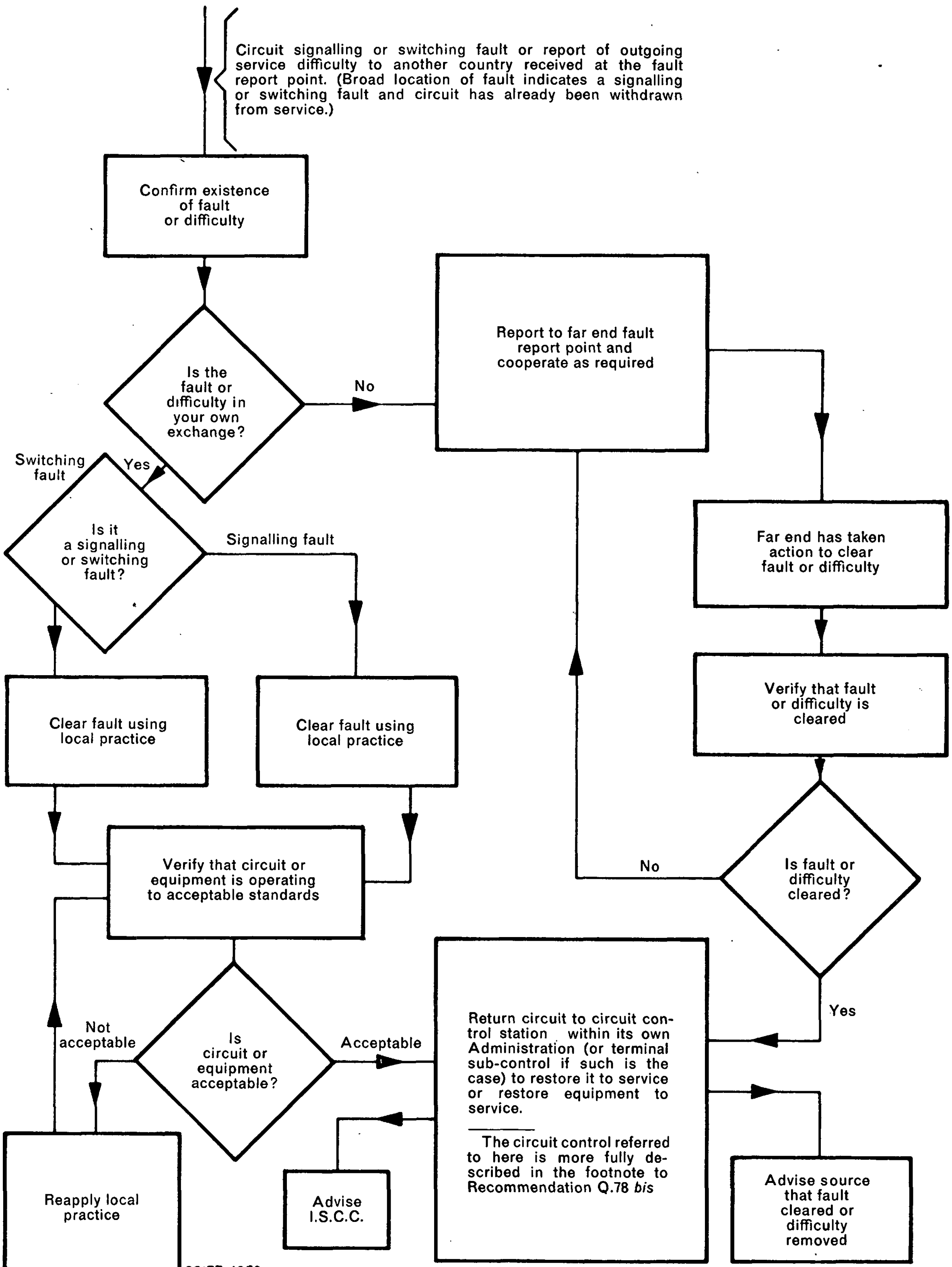


FIGURE 1/Q.79 — **Possible method of dealing with a fault or service difficulty on an outgoing connection to another country.**

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Volume II-A **Volume VI**

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 five 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.

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 the busy season at the end of the year to appear to exceed the busiest season which occurs 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.

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[1] See the definitions of the terms used in the Annex to Part VI (for Volume VI only). See Question 5/XIII.

Recommendation E.501 **Recommendation Q.81**

AUTOMATIC TRAFFIC-RECORDING DEVICES

Greater use should be made of automatic methods of recording and analyzing 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/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.

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 [2] (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.

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[1] The word "relations" is used to describe the traffic from one particular country to another particular country.

[2] Generally, in this Recommendation, the term "call attempts" includes all attempts to establish communication whether successful or not.

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.

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/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 R).
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 two-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 analyzing equipment*

Central analyzing 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 analyzing 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.

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 five 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

FORECASTING OF TRAFFIC

Recommendation E.502 **Recommendation Q.82**

FORECASTING INTERNATIONAL TELEPHONE TRAFFIC

1. *Introduction*

In the operation and administration of the international telephone network, proper and successful development depends to a large degree upon estimates for the future. Accordingly, for the planning of equipment and circuit provision and of telephone plant investments it is necessary that the Administrations forecast the traffic the network will carry. In view of the heavy investments in the international network the economic importance of the most reliable forecast is evident.

2. *Base data for forecasting*

2.1 Forecasts of the traffic flows are needed not only for individual routes, which may carry traffic streams for larger areas, but more importantly on a point-to-point basis (between CTs of terminal countries). The forecasts should be prepared by the country originating the traffic, and should be supplied to the destination country and any other country involved in transit arrangements. It also has to be recognized that certain reconciliations between the two ends of a traffic relation may be necessary in arriving at the final forecast.

2.2 The offered traffic for each relation should be regarded as base data in forecasting traffic growth. The offered traffic can be deduced from the measured carried traffic flow. The offered traffic is normally either greater than or equal to the traffic carried. When the congestion is small the difference is negligible. In other cases appropriate formulae [1] may be applied to determine limits between which the offered traffic will lie.

The average carried traffic flow should be determined from measurements according to Recommendation E.500/Q.80 [2] and the point-to-point traffic streams must then be derived from these measurements, together with any additional information such as that from accounting or route analysis equipment.

On account of the time differences which affect international telephone traffic, recording of traffic data for forecasting purposes often has to be maintained over several hours of the day and not be confined to the busy hour of each relation.

[1] When congestion is moderate and the Erlang traffic model is appropriate the lower limit is given by $A = y$ and the upper limit is given by $A = y/(1 - B)$ where y is the traffic carried and B is the loss for random offered traffic according to Erlang B formula. The relation between offered and carried traffic, when congestion is high and when models incorporating the effects of subscriber re-attempts are considered appropriate, will require further study (see Question 10/XIII).

[2] See Question 5/XIII.

2.3 Administrations planning installation of traffic measuring equipment are advised to ensure that the equipment records the data in computer-legible form (punched paper tape, magnetic tape, etc.); c.f. paragraph 1.8.3 in the Annex to Recommendation E.501/Q.81. This greatly facilitates computer processing and makes it easier to analyze more frequent measurements.

3. *Length of forecast period*

For normal extensions of switching equipment and additions of circuits a forecast period of about six years is necessary. However, a longer forecast period may be necessary for the planning of new cables or other transmission media, or for major plant installations. Estimates in the long term would necessarily be less accurate than short-term forecasts but that would be acceptable.

4. *Methods and models appropriate to international forecasting*

4.1 In order to prepare a traffic forecast it is necessary to take into account non-regularly recurring features which have affected past traffic, or may affect present traffic, for example, tariff changes or the substitution of subscriber-to-subscriber dialling methods for manual methods of setting up calls. Administrations should develop means of identifying these factors and evaluating them quantitatively (see examples of discontinuities in Graphs 2/E.502/Q.82 and 3/E.502/Q.82 annexed). From such an evaluation it will be possible to make a modified set of values of past traffic from which a future trend may be extrapolated.

4.2 An adapting forecasting system using time as an independent variable is recommended for estimates of the future traffic from the values derived in accordance with 4.1. On this basis the traffic trend is extrapolated by calculating the values of the parameters of some function which is expected to characterize the growth of international traffic. The numerical calculations in curve fitting can be performed by using the least squares method. If the traffic values available cannot be expected to yield mathematically reliable values, a rough survey can be obtained by simply plotting a continuation of the curve of available traffic data.

In view of the historical absence of saturation effects in international communications, and the prospects for future expansion, a simple exponential or a parabolic function may be used to represent the growth of international telephone traffic. The equations of these two functions are given below:

$$\text{Exponential: } Y_t = Ae^{Bt}$$
$$\text{Parabolic: } Y_t = A + Bt + Ct^2$$

In the above equations, Y_t is the traffic after t time intervals, while A, B and C are constants (parameters depending on the route observed). It is found that both these functions can be used for forecasts up to, say, six years, whereas the parabolic function can be applied for longer term forecasts. However, care must be applied in the use of the parabolic function if the estimate of C is negative.

Examples of curve fitting by means of the method of least squares applied to traffic data from some international telephone relations are given in Graphs 1 to 3. In the examples the growth trends are approximated by the exponential and parabolic functions.

4.3 By using a smoothing process in curve fitting, it is possible to calculate the parameters of the model to fit current data very well but not necessarily the data obtained a long time ago.

The best known smoothing process is the moving average. The degree of smoothing is here controlled by the number of most recent observations included in the average. All observations included in the average have the same weight. In the method of exponential smoothing the weight given to previous observations decreases geometrically with age. The speed with which the effect of past observations is reduced is here controlled by the chosen value of a smoothing constant. Use of smoothing methods is appropriate especially for short-term forecasts.

4.4 The historical data for forecasting purposes must be extended into the past far enough to include a sufficient number of observations for estimating the values of the parameters in the fitting curve or regression function. Historical data are needed for a period which at least is as long as the forecast period.

4.5 The forecasting methods recommended are suitable for computer application.

5. *Discontinuities in traffic growth*

It may be difficult to assess in advance the magnitude of a discontinuity. The influence of the factors which cause discontinuities often is spread over a transitional period, the discontinuity is then not so obvious. Furthermore, discontinuities arising from the introduction of, e.g. international subscriber dialling are difficult to identify accurately, because changes in the method of working are usually associated with other changes (e.g. tariff reductions).

An illustration of the bearing of discontinuities on traffic growth can be observed in Graphs 2/E.502/Q.82 and 3/E.502/Q.82.

Discontinuities representing the doubling and even more of traffic flow are known. It may also be noted that changes could occur in the growth trend after discontinuities.

In the Annex the experiences from some Administrations of irregularities in traffic growth are presented.

In short-term forecasts it may be desirable to use the trend of the traffic between discontinuities, but for long-term forecasts it may be desirable to use a trend estimate which is based on long-term observations, including previous discontinuities.

6. *Accuracy in forecasting*

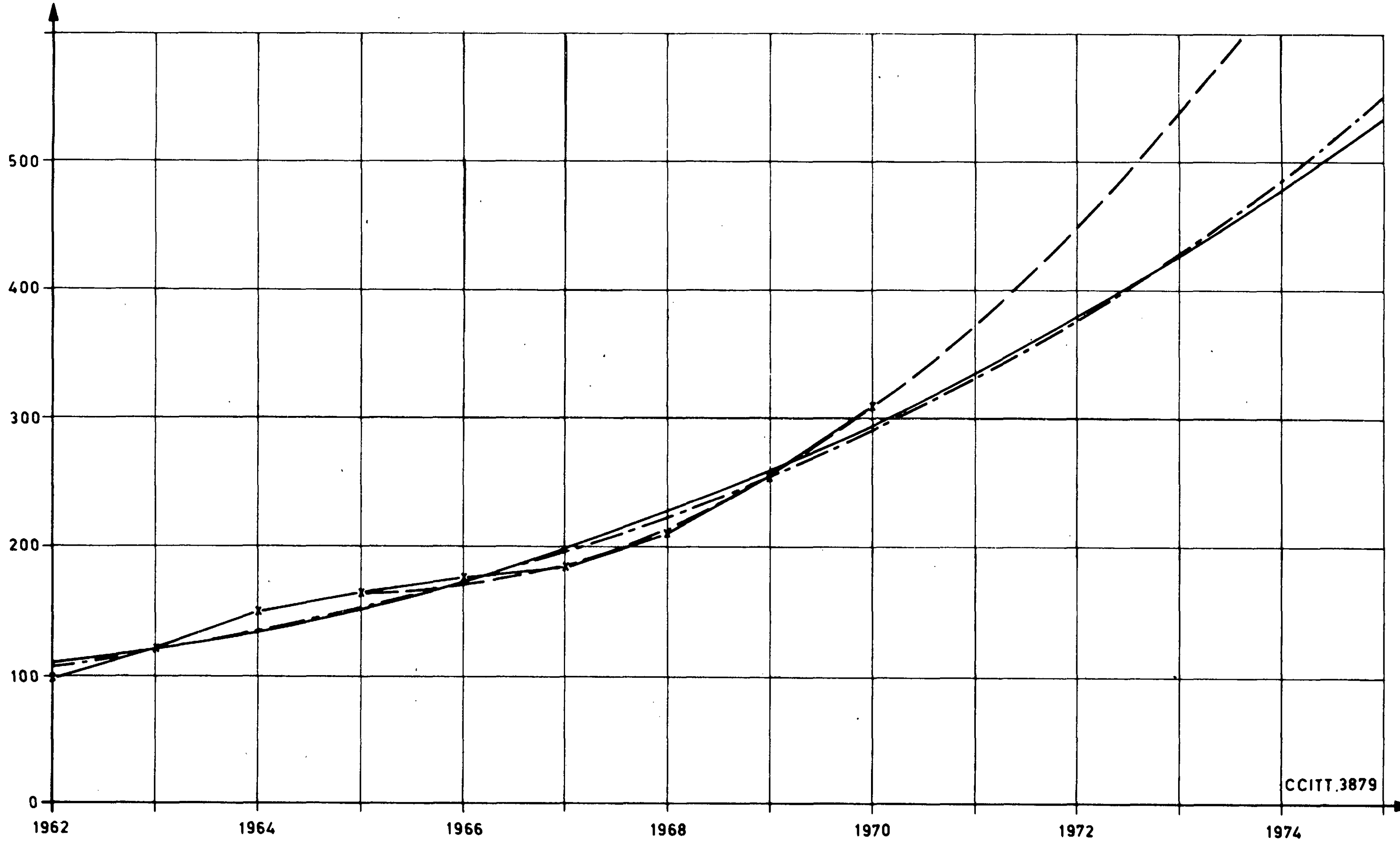
The accuracy of the forecast depends on the completeness of information, the identification of the causes of past and present conditions and the skill of judgement. It is apparent that particularly in forecasting international traffic the forecasts must of necessity contain a high degree of informed judgement (see item 5 above).

A forecast made for the total outgoing international traffic of a country is usually more accurate than the sum of individual forecasts made for routes or on a point-to-point basis. However, these individual forecasts are necessary (c.f. paragraph 2.2). An approach in forecasting both from a "top down" and a "bottom up" concept ensures maximum efficiency and control. If substantial deviations occur between these independently prepared views, the underlying basic assumptions and factors affecting growth should be analyzed and the two views reconciled within a reasonable relationship.

7. *Follow-up of forecasts made*

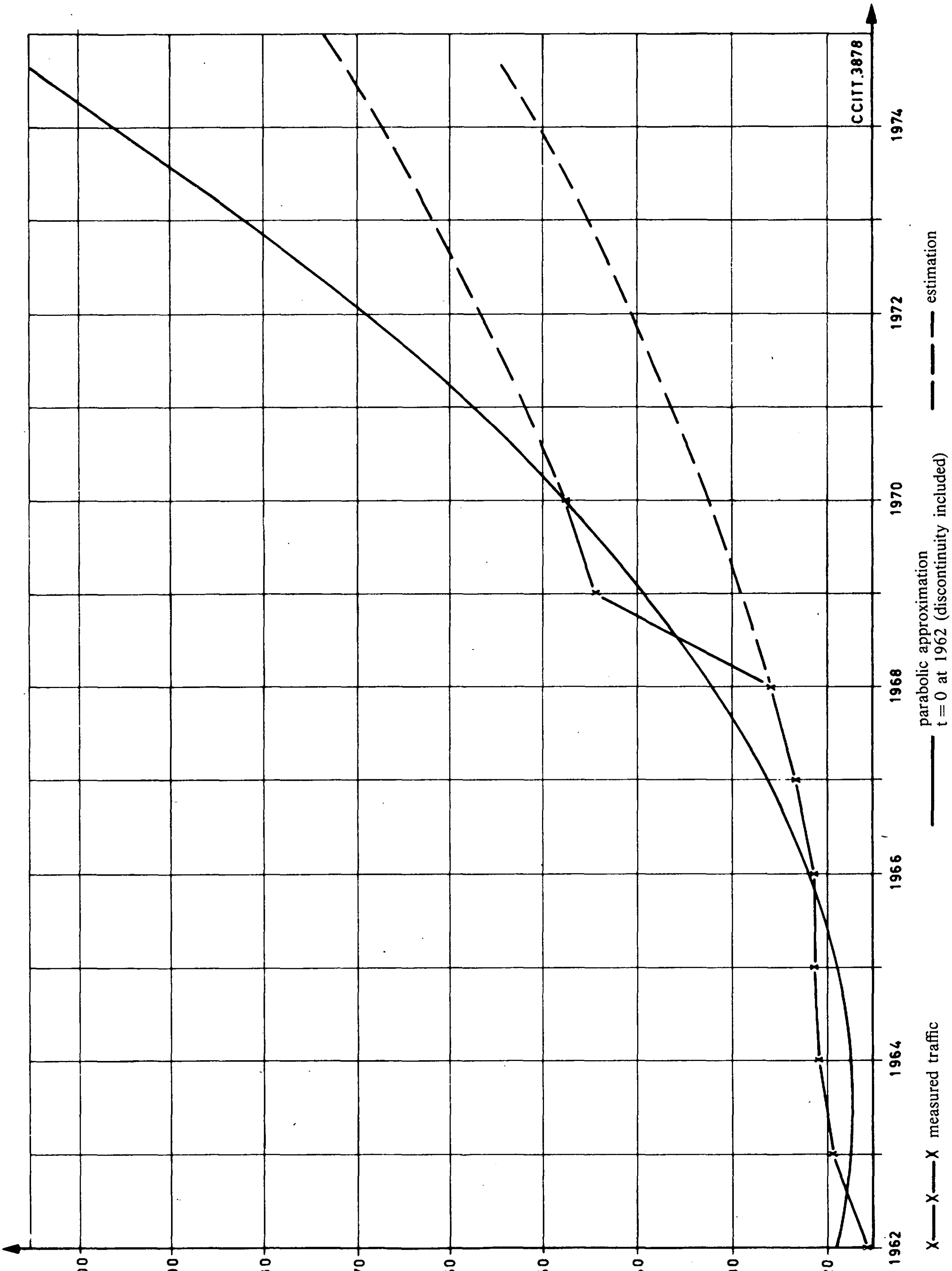
It is essential to make regular comparisons between forecasts made and subsequent observed growth. Reasons for significant differences should be analyzed and forecasts made should be revised in the light of the result of this analysis. Furthermore, whenever information is received about changes in factors affecting growth, e.g. changes in the tariff structure, forecasts made should be modified.

The foregoing recommendations and observations are intended as a guide and it can be hoped that, with increasing experience, better and more accurate methods will be developed and especially that these can be made, for the most part, suitable for computer implementation. However, some human judgement will always be required in making traffic forecasts.



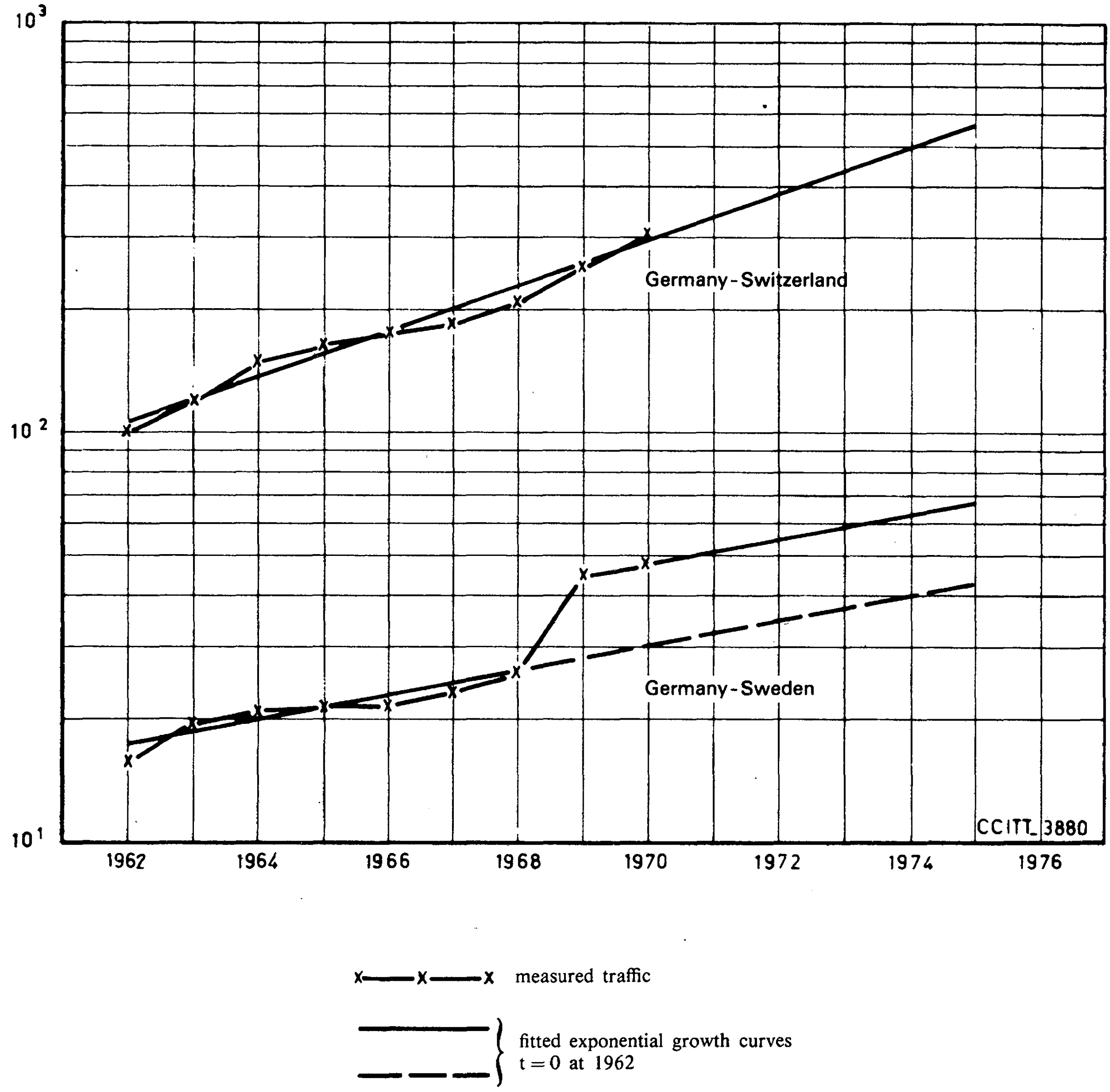
GRAPH 1. — **Germany - Switzerland.**

Mean busy hour traffic (Erlangs); 10 consecutive working days.
Recommendation E.500/Q.80, paragraph 2.



GRAPH 2. — **Germany-Sweden.**

Mean busy hour traffic (Erlangs); 10 consecutive working days.
Recommendation E.500/Q.80, paragraph 2.



GRAPH 3. — **Germany-Switzerland and Germany-Sweden.**

Mean busy hour traffic (Erlangs); 10 consecutive working days.
Recommendation E.500/Q.80, paragraph 2.

ANNEX
(to Recommendation E.502/Q.82)

1. Experience of the Australian Administration with traffic discontinuities

Effects of conversion from HF radio to a high-quality submarine cable system (COMPAC cable)

Stream	Stimulus (%)	Growth rate (%)	
		Before cable	After cable
Australia — New Zealand	84	7.5	28.3
Australia — United Kingdom	168	5.2	30.7
Australia — United States	53	8.5	33.1

Notes. — 1. Cable working to New Zealand commenced in July 1962 and to U.K. and U.S.A. in December 1963.

2. The above figures are based on statistics of outgoing paid minutes over the period 1955-1968 (N.Z., U.S.A.), and 1945-1968 (U.K.).

2. Examples of Cable and Wireless Ltd. experience on the effects of conversion from HF radio to high quality wide-band systems

Stream		Terminal paid minutes in preceding year	Stimulus %	Growth rate %		Type and date of new system
				Before	After	
Hong Kong - USA	Outgoing	121,000	116	16	71	Cable, August 1966
	Incoming	212,000	69	72	56	
Hong Kong - Indonesia	Outgoing	57,000	91	9	25	Cable/satellite, August 1970
	Incoming	45,000	103	22	38	
Bahrain - United Kingdom						
	Outgoing	32,400	0	99	59	Satellite, July 1969
	Incoming	13,000	43	56	29	
Bahrain - Dubai	Outgoing	17,500	60	63	70	Tropospheric scatter, July 1969
	Incoming	17,500	50	40	56	
Barbados - Guyana	Outgoing	11,600	122	22	11	Tropospheric scatter, March 1969
	Incoming	12,000	182	4	5	
Antigua-USA	Outgoing	11,000	117	91	37	Tropospheric scatter/ cable, August 1966
	Incoming	15,400	137	84	29	
Mauritius - Reunion	Outgoing	12,500	140	9	38	VHF, October 1971
	Incoming	22,000	137	12	47	
Fiji-New Zealand	Outgoing	2,100	290	18	56	Cable, December 1962
	Incoming	2,400	300	5	94	

Notes. — 1. The growth rates represent the trend over the twelve months before and after conversion, calculated at an annual rate.

2. The Bahrain-United Kingdom H.F. route and the Barbados-Guyana route were equipped with Lincompex.

CHAPTER III

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 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.

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.

[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 was studied under Question 13/II in the period 1968-1972 and was found to be still valid.

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.

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

Note. — Tables A and B can be extended for groups comprising more than 20 circuits by using the values given for 20 circuits.

CHAPTER IV

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 Supplements Nos. 1 and 2 to Volume II-A and Supplements Nos. 9 and 10 to Volume VI), which refers to full availability groups. Recommended methods for traffic determination are indicated in Recommendation E.500/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.

3.2 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.

[1] See article by I. TÅNGE: "Optimal use of both-way circuits in cases of unlimited availability", *TELE*, English Edition No. 1, 1956.

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
	(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. 9 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.

For groups requiring more than 20 circuits the table quoted above for loss probability of 1% should be used (see Supplement No. 9 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 [1]

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 under-estimates and provides safeguards for traffic surges [2].

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:

[1] See Question 6/XIII.

[2] See "Processing by computers or 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.

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

[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.

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 *(conclusion)*

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	7.74	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	27.58	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 *(conclusion)*

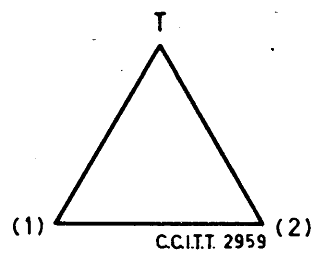
Required number of circuits	Weighted mean peakedness factor												
	2.1	2.2	2.3	2.4	2.5	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0
	Overflow traffic in erlangs												
26	13.00	12.70	12.41	12.12	11.84	11.57	11.03	10.51	10.01	9.51	9.04	8.57	8.11
27	13.75	13.45	13.15	12.86	12.57	12.29	11.74	11.21	10.70	10.20	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 are at 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).

$$F_n(A) = A\left\{E_1 n(A) - E_1(n+1)(A)\right\} = M \times \frac{\text{annual charge (1-2)}}{\text{annual charge (1-}T\text{-2)}}$$

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 references 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 [2]. 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] See Question 7/XIII.

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:

$$R = \frac{\text{annual charge of one additional circuit on the alternative route}}{\text{annual charge of one additional circuit on the high-usage route}}$$

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

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[1] See Question 13/XIII.

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
3.0	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 V

GRADE OF SERVICE

Recommendation E.540 **Recommendation Q.95**

OVERALL GRADE OF SERVICE OF THE INTERNATIONAL PART OF AN INTERNATIONAL CONNECTION

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.

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. 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. 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.

Recommendation E.541 **Recommendation Q.95 bis**

OVERALL GRADE OF SERVICE FOR THE INTERNATIONAL CONNECTIONS (SUBSCRIBER-TO-SUBSCRIBER)

1. *Introduction*

The overall grade of service (subscriber-to-subscriber) on international connections—relating only to the phenomena of congestion in the entire network as a result of the traffic flow—depends on a number of different factors, such as the routing arrangements in the national and international parts of the connection, congestion allowed per switching stage, the methods used to measure traffic and compute the traffic base, and the time differences between the busy hours of the various links involved in the connection.

The most satisfactory way in which this grade of service could be described would be to give its distribution. The design average grade of service during the busy hour of the complete connection would be the most useful single parameter. However, until such time when continuous traffic measurements are carried out during the busy season in all parts of the network on a routine basis, it is not possible to compute this average grade of service. Therefore, at this stage it cannot be used as a criterion for the dimensioning of the network.

The only practical way of ensuring an acceptable overall grade of service on international calls is to specify an upper limit on the design loss probability per connecting link in the national network as is done for the links in the international network. (See Recommendation E.540/Q.95.)

2. *General considerations*

Since the success of the international automatic service is highly dependent on the grade of service of all links involved in the connection from subscriber-to-subscriber it is desirable that the originating and terminating national network involved in the connection has grade of service standards comparable with those of the international network.

It is especially important that the links in the country of destination should have a good grade of service for handling the traffic, since high congestion in the terminating national network could have serious effects on the international network. High congestion in the network of the country of destination causes added retrials with consequent increased loading on common switching devices as well as increased occupation of the routes with ineffective calls.

3. *Design objectives*

It is recommended that the links in the national network should be designed for a loss probability [1] not exceeding 1 per cent per link in the final choice route during its applicable busy hour. It is recognized however that in some countries additional congestion is permitted for the internal switching stages of the transit exchanges. It is also recognized that, where this recommended grade of service is not provided for the national service, it may not be economically feasible to provide it for international relations.

The maximum number of links in tandem used by an international connection is defined by Recommendations E.171/Q.13 and E.171/Q.40.

Although the worst overall grade of service would be approximated by the sum of loss probabilities for individual links connected in tandem, on most calls the overall grade of service will be significantly better.

[1] The loss probability mentioned refers to busy hour traffic values as defined in Recommendation E.500/Q.80.

Notes. —

a) Alternative routing in the national and in the international networks provides on average a grade of service that is better than that provided in the theoretical final route.

b) Non-coincidence of traffic peaks in the national and international networks will provide reduction in the overall grade of service compared with the sum of the design grade of service values per link.

c) Time differences will also improve the resulting grade of service.

d) The methods of measuring and calculating the traffic base for provisioning purposes in the national networks may be different in various countries and differ from the methods for the international network given in Recommendation E.500/Q.80. This means that the national traffic values are not always comparable among themselves or with the values of the international network. Each Administration must estimate how its design traffic level compares with that recommended for the international network.

e) The design grade of service value of each link will only apply if the traffic at each switching stage is equal to the forecast. In practice such a situation will seldom occur. Furthermore, the planning procedure normally is such that the specified grade of service should not be exceeded until the end of the planning period. In a growing network this means that the circuit groups during almost the whole planning period give a better service than the specified critical standard.

In conclusion, the overall grade of service depends on the accuracy of forecasts made and the planning procedure used, i.e. it depends on the interval between plant additions and on the specific traffic value in future to which the grade of service is related.

Recommendation E.542 **Recommendation Q.96**

ACCEPTABLE REDUCTION IN THE NUMBER OF CIRCUITS OF A FINAL ROUTE IN THE EVENT OF A BREAKDOWN

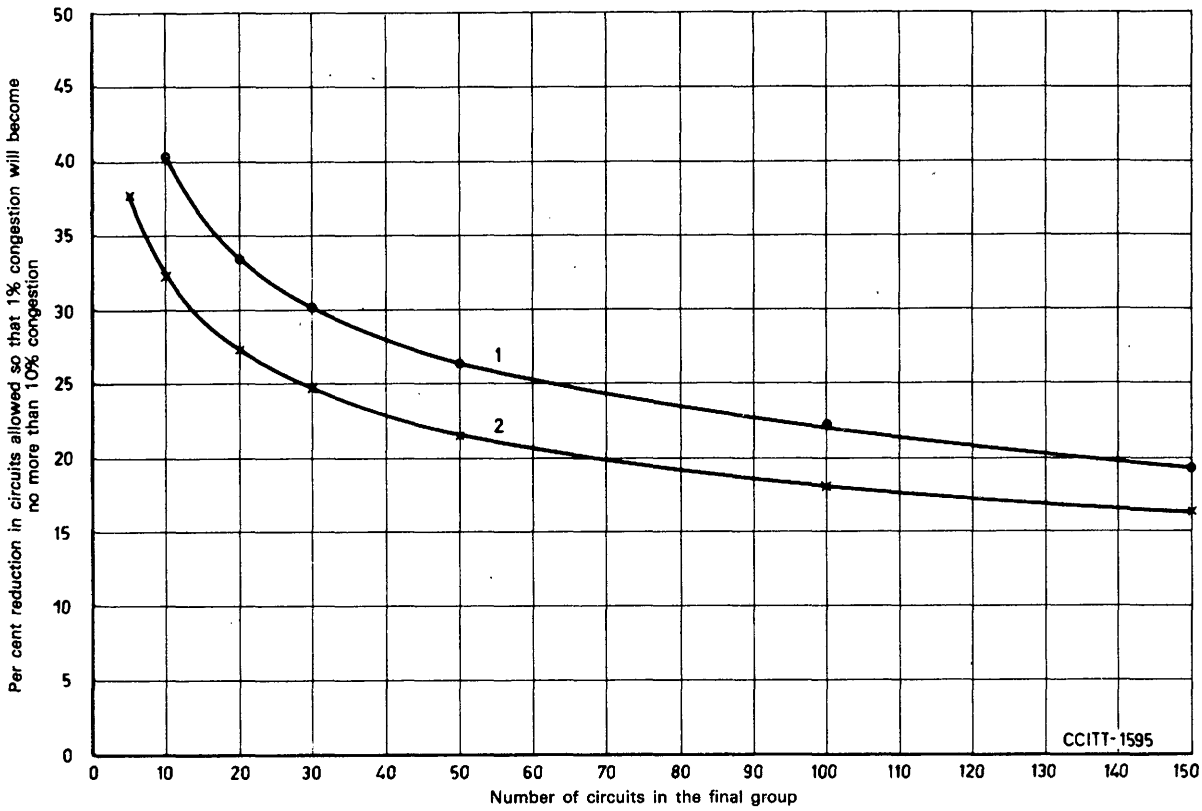
1. *Maximum traffic loading*

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 (Figure 1/E.542/Q.96) 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.



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

FIGURE 1/E.542/Q.96.

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

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.

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 will a call 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 are 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.

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.

[1] See Question 3/XIII.

ANNEX

(to Volume VI, Part VI)

Definitions relating to traffic engineering appearing in Recommendation E.100

. . . .

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 analyzing 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.