Specification TNA 151

Telecom Telephone Network Transmission Plan

Access Standards
Spark New Zealand Limited
Wellington
New Zealand

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Spark nz

FIGURES

RELATED DOCUMENTS

ITU-T Recommendations and the current CCITT Blue Book Recommendations:-

G. 100 - 191	General Characteristics of International Telephone Connections and Circuits
G. 701 - 797	General Aspects of Digital Transmission Systems
G. 801 - 958	Digital Networks, Digital Sections and Digital Line Systems
O. 41	Phosphometer for Use On Telephone Type Circuits
P. 31	Transmission Characteristics for Digital Telephones
P. 76 - 79	Determination of Loudness Rating
Q. 44 - 45	General Characteristics for International Telephone Connections and Circuits - Signalling & Switching
Q. 511 - 522	Exchange Interfaces, Functions and Connections
Q. 551 - 554	Transmission Characteristics of Digital Exchanges

• *References in this document are to the published ITU-T Recommendations or the CCITT Blue Book Recommendations where they have not been superseded by the respective ITU-T equivalent. They are both referred to as* ***"Recommendations"*** *in the text.*

Telecom Specifications

TNA 102	Telecom Public Switched Telephone Network (PSTN) Analogue Line Interface
PTC 109	PABX Transmission Requirements
PTC 110	PABX Network Requirements
PTC 200	Requirements for Connection of Customer Equipment to Analogue Lines
PTC 217	Requirements for Bandwidth Management Devices
PTC 301	Telephone Network Interconnection (using MFC signalling)
PTC 331	Telephone Network Interconnection (using ITU No. 7 signalling)
PTC 332	Local Network Interconnection

DATES OF ISSUE

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FOREWORD

The primary purpose of this document is to advise telecommunications equipment suppliers and network operators of the transmission plan being followed by Telecom in the development of its Public Switched Telephone Network (PSTN). The plan forms the basis for the more detailed transmission requirements contained in Telecom's Permit To Connect (PTC) and Telecom Network Advisory (TNA) series of specifications, which cover the connection of customer premises equipment and private networks to the Telecom PSTN network, and interconnection with other network operators. It also reflects into interconnection agreements and other arrangements.

Transmission plans are used by telecommunications administrations and network operators to ensure that any two customers, regardless of their location either nationally or internationally, can satisfactorily communicate via the public switched network. International consistency between plans is achieved through alignment, where practicable, with the recommendations of the International Telecommunications Union, now known as ITU-T recommendations and previously CCITT recommendations. Country specific and/or network operator specific variations will be found within plans.

PSTN networks, private networks, customer equipment, and the technologies used are continually evolving and expanding. Transmission plans consequently need to be adjusted at intervals. A number of changes have been made to Telecom's Telephone Transmission Plan since TNA 151 was first published in 1990, and these have now been incorporated into this document together with the results of a recent review. Consequently the transmission plan reflects current objectives. However, the existing Telecom PSTN, private networks, and customer equipment may not necessarily meet these latest requirements in all respects. Upgrading will generally take place when equipment addition and/or replacement occurs in line with this 1996 plan.

Readers should direct any queries about this document and its application to Telecom Access Standards.

References in this document are to the published ITU-T Recommendations or the CCITT Blue Book Recommendations where they have not been superseded by the respective ITU-T equivalent. They are both referred to as **"Recommendations"** in the text.

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1
GENERAL

1.1
International obligations

(1) The New Zealand Government is a member of the International Telecommunications Union (ITU) and, along with all other members, agreed at the 1988 World Administrative Telegraph and Teleconference (WATTC-88) in Melbourne to ensure “that administrations cooperate” and in the international network “a satisfactory quality of service should be maintained to the greatest extent practicable, corresponding to relevant ITU-T Recommendations" - see Appendix 1. Accordingly the Telecom Transmission Plan is in general consistent with Recommendations of the ITU-T.

(2) This Plan is designed to ensure that any customer connected to the Telecom PSTN can satisfactorily communicate with any other customer within their own or any other interconnecting network, including that of an overseas country. The Plan also covers connections via an individual PABX, or a PABX network, connected to the Telecom PSTN. Telecom will advise the interconnection requirements for private networks and negotiate with other network operators to achieve satisfactory communications.

1.2
Transmission plans

(1) For satisfactory operation it is essential that the transmission performance of any switched telephone network be properly planned so that an acceptable quality of signal (speech or data) is achieved for all possible types of call connection.

(2) Other network operators are encouraged to develop their transmission plans in accordance with ITU-T Recommendations to enable the full range of digital services to be switched nationally and internationally through a mix of networks as selected by the customer.

(3) Telecom will continue to update the Plan as technology and customer service requirements develop.

1.3
Telecom network interface specifications

(1) As will be understood from the issues outlined in this document, the Transmission Plan is one of the primary bases on which the Telecom PSTN is designed. The plan also provides a reference for the interconnection of the Telecom PSTN with other public and private networks within New Zealand.

(2) As there needs to be close correlation between the network and its terminal equipment if this plan is to be met, Telecom defines its interfaces for the information of terminal equipment designers in the form of TNA Specifications, of which this is just one. Telecom’s network interface specifications, especially TNA 102: 1996, are based on and aligned with this 1996 PSTN Transmission Plan.

1.4
Telepermit requirements

Telecom's Telepermit requirements for customer premises equipment are published in a series of PTC Specifications. For the analogue network, the primary document is PTC 200: 1996. The transmission requirements of PTC 200 are also based on and aligned with this 1996 PSTN Transmission Plan. This should ensure that new privately-supplied terminal equipment (Customer Premises Equipment or "CPE") will progressively be brought into line with this plan.

2
SCOPE

2.1
Transmission Plan

(1) This document details the 1996 Transmission Plan for the Telecom Public Switched Telephone Network (PSTN). Compliance with the Plan should ensure satisfactory transmission performance for telephony purposes between any two telephone customers in the Telecom Network, or between any Telecom customer and customers in other public and private networks, including the International PSTN.

(2) The Plan represents Telecom's current objectives, and the existing Telecom PSTN, private networks, and customer equipment may not meet these objectives in all respects. This is largely a result of refinements which have been necessary as the technologies used have evolved and been deployed. The process of meeting changed objectives is one of evolution as the installed base is progressively extended, rearranged or replaced. Changes to the Plan are made in such a way as to ensure that transmission quality is maintained.

(3) This Plan places an emphasis on voice telephony transmission requirements. Digital data in the form of ISDN is covered. Voice band data performance is largely constrained by provision made for voice telephony.

(4) For the purposes of this plan, mobile cellular networks are not considered to be part of the PSTN. Further, while the requirements of international connections are taken into account in this plan, Telecom's international links are not considered to be part of the Telecom PSTN.

(5) The Telecom Telephone Transmission Plan is referred to as the "Plan" throughout the remainder of this document.

2.2
Objective

The objectives of the Plan are to:

(a) Minimise the number of customers experiencing difficulty on any connection through the network.

(b) Maximise the number of connections falling within the customers' range of preferred losses.

(c) Provide for a digital switched network capable of terminating both the integrated services digital network (ISDN) lines and the existing analogue customers' lines.

2.3
Digital network

(1) The existing (1996) PSTN operated by Telecom New Zealand Limited consists in the main of digital switching nodes interconnected by digital transmission links, and the very few remaining analogue switches are expected to be replaced by the end of 1998. For this reason the main thrust of this document is directed towards defining the transmission quality of an all-digital network.

(2) It will however be some years before analogue components are completely replaced in the customer access network. For this reason it is necessary to accommodate the use of analogue transmission processes at network interfaces.

2.4
Transmission aspects

2.4.1
There are several aspects which must be considered when designing a transmission plan if the overall objectives given in clause 2.2 above are to be met. These are described in the following subclauses.

2.4.2
Overall loss
(1) The total combination of distributed losses between customers and their local exchanges, and the losses incurred in the intermediate switches, links between switches and any associated mismatches, should fall within the customers' range of preferred losses.

(2) Since loss is independent of distance in digital systems, loss considerations in this Plan apply to the analogue sections of the network.

2.4.3
Digital integrity
(1) Telecom uses A-law 8-bit encoding to convert analogue speech signals into 64 kbit/s digital signals.

(2) The objective is to provide 64 kbit/s transmission paths customer to customer for the ISDN.

(3) Low bit rate encoding in the Telecom telephone switched network (i.e., PSTN excluding the customer access network) is not permitted. Digital processing will occur in digital cross-connect, digital multiplexers and proposed asynchronous transfer mode systems, but the 64 kbit/s integrity is maintained. Digital compression may be used on a restricted basis in the customer access network, but the objective is to provide a full 64 kbit/s circuit to the customer.

(4) Digital processing and compression on international routes from 64 kbit/s to 32 kbit/s is generally accepted. When ISDN signalling is received two 32 kbit/s circuits are allocated for full 64 kbit/s integrity. When facsimile is detected it may be decoded and transported digitally for re-encoding at the distant end.

(5) Transmission performance is particularly important when interconnecting two or more networks and it is required under interconnect agreements that interconnection be digital and at 64 kbit/s or above to avoid any degradation.

2.4.4
Echo

(1) Echo is caused by reflections in combination with transmission delay. Reflections are due to impedance mismatches which can arise at 2w/4w transitions. These commonly occur in the analogue customer's loop, either at the interface with a digital exchange or derived bearer system, or at the interface with a digital PABX, or other customer equipment. Other transmission attributes such as signal delays, low circuit losses and high signal levels add to customer awareness of any echo produced. Echo control measures are required where the accumulated delay becomes significant.

(2) All digital equipment introduces delay and this is added to by the propagation time of the signals transmitted. Propagation time is particularly significant whenever satellite systems are used due to the additional distance the signals are required to travel.

(3) Path delays within New Zealand have not been a major problem in the past, but are becoming longer. An increasingly common source of delay is digital signal processing in customer terminal equipment (e.g. 8 and 13 kbit/s encoders in digital mobile equipment and bandwidth management equipment in private networks).

2.4.5
Transmission impairment

Digital encoding/decoding processes produce a degree of degradation in transmission quality and it is necessary to specify overall limits which are acceptable to customers. To achieve such a satisfactory overall quality, this degradation needs to be apportioned between various sections of the network, and also between individual networks, both nationally and internationally. This degradation, is called quantisation distortion.

- *Present methods of assessment of quantisation distortion are under review by ITU-T following development of new and improved algorithms for encoding.*

2.4.6
Noise

Digital switches and transmission systems are essentially free of traditional noise sources (e.g. line noise, etc) so long as the bit error rate is satisfactory. Some noise is introduced by digital processing such as quantisation distortion and conversion noise, but these are controllable. Once derived, digital signals can remain noise free irrespective of distance and the number of links involved.

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3
DEFINITIONS AND ABBREVIATIONS

The following terms are defined to ensure clarity of interpretation. Where appropriate ITU-T or current CCITT references are included.

Adaptive differential pulse code modulation (ADPCM): is a transcoding technique consisting of a form of differential PCM using adaptive quantising .

- *See also "differential pulse code modulation".*

Balance return loss: is the portion of the loss over the a-t-b path (see Fig. 4) which is attributed to the degree of mismatch between the 2-wire terminal impedance and the balance impedance of the terminating hybrid. The ***terminal balance return loss (TBRL)*** is the balance return loss measured against a specified impedance.

- *For measurement of balance return loss, the 'T' and 'R' pads shown in Fig. 4 must be set to zero.*
- *Reference Recommendation G. 122.*

Bit error ratio (BER): is the ratio of the number of bit errors to the total number of bits in a digital signal transmitted in a given time interval.

- *Reference Recommendation G. 701, clause 2.2 "error ratio".*

Customer access circuit: the circuit linking the customer's premises to the Telecom switch serving that customer.

- *Customer access circuits may comprise copper cable, transmission systems, or some combination thereof. While the switch may be located at some distance from the customer's premises, there could be relatively short lengths of copper cable between the 2-wire/4-wire point and the customer's equipment.*

dBm: is the absolute power level in decibels (dB's) relative to 1 mW.

dBm0: is the absolute power level in decibels referred to a point of zero relative level.

dBm0p: is the absolute psophometric power level in decibels referred to a point of zero relative level.

- *Psophometric weighting for use on telephone-type circuits is to Recommendation 0.41.*

dBr: is the nominal relative power level in decibels referred to a point of zero relative level.

- *See also the definition of "Transmission reference point".*
- *"dBr" is sometimes further defined as the level relative to a point at which the long term average power is assumed to be -15 dBm. However, more recent studies by the ITU-T have indicated that there is disparity in the mean active speech power between different countries and it appears that - 19*

dBm0 or lower may be a more realistic recommended level. For this 1996 Transmission Plan, telephone Loudness Ratings have been "quietened" to achieve a level at the 0 dBr point closer to the -19 dBm level.

- *Relative power level is defined in, Recommendation G. 101, clause 2.3.*

- *dBr, dBm0 and dBm at any given point are related as follows: dBm = dBm0 + dBr, Recommendation G. 101 Annex A.*

Digital reference sequence (DRS): is a PCM code sequence that, when decoded by an ideal decoder, produces an analogue sinusoidal signal of 1020 Hz at a level of 0 dBm0.

- *Conversely, an analogue sinusoidal signal of 1020 Hz at a dBm0 applied to the input of an ideal coder will generate a PCM digital reference sequence.*

- *Reference, Recommendation G. 101, clause .2.9.1.*

Echo: is a reflected signal which is of sufficient magnitude for it to be noticeable to the user of a telecommunication circuit.

Echo loss: is an expression of the loss between points a - b in a 4-wire transmission path derived from the measured losses at various frequencies in the range 300 Hz - 3400 Hz, 'a' and 'b' are at the 0 dBr reference points in the two directions of transmission (see also Fig. 4).

- *Reference Recommendation G. 122*

- *Return loss and echo loss are the result of impedance mismatch occurring in the 2-wire path of any network*

Echo return loss: is the echo loss averaged with 1/f power weighted over the telephone band, 300 - 3400 Hz.

Echo balance return loss (EBRL): is the balance return loss averaged with 1/f power weighted over the telephone band, 300 - 3400 Hz

- *Reference Recommendation G. 122.*

Encoding/decoding pair: A pair of devices, physically separated in the network which enables a digital or analogue signal to be encoded to, and then decoded from a particular digital signal format.

Encoding laws (A-law or μ-law): are two alternative methods of encoding samples of analogue signals into a binary form for pulse code modulation.

- *The standard adopted in New Zealand is A-law, in common with European countries, Australia, and many other parts of the world. The North American standard is μ-law*

- *Reference , Recommendation G. 711.*

4-wire path: is a section or series of sections of a transmission link using a separate path, frequency band, or time interval for each direction of transmission.

- *Reference Recommendation G. 101.*

Gateway (or International) Exchange (IX): is an interconnection point between the Telecom network and the international network, providing switching, international call charging and international traffic assistance facilities.

Integrated services digital network (ISDN): is a network in which digitally switched connections are used for the transmission of digital signals. The same switches and digital paths are used to establish connections for different services in the Telecom network.

- *ISDN provides digital connections between user/network interfaces and enables different services such as telephony and data to pass over the same connection facility.*

Interconnect: is the formal description of connection between two networks made by means of a connection equivalent to that of inter-exchange trunks to a transit exchange.

- *This is also sometimes referred to as "trunkside interconnection".*

Jitter: is the short term variation of the significant instants of a digital signal from their ideal position in time.

- *See also "wander".*

- *Reference Recommendation G. 823.*

Local exchange(LX): is a telephone exchange which provides local customer switching.

- *In the Figures associated with this document, the term "switch" is commonly used in place of "local exchange". "Switch" more clearly represents the fact that the "local" exchange may be many kilometres from the customer's premises due to the use of a transmission system to provide all or part of the customer access circuit.*

LX MDF: Telephone exchange main distribution frame (2-wire copper cable circuits).

- *With the trend to use distributed multiplex to extend the digital path closer to the customer terminal, the point equivalent to the LX MDF may now be at some distance from the LX switch or even in the customers premises.*

Loudness rating(LR): is a measure, expressed in decibels, for characterising the loudness performance of complete telephone connections, or parts thereof, such as the sending system, line, or receiving system.

- *Loudness rating is an internationally accepted concept, also used for measuring the performance of telephones in a completely objective way, such that computer-controlled measuring equipment can be*

used to make quick, accurate and, above all, repeatable tests (ref. Recommendations G. 111, G. 121 and P. 76 - 79).

- *A loudness rating is the result of a calculation based on fourteen separate measurements made, to a reference point in a network, at predetermined frequencies within the normal telephony frequency range. Each measurement is "weighted" according to its effect as perceived by the human ear when listening to normal spoken words.*

- *The loudness rating measurement is actually the loss involved in the circuit under test, relative to the internationally accepted reference standard (IRS). Thus the higher the loudness rating the quieter the perceived signal volume. A negative value occurs when the loss is actually less than that of the reference standard.*

Network: is any telecommunications link or combination of links and switching equipment operated by an organisation for the purposes of providing telecommunications services.

Network operator: is any person declared by the Governor General by Order-in-Council to be a network operator under Section 2A of the Telecommunications Amendment Act 1988.

- *The full definition is as given in the above Act.*

PABX (Private Automatic Branch Exchange): is any form of telecommunications switching system installed in or intended to be installed in a customer's premises.

PABX trunk: is any circuit connecting a PABX with the local exchange.

Private network: is any telecommunications link or combination of links and switching equipment operated by an organisation for the purposes of providing private telecommunications services which may or may not be interconnected with the PSTN.

- *The simplest an most common form of private network is a PABX network.*

Public Switched Telephone Network (PSTN): is a network, accessible to the public, which is primarily used for the switching and transmission of telephone traffic. It includes the Telecom PSTN and the PSTN networks of other network operators. Services carried include plain ordinary telephone service (POTS) and ISDN.

Quantising distortion: is distortion resulting from the process of quantising samples of an analogue signal, within the working amplitude range, into a limited number of discrete steps, and its decoding back to the analogue form. Quantisation distortion also occurs with digital compression where the bit rate is changed and averaging takes place to establish a new bit rate.

Quantising distortion unit (QDU): is a basic reference unit of distortion produced by a single 8-bit PCM process consisting of one coder and one decoder, using either A-law or μ-law.

- *The QDU is used as a means of assessing the overall transmission impairment of mixed digital and analogue networks (not including distortion of analogue paths).*

Return loss: is a quantity associated with the degree of match between two impedances in a 2-wire speech path given by the expression:-

$$\text{Return loss of Z1 versus Z2} = 20 \log_{10} (Z1 + Z2)/(Z1 - Z2) \text{ dB}$$

- *Reference Recommendation G. 122, Annex B.1, which also covers other related terms such as "echo loss" and "stability loss".*

Service operator: is any organisation, operating a telecommunications network or service, which enters into an interconnection contract with one or more network operators.

- *For ease of reference in this Specification, the term is used as a general term to describe any operator of a telecommunications network or service, notwithstanding whether that operator is a "network operator" in the legal sense, and whether that operator actually owns the network concerned or leases it from another party.*

Sidetone: is the reproduction in a telephone receiver of sounds picked up by the microphone of the same telephone. From a customer's perception it may include echo reflected from some distant point of a telephone connection.

- *A measure of sidetone performance is "sidetone masking rating (STMR)" reference Recommendations G. 121 and P. 76.*

Specialised networks: is a general term to describe the various networks, which need to be connected to the public switched network for their function, but which use separate specialised types of equipment for their operation.

- *Examples of 'specialised networks' are PABX cellular radio, voice mail, paging, store and forward facsimile, intelligent networks, etc.*

Stability loss: is the least value of measured loss in the band 0 - 4 kHz between points 'a' and 'b' in a 4-wire transmission path where a and 'b' are 0 dBr reference points in the two directions of transmission respectively.

- *Reference Recommendation G. 122 Annex B.6.*

Telecom: Telecom New Zealand Limited or any of its subsidiary companies.

Telecom network: is any part of a network owned and operated by the Telecom Corporation of New Zealand Limited or any of its subsidiaries, whether for public or private use.

Telecom Public Switched Telephone Network: is that part of the Public Switched Telephone Network (PSTN) owned and operated by Telecom.

Terminal balance return loss (TBRL): see “Balance return loss”.

Transmission reference point (TRP): is a hypothetical point used as a relative level point in the computation of levels for the transmission of signals through a telecommunication network.

- *See also definition of "dBr"*
- *Reference Recommendation G. 101, clause 2.2.*

2-wire path: is a section or series of sections of a transmission link using the same path, frequency band, or time interval for both directions of transmission.

Wander: is the long term variation of the significant instants of a digital signal from their ideal position in time.

- *See also 'Jitter".*
- *Reference Recommendation G. 823.*

4
NETWORK CONFIGURATIONS

4.1
International telephone connection

A complete international telephone connection is comprised of three basic sections (ref. Fig. 1) as follows:-

(a) Originating national system,

(b) International chain (or system),

(c) Terminating national system.

4.2
Telecom network and the national system

(1) The intent of this document is to specify the transmission requirements of the Telecom telephone network as they relate to both the international network and the networks of other operators within New Zealand. Because international telephone connections may be incoming to, or outgoing from New Zealand, the Telecom telephone network incorporates facilities which should satisfy requirements for both originating and terminating national systems referred to above in clause 4.1.

(2) The New Zealand national system incorporates Telecom and all other service operator networks within New Zealand which are interconnected and have access either directly or indirectly to the international network. International access may be via Telecom or another network operator (see Fig. 2).

(3) Because the New Zealand national system comprises several networks interconnected with one another, it is desirable for a transmission network standard to be established which will embrace all possible telephone connections within the country.

4.3
Network relationships

(1) Figure 2 shows typical relationships within the Telecom network and to networks of other service operators which together make up the national system.

(2) The switching and conversion processes used to connect two customers via a network introduces various impairments to voice band signals. These impairments are cumulative and therefore the overall performance of a connection is dependent on the number of such processes involved. Guidelines for the impairments permitted in the Telecom network are given in subsequent sections.

(3) This document addresses, primarily, the all-digital national system. The international network is also rapidly becoming all-digital with the deployment of optical fibre submarine cable and digital satellites.

• *The most significant area where analogue links are likely to remain for some years is in the customer access circuit, in particular the "last kilometre" between customers and the local exchange or digital multiplex point.*

4.4
Rules for connection of two end users

(1) In an all digital network the number of inter exchange links in tandem are no longer relevant. What is important is the accumulation of transmission impairments due to digital processes and propagation time due to distance and those processes.

(2) There is a limit to the quantisation distortion on any international telephone connection including the New Zealand national system.

(3) There is a limit to the propagation time acceptable on any international and national connection before echo control is required.

(4) The propagation time for 2-way speech over two or more satellite hops is regarded as being less than desirable. Nevertheless it is recognised that there are situations in a national network that necessitate a satellite hop (giving the possibility of 2 satellite hops on an international connection), and hence dispensation is given to one national satellite hop.

4.5
Integrated services digital network

(1) The all-digital network provides the platform for the objective switched ISDN network. Provision of 64 kbit/s customer-to-customer on the switched and bearer network, internationally and nationally, works towards this objective.

(2) The ISDN network provides for an increasing number of application such as video conferencing, etc, using basic rate ISDN (2B+D)

(3) Interconnection between service operators must be at basic or primary rate for ISDN connections.

(4) ISDN connections to and through PABX's require ISDN signalling in addition to 64 kbit/s integrity .

5
REFERENCE POINTS

5.1
General

(1) For the purpose of establishing and maintaining overall loss and noise standards in an all-digital network, a number of points in the network are nominated as transmission reference points (TRP's) to which fixed relative levels are assigned.

- *Reference Recommendation G. 101, clause 2.2.*

(2) Many of these points are hypothetical because they cannot be directly accessed. However, they do serve as a convenient means of planning and establishing the performance of various sections of any network.

(3) The most commonly used reference is the 0 dBr point. The nominated points and assigned levels shown in the following table and diagrammatically in Fig. 3, are based on the virtual international connecting point (VICP), 'a' and 'b' shown on Fig 1.

TABLE 1: REFERENCE LEVELS AT A TRP

REFERENCE POINT (TRP)	REFERENCE LEVEL
LX MDF	+0.5 dBr Send -6.0 dBr Receive
LX switch	0 dBr
Transit exchange switch	0 dBr
IX switch	0 dBr

- *With the trend to use distributed multiplex to extend the digital path closer to customer terminal, the reference point equivalent to the LX MDF may now be at some distance from the LX switch. Equivalent reference levels may typically be 2.5 to 3 dB lower if the point equivalent to the LX MDF is in the customer premises, see clause 6.2(5) and (6).*

- *Reference levels at the LX MDF assume that no gain has been applied in the 4-wire path to offset 2-wire copper cable pair losses.*

(4) PCM digital reference sequences 'DRS' are defined in Recommendation G. 711 in respect to A-law and, μ-law codecs.

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6
OVERALL NETWORK TRANSMISSION PERFORMANCE

6.1
Transmission Plan

(1) For satisfactory end-to-end transmission where there is interworking between networks, whether nationally or internationally, it is essential that performance limits be properly defined. This applies to the transmission performance between network interfaces where customers can place calls that transit two or more networks.

- *The telephone connection transmission performance objectives for national networks connected to the international network, either directly or indirectly, are outlined in Recommendations G. 101 and detailed in G. 120 to G. 135, G. 171 to G. 174.*

(2) This section specifies the requirements for network transmission performance applicable at particular interfaces. Other performance limits are given in Sections 7 - 11.

(3) The general transmission characteristics for circuits of international connections are described by Recommendations G. 111 to 117. They cover loudness ratings, noise limits, crosstalk, distortion, impairment and factors affecting stability and echo. These Recommendations are used to define the New Zealand interface with the international network.

(4) All international connections with New Zealand shall be equipped with devices at the international gateway exchange to control echo originating in the New Zealand network.

- *Reference Recommendation G. 114, G. 131 and G. 165*

6.2
Loudness rating (LR)

(1) The loudness ratings in the Telecom network have been apportioned as shown in Fig 4:-

(a) Send and receive loudness rating of the telephone instrument (SLR and RLR) on a zero length line, and

(b) Circuit loudness rating (CLR) of the customer access circuit, and

(c) Switched circuit loss comprising the R and T pads.

- *Principles and methods for determination of loudness ratings are given in Recommendations P. 76 to P. 79.*

- *Minimum technical requirements, including loudness ratings for telephony products connected to the Telecom network are given in Telecom Specification PTC 200.*

(2) It is convenient to extend this concept to define performance through a network, and particularly at the interface with other networks. This approach is used by the ITU-T and is given in Recommendations G. 111 and G. 121.

(3) The loudness rating limits stated in this section are expressed for convenience relative to a 0 dBr point. They include the customer access CLR and the effects of the R and T pads shown in Figs. 3 and 4.

• *Recommendation G. 121 describes the use of "R" and "T" pads and indicates values used by the former NZ Post Office in New Zealand as 7 dB and 0.5 dB respectively. The published 'R' value is however incorrect. The values actually used by Telecom, are 6.0 dB and 0.5 dB for the 'R' and 'T' pads respectively.*

(4) The loudness rating limits for interconnecting networks are given below in Table 2 and other network operators should apply these limits when interconnecting with the Telecom network. These limits are consistent with the intent of Recommendation G. 121 and P. 31.

TABLE 2: LOUDNESS RATING LIMITS

TELEPHONE TYPE	TELECOM NZ LIMITS (dB)		
	Max	Min	Obj. Mean
ANALOGUE			
SLR (dB)	19.5	2.5	8
RLR (dB)	13	-8	2
DIGITAL			
SLR (dB)	12.5	3.5	8
RLR (dB)	6.5	-10	2

• *The above loudness rating limits are expressed relative to a 0 dBr point. Loudness ratings for analogue 2-wire telephones (as specified in PTC 200) are related as follows:*

SLR (Tel) = SLR (0 dBr) - T Pad - CLR

RLR (Tel) = RLR (0 dBr) - R Pad - CLR

For the minimum telephone loudness rating limit CLR = 0 dB, for the maximum telephone loudness rating limit CLR = 8 dB.

• *The circuit loudness rating (CLR) is the circuit loudness loss of the 2-wire customer access circuit connecting the telephone to the 2/4-wire interface of the digital network (see Fig. 4). CLR does not include the R and T pads of the 4-wire path. The traffic weighted mean CLR in the Telecom network is currently 2.5 dB.*

• *Maximum SLR limit for analogue telephones exceeds ITU-T Recommendation G.121 nominal SLR maximum for average size countries by 3 dB. It is however acceptable to add manufacturing tolerances (which can be as large as ±3 dB) to nominal values when setting limits for individual telephone sets. Further, the percentage of connections containing both limiting lines and limiting telephones is expected to be small. The maximum value of SLR is 14.5 dB for limiting customer access lines with a CLR of 8 dB when using telephones complying with the design target area indicated in PTC 200.*

• *RLR limits include the full range of any receive volume control fitted. This applies to both analogue and digital telephones. The preferred RLR limit for telephones with no receive volume control is -2 dB.*

• *Use of non-regulated analogue telephones is preferred and a regulation of less than 3 dB is recommended for new types of telephones. This reduces the possibility of overloading the encoder when being fed by limited current feed bridges.*

(5) The 4-wire digital path is being extended to customers premises. PABX's and multiplex equipment in the customers premises derive the 2-wire analogue circuit. To meet objective loudness ratings the R and T pads are required in the 4-wire path, together with an additional 2.5 to 3 dB of loss in either the 2-wire or 4-wire path, to provide the objective OLR (overall loudness rating) and to reduce the effects of echo.

(6) Likewise cable television networks providing telephony will have the 2/4-wire interface in the customers premises and will also need to incorporate the correct R and T pads together with a 2.5 to 3 dB loss.

6.3
Overall loudness rating (OLR)

(1) The overall loudness rating of a telephone connection is simply the sum of the SLR of one party, the RLR of the other party and any additional losses incurred, including mismatch losses, over the connection between. If both SLR and RLR of the respective parties are referred to the same 0 dBr reference point then:

$$OLR = SLR + RLR$$

This applies separately in each direction of transmission.

(2) ITU-T Recommendation G.111 notes that for connections under practical conditions a suitable value of OLR in most cases seems to be 10 dB for the traffic weighted mean. Further, a long term objective range of 8 - 12 dB for the traffic weighted mean is specified. Networks should be designed such that at least 90 % of call connections satisfy this objective requirement.

(3) The loudness ratings contained in Table 2 above are designed to meet these objectives.

6.4
Sidetone

ITU-T specifies sidetone masking rating (STMR) as a measure of the sidetone loss as experienced by the user of a telephone. The preferred range for STMR for 2-wire telephone sets is 7 to 12 dB for a complete connection, and 15 ± 5 dB for digital 4-wire telephone sets for near-end introduced sidetone.

• *Telecom's impedance strategy and PTC stability requirements for telephones and other devices inherently limit sidetone. There is no mandatory STMR limit imposed for Telepermit purposes, but it is recommended that STMR for 2-wire telephones be no less than 7 dB.*

• *Reference Recommendation G. 111 and G. 121 for sidetone experienced on 2-wire telephone sets.*

• *The fundamental principles for determination of STMR are given in Recommendation P. 76.*

6.5
Attenuation distortion
(1) In an all digital network, attenuation distortion can be expected to satisfy ITU-T requirements if the requirements of section 9 of this document are satisfied.

• *Reference Recommendation G. 113 and G. 132.*

(2) The requirements for individual digital exchanges shall comply with Recommendations Q. 552 and Q. 553.

6.6
Group delay distortion
(1) In an all digital network, group delay distortion can be expected to satisfy ITU-T requirements if the requirements of section 9 of this document are satisfied.

• *Reference Recommendation G. 113.*

(2) For overall group delay distortion in a mixed analogue/digital network, the requirements of Recommendation G. 133 shall be satisfied.

(3) The requirements for individual digital exchanges shall comply with Recommendations Q. 552 and Q. 553.

6.7
Timing and synchronisation
Design objectives and performance limits for synchronisation and the control of timing, jitter, wander, slip and bit errors in digital networks shall comply with Recommendations G. 810 to G. 812 and G. 821 to G. 826.

7
TRANSMISSION LOSS

7.1
Loss plan

(1) Any network can be regarded as a number of individual links connected together in tandem to provide a connection between two terminal stations. In order to provide a satisfactory overall network performance it is necessary to specify the performance requirements for each type of individual link and switch making up that network.

(2) The losses on analogue customer lines are specified by the loudness rating limits given in Section 6.

- *The objective maximum loss on Telecom local access lines is 8 dB CLR. Other constraints placed on cable circuits may limit permitted maximum losses on many Telecom lines to less than 8 dB CLR.*

7.2
Digital network

(1) A nominal loss of 0 dB is specified in the digital 4-wire path, see Fig 3.

(2) A fixed loss of 6.5 dB is specified between 2-wire analogue interfaces with the digital network, 6 dB in the receive path and 0.5 dB in the send path (assuming that no gain has been applied in the 4-wire path to offset 2-wire copper cable pair losses).

- *Additional loss is required in either the 2-wire or 4-wire path if the 2-wire interface is in the customer's premises, ref clauses 6.2, (5) and (6) above.*

(3) If digital customer loops are used (e.g. ISDN or digital PABX trunks) then the connection has 0 dB loss to the customer premises. The digital telephone loudness ratings given in Table 2 (Clause 6.2) apply if digital telephones are connected to such customer loops. It is assumed that any additional loss required to meet the limits given in Table 2 will be incorporated into the digital telephone instrument itself.

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8
NOISE AND CROSSTALK

8.1
Digital processes

(1) In an all digital network the predominant noise present is that produced by the digital coding and decoding processes. Requirements for these are covered in Section 10.

(2) The noise and crosstalk of individual digital exchanges shall comply with Recommendations Q. 551 to Q. 553.

8.2
Analogue noise components

(1) In a predominantly all digital network analogue noise components are limited to the analogue telephone and customer's local access line. Noise measurements are made using a psophometer with telephone type weighting in accordance with Recommendation O. 41.

(2) Local circuit noise, which is that produced by a combination of customer premises equipment and the local access line, is measured at the local exchange MDF.

- *Provisional limits are circuit noise ≤-65 dBm and ground noise ≤-5 dBm.*

8.3
Crosstalk

In a predominantly digital network audible crosstalk is restricted to the 2-wire customer access circuit. Linear crosstalk shall comply with G. 151.

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9
ECHO AND STABILITY

9.1 Echo

(1) Echo is not usually a problem in an all-digital network terminated with 4-wire digital terminal devices. However, while some analogue 2-wire components including telephones remain, it is necessary for all network operators to take the effects of echo into account. Parameters which affect echo are impedance mismatch, circuit loss, delay (or propagation time) due to distance and/or digital processes, and telephone transmit and receive levels. It is noted that acoustic echo is a significant factor in the operation of handsfree mobile cellular customer terminals.

(2) Noticeable echo is disturbing to telephone users. With short round-trip times reflections are perceived as sidetone, rather than echo. However, reflections are perceived as echo when round trip delay times exceed about 20 ms. This becomes significant on long distance or international calls where signal delay causes the echo to be much more noticeable to a telephone user.

(3) Also, the introduction of digital components into the international network has accentuated the effect of echo because of processing delays inherent in digital coding and decoding. Thus, in the mixed analogue/digital network which exists in the international network, it is extremely important to limit both the cause of echo and the effect it produces. This situation is likely to exist for several years yet.

- *The effects of echo and method of measurement are described in Recommendation G. 122.*

(4) The objective of this plan on international and national connections is to limit the overall probability of objectionable echo being encountered to less than 1%, and to tolerate a probability of not more than 10% in any specific situation. This is consistent with Recommendation G. 131.

9.2
Impedance

(1) The major source of echo is signal reflections at impedance mismatches. These can occur at both ends of a connection between the terminal customer loop and the hybrid balance network. Assessment of this mismatch is achieved by measurement of echo loss as indicated in Recommendation G. 122 (see also Fig. 4).

(2) To minimise mismatch Telecom specifies an objective standard impedance for the input impedance of telephones, input impedance of digital switches, and balance networks associated with 2-wire/4-wire hybrids. The objective standard impedance is represented by a 370 Ω resistor in series with the parallel combination of a 620 Ω resistor and a 310 nF capacitor (see Fig 5a). This impedance, which originated in the British Telecom network, is commonly known as "BT 3".

- *Telecom switches and transmission systems use a number of alternative balance networks from which the best match can be selected for individual customer line conditions. BT 3 is however an all round compromise and is now increasingly being used.*

9.3
Delay

(1) Consideration will be given to fitting echo control devices for national calls where the delay within the Telecom network exceeds 10 ms mean one way propagation time (MOPT).

(2) It is expected that any party which introduces significant additional delay into a call will be responsible for the control of echo, even if the signal reflection which gives rise to that echo is produced by customer equipment connected to a network operated by another party.

(3) Echo control devices are used on all international calls as per Recommendation G. 114. The following are the recommended limits for the mean one way propagation times for any call through the national or international PSTN where appropriate echo control devices, i.e. echo cancellers, are used:-

(a) 0 to 150 ms, acceptable for most user applications.

(b) 150 to 400 ms acceptable providing the impact on transmission quality of user applications is recognised.

(c) above 400 ms, unacceptable for network planning purposes.

(4) For Recommendation G. 114 to be achieved, there should not be more than one satellite link used in any given call through the national or international network. However it is recognised that for special cases a second satellite link may be used for domestic calls, i.e. Chatham Islands and Scott Base.

(5) The contribution of individual network components to the one-way propagation time is given in Recommendation G. 114, Table A.1.

9.4
Echo loss

(1) Echo is made up of several components. The echo loss at the 2w/4w point, any impedance mismatches due to customer access circuit discontinuities, and the return loss at the customer's 2-wire termination. This is further contributed to by any 2w/4w conversions within the customer's premises.

(2) The minimum echo loss at any transmission system 2-wire analogue port is measured at the four-wire path (0 dBr point) with the two-wire port terminated in the nominal impedance (BT3) and with adjusting pads set to zero.

(3) The minimum echo loss shall be no less than 12 dB in the band 300 to 600 Hz and no less than 15 dB in the band 600 to 3400 Hz.

(4) To ensure adequate performance of the hybrid and its balance network, the terminal balance return loss (TBRL) is measured, as in (2) against BT3, shall be no less than:-

(a) 13 dB in the band 300 to 500 Hz, and

(b) 18 dB in the band 500 to 2500 Hz, and

(c) 14 dB in the band 2500 to 3400 Hz.

- *Reference Recommendation G. 712 clauses 5.2 and 16.1.*

(5) The reflections caused by line mismatches are kept to a minimum by appropriate design and are not usually significant in comparison with echo loss and return loss.

(6) The minimum return loss of the telephone against the impedance BT 3 shall be no less than 10 dB at any frequency in the band 200 to 1000 Hz or 12 dB in the band 1000 to 3400 Hz. The echo return loss of the telephone against the impedance BT3 shall be no less than 14 dB.

- *Reference PTC 200.*

9.5
Stability loss

(1) Instability is the specific result of echo when signals can recirculate without being diminished because the sum of the losses around the four-wire loop is less than the sum of the gains. To prevent instability, it is necessary to ensure that there is an adequate net loss around any four-wire path.

(2) To avoid instability on international and national connections, it is necessary to limit the risk of an echo loss (a - b in Fig. 1) of 0 dB or less at any frequency 0 - 4 kHz. The objective of this plan is to ensure that the probability of such a loss occurring does not exceed 6 in 1000 calls.

(3) Use of R and T pads as stated in clause 6.2 normally ensures that an adequate stability loss margin is maintained. Application of gain to offset losses in the 2-wire customer access circuit reduces both stability and echo margins (see clause 9.1).

- *Application of gain in the 4-wire path reduces stability and echo loss margins by twice the level of gain applied. Effect of gain applied in the 2-wire path is less but of the same order. However, amplifiers placed in the two wire path may additionally become unstable during call set up and clear down, hence it is preferred that gain be located in the 4-wire path.*

- *Gain applied in either the 2-wire or 4-wire path to offset loss in new 2-wire copper cable customer access circuits is limited to a maximum of 4 dB. Existing customer access circuits may have up to 6 dB of gain applied.*

- *Echo control devices typically require an echo loss (a - b) of 6 dB or greater for effective operation.*

(4) Digital transmission systems forming separate permanent 4-wire loops in a connection shall have a 2-wire to 2-wire loss of 2 dB

- *Gain is not applied in conjunction with transmission systems to offset loss in copper cable extensions.*

9.6
Telephone transmit and receive levels

(1) Maximum telephone transmit and receive levels are specified in Section 6. Excessive transmit and/or receive levels will result in the perception of any echo present being enhanced.

- *Excessive send levels also result in overloading of encoders. Excessive receive loudness levels increase the contrast in loudness with other telephones and may reduce listener comfort.*

- *Receive volume controls provided on many telephones can be used to reduce the perception of any echo effects present by being turned down.*

(2) The transmission performance of analogue-connected CPE is specified in Specification PTC 200: 1996.

10
DIGITAL TRANSMISSION IMPAIRMENT

10.1
Quantising distortion units (QDU's)

(1) Some digital encoding devices introduce impairments into a connection, principally quantising distortion. A system of impairment units known as "quantising distortion units (QDU's)" is used to define the total impairment in a connection.

(2) By definition, the signal-to-total distortion ratio for one integrated digital process using an 8-bit PCM codec pair, whether A-law or μ-law, is stated to be 1 QDU. This is used as the reference. The levels of distortion for other digital processes are compared with that of the basic codec pair and allocated QDU values as appropriate.

(3) Recommendation G. 113 gives a table of planning values for quantising distortion. This has been incorporated into Table 3 below. These values are a guide only and are liable to change from time to time as more and improved values are published.

TABLE 3: PLANNING VALUES OF QDU'S

DIGITAL PROCESS	QDU's
Processes involving A/D conversion:	
8-bit PCM codec-pair (Rec. G. 711, A- or μ-law)	1
7-bit PCM codec-pair (A- or μ-law)	3
Transmultiplexer pair based on 8-bit PCM, A- or μ-law (Rec. G. 792)	1
32 kbit/s ADPCM (with adaptive predictor) (combination of an 8-bit PCM codec-pair and a PCM-ADPCM-PCM tandem conversion) (Rec. G. 726 or G. 727)	3.5
16 kbit/s LD-CELP codec-pair (Rec. G. 728)	3.5
Purely digital processes:	
Digital loss pad (8-bit PCM, A- or μ-law)	0.7
(Special case; 6 dB A law digital loss pad)	0
A/μ-law or μ/A-law converter (Rec. G. 711)	0.5
A/μ/A-law tandem conversions	0.5
μ/A/μ-law tandem conversions	0.25
PCM to ADPCM to PCM conversions (Rec. G. 721 or G. 727)	2.5
8 - 7 - 8 bit transcoding (A- or μ-law)	3

(4) The total impairment on any national connection shall not exceed 14 QDU's. The total impairment between any customer and the international switching point shall not exceed 5 QDU's.

(5) The total impairment contribution by any customer system or private network from which calls are extended to or received from the PSTN shall not exceed 3.5 QDU's.

- *Ref. PTC 110.*

(6) The total impairment contributed by any interconnecting network between the customer and point of interconnection shall not exceed 3 QDU's.

- *In theory (5) and (6) above could result in 6.5 QDU's being added between the customer and the international switching point. However this is expected to be rare in practice. Most connections will only encounter 0.5 or 1.5 QDU's within the Telecom network to the international switching point, or to the point of interconnection with other networks.*

(7) Certain multiple synchronous digital conversions can be assigned a total impairment equal to that of a single digital conversion if the following conditions are satisfied (see Recommendation G. 113):-

(a) All conversions are synchronous, and

(b) the same algorithm is used throughout, and

(c) Only 64 kbit/s/s PCM is used between conversions.

- *One example of this is ADPCM, where an allocation of 2.5 QDU's can be made for a chain consisting of PCM - ADPCM - PCM - ADPCM - PCM conversions, if it satisfies the above conditions.*

(8) It is noted that the use of QDU’s is under review by ITU-T. The intent of this Plan is to generally limit the use of sub 64 kbit/s encoding processes to one encoding pair within cellular mobile networks, to one encoding/decoding pair within private networks, and to one encoding/decoding pair within the Telecom PSTN or national PSTN networks of other operators.

- *One encoding/decoding pair is taken to include a number of systems in tandem where the additional encoding/decoding stages in the chain do not introduce any further degradation. An example is ADPCM, see sub-clause (7) above.*

11
OTHER NETWORKS

11.1
General

(1) When PABXs or other devices/services (e.g. radio telephone systems) are connected to function as a specialised network associated with the Telecom PSTN, the combined performance of the PSTN and the specialised network shall be within the limits specified in this document.

(2) While operators of private networks which are in no way connected to a public network need not comply with (1) above, it is important to note that such networks rarely remain independent of a public network. In the circumstances, compliance with the requirements of this Plan should ensure adequate performance if connection to a public network occurs at a future date.

- *See PTC 110.*

11.2
PABX networks

(1) Any PABX networks connected to the PSTN shall comply with the ITU-T Recommendations as follows:-

(a) Analogue or mixed analogue/digital PABX networks shall comply with Recommendation G. 171, clauses 1 - 9.

(b) All digital PABX networks shall comply with Recommendation G. 171, clauses 10 and 11.

(2) For all PABX networks, the loudness rating between any PABX extension telephone and the PSTN exchange to which it is connected shall be within the limits specified in Section 6. This requirement applies whether the PABX is stand-alone or is networked with other PABX's.

- *Reference Recommendation G. 171, clauses 7.& 11.*

(3) For digital PABX's, the recommended TRP (known as the "Ports TRP" or PTRP) is 0 dBr, the same as for the LX.

- *A PTRP of 0 dBr simplifies digital connection of the PABX to the PSTN.*

- *Where analogue trunks are used between PABX and LX, the 0 dBr points are reference points only. In practice they will usually be at different levels.*

(4) Echo is a frequent problem in mixed analogue/digital PABX networks. It is therefore important that echo be carefully controlled when such a network is connected to the PSTN, see Section 9.

- *Reference Recommendation G. 171, clause 11.*

11.3
Other Telecom Networks

(1) Telecom has two mobile networks that interconnect with the Telecom PSTN:-

(a) cellular mobile telephone network.

(b) land mobile radio dispatch network.

The transmission aspects of these networks are defined in their separate plans.

(2) The transmission aspects of future Digital Public Land Mobile Networks as defined by the ITU-T are covered in Recommendation G. 173.

(3) Network transmission plans will evolve to incorporate future services and applications like personal communications service (PCS) and universal personal telecommunications (UPT), but are expected to be based on this Plan.

12
NETWORK ASSISTANCE OPERATOR'S CIRCUITS

12.1
Loudness rating

The objective operator circuit loudness ratings referenced to a 0 dBr point are as follows:

	Max	Min	Obj. Mean
Send loudness rating SLR (dB)	11.5	3.5	8
Receive loudness rating RLR (dB)	6.5	-10	2

- *The RLR includes the full range of receive volume control fitted.*

12.2
Connection

(1) The operator's circuit in a digital exchange is connected at a 0 dBr transmission reference point and as shown in Fig. 6.

(2) Any additional loss introduced into a connection by the operator's circuit shall not exceed the following:

Monitoring condition	0.3 dB
Speaking condition	1.0 dB

(3) Connection of the operator's circuit shall not degrade the return loss requirements stated in Section 9, see Fig. 6.

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APPENDIX 1

Excerpts from:-

FINAL ACTS

OF THE WORLD ADMINISTRATIVE TELEGRAPH AND TELEPHONE CONFERENCE (WATTC-88)

MELBOURNE, 1988

NOTE: Emphasis has been added to the key clauses of this document which relate to the Telecom New Zealand Transmission Plan

INTERNATIONAL TELECOMMUNICATION REGULATIONS

PREAMBLE

While the sovereign right of each country to regulate its telecommunications is fully recognised, the provisions of the present Regulations supplement the international Telecommunications Convention, with a view to attaining the purposes of the International Telecommunication Union in promoting the development of telecommunication services and their most efficient operation while harmonising the development of facilities for world-wide telecommunications.

Article 1

PURPOSE AND SCOPE OF THE REGULATIONS

1.1.1 These Regulations establish general principles which relate to the provision and operation of international telecommunication services offered to the public as well as to the underlying international telecommunication transport means used to provide such services. They also set rules applicable to administrations•.

1.1.2 These Regulations recognise in Article 9 the right of Members to allow special arrangements.

1.2 In these Regulations, "the public" is used in the sense of the population, including governmental and legal bodies.

1.3 These Regulations are established with a view to facilitating global: interconnection and interoperability of telecommunication facilities and to promoting the harmonious development and efficient operation of technical facilities, as well as the efficiency, usefulness and availability to the public of international telecommunication services.

1.4 References to CCITT Recommendations and Instructions in these Regulations are not to be taken as giving to those Recommendations and Instructions the same legal status as the Regulations.

1.5 Within the framework of the present Regulations, the provision and operation of international telecommunication services in each relation pursuant to mutual agreement between administrations•.

1.6 In implementing the principles of these Regulations, administrations• should comply with, to the greatest extent practicable, the relevant CCITT Recommendations, including any Instructions forming part of or derived from these Recommendations.

1.7 (a) These Regulations recognise the right of any Member, subject to national law and should it decide to do so, to require that **administrations and private operating agencies**, which operate in its territory and provide an international telecommunication service to the public, be authorised by that Member.

(b) **The Member concerned shall, as appropriate, encourage the application of relevant CCITT Recommendations by such service providers.**

(c) The Members, where appropriate, shall cooperate in implementing the International Telecommunications Regulations (For interpretation, also see Resolution No. PL/2).

1.8 The Regulations shall apply, regardless of the means of transmission used, so far as the Radio Regulations do not provide otherwise.

Article 2

2.8 Accounting rate: The rate agreed between administrations• in a given relation that is used for the establishment of international accounts.

2.9 Connection charge: The charge established and collected by an administration• from its customers for the use of an international telecommunication service.

2,10 Instructions: A collection of provisions drawn from one or more CCITT Recommendations dealing with practical operational procedures for the handling of telecommunication traffic (e.g. acceptance, transmission, accounting).

Article 3

INTERNATIONAL NETWORK

3.1 **Members shall ensure that administrations• cooperate in the establishment, operation and maintenance of the international network to provide a satisfactory quality of service.**

3.2 Administrations• shall endeavour to provide sufficient telecommunication facilities to meet the requirements of and demand for international telecommunication services.

3.3 Administrations• shall determine by mutual agreement which international routes are to be used. Pending agreement and provided that there is no direct route existing between the terminal administrations• concerned, the origin administration has the choice to determine the routing of its outgoing telecommunication traffic, taking into account the interests of the relevant transit and destination administrations•.

3.4 Subject to national law, any user, by having access to the international network established by an administration•, has the right to send traffic. **A satisfactory quality of service should be maintained to the greatest extent practicable, corresponding to relevant CCITT Recommendations.**

Article 4

INTERNATIONAL TELECOMMUNICATION SERVICES

4.1 Members shall promote the implementation of international telecommunication services and shall endeavour to make such services generally available to the public in their national network(s).

4.2 Members shall ensure that administrations• cooperate within the framework of these Regulations to provide by mutual agreement, a wide range of international telecommunication services which **should conform, to the greatest extent practicable, to the relevant CCITT Recommendations.**

4.3 Subject to national law, Members shall endeavour to ensure that administrations• provide and maintain, to the greatest extent practicable, **a minimum quality of service corresponding to relevant CCITT Recommendations with respect to:**

(a) access to the international network by users using terminals which are permitted to be connected to the network and which do not cause harm to technical facilities and personnel;

(b) international telecommunication facilities and services available to customers for their dedicated use;

(c) at least a form of telecommunication which is reasonably accessible to the public, including those who may not be subscribers to a specific telecommunication service; and

(d) a capability for interworking between different services, as appropriate, to facilitate international communications.

• or recognised private operating agency(ies).

END OF APPENDIX 1

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