5i’

PART II

Recommendations Q.140 to Q.164

SPECIFICATIONS OF SIGNALLING

SYSTEM No. 5

MONTAGE: PAGE . | | = PAGE BLANCHE

SIGNALLING SYSTEM No. 5

INTRODUCTION

PRINCIPLES OF No. 5 SIGNALLING SYSTEM

General

System No. 5 is compatible with both TASI and non-TASI-equipped circuits and may be applied for automatic and semi-automatic operation and both-way working. It requires four-wire signalling and automatic access to the outgoing circuits.

The signalling equipment is in two parts:

a) line signalling — for the so-called supervisory signals; and

b) register signalling — for the numerical signals.

a) *Line signalling*

This is a link-by-link system using two in-band signalling frequencies 2400 Hz and 2600 Hz, two frequencies, instead of one frequency, being adopted for the following reasons:

i) Automatic detection of double seizing on both-way working;

ii) Frequency discrimination between signals, no time discrimination being incorporated.

Automatic detection of double seizing requires that the frequency of the proceed-to-send signal (2600 Hz) be different from that of the seizing signal (2400 Hz). The detection is achieved when one end transmits the outgoing seizing signal (2400 Hz) and at the same time receives the seizing signal (2400 Hz) from the other end and not the 2600 Hz proceed-to-send signal expected.

All signal recognition times are the same (125 ms) except for the seizing and proceed-to-send signals (40 ms). These two signals are not subject to signal imitation by speech and fast signalling is desired in particular to minimize double seizings.

To avoid, with this signalling system, relatively slow signalling in non-TASI applications and in lightly loaded conditions (the more usual) of TASI applications, all signals are the continuous compelled type except the forward transfer signal. Continuous signals ensure TASI trunk/channel association during the actual time this function requires. (The alternative of TASI-prefix pulse type signals

would, due to the 500-ms TASI prefix, introduce a slight risk of failure to associate a trunk with a channel, and would slow the signalling in terms of restoration of the transmission path after the signalling line splits under the more usual conditions of TASI loading and in non-TASI applications.) Only the forward-transfer signal is a TASI-prefixed pulse since for this signal a slight risk of failure can be accepted because it is operator-controlled and may be repeated at will.

See Supplement No. 2 in this Volume.
See for this term Recommendation Q.141, § 2.1.6

See for these terms footnote to Recommendation Q.151, § 3.1.1
Except for the answer signal, all the compelled signals are normal compelled type. For reasons of fast speed, the answer signal is overlap-compelled at transit points. Fast answer signalling is desirable to minimize the risk of an abandoned call by either the called or calling party, should the verbal answer be lost due to the line splitting on answer signalling.

b) *Register signalling*

This is a link-by-link 2/6 multifrequency (m.f.) in-band en block pulse signalling system, forward signalling only. The alternative, continuous compelled signalling, would be slow due to the long circuit propagation times in certain applications. The frequencies (700 Hz . | | 1700 Hz) are outside of the line signalling frequencies. The numerical information signalling is preceded by a KP signal (start-of-pulsing) and terminated by an ST signal (end-of-pulsing). En bloc non-overlap sending applies at the outgoing international register, the seizing signal being sent, and thus the international circuit being taken as late as possible, namely when the ST condition is available in the outgoing international register. When sending, the outgoing register pulses out in a continuous sequence. The prior GO trunk/channel association due to the seizing signal is maintained by the TASI speech detector hangover during the interval between cessation of the seizing signal (on receipt of the proceed-to-send signal) and the start of the register pulse out, and during the intervals between successive m.f. signals.

En bloc overlap register signalling applies at the international transit registers and at the incoming international register to minimize the post-dialling delay.

Compandors affect signalling, particularly short-pulse compound signalling (e.g. register signalling), due to distortion and the production of intermodulation frequencies. By virtue of the lin-by-link signalling and the adopted duration of the m.f. pulses, system No. 5 functions correctly in the presence of compandors.

See for these terms Recommendation Q.141, § 2.1.7.

CHAPTER I

DEFINITION AND FUNCTION OF SIGNALS

Recommendation Q.140

1. DEFINITION AND FUNCTION OF SIGNALS

1.1 seizing signal (sent in the forward direction)

This signal is transmitted at the beginning of a call to initiate circuit operation at the incoming end of an international circuit and to seize equipment for switching the call either to the national network of the incoming country or to another international exchange.

1.2 proceed-to-send signal (sent in the backward direction)

This signal is sent from the incoming end of an international circuit, following the receipt of a seizing signal, to indicate that the equipment is ready to receive the numerical signals.

1.3 start-of-pulsing signal, also called for system No. 5 ‘‘KP signal’’ (sent in the forward direction)

This numerical type signal is sent on receipt of a proceed-to-send signal and may be used to prepare the incoming international register for the receipt of the subsequent numerical signals.

Two different KP signals are provided to discriminate between terminal and transit calls:

a) KP1, terminal; and

b) KP2, transit.

1.4 numerical signal (sent in the forward direction)

This signal provides an element of information necessary to effect the switching of the call in the desired direction. There is always a succession of numerical signals sent.

1.5 end-of-pulsing signal, also called for system No. 5 ‘‘ST signal’’ (sent in the forward direction)

This numerical type signal is sent to show that there are no more numerical signals to follow. The signal is always sent in semi-automatic as well as in automatic working.

1.6 busy-flash signal (sent in the backward direction)

This signal, which is sent only after the proceed-to-send signal, is sent to the outgoing international exchange to show that either the route, or the called subscriber, is busy. The conditions of use of this signal are as follows:

a) An international transit exchange *must* send this signal after register association, to indicate that there is congestion at that exchange or on the appropriate outgoing routes.

b) An incoming international exchange *must* send this signal, after register association, if there is congestion at that exchange or on the outgoing routes directly connected to it, but sending the signal is *optional* when there is congestion beyond that exchange (when there is congestion at a point in the national network of the incoming country or when the called subscriber's line is busy). This signal is optional because there are several countries that do not send it from their national networks.

Note — The receipt of the busy-flash signal at the outgoing exchange will cause:

— an appropriate indication to be given to the outgoing operator or to the calling subscriber; and

— the sending of the clear-forward by the outgoing exchange to release the international connection (except when otherwise arranged, for example, in this case of observations on circuits).

1.7 answer signal (sent in the backward direction)

This signal is sent to the outgoing international exchange to show that the called party has answered the call

In semi-automatic working, the signal has a supervisory function.

In automatic working, it is used:

— to start metering the charge to the calling subscriber;

— to start the measurement of call duration for international accounting purposes.

1.8 clear-back signal (sent in the backward direction)

This signal is sent to the outgoing international exchange to indicate that the called party has cleared. In the semi-automatic service, it performs a supervisory function. It must not permanently open the speech path at the outgoing international exchange.

In automatic working, arrangements must be made to clear the international connection, stop the charging and stop the measurement of call duration if, between 1 and 2 minutes after receipt of the clear-back signal, the calling subscriber has not cleared. Clearing of the international connection should preferably be controlled from the point where the charging of the calling subscriber is carried out.

Notes on the answer and clear-back signals . — See the corresponding Notes in Recommendation Q.120.

1.9 clear-forward signal (sent in the forward direction)

This signal is sent in the forward direction at the end of a call when:

See Recommendation Q.27 for the action to be taken to ensure that answer signals, both national and international, are transmitted as quickly as possible.

a) in semi-automatic working, the operator at the outgoing international exchange withdraws her plug from the jack, or when an equivalent operation is performed;

b) in automatic working, when the calling subscriber hangs up or otherwise clears (as in the case of a subscriber's installation with extension telephones).

This signal is also sent after receipt of a busy-flash signal by the outgoing international exchange, and when there is forced release of the connection (see Recommendation Q.118, §§ 4.3.1 and 4.3.2 for automatic working and § 4.3.1 for semi-automatic working). This signal may also be sent after an abnormal release of an outgoing register in the case indicated in Recommendation Q.156 under § 3.6.2 a) 1.

1.10 release-guard signal (sent in the backward direction)

This signal is sent in the backward direction in response to the clear-forward signal. It serves to protect an international circuit against subsequent seizure as long as the disconnection operations controlled by reception of the clear-forward signal have not been completed at its incoming end.

1.11 **forward-transfer signal (sent the forward direction)**

This signal is sent to the incoming international exchange when the outgoing international exchange operator wants the help of an operator at the incoming international exchange.

The signal will normally serve to bring an assistance operator into the circuit if the call is automatically set up at that exchange. When a call is completed via an operator (incoming or delay operator) at the incoming international exchange, the signal should preferably cause this operator to be recalled.

1.12 *Diagrams showing signal sequence*

The sequence of signals in semi-automatic and automatic working is shown in Tables 1 and 2 of Annex 1 to Part II.

A description of the various operations corresponding to the various normal and abnormal conditions which may arise in setting up a call are given in the tables of Annex 2 to Part II.

See the definition of assistance operator in § 1.1.6 of Recommendation Q.101.

MONTAGE: PAGE 54 = BLANCHE

CHAPTER II

LINE SIGNALLING

Recommendation Q.141

2.1
SIGNAL CODE FOR LINE SIGNALLING

2.1.1 *General*

The line-signal coding arrangement is based on the use of two frequencies f 1 (2400 Hz) and f 2 (2600 Hz) transmitted individually or in combination as shown in Table 1. The use of compound signalling for the clear-forward/release-guard sequence increases the immunity to false release by signal imitation.

By taking advantage of the fixed order of occurrence of specific signals, signals of the same frequency content are used to characterize different functions. For example, in the backward direction f 2 is used to indicate proceed-to-send, busy-flash and clear-back without conflict. The

signalling equipment must operate in a sequential manner retaining memory of the preceding signalling states and the direction of signalling in order to differentiate between signals of the same frequency content. All signals except the forward-transfer signal are acknowledged in the compelled-type manner as indicated in Table 1. The order of transmission of backward signals is subject to the following restrictions:

a) busy-flash signal: never after an answer signal and only after a proceed-to-send signal;

b) answer signal: never after a busy-flash signal;

c) clear-back signal: only after an answer signal.

Note — The receipt of the answer signal (f 1) permits discrimination between the busy-flash and the clear-back signals (both f 2).

A clear-forward signal, which must be acknowledged by a release-guard signal under all conditions of the equipment including the idle condition, may be sent from an outgoing end at any time to initiate the release of the circuit. The clear-forward signal is completely overriding and may break into any other signal sequence.

2.1.2 *Transit working*

In transit operation, the line equipment at the transit exchange shall be informed (e.g. by the register) that the condition is transit. This will facilitate the link-by-link transmission of line signals through the transit exchange without bringing about consequences appropriate to the terminal exchanges.

2.1.3 *Sending duration of line signalling*

2.1.3.1 The sending durations of the line signals are shown in Table 1. Additional requirements are:

a) In the event of double seizing (due to both-way operation), the seizing signal transmitted from the end having detected double seizing should persist for at least 850 ± 200 ms to permit the other end to detect the double seizing.

b) Should the called party flash his switch-hook at a faster rate than the equipment can transmit a succession of clear-back and answer signals, the correct indication of the final position of the switch-hook must always be given by the appropriate signal.

c) Once the sending of a signal (pulse or compelled) has begun it should be completed (but see § 2.1.1 in regard to the clear-forward signal releasing the circuit at any stage and § 2.1.7 in regard to the overlap answer signal at transit points). If two signals have to be sent one immediately after the other in the same direction, a silent interval of not less than 100 ms should separate the two successive signals. The silent interval should not be so long as to cause unreasonable delay in signalling.

Exceptionally

1) the intervals between successive signals may be less than 100 ms. However, the technique of complete signals with intervals of at least 100 ms is the preferred arrangement;

2) the forward-transfer signal may be ceased immediately if a backward signal is received. The acknowledgement of the backward signal is then sent.

d) When sending a compound signal, the interval of time between the moments when each of the two frequencies is sent must not exceed 5 ms. The interval of time between the moments when each of the two frequencies ceases must not exceed 5 ms.

e) *Time-out and alarm procedures*

i) Should the transmission of any size, busy-flash, answer, clear-back or clear-forward signal persist beyond a maximum of 10 to 20 seconds, the signal shall be terminated.

Note — 10 to 20 seconds time-out for the seizing signal allows reasonable time for association of a register in a distant centre.

ii) Should the transmission of any proceed-to-send, release-guard or other acknowledgement signal persist beyond a maximum of 4 to 9 seconds, the signal shall be terminated.

Note 1 — The shorter time-out periods for secondary signals enable, under many conditions, detection of a fault at both ends of a circuit on a single call.

Note 2 — Time-out of the answer acknowledgement signal may cause charging without a satisfactory transmission path to the called party. If the occurrence of such time-outs should reach unacceptable levels, a delay in the transfer of the answer signal into the national network until the compelled answer signalling cycle is complete, may be justified.

iii) Upon the occurrence of a time-out under the two above conditions, the attention of the maintenance personnel should be drawn to the fact that time-out has occurred.

Note — An Administration may decide that on the time-out of an acknowledgement signal at the incoming end of the connection, when an automatic repeat clear-forward sequence is known to be provided at the outgoing end, no indication is given to the maintenance personnel, neither is the circuit taken out of service.

iv) Upon the occurrence of a time-out, the circuit should automatically be removed from service after clear-down by the subscriber and blocked to outgoing calls. However, time-out of a seize signal may be excluded from this provision if time-out of that signal is followed by a clear-forward attempt.

v) As a test procedure, Administrations may make repeated signalling attempts and restore the circuit to service if it is found to perform in a normal manner.

vi) Each Administration shall make appropriate arrangements to ensure that a single fault will not cause removal from service of more than one circuit or of more than one register.

2.1.3.2 The duration of the forward-transfer signal is based on the possibility that TASI may clip a signal by up to 500 ms on rare occasions during heavy traffic periods, and on the need for establishing a recognition time that minimizes signal imitation.

2.1.4 *Recognition times of line signals*

Recognition time is defined as the minimum duration a direct-current signal, at the output of the signal receiver, must have in order to be recognized as a valid condition by the switching equipment. The recognition times are given in Table 1.

For equal immunity against signal imitation, the recognition time of compound signals such as the clear-forward/release-guard sequence could be less than that of the single-frequency signals liable to signal imitation. However, for convenient design arrangements, and to improve the immunity of the clear-forward/release-guard sequence, the recognition time of the compound signals is the same (125 ± 25 ms) as that of the single-frequency signals liable to signal imitation.

After signal recognition, interruptions of up to 15 ms in the primary or acknowledgement signals shall be ignored in the compelled signalling sequences. Interruptions of more than 40 ms must be recognized as the end of the appropriate signal in the compelled signalling sequences.

2.1.5 *Line signal code of System No. 5*

The line signal code is given in Table 1.

Table [1], p.18

2.1.6 *Further specification clauses relative to the signalling code*

This type of signalling is called ‘‘*continuous compelled* ’’.

a) The seizing signal continues until acknowledged by the proceed-to-send signal. The proceed-to-send signal is transmitted when an incoming register is associated and continues until acknowledged by the stopping of the seizing signal

b) The clear-forward signal continues until acknowledged by the release-guard signal, which may be sent as described under 1 or 2 below:

1) The release-guard signal is sent on recognition of the clear-forward signal and continues until acknowledged by the cessation of the clear-forward signal or until the relevant incoming equipment at the international exchange is released, whichever occurs later.

2) The release-guard signal is sent in response to the clear-forward signal to indicate that the latter has brought about the release of the relevant incoming equipment at the international exchange. The release-guard signal continues until cessation of the clear-forward signal is recognized.

The outgoing access of the incoming end of the both-way circuit shall be maintained busy for 200 to 300 ms after the end of the transmission of the release-guard signal.

c) With respect to the busy-flash, answer and clear-back signals the acknowledgement signal shall not be transmitted before the signal recognition time (125 ± 25 ms) of the primary signal has elapsed. The primary signal shall not be ceased

until the signal recognition time (125 ± 25 ms) of the acknow ledgement signal has elapsed (see § 2.1.7 with respect to the transmission of the answer signal at a transit point).

d) The busy-flash will be transmitted if the call cannot be completed for any of the following reasons:

1) congestion at an incoming international exchange;

2) congestion at a transit international exchange;

3) error detected in the receipt of the register signals;

4) busy-flash (if received) from a subsequent international system (e.g. system No. 4) or from the national network;

5) time-out of an incoming international register.

e) Receipt of busy-flash at the outgoing international exchange will cause:

— after signal recognition time (125 ± 25):

1) the acknowledgement signal to be sent; and

2) an appropriate audible indication to be transmitted to the operator or to the subscriber. When the preceding circuit provides for the transmission of busy-flash, this signal should be transmitted to that preceding circuit;

— after the end of the compelled sequence, i.e. 100 ms after termination of the acknowledgement signal (see § 2.1.3 c):

3) a clear-forward signal to be transmitted from that exchange and the international circuit or chain of circuits to be released by the clear-forward/release-guard sequence.

f) Receipt of busy-flash at a transit exchange will cause after signal recognition time:

1) the acknowledgement signal to be sent; and

2) the busy-flash signal to be sent on the preceding incoming circuit;

3) the transit exchange and forward connection to be cleared.

Note — Where existing equipment is designed to allow clearing only from the outgoing international exchange, this need not be modified retrospectively.

g) Upon receipt of the answer signal in the answer state or the clear-back signal in the clear-back state, the international exchange should, nevertheless, respond by sending the acknowledgement signal.

Note — This procedure will be helpful to avoid unnecessary discontinuity of the compelled sequence when the international exchange receives answer (*f* 1) of clear-back (*f* 2) signal twice within a short interval.

h) In order to prevent irregularities Administrations may decide that the sending time of the release guard signal has a minimum duration of 200 ms. The recognition of a release guard signal without prior sending of a clear forward signal should be regarded as an irregularity. Administrations may decide to react on detection of that irregularity by sending the clear forward signal.

Figure 1/Q.141, p.19

2.1.7 *Backward signals on multilink connections* (consider as an example a connection A-T-B)

a) *Normal compelled signalling for busy-flash and clear-back signals*

With *normal compelled signalling* (see § 2.1.6 c) above) at a transit point T, the transmission of the primary signal from T to A does not commence until the signal recognition time of the primary signal sent from B to T has elapsed. This technique is applied for the transmission of busy-flash and clear-back signals.

b) *Overlap compelled signalling for the answer signal*

With *overlap compelled signalling* at a transit point T, the process of transmitting the primary signal from T to A is initiated as soon as the signal receiver response has caused at T the receiving end line split of BT. The normal signal recognition of the primary signal is still required at each transit point. The acknowledgement signal on a particular link should not be transmitted until signal recognition time of the primary signal has elapsed. To speed up the transmission of the answer signal, the overlap compelled technique is applied for this signal at a transit exchange when two No. 5 circuits are switched in tandem.

More details of the overlap compelled technique are given below:

If the primary signal from B to T lasts less than the signal recognition time, transmission of a primary signal already initiated at a transit point T from T to A will be stopped.

After the recognition time at T of a primary signal from B to T has elapsed, there shall be no control at T of the primary signal sent from T to A by the primary signal sent from B to T. In this case the primary signal on each link is ceased by its acknowledgement signal on that link (as in § 2.1.6 c) above).

Figure 1/Q.141 illustrates a typical arrangement and is included to illustrate the principle of overlap compelled signalling at transit points. Other design arrangements may be adopted as preferred by Administrations.

Transmission of the primary signal from T to A is initiated (by a ''start to send'' control condition *X* through the switch block at the transit point) as soon as the signal receiver response on the primary signal from B to T has caused the receiving-end line split (t_1 of T_1). The primary signal is transmitted from T to A after the sending-end line split (t_3 of T_3). Signal recognition of the primary signal is required at the transit point and the acknowledgement signal on a particular link should not be transmitted until the signal recognition time (t_2 of T_1, t_2 of T_4) has elapsed. The primary signal is ceased after the signal recognition time (t_2 of T_2, t_2 of T_5) of the relevant acknowledgement signal.

To prevent imitations of the primary signal on link BT lasting less than the signal recognition time from giving rise to an effective compelled signalling sequence on link TA, transmission of the primary signal on link TA is first under the ''start to send'' control *X* of a time base T_3 followed, without break at the termination of the time base (at time *Z*), by the continuous signal control required for compelled signalling. Should the duration of the

primary signal on link BT be less than the signal recognition time (t_2 of T_1), the ''start to send'' control (*X* control) is interrupted. This stops transmission of a primary signal on link TA (should this have commenced) within the period *X-Z* of T_3 and hence before the continuous signal control can be applied.

After the signal recognition time of the primary signal on link BT has elapsed, there shall be no control of the transmission of the primary signal on link TA by the primary signal on link BT at the transit point. To achieve this, a condition is applied to the *Y* control to inhibit the *X* control, which should ensure that transmission of the primary signal on link TA cannot be stopped during the period *X-Y* of T_3 and that the continuous signal control of the primary signal is applied without break at time *Y* (or at time *Z* depending upon the particular design). In these circumstances the primary signal on each link is ceased by its relevant acknowledgement signal.

Recommendation Q.142

2.2 DOUBLE SEIZING WITH BOTH-WAY OPERATION

2.2.1 *Unguarded interval*

Considering that on long international (intercontinental) circuits:

a) the sending end splitting time may be 50 ms prior to signal transmission;

b) TASI may occasionally clip the initial 500 ms of seizing signals;

c) circuit propagation time may be relatively long;

d) the signal receiver response time must be taken into account;

e) the recognition time of seizing signals is 40 ± 10 ms;

the unguarded interval relative to double seizing in the extreme case approaches 600 ms plus the circuit propagation time and the signal receiver response time. The signalling system should therefore detect double seizing and take action as defined in § 2.2.2.

2.2.2 *Detection of double seizing*

In the event of double seizing, the same frequency (f 1) is received as is being transmitted at each terminal. This condition shall be detected by the signalling equipment and shall cause stoppage of the outgoing seizing signal at each end. An end having detected double seizing, and terminated the outgoing seizing signal 850 ± 200 ms after this signal has been transmitted, will maintain the circuit in the busy condition until the stoppage of the incoming seizing signal from the distant end. Each outgoing seizing signal maintained for at least 850 ± 200 ms will ensure that both ends of the circuit will detect the double seizing.

The signalling equipment will be released on termination of both the outgoing and incoming seizing signals and a clear-forward shall not be sent.

Either of the following arrangements may apply on detection of double seizing:

a) an automatic repeat attempt to set up the call; or

b) a re-order indication is given to the operator or to the subscriber and no automatic repeat attempt is made.

Method a) is the preferred arrangement (see Recommendation Q.108).

Method a) does not require the repeat attempt to be limited to the circuit used at the first attempt, but should the first circuit be seized again at the second attempt on the second search over the circuits, a minimum time of 100 ms shall elapse between the termination of the first attempt outgoing seizing signal (or the recognition of the cessation of the incoming seizing signal, whichever occurs later) and the commencement of the second attempt seizing signal.

To minimize the probability of double seizing, the circuit selection at the two ends should be such that, as far as possible, double seizing can occur only when a single circuit remains (e.g. by selection of circuits in opposite order at the two ends).

Recommendation Q.143

See also Recommendation Q.112.

2.3 LINE SIGNAL SENDER

2.3.1 *Signalling frequencies*

2400 ± 6 Hz (f 1) and 2600 ± Hz (f 2).

These frequencies are applied separately or in combination.

2.3.2 *Transmitted signal level*

—9 ± 1 dBm0 per frequency.

For compound signals the difference in transmitted level between f 1 and f 2 shall not exceed 1 dB.

Note 1 — The noise as measured at the output of the line signal sender shall be as low as practicable but in any event, at least 40 dB below signal level. This noise includes all extraneous power in the frequency band between 300 Hz and 3400 Hz including power resulting from non-linear distortion of the signal.

Note 2 — The level of the leak current transmitted to line should be at least 50 dB below signal level per frequency.

Recommendation Q.144

2.4 LINE SIGNAL RECEIVER

2.4.1 *Operating limits*

The line signal receiver shall operate in the conditions specified under § 2.4.5 for the distortion of received signals that meet the following conditions:

a) f 1: 2400 ± 15 Hz; f 2: 2600 ± 15 Hz.

b) The absolute power level N of each unmodulated signal received shall be within the limits:

$$(-16 + n) \quad (-2 + n) \text{ dBm}$$

where n is the relative power level at the signal received input.

These limits give a margin of ±7 dB on the nominal absolute level of each received signal at the input to the signal receiver.

c) The absolute level of the two unmodulated signal frequencies in a compound signal may differ from each other by not more than 5 dB.

The tolerances given in a), b) and c) are to allow for variations at the sending end and for variations in line transmission.

2.4.2 *Non-operate conditions of line signal receiver*

a) *Selectivity*

The signal receiver shall not operate on a signal having an absolute power level at the receiving end within the limits specified in § 2.4.1 when the frequency is outside:

2400 |00 *u*—|50 Hz for the *f* 1 signal circuit or

2600 |50 *u*—|00 Hz for the *f* 2 signal circuit.

b) *Maximum sensitivity of line signal receiver*

The signal receiver shall not operate on a signal of 2400 ± 15 Hz or 2600 ± 15 Hz whose absolute power level at the point of connection of the receiver is (—17 —9 +*n*) dBm, *n* being the relative power level at this point. This limit is 17 dB below the nominal absolute level of the signal current at the input to the signal receiver.

2.4.3 *Efficiency of the guard circuit*

The signal receiver must be protected by a guard circuit against false operation due to speech currents, circuit noise, or other currents of miscellaneous origin circulating in the line.

The purpose of the guard circuit is to prevent:

a) signal imitation. (Signals are imitated if the duration of the resulting direct-current pulses at the output of the signal receiver is long enough to be recognized as signals by the switching equipment);

b) operation of the splitting device from interfering with speech.

To minimize signal imitation by speech currents it is advisable that the guard circuit be tuned.

To minimize signal interference by low-frequency noise it is advisable that the response of the guard circuit falls off towards the lower frequencies and that the sensitivity of the guard circuit at 200 Hz be at least 10 dB less than that at 1000 Hz.

An indication of the efficiency of the guard circuit is given by the following:

a) during 10 hours of speech, normal speech currents should not, on the average, cause more than one false operation of the *f* 1 or the *f* 2 signal circuit lasting more than 90 ms (the minimum recognition time of a signal liable to imitation is 100 ms);

b) the number of false splits of the speech path caused by speech currents should not cause an appreciable reduction in the transmission quality of the circuit.

Note — Since Signalling System No. 5 and V.22 modems are using the same frequency, additional tests where speech is replaced by data transmission should be performed so that the connection is not released at the start of data transmission. The quality requirement is for further study.

2.4.4 *Guard circuit limits*

A. *Steady noise*

Considering :

a) that when there is noise on a telephone circuit an over-sensitive guard circuit might give rise to signalling difficulties and, in particular, inhibit the response of the signal receiver;

b) that unweighted noise of a level —40 dBm0 (100 | 00 pW) and uniform spectrum energy may arise on the longest international, i.e. intercontinental, circuit;

it is recommended that, for either one or two signalling currents (each being within the limits specified in § 2.4.1), the signal receiver should satisfy the conditions indicated in § 2.4.5 for the distortion of signals in the presence of noise of a level of —40 dBm0 and uniform spectrum energy over the frequency range 300 to 3400 Hz.

B. *Surges*

A guard circuit with an excessive hand-over time may cause difficulties in receiving a signal, for example, when it has been immediately preceded by surges, and it is therefore recommended that the following condition should be fulfilled:

If a disturbing current of a frequency corresponding to the maximum sensitivity of the guard circuit and having an absolute power level of (—10 + *n*) dBm at the relative level point *n* where the receiver is connected ceases 30 ms before the application of a signal satisfying the limits defined in § 2.4.1, the lengths of the received signals must remain within the limits specified in § 2.4.5.

2.4.5 *Distortion of received signals*

When the signal frequencies and levels are within the limits specified in § 2.4.1, the change in signal length in the presence of noise as defined in § 2.4.4, A should not exceed:

a) 15 ms when the signal receiver receives a pulse of one frequency *f* 1 or *f* 2 with a minimum duration of 150 ms;

b) 25 ms when the signal receiver receives a compound pulse of the two frequencies *f* 1 and *f* 2 with a minimum duration of 150 ms, the change being defined as the difference between the simultaneous reception of the two frequencies at the input to the receiver and the simultaneous production of the two components as a direct-current signal at the output of the signal receiver.

In general, the response time of the signal receiver should be as short as practicable to minimize the time required for signalling purposes.

Except for the forward transfer pulse signal the above pulse distortion requirements are of minor importance for the remaining line signals, which are all of the continuous compelled type the limits are specified for receiver design and test purposes.

Recommendation Q.145

2.5 SPLITTING ARRANGEMENTS

Sending line split

2.5.1 According to Recommendation Q.25, § 2, sending split arrangements have to be provided.

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

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

2.5.4 Exceptionally, the values quoted in §§ 2.5.2 and 2.5.3 above may be 0 to 50 ms as the values are of minor importance with respect to compelled-type signals.

Receiving line split

2.5.5 The international circuit should be split at the international exchange when either a single-frequency or a compound-frequency signal is received, to ensure that no fraction of the signal exceeding 35 ms duration may pass out of the international circuit.

The splitting time of 35 ms may be reduced by each Administration concerned in order to help to protect its national network against the effect of signals coming from the international circuit. It should be noted, however, that a shorter splitting time can lead to an increase in the number of false operations of the splitting device by speech currents and impair speech transmission.

See Recommendation Q.141, § 2.1.6, explaining the term ‘‘continuous compelled.’’

2.5.6 The split must be maintained for the duration of the signal but must cease within 25 ms of the end of the direct-current signal which caused the splitting device to operate.

2.5.7 The splitting of the line must not give rise to surges which might cause interference with signalling over the international circuit or with other signalling systems associated with it for setting up an international call.

2.5.8 The splitting device may be any suitable arrangement — for example, physical line disconnection, high impedance electronic device, insertion of signalling frequency band stop filter, etc. The level of leak current transmitted to the subsequent circuit from the splitting device in the split condition should be at least 40 dB below the received signal level. Exceptionally, the level of the leak current may be 25 dB below the received signal level if this causes no interference with the relevant networks.

Recommendation Q.146

2.6 SPEED OF SWITCHING IN INTERNATIONAL EXCHANGES

2.6.1 It is recommended that the equipment in the international exchanges shall have a high switching speed so that the switching time may be as short as possible.

2.6.2 At the outgoing international exchange the seizing of the circuit and the setting up of the connection should take place as soon as the ST end-of-pulsing condition is available (see Recommendation Q.152). In automatic operation advantage should be taken of all cases in which the ST condition can be reasonably determined at once, i.e. with avoidance of the 4-6 seconds time-out.

At an international transit exchange the setting up of the connection on the outgoing circuit should take place as soon as the digits necessary to determine the routing, are received and analyzed.

At the incoming international exchange the setting up of the national part of the connection should start as soon as the register has received a sufficient number of digits.

2.6.3 At international exchanges the return of a proceed-to-send signal should be as fast as possible but in any case the return should normally be guaranteed before the time-out (minimum 10 seconds) of the seizing signal.

Furthermore, in the case of congestion on the circuits outgoing from a transit or an incoming exchange, a busy-flash signal should be returned as soon as practicable, but in any case within a maximum delay of 10 seconds following the receipt of the information necessary to determine the routing.

MONTAGE: PAGE 64 = PAGE BLANCHE

CHAPTER III

REGISTER SIGNALLING

Recommendation Q.151

3.1 SIGNAL CODE FOR REGISTER SIGNALLING

3.1.1 *General*

1) Automatic access to the international circuits must be used for outgoing traffic and the numerical signals from the operator or subscriber are stored in an outgoing international register before an international circuit is seized. As soon as the ST (end-of-pulsing) condition is available to the outgoing register, a free international circuit is selected and a seizing line signal transmitted. On receipt of a proceed-to-send line signal the seizing signal is terminated and a KP (‘‘start of pulsing’’) pulse, followed by the numerical signals, is transmitted by the register. The final register signal transmitted is an end-of-pulsing (ST) pulse. The register signalling is not required to be TASI-prefixed.

En bloc register signalling is the transmission, by a register, of all the call information as a whole in a regular timed sequence of signals. The technique requires that, in one register on the connection, all the relevant call information from a subscriber or operator shall be completely stored before output en bloc signal transmission takes place from that register. At registers subsequent to the one where all the call information from a subscriber or operator is completely stored, the output signal transmission may commence before the complete reception of the input information; thus overlap to any desired degree of the output signal transmission with the input signal reception may occur and this may be understood as being *en block overlap* . Alternatively, the output signal transmission may be delayed until all the call information is received and stored. This may be understood as being *en bloc non-overlap* .

2) Link-by-link register signalling applies. The register signals are always sent en bloc non-overlap applies at the outgoing international register. En bloc overlap applies at the transit and incoming international registers.

3) On a particular link, the KP signal sent by the international register (outgoing or transit register) on receipt of a proceed-to-send signal may be used to prepare the distant international register on this link for the receipt of the subsequent numerical signals. This signal may also serve to discriminate between terminal and transit traffic:

a) Terminal KP (KP1). Used to create conditions at the next exchange so that equipment (or techniques) used exclusively for switching the call to the national network of the incoming country is brought into circuit.

b) Transit KP (KP2). Used to bring into circuit, at the next exchange, equipment (or techniques) required to switch to call to another international exchange.

4) The register signalling is a 2-out-of-6 multifrequency code, forwad signalling only, as shown in Table 2.

TABLE [2], p.20

3.1.2 *Sending sequence of register signals*

The sequence of the register signals shall conform to the sequence indicated in Recommendation Q.107, noting the following:

a) a KP start-of-pulsing signal shall precede the sequence of numerical signals in all the cases indicated;

b) the ST end-of-pulsing signal will be transmitted from the register in automatic as well as in semi-automatic operation;

c) exceptionally, special numbers for giving access to incoming operators or delay operators may be dialled by outgoing operators and submitted by outgoing international registers instead of code 11 and code 12 signals.

Recommendation Q.152

3.2 END-OF-PULSING CONDITIONS — REGISTER ARRANGEMENTS

CONCERNING ST (END-OF-PULSING) SIGNAL

3.2.1 The register signalling arrangements provide for the sending of a ST signal for both semi-automatic and automatic operation; the arrangements in the outgoing international register for recognizing the ST end-of-pulsing condition will vary as follows:

a) *Semi-automatic operation*

The ST condition is determined by the receipt of the ‘‘sending-finished’’ signal from the operator (see Recommendation Q.106).

b) *Automatic operation*

1) Where the ST condition is determined by the originating national network and an ST signal is produced and transmitted to the outgoing international register, no further arrangements are necessary in that register for this

purpose.

2) Where the ST condition is not received from the originating national network, the outgoing international register will be required to determine the ST condition. This ST condition is determined when the cessation of numerical information input to the register exceeds a period of 4 seconds (5 | (+- | seconds) in either of the following two circumstances, as preferred by the Administration:

i) after the minimum number of digits in the world numbering plan; or

ii) after the minimum number of digits of the destination country numbering plan.

In i) and ii), prolonged cessation of the numerical information input before the minimum number of digits should result in time-out of the register without the production of the ST condition.

An immediate ST condition may be produced by a digit count to avoid the 4-second delay ST condition in the following circumstances:

i) when the destination country numbering plan has a fixed number of digits;

ii) when the maximum number of digits in the numbering plan of the destination country has been received.

3.2.2 Under all conditions, the outgoing international circuit should not be seized until the ST end-of-pulsing condition is available in the outgoing international register.

Recommendation Q.153

3.3 MULTIFREQUENCY SIGNAL SENDER

3.3.1 *Signalling frequencies*

700, 900, 1100, 1300, 1500 and 1700 Hz.

A signal shall consist of a combination of any two of these six frequencies. The frequency variation shall not exceed ± | Hz of each nominal frequency.

3.3.2 *Transmitted signal level*

—7 | (+- | dBmO per frequency.

The difference in transmitted level between the two frequencies comprising a signal shall not exceed 1 dB.

Note — The level of the leak current transmitted to line should be at least:

a) 50 dB below the single-frequency level when a multifrequency signal is not being transmitted;

b) 30 dB below the transmitted signal level of either of the two frequencies when a multifrequency signal is being transmitted.

3.3.3 *Signal duration*

KP1 and KP2 signals: 100 | (+- | 0 ms

All other signals: 55 | (+- | ms

Interval between all signals: 55 | (+- | ms

Interval between cessation of the seizing line signal and transmission of the register KP signal: 80 | (+- | 0 ms.

3.3.4 *Compound signal tolerance*

The interval of time between the moments when each of the two frequencies comprising a signal is sent must not exceed 1 ms. The interval of time between the moments when each of the two frequencies ceases must not exceed 1 ms.

Recommendation Q.154

3.4 MULTIFREQUENCY SIGNAL RECEIVER

3.4.1 *Operating limits*

The signal receiver must ensure a separate output signal for each of the six voice-frequency signals received, and must operate satisfactorily for any combination of two of the frequencies, received as a single pulse or in a train of pulses, satisfying the following conditions:

a) the frequency of the received signal is within ± | 5 Hz of the nominal signalling frequency;

b) the absolute power level N of each unmodulated signal shall be within the limits (—14 + n N n) dBm where n is the relative power level at the signal receiver input. These limits give a margin of ± | dB on the nominal absolute level of each received signal at the input to the signal receiver;

c) the absolute levels of the two unmodulated frequencies comprising a signal must not differ from each other by more than 4 dB;

d) when the signal frequencies and levels are within the limits specified in a), b) and c) above, and in the presence of noise as defined in § 3.4.3:

1) at the input of a signal receiver, the minimum duration of an MF signal necessary to ensure correct registration of the digit shall not exceed 30 ms; this includes the operate time of the signal receiver and the two-and-two only check feature;

2) furthermore, at the input of the signal receiver, the minimum duration of an interval necessary to ensure the correct functioning of the registration device shall not exceed 30 ms; this includes the release time of the signal receiver and the restoration time of the two-and-two only check feature.

Note 1 — The tolerances given in a), b) and c) are to allow for variations at the sending end and in line transmission.

Note 2 — The test values indicated in d) are less than the working values. The difference between the test and working values will allow for pulse distortion, difference in time of the receipt of the two frequencies comprising a signal, etc.

3.4.2 *Non-operating conditions*

a) *Maximum sensitivity*

The signal receiver shall not operate under the effect of a signal as indicated in § 3.4.1 **|**) whose absolute power level at the point of connection of the receiver is (—17 —7 + *n*) dBm, *n* being the relative power level at this point.

This limit is 17 dB below the nominal absolute power level of the signal current at the input to the signal receiver.

b) *Transient response*

Operation of the signal receiver shall be delayed for a minimum period necessary to guard against false operation due to spurious signals generated within the receiver on reception of any signal.

c) *Short signal response*

The signal receiver should not operate to a pulse signal of 10 ms or less. This signal may be of single frequency or two frequencies received simultaneously.

Likewise the signal receiver should ignore short intervals.

3.4.3 *Steady noise*

Considering that unweighted noise of a level —40 dBm0 (100 000 pW) and uniform spectrum energy may arise on the longest international circuit, the multifrequency receiver should satisfy the condition indicated in § 3.4.1 **|**) for minimum signal and interval durations in the presence of noise of level —40 dBm0 and uniform spectrum energy over the frequency range 300 to 3400 Hz.

3.4.4 *Input impedance*

The input impedance should be such that the return loss over a frequency range 300 to 3400 Hz against a 600 ohm non-inductive resistor is greater than 20 dB.

Recommendation Q.155

3.5 ANALYSIS OF DIGITAL INFORMATION FOR ROUTING

(see Recommendation Q.107 **|** fIbis in Fascicle VI.1)

Recommendation Q.156

3.6 RELEASE OF INTERNATIONAL REGISTERS

3.6.1 *Normal release conditions*

a) An outgoing international register shall be released when it has transmitted the ST signal.

b) An incoming international register shall be released in either one of the following two cases:

1) Depending on the arrangements adopted by the Administration concerned at the incoming international exchange.

For example: release on transmission of the ST signal, release on receipt of a number-received condition from the national network, etc.

2) When the busy-flash signal is returned. The return of the busy-flash signal in the case of congestion at the incoming exchange should take place as soon as practicable, but in any case within a maximum delay of 10 seconds following the receipt, at the incoming exchange, of the digits necessary to determine the routing.

c) A transit international register shall be released in either one of the following two cases:

1. When it has transmitted the ST signal.

2. When the busy-flash signal is returned. The return of the busy-flash signal in the case of congestion at the transit exchange should take place as soon as possible, but in any case within a maximum delay of 10 seconds following the receipt, at the transit exchange, of the digits necessary to determine the routing.

3.6.2 *Abnormal release conditions*

a) An outgoing international register shall be released in either one of the following two cases:

1. Proceed-to-send signal not received.

To release after the maximum delay of 10 to 20 seconds indicated by the time-out of the seizing signal. Register release after this delay will depend upon the arrangements preferred by the Administrations concerned, but release should preferably take place as quickly as possible after the time-out of the seizing line signal. On the affected incoming circuit, the preferred action is to return a congestion signal.

2. Proceed-to-send signal received.

This case assumes that the proceed-to-send signal has ceased at the incoming end in the normal way but owing to a fault condition the outgoing register has not pulsed out. The outgoing register will be released by the

clear-forward/release-guard sequence prompted by the busy-flash signal sent from the incoming end on non-receipt of register signals within the appropriate time. This assumes that the busy-flash signal is received at the outgoing end before the termination of any forced release delay that Administrations may wish to incorporate in the outgoing register.

b) An incoming international register shall be released in either one of the following two cases:

1. The ST signal not received within a certain time after commencement of the transmission of the proceed-to-send signal from the incoming end.

2. On return of the busy-flash signal, transmitted from the incoming end when an error is detected in the receipt of the register multifrequency signals.

c) A transit international register shall be released in any one of the cases stated for the release of the outgoing and incoming registers in §§ a) and b) above.

Recommendation Q.157

3.7 SWITCHING TO THE SPEECH POSITION

At the outgoing and transit international exchanges, the circuit shall be switched to the speech position when the register (outgoing or transit) is released after sending the ST signal.

At the incoming international exchange, the circuit will be switched to the speech position when the register is released (see § 3.6.1 of Recommendation Q.156).

MONTAGE: PAGE 70 = PAGE BLANCHE

CHAPTER IV

MANUAL TESTING ARRANGEMENTS FOR SIGNALLING SYSTEM No. 5

Recommendation Q.161

4.1 GENERAL ARRANGEMENTS FOR MANUAL TESTING

(see Recommendation Q.107 | fIbis in Fascicle VI.1)

Recommendation Q.162

4.2 ROUTING TESTING OF EQUIPMENT (LOCAL MAINTENANCE)

4.2.1 Routine tests for testing individual items of equipment such as circuit equipment, connecting circuits, operator's line calling equipment, selectors, registers, etc., must be provided for in every international exchange equipped for automatic switching. These routine tests will be made in accordance with the practice followed in each country for the local maintenance of the switching equipment.

4.2.2 The testing equipment must conform to the following principles:

a) an item of equipment must not be taken for test until it is free;

b) an item of equipment taken for test will be marked ''engaged'' for the duration of the test. Before a circuit equipment is taken for test, the circuit will be withdrawn from service at both international exchanges;

c) as an alternative to b), a like item of equipment, known to be properly adjusted, may be switched in, and the item of equipment to be tested is switched out during the test.

4.2.3 Testing of the circuit and signalling equipment should include a check that the specifications of System No. 5 are met in regard to the following:

a) *Line signalling system*

Signalling frequencies

Transmitted signal levels

Signal frequency leak

See Recommendation Q.49/O.22: ''Specifications for the CCITT automatic transmission measuring and signalling testing equipment ATME No. 2.''

Receiver operate and non-operate limits

Receiving-end line split

Sending-end line split

Line signal codes

Sending duration of signals

Recognition time of signals

Overlap transmission of answer signal on transit calls

Double seizing

Time-out and alarm features

b) *Register signalling system*

Signalling frequencies

Transmitted signal levels

Signal frequency leak

Sending duration of signals

Receiver operate and non-operate limits

Operation of the receiver to a series of pulses

Error-checking features

4.2.4 *Simulated end-to-end tests*

It is desirable that a means be provided whereby end-to-end testing can be simulated on a local basis. A local loop-around arrangement permitting an outgoing test call to be routed directly on a four-wire basis into incoming equipment should be provided. The loop-around arrangement replaces the international line and is connected to the circuit equipment under test on the one side and on the other side to similar working spare both-way circuit equipment and signalling equipment having access to the switching system.

Recommendation Q.163

4.3 MANUAL TESTING

4.3.1 *Functional testing of signalling arrangements*

Functional tests from one end of the circuit to the other can be made in the following three ways:

a) The first method consists of a rapid verification of satisfactory signal transmission by ensuring that a seizing signal is followed by the return of a proceed-to-end signal, that a clear-forward signal is followed by the return of a release-guard signal.

b) The second method consists of verification of satisfactory signal transmission by initiating a test call:

1. to technical personnel at the distant-end international exchange; or

2. to a test call signal testing and answering device, if such equipment is available at the distant-end international exchange.

c) The third method consists of complete verification of satisfactory line and register signal transmission. The verification consists of a check of ability to:

1. generate and receive line and register signals;

2. transmit the appropriate acknowledgement signals;

3. provide required duration and spacing of MF signals;

4. complete terminal and transit calls.

See the note to § 4.3.4.3.

4.3.2 *First method: rapid test*

1. Verification of satisfactory signal transmission:

a) Initiate a seizing signal and verify the receipt and recognition of the proceed-to-send signal from the distant end.

Note — Absence of numerical information following termination of the seizing signal may result in receipt of a busy-flash signal provided by some Administrations from the distant-end equipment.

b) Initiate a clear-forward signal and verify the receipt and recognition of the release-guard signal from the distant end.

2. Failure to complete the seizing/proceed-to-end signalling sequence or the clear-forward/release-guard signalling sequence should result in the automatic termination of the frequencies being transmitted within 10-20 seconds/4-9 seconds (see Recommendation Q.141, § 2.1.3.1 |).

3. In the event of a failure, appropriate steps should be taken to locate and correct the trouble.

4. The above tests are short, simple, and should be performed at least monthly from each end of the circuit as appropriate. This minimum periodicity should be increased to as often as daily if the incidence of trouble encountered is unsatisfactory.

4.3.3 *Second method: test calls*

1. Verification of satisfactory transmission of signals involved in completion of test calls (manual method):

a) Place a call to the technical personnel at the distant international exchange.

b) On completion of connection:

i) the audible ringing tone should be heard;

ii) the answer signal should be received when the call is answered at the distant end.

c) Request distant end to initiate a clear-back signal, followed by an answer signal.

d) A clear-back signal should be received and recognized when the distant end hangs up and a second answer signal should be received and recognized when the distant end re-answers the call.

e) Initiate a forward-transfer signal which should result in bringing in the assistance operator at the distant end.

f) Terminate the call and observe that the circuit restores to the idle condition.

2. Verification of satisfactory transmission of signals involved in completion of test calls (semi-automatic method).

If test call signal testing and answering devices are available at the distant international exchange, the signal verification tests should be made using this equipment to the extent that the applicable features indicated in 1 above are available.

3. The above tests should be made from each end of the circuit. They should be made monthly when the manual testing methods prescribed in 1 are used.

They may be made daily when semi-automatic test arrangements are available.

4.3.4 *Third method: comprehensive tests; terminal and transit test calls*

1. Verification of satisfactory signal transmission (frequency, level, duration, etc.) involved in terminal and transit calls.

a) These tests are made in conjunction with:

— verification and location of faults;

— ensuring that new circuits are satisfactory in operation before being brought into service.

b) When establishing new circuits all of the tests outlined in 4.2.3 should have been completed at both terminals. New circuits assigned to Time Assignment Speech Interpolation (TASI) equipment should be patched as non-TASI for the duration of these tests.

2. Terminal calls

Initiate a call to the distant end test centre. Coordinate this test with the distant end so that appropriate test equipment is connected prior to establishing the call. Check the following:

a) At the originating end check that a seizing signal is following by the receipt and recognition of the proceed-to-send signal from the distant end. Check that the proceed-to-send signal persists until the seizing signal ceases.

b) At the distant end check the following: *Duration of transmitted signal*

1. Interval between termination of seizing signal and start of KP signal 80 ± 20 ms

2. KP signal duration 100 ± 10 ms
3. Digital and ST signal duration 55 ± 5 ms
4. Interval between all signals 55 ± 5 ms

c) Check that the audible ringing tone is heard at the originating end.

d) At the originating end check that the answer signal is received, recognized and acknowledged. Check that the acknowledgement signal persists until the answer signal ceases.

e) At the distant end initiate a clear-back signal.

f) At the originating end check that a clear-back signal is received, recognized and acknowledged. Check that the acknowledgement signal persists until the clear-back signal ceases.

g) At the originating end initiate a forward-transfer signal.

h) At the distant end check the receipt of the forward-transfer signal. The transmitted duration of this signal should be 850 | (+- | 00 ms. This signal may be subject to TASI clipping.

i) At the distant end arrange to transmit a succession of clear-back and answer signals; first at a slow rate, then at a rate which is faster than the system is capable of following.

j) At the originating end check during the slow transmission of the switch-hook flashes that each clear-back and answer signal is received and properly recognized. Verify that after the fast transmission of switch-hook flashes the equipment indicates the final position of the switch-hook.

k) At the originating end release the circuit and check that the clear-forward signal is followed by the receipt and recognition of the release-guard signal from the distant end. Check that the release-guard signal ceases after the clear-forward signal ceases. Check that the circuit restores to the idle condition.

l) At the originating end check that the clear-forward signal sent to the incoming equipment in the idle condition results in the return of the release-guard signal and that the equipment restores to the idle condition.

m) At the originating end check that the busy-flash signal is received, recognized and acknowledged. Check that the acknowledgement ceases after the busy-flash signal ceases. (Some Administrations at the incoming end may find it convenient to provide a test call device which prompts the return of a busy-flash signal.)

In normal service the receipt of a busy-flash signal causes (after the acknowledgement) a clear-forward signal to be sent automatically from the international exchange originating the call. On a test call procedure some Administrations may prefer to avoid this process. In this case, the release of the connection is controlled by the personnel at the terminal originating the test call.

Note on items a) to m) — As part of the comprehensive tests it may, in certain circumstances such as fault localization, be desirable to test the frequency, level, and duration of received signals. Normally, however, it may be assumed that each Administration has verified the accuracy of its signal transmission locally as covered in § 4.2.3.

3. Transit calls

a) After securing the cooperation of a third international exchange initiate a transit call to this exchange through the international exchange covered in 2 above.

b) With the assistance of technical personnel at the third international exchange repeat steps 2 |) to 2 |) except that in step 2 |) measurement of the duration of the forward-transfer signal need not be made.

Note — Detailed tests of certain transit features such as that of the transmission of the answer signal on an overlap basis at the transit point should be performed locally.

Recommendation Q.164

4.4 TEST EQUIPMENT FOR CHECKING EQUIPMENT AND SIGNALS

4.4.1 *General*

For local checks of correct equipment operation and for readjusting the equipment, international exchanges should have test equipment available which includes:

a) Line and register signal generators.

b) Signal-measuring apparatus.

When making transit test calls it is not the intention to check the performance or the quality of the circuit beyond the transit exchange, this being completely the responsibility of the Administration concerned. However, it is important that in principle the transit operations can be checked.

c) Loop-around equipment (see 4.4.4).

4.4.2 *Signal generators*

The signal generators should be able to simulate all line and register signals. The generators may be part of test equipment which cycles the equipment to be tested through actual signalling sequences, in a manner which enables rapid complete testing to determine whether the equipment meets the system specifications. The generators should have the following characteristics:

a) *Line signal generator*

1) Signal frequencies should be within ± | Hz of the nominal signalling frequency or frequencies and shall not vary during the time required for testing.

2) Signal levels should be variable between the limit given in the specification and be able to be set within ± | .2 dB.

3) Signal duration should be long enough so that the signals can be recognized and long enough in the case of compelled signals to complete the acknowledgement process.

b) *Register signal generator*

1. Signal frequencies should be within ± | Hz of the nominal signalling frequency or frequencies and shall not vary during the time required for testing.

2. Signal levels should be variable between the limits given in the specification and be able to be set within ± | .2 dB.

3. Signal durations and intervals between signals shall be within the limits given in the specification in Recommendation Q.153, § 3.3.3, for normal operate values and in Recommendation Q.154, § 3.4.1 |), for test operate values.

4.4.3 *Signal-measuring equipment*

Equipment capable of measuring signal frequencies, signal levels, signal durations and other significant signal time intervals may be part of the test equipment referred to in § 4.4.2, or separate instruments. In either case the characteristics of the measuring equipment should be as follows:

a) *Line signal-measuring equipment*

1. Signal frequency or frequencies to be measured to be between the extreme limits given in the specification, the reading being made with an accuracy of ± | Hz.

2. Level of the signal frequency or frequencies measured over the range given in the specification to be measured with an accuracy of ± | .2 dB.

3. Signal durations, signal recognition times and other significant time intervals as given in the specification should be measured within an accuracy of 1 ms or ± | % of the nominal duration, whichever yields the higher value. The range of time intervals to be measured is approximately 5 to 1050 ms. Time-out intervals of 10 to 20 seconds and of 4 to 9 seconds should be determinable within an accuracy of ± | second.

b) *Register signal-measuring equipment*

1. Signal frequency or frequencies to be measured to be between the extreme limits given in the specification, the reading being made with an accuracy of ± | Hz.

2. Level of the signal frequency or frequencies measured over the range given in the specification to be measured within an accuracy of ± | .2 dB.

3. Signal duration and intervals between signals as given in the specification should be measured with an accuracy within 1 ms.

c) In regard to measuring time intervals a recorder having a minimum of two input channels may be useful. The recorded characteristic should conform with the accuracy quoted in a) and b) above and be easily connected to the circuit under test. The recorder input characteristic should be such as to have a negligible effect on circuit performance.

4.4.4 *Loop-around equipment*

Local four-wire loop-around equipment should simulate line facilities without introducing signalling degradation. The gain of the loop-around equipment should be set to provide proper transmission levels. Alternatively, if the testing of the individual items of equipment is on a limit test basis it would not be essential to set the gain of the loop to provide the exact transmission levels. In this event a straight patch would be adequate.

MONTAGE: PAGE 76 = PAGE BLANCHE

ANNEXES TO SIGNALLING SYSTEM No. 5

SPECIFICATIONS

ANNEX 1

Signalling sequences

Table 1 — Semi-automatic (SA) and automatic (A) terminal traffic.

Table 2 — Semi-automatic (SA) and automatic (A) transit traffic.

In these tables the arrows have the following meanings :

transmission of a signalling frequency (permanent or pulse emission).

end of transmission of the signalling frequency in the case of its permanent transmission.

transmission of an audible tone.

ANNEX 2

Description of the operations corresponding

to the various normal and abnormal conditions which may arise in setting up a call

Table 1 — Outgoing exchange — Normal conditions

Table 2 — Outgoing exchange — Abnormal conditions

Table 3 — Incoming exchange — Normal conditions

Table 4 — Incoming exchange — Abnormal conditions

Table 5 — Transit exchange — Normal conditions

Table 6 — Transit exchange — Abnormal conditions

ANNEX 1 TABLE [1] (a l'italienne), p. 21

ANNEX 1 TABLE [1 CONT],(`a l'italienne), p. 22

ANNEX 1 TABLE [1 CONCLUDED], (a l'italienne), p. 23

ANNEX 1 TABLE [2], (a l’italienne), p. 24

ANNEX 1 TABLE [2 CONT], (a l'italienne), p. 25

ANNEX 1 TABLE [2 CONT], (a l’italienne), p. 21

ANNEX 1 TABLE [2 CONT], (a l'italienne), p. 21

ANNEX 1 TABLE [2 CONCLUDED], (a l’italienne), p. 21

ANNEX 2 TABLE [1], p.

Table [2] (annex 2), p.30

Table [3] (annex 2), p.31

Table [4] (annex 2), p.32

Table [5] (annex 2), p.33

Table [6] (annex 2), p.34

MONTAGE: PAGE 92 = PAGE BLANCHE

PART III

Recommendation Q.180

INTERWORKING OF SIGNALLING

SYSTEMS No. 4 AND No. 5

MONTAGE: PAGE 94 = PAGE BLANCHE

INTERWORKING OF SYSTEMS No. 4 AND No. 5

Recommendation Q.180

INTERWORKING OF SYSTEMS No. 4 AND No. 5

General

It is possible to ensure normal operation for both semi-automatic and automatic service when interworking takes place between Signalling Systems No. 4 and No. 5, in either the ‘‘4 to 5’’ of ‘‘5 to 4’’ direction.

The interworking is possible because:

— the line signals (i.e. the supervisory signals) generally have the same meaning and the same function in both systems;

— the numerical (address) information is sent in the same sequence in both systems;

— all conditions for the use of the language digit in the semi-automatic service and the discriminating digit in the automatic service are the same in both systems.

In general, the interworking of the two systems merely requires that a signal received in the code of one of the systems be converted into the corresponding signal of the code used by the other system. Nevertheless, in a transit exchange where there is interworking of Systems No. 4 and No. 5, special precautions are necessary with regard to signals which are used differently in the two systems. These differenes are as follows:

a) System No. 5 always uses a forward end-of-pulsing signal (the ST signal), whereas the end-of-pulsing signal (code 15) is not always given in System No. 4;

b) System No. 4 uses a backward number-received signal which is not provided in System No. 5.

2 *Calls from System No. 4 to System No. 5*

2.1 *Semi-automatic calls from System No. 4 to System No. 5*

Figure, p.

1. In semi-automatic operation, the outgoing exchange A of System No. 4 sends an end-of-pulsing signal over link AT and the outgoing register at A is released.

2. The end-of-pulsing signal of System No. 4, which is a numerical type signal (code 15), is acknowledged.

3. On receipt of an end-of-pulsing signal from A, the incoming part of System No. 4 at transit exchange T sends to A an acknowledgement of the end-of-pulsing signal and then sends to A a number-received signal.

4. At T, an end-of-pulsing signal ST is sent over link TB on System No.5; this ST signal is obtained by converting the end-of-pulsing signal (code 15) of Sysem No. 4.

These register functions may be combined in a single register.

5. At T, the outgoing register of System No. 5 is released as soon as the signal ST has been sent over link TB on System No. 5. At T, the incoming register of System No. 4 is released after the number-received signal of System No. 4 has been sent back to A.

Note — The number-received signal is sent from T over link TA in order to conform to the specifications of System No. 4. Since the outgoing register at A will be released as soon as A has sent the end-of-pulsing signal (in accordance with the specifications of System No. 4), the only possible role of the number-received signal at A is to indicate to the operator that the selection procedure has been effected. However, since the number-received signal relates only to operations on the link AT on System No. 4, this signal provides no information about the entire selection process from A to B; the indication to the operator is hence of little value.

2.2 *Automatic calls from System No. 4 to System No. 5*

Figure, p.

1. The System No. 4 link AT does not provide for an end-of-pulsing signal from exchange A in automatic operation; the transit exchange T will therefore have to recognize that all the digits have been received in order to:

a) send a forward ST signal to B in System No. 5; and

b) send a backward number-received signal to A in System No. 4.

In this situation, the System No. 5 register signalling at T will be *en bloc* non-overlap taken by the System No. 5 register at T to recognize that all digits have been received.)

2. At A, release of the outgoing register of System No. 4 depends upon reception of the number-received signal.

At the incoming end of System No. 4 at T, the incoming register of System No. 4 is released as soon as the number-received signal is sent backward and all the numerical information necessary for setting up the call is sent to B.

At T, an ST end-of-pulsing signal is sent to B by System No. 5 after the numerical information has been sent, and the outgoing register of System No. 5 at T is then released.

3. *Calls from System No. 5 to System No. 4*

3.1 *Semi-automatic calls from System No. 5 to System No. 4*

See for this term the footnote to Recommendation Q.151.

Figure, p.

1. In semi-automatic operation at transit exchange T the incoming register part of System No. 5 receives an ST end-of-pulsing signal 55 ms after reception of the last numerical signal.

2. At T, the ST end-of-pulsing signal of System No. 5 is converted into an end-of-pulsing signal of System No. 4, which is sent to the incoming end B of this system.

3. The end-of-pulsing signal of System No. 4, which is a numerical type signal (code 15), is acknowledged.

4. At A, the outgoing register of System No. 5 is released after the ST signal has been sent.

5. At T, the outgoing register of System No. 4 is released when the end-of-pulsing signal is sent.

6. At B, the incoming register of System No. 4 is released as soon as the number-received signal is sent backward to T on System No.4 and all the numerical information necessary for setting up the call in the incoming country has been sent forward.

7. The number-received signal is sent over link BT upon reception at B of the end-of-pulsing signal. It will be noted that number-received signal is sent over link BT solely in order to conform to the specifications of System No. 4, even though this signal is superfluous in this case as:

a) the number-received signal is not needed to release the outgoing register of System No. 4 at T since it is released when it sends the end-of-pulsing signal;

b) this signal cannot be used to give any information to the operator at A since it cannot be passed by System No. 5 on link AT.

3.2 *Automatic calls from System No. 5 to System No. 4*

Figure, p.

1. This situation raises no difficulties since System No. 5 posses the ST signal which, by determining the end-of-pulsing at T, places the outgoing register of System No. 4 a T in conditions that are comparable to those existing with semi-automatic operation in System No. 4.

2. At T, the ST signal of System No. 5 is converted into the end-of-pulsing signal (code 15) of System No. 4.

3. The specifications of System No. 4 require that the incoming exchange B of System No. 4 must send the number-received signal as soon as:

a) an end-of-pulsing signal has been received, or

b) it has recognized that all the digits have been received.

In this case of interworking, condition a) is generally fulfilled first. It may happen, however, that a complete national number is recognized before the end-of-pulsing signal is received (for example, when the number of digits in the national number of the incoming country is constant). The transit exchange T must hence be capable of receiving the number-received signal not only after emission of the end-of-pulsing signal but also when the last digit preceding that signal has been sent.

4. Exchange B must be capable of receiving the end-of-pulsing signal (code 15) on automatic calls.

4. *Overflow from System No. 5 to System No. 4*

4.1 In an exchange equipped with System No. 4 and System No. 5, it may be desirable to provide for overflow from a group of circuits operated by System No. 5 to a group operated by System No. 4. This may be the case for a call outgoing from an exchange A (Figure 1/Q.180) or for a call from an outgoing exchange K (Figure 2/Q.180) and arriving via a group of circuits in System No. 4 at transit exchange T where a choice must be made between a first-choice route operated by System No. 5 and an overflow route operated by System No. 4.

4.2 There are two possible ways of arranging for the overflow, in particular with respect to the moment at which the decision is taken to use the overflow route:

— Single exploration;

— Double exploration.

FIGURES 1/Q.180 + 2/Q.180, pp.39-40

4.2.1 *Single exploration*

With single exploration, the state of occupation, or availability, of the System No. 5 group at exchange A or exchange T is considered only when the condition ST is determined at this exchange in the System No. 5 outgoing register.

a) If the exploration at A or at T shows that no free circuit in the System No. 5 group is available, overflow to the System No. 4 group takes place.

For this overflow the register has all the numerical information (even in the case of a transit register like that of the T exchange mentioned above), and the end-of-pulsing indication ST. The register at the transit exchange T will be regarded, for successive selection operations, as an outgoing System No. 4 register. Thus, in this case, signalling between the three System No. 4 registers involved will be link-by-link and not end-to-end.

In the case of Figure 2, as soon as the ST condition is available (at the latest immediately after the 5 | (+- | seconds delay provided for in the specifications for System No. 5) the number-received signal will be sent back from T to K in System No. 4.

The ST condition will also be used to cause the end-of-pulsing signal (code 15) to be sent forward from T to L, even in automatic working. The code 15 signal will cause the number-received signal to be sent back from L to T, so that there will be no need to wait for five or ten seconds at L before it is known that a complete number has been received.

The number-received signal sent by T will be received at K and will, in the case of an automatic call, release the outgoing register at that exchange. The second number-received signal, which will be sent by L, will be received at T to release the register at that exchange, despite the fact that the register has transmitted an end-of-pulsing signal which could have been used for releasing the register. The establishment of the speech path at T takes place immediately after the release of the register.

If in the case of Figure 1/Q.180 the ST condition is recognized in the outgoing exchange A, even in automatic operation. This end-of-pulsing signal will in the same way cause the number-received signal to be sent back from L to A.

b) If the exploration at A or at T shows that a free circuit in the System No. 5 group is available, the *en bloc* numerical information has to be transmited over this circuit, followed by the end-of-pulsing signal ST, in accordance with the specifications for System No. 5.

In the case of Figure 2/Q.180, the conditions for the number-received signal and the release of the outgoing register are the same as under 4.2.1 |).

4.2.2 *Double exploration*

With double exploration the state of availabiliy of the System No. 5 circuit group is examined twice, namely:

— as soon as the direction to be chosen is determined;

— after receipt of the complete numerical information.

With the double exploration, advantage is taken of the fact that, without awaiting condition ST, exchange A or exchange T can know that the direct route by System No. 5 is occupied as soon as the direction to be chosen is determined.

a) If the first exploration at A or at T shows that no free circuit in the System No. 5 group is available, overflow to the System No. 4 group should take place immediately; the use of the signals on the System No. 4 circuit(s) must be in accordance with the normal procedure of that system:

— in the case of Figure 2, end-to-end working (K-T-L) for the numerical signals and the number-received signal;

— the end-of-pulsing signal (code 15) only for semi-automatic calls.

The procedure of overflow at this first exploration reduces post-dialling delay in automatic working since there is no need to wait until all the digital information is assembled *en bloc* before proceeding with the setting up of the connection. On the other hand, there is a slight reduction in the efficiency of the first choice System No. 5 group.

b) After the first exploration has shown no congestion of the System No. 5 group, it may happen, during or after reception in the outgoing register at A (or transit register, in the case of T) of the digits following the digits necessary to determine the routing, that the System No. 5 group gets busy, more particularly because such a circuit group is a first-choice high-usage route with consequently a high probability of loss. When this hapens, after noting by this second exploration that all circuits in the System No. 5 group are busy, overflow to the System No. 4 group takes place.

For this case of overflow, the conditions can be considered to be the same as in 4.2.1 |).

c) If also the second exploration shows no congestion of System No. 5 group, the conditions mentioned in 4.2.1 |) fully apply.

4.3 Line signalling for calls set up in overflow through two successive No. 4 systems will be done normally, that is, end-to-end. The number-received signal, however, will be sent as stated in 4.2.1 |), 4.2.2 |) or 4.2.2 |).

5. *Interworking line signalling conditions*

5.1 *Forward-transfer signal*

The forward-transfer signal, in the event of a transit call going from System No. 4 to System No. 5, or from System No. 5 to System No. 4, should cause the assistance operator to intervene in the country of arrival, and not at the transit exchange.

The incoming line relay set of the first system at the transit exchange is informed, e.g. by the transit register, that the call is a transit call. Hence, when a forward-ransfer signal arrives on the first system, it causes the forward-transfer signal to be transferred to the outgoing line relay set of the second system without intervention by the operator at the transit exchange.

5.2 *Answer signal*

5.2.1 *System No. 4 to System No. 5 (traffic direction)*

The answer signal on the System No. 4 link should be sent only after complete recognition of the answer signal received from the System No. 5 link, i.e. overlap transmission should not be used.

The considerations for this requirement are:

— the overlap technique could give rise to troubles in signalling system No. 4 in case of imitation of the P signal;

— in the transfer of the answer signal from System No. 5 to System No. 4 the sending end line split (silent period) before starting P is a necessity due to the pulse type signals of System No. 4. The requirement for this sending-end line split period (40 | (+- | 0 ms) would have meant little speed advantage of overlap operation in transferring the answer signal from System No. 5 to System No. 4 (about 40 ms);

— overlap operation would be contrary to the design characeristic of System No. 4 in that once the sending of a signal has begun it must be sent completely.

5.2.2 *System No. 5 to System No. 4 (traffic direction)*

In the interworking arrangements in a transit centre for transferring the answer signal backward from System No. 4 to System No. 5, overlap transmission should not be used.

In System No. 4, overlap operation is incompatible with the use of time measurement for recognition of the suffix signal (short suffix or long suffix). The overlap operation would not permit waiting for the end of a signal PY (answer signal), to determine that it is not a PYY signal release-guard signal).

5.3 *Busy-flash signal*

In the case of interworking at a transit point from System No. 4 to System No. 5 or vice visa, a busy-flash signal received at that transit point from the outgoing circuit is to be converted to a busy-flash signal on the incoming circuit.

In the case of interwoking from System No. 5 to System No. 4, the busy-flash signal will cause the release of the international connection initiated from the outgoing exchange.

In the case of interworking from System No. 4 to System No. 5, the System No. 5 equipment at this transit exchange should function as an outgoing System No. 5 equipment on the receipt of a busy-flash signal and release the System No. 5 circuit from the transit point. It should be noted that the System No. 4 circuit is also released in the case of automatic calls.

Note — In the case of interworking from System No. 5 to System No. 4 it has been determined that no advantage is to be gained by the release of the international connection being initiated only by the outgoing exchange. Therefore in both cases of interworking, the transit exchange and the forward connection may be released immediately on receipt of the busy-flash signal. However, there is no need to modify existing equipment.

5.4 *Time-out delays to clear a connection in the event of signal failures*

5.4.1 *Non-reception of a clear-forward signal after a clear-back signal has been sent*

In the event of transit working System No. 4 to System No. 5 at an exchange T, this latter represents the terminal for System No. 4.

The action to be taken at an international incoming exchange for System No. 4 holds good for the exchange T. After a time-out of 2 to 3 minutes, the System No. 4 incoming equipment at T should produce an effect forward on the circuit of System No. 5, so as to release the international circuit (for example, should there be some interruption in the System No. 4 circuit). This release should proceed in the same way as the release of the national part of the connection, when the incoming exchange is indeed the incoming international exchange of the international connection.

For symmetry's sake, the action at T to release the connection should also be undertaken when there is transit working from System No. 5 to System No. 4, since a time-out of 2 to 3 minutes exists in System No. 5 to release the connection forward.

5.4.2 *Delay in clearing by the calling subscriber in automatic working*

In the case of automatic calls with interworking from System No. 4 to System No. 5, or from System No. 5 to System No. 4, release of the international connection as brought about by the time-out of 1 to 2 minutes must take place *at the outgoing exchange only* , and not at the exchange T, the point of connection of the two systems. In exchange T, the outgoing line relay sets of the second system in the connection must accordingly be marked that

they are acting, not as relay sets for the terminal outgoing end of the system in question, but as transit exchange relay sets.

5.4.3 *Non-reception of an answer-signal at the outgoing exchange after reception of a number-received signal or generation of the ST condition*

When a connection passes through System No. 4 towards System No. 5, or vice versa, release must be undertaken *at the outgoing exchange only* Hence nothing must be done at the transit exchange T, the point at which Systems Nos. 4 and 5 are connected.

In the case of System No. 4 towards System No. 5, exchange T represents the connection transit exchange for both systems. Non-reception at T of an answer-signal within 2 to 4 minutes after condition ST has been determined must produce *no* effect at exchange T. It will be for the outgoing exchange to cause release (by sending the clear-forward signal) on the 2 to 4 minutes' time-out after reception of the number-reeived signal from exchange T.

In the case of System No. 5 towards System No. 4 exchange T represents the connecting transit exchange for both systems. Non-reception at T of an answer-signal within 2 to 4 minutes after reception of the number-received signal from the incoming exchange must *not* affect exchange T. It will be for the outgoing exchange to cause release of the connection (by sending the clear-forward signal) after the delay of 2 to 4 minutes following the generation of the ST condition at that exchange.

MONTAGE: PAGE 102 = PAGE BLANCHE

ANNEXES TO INTERWORKING SPECIFICATIONS
OF SYSTEMS No. 4 AND No. 5

ANNEX 1

Signalling sequences in interworking

from System No. 4 to System No. 5
ANNEX 2
Signalling sequences in interworking

from System No. 5 to System No. 4

In these tables the arrows have the following meanings :

Transmission of a signalling frequency (permanent or pulse emission).

end of transmission of the signalling frequency in the case of its permanent transmission.

transmission of an audible tone.

annex 1 (table) (a l’italienne) p.41

annex 1 (table) (suite) (a l'italienne) p.42

annex 1 (table) (suite) (a l'italienne) p.43

annex 1 (table) (suite) (a l'italienne) p.44

annex 1 (table) (ﬁn) (a l'italienne) p.45

annex 2 (table) (a l’italienne) p.46

annex 2 (table) (suite) (a l’italienne) p.47

annex 2 (table) (suite) (a l’italienne) p.48

annex 2 (table) (fin) (a l'italienne) p.49