BHUTAN CIVIL AVAITION REQUIREMENT

BCAR-10

AERONAUTICAL TELECOMMUNICATION

VOLUME III

COMMUNICATION SYSTEMS

Second Edition, Dec 2017

Issued under the authority of the Director General
Bhutan Civil Aviation Authority

RECORD OF AMENDMENTS AND CORRIGENDA

AMENDMENTS			
No	Date applicable	Date entered	Entered by

CORRIGENDA			
No	Date of issue	Date entered	Entered by

TABLE OF CONTENT

ATTACHMENTS AND APPENDICES

APPENDIX TO CHAPTER 9 Part I. A WORLDWIDE SCHEME FOR THE ALLOCATION, ASSIGNMENT AND APPLICATION OF AIRCRAFT ADDRESSES

APPENDIX TO CHAPTER 5 Part II. EMERGENCY LOCATOR TRANSMITTER CODING

ATTACHMENT TO PART II. GUIDANCE MATERIALFOR COMMUNICATION SYSTEMS

FOREWORD

Section 59 of the Civil Aviation Act of Bhutan 2016 empowers the Head of Authority, in this case the Director General of Civil Aviation Authority of Bhutan (BCAA), to make Rules and Regulations concerning the use of the airspace, air navigation facilities and services. Accordingly, BCAR-10 Volume III (Communication systems) containing provision incorporating the standard and recommended practices of ICAO Annex 10 Volume III has been developed.

BCAR-10 or BCAR – Aeronautical Telecommunication, which are to be used interchangeably and construed to refer to this document, is hereby published in accordance with section 56 of the act.

During the transposing of the standard and recommended practices of ICAO Annex 10 Volume III to this BCAR, some provisions that are not applicable or currently irrelevant have been left out and marked as "Reserved". These provisions will be incorporated as and when appropriate.

Any difference existing in this BCAR and the related ICAO Standards and Recommended Practices and any amendments thereto will be notified to the ICAO and the same shall be published in the Aeronautical Information Publication (AIP).

BCAR-10 Volume III hereby supersedes the BCAR-Aeronautical Telecommunication Volume III that was published on October 1, 2010.

This BCAR is a controlled document and the provisions contained herein are subject to change through amendments.

Wangdi Gyaltshen
Director General
Bhutan Civil Aviation Authority
Date: 07/12/2017

PART I - DIGITAL DATA COMMUNICATION SYSTEMS
CHAPTER 1. DEFINITIONS

Note 1.— All references to "Radio Regulations" are to the Radio Regulations published by the International Telecommunication Union (ITU). Radio Regulations are amended from time to time by the decisions embodied in the Final Acts of World Radio Communication Conferences held normally every two to three years. Further information on the ITU processes as they relate to aeronautical radio system frequency use is contained in the Handbook on Radio Frequency Spectrum Requirements for Civil Aviation including statement of approved ICAO policies *(ICAO Doc 9718).*

Note 2.— This chapter contains general definitions relevant to communication systems. Definitions specific to each of the systems included in this volume are contained in the relevant chapters.

Note 3— Material on secondary power supply and guidance material concerning reliability and availability for communication systems is contained in BCAR 10, Volume I, 2.9 and Volume I, Attachment F, respectively.

Aeronautical administrative communications (AAC). Communications necessary for the exchange of aeronautical administrative messages.

Aeronautical operational control (AOC). Communication required for the exercise of authority over the initiation, continuation, diversion or termination of flight for safety, regularity and efficiency reasons.

Aeronautical telecommunication network (ATN). A global internetwork architecture that allows ground, air-ground and avionic data sub networks to exchange digital data for the safety of air navigation and for the regular, efficient and economic operation of air traffic services.

Aircraft address. A unique combination of twenty-four bits available for assignment to an aircraft for the purpose of air-ground communications, navigation and surveillance.

Aircraft earth station (AES). A mobile earth station in the aeronautical mobile-satellite service located on board an aircraft (see also "GES").

Air traffic service. A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).

Automatic dependent surveillance — contract (ADS-C). A means by which the terms of an ADS-C agreement will be exchanged between the ground system and the aircraft, via a data link, specifying under what conditions ADS-C reports would be initiated, and what data would be contained in the reports.

Automatic terminal information service (ATIS). The automatic provision of current, routine information to arriving and departing aircraft throughout 24 hours or a specified portion thereof.
Data link-automatic terminal information service (D-ATIS). The provision of ATIS via data link.

Voice-automatic terminal information service (Voice-ATIS). The provision of ATIS by means of continuous and repetitive voice broadcasts.

Bit error rate (BER). The number of bit errors in a sample divided by the total number of bits in the sample, generally averaged over many such samples.

Carrier-to-multipath ratio (C/M). The ratio of the carrier power received directly, i.e. without reflection, to the multipath power, i.e. carrier power received via reflection.

Carrier-to-noise density ratio (C/N_o). The ratio of the total carrier power to the average noise power in a 1 Hz bandwidth, usually expressed in dBHz.

Channel rate. The rate at which bits are transmitted over the RF channel. These bits include those bits used for framing and error correction, as well as the information bits. For burst transmission, the channel rate refers to the instantaneous burst rate over the period of the burst.

Channel rate accuracy. This is relative accuracy of the clock to which the transmitted channel bits are synchronized. For example, at a channel rate of 1.2 kbits/s, maximum error of one part in 10^6 implies the maximum allowed error in the clock is $\pm 1.2 \times 10^{-3}$ Hz.

Circuit mode. A configuration of the communications network which gives the appearance to the application of a dedicated transmission path.

Controller pilot data link communications (CPDLC). A means of communication between controller and pilot, using data link for ATC communications.

Data link flight information services (D-FIS). The provision of FIS via data link.

Doppler shift. The frequency shift observed at a receiver due to any relative motion between transmitter and receiver.

End-to-end. Pertaining or relating to an entire communication path, typically from (1) the interface between the information source and the communication system at the transmitting end to (2) the interface between the communication system and the information user or processor or application at the receiving end.

End-user. An ultimate source and/or consumer of information.

Energy per symbol to noise density ratio (E_s/N_o). The ratio of the average energy transmitted per channel symbol to the average noise power in a 1 Hz bandwidth, usually expressed in dB. For A-BPSK and A-QPSK, one channel symbol refers to one channel bit.

Equivalent isotropically radiated power (e.i.r.p.). The product of the power supplied to the antenna and the antenna gain in a given direction relative to an isotropic antenna (absolute or isotropic gain).

Flight information service (FIS). A service provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights.

Forward error correction (FEC). The process of adding redundant information to the transmitted signal in a manner which allows correction, at the receiver, of errors incurred in the transmission.

Gain-to-noise temperature ratio. The ratio, usually expressed in dB/K, of the antenna gain to the noise at the receiver output of the antenna subsystem. The noise is expressed as the temperature that a 1 ohm resistor must be raised to produce the same noise power density.

Ground earth station (GES). An earth station in the fixed satellite service, or, in some cases, in the aeronautical mobile-satellite service, located at a specified fixed point on land to provide a feeder link for the aeronautical mobile-satellite service.

Note.— This definition is used in the ITU's Radio Regulations under the term "aeronautical earth station". The definition herein as "GES" for use in the SARPs is to clearly distinguish it from an aircraft earth station (AES), which is a mobile station on an aircraft.

Mode S subnetwork. A means of performing an interchange of digital data through the use of secondary surveillance radar (SSR) Mode S interrogators and transponders in accordance with defined protocols.

point-to-point. Pertaining or relating to the interconnection of two devices, particularly end-user instruments. A communication path of service intended to connect two discrete end-users; as distinguished from broadcast or multipoint service.

Slotted aloha. A random access strategy whereby multiple users access the same communications channel independently, but each communication must be confined to a fixed time slot. The same timing slot structure is known to all users, but there is no other coordination between the users.

Time division multiple access (TDMA). A multiple access scheme based on time-shared use of an RF channel employing:

1) discrete contiguous time slots as the fundamental shared resource; and
2) a set of operating protocols that allows users to interact with a master control station to mediate access to the channel.

Time division multiplex (TDM). A channel sharing strategy in which packets of information from the same source but with different destinations are sequenced in time on the same channel.

Transit delay. In packet data systems, the elapsed time between a request to transmit an assembled data packet and an indication at the receiving end that the corresponding packet has been received and is ready to be used or forwarded.

VHF digital link (VDL). A constituent mobile subnetwork of the aeronautical telecommunication network (ATN), operating in the aeronautical mobile VHF frequency band. In addition, the VDL may provide non-ATN functions such as, for instance, digitized voice.

CHAPTER 2. GENERAL

[to be developed]

———— INTENTIONALLY LEFT BLANK————

CHAPTER 3. AERONAUTICAL TELECOMMUNICATION NETWORK

Note 1.— Detailed technical specifications for ATN/OSI applications are contained in the Manual on Detailed Technical Specifications for the Aeronautical Telecommunication Network (ATN) using ISO/OSI Standards and Protocols *(ICAO Doc 9880) and in the* Manual of Technical Provisions for the Aeronautical Telecommunication Network (ATN) *(ICAO Doc 9705).*

Note 2.— Detailed technical specifications for ATN/IPS applications are contained in the Manual for the Aeronautical Telecommunication Network (ATN) using Internet Protocol Suite (IPS) Standards and Protocols *(ICAO Doc 9896) (available electronically on the ICAO-Net).*

3.1 Definitions

Application entity (AE). An AE represents a set of ISO/OSI communication capabilities of a particular application process (see ISO/IEC 9545 for further details).

ATN security services. A set of information security provisions allowing the receiving end system or intermediate system to unambiguously identify (i.e. authenticate) the source of the received information and to verify the integrity of that information.

ATS interfacility data communication (AIDC). Automated data exchange between air traffic services units in support of flight notification, flight coordination, transfer of control and transfer of communication.

ATS message handling service (ATSMHS). An ATN application consisting of procedures used to exchange ATS messages in store-and-forward mode over the ATN such that the conveyance of an ATS message is in general not correlated with the conveyance of another ATS message by the service provider.

ATS message handling system (AMHS). The set of computing and communication resources implemented by ATS organizations to provide the ATS message handling service.

Authorized path. A communication path suitable for a given message category.

Data link initiation capability (DLIC). A data link application that provides the ability to exchange addresses, names and version numbers necessary to initiate data link applications (see ICAO Doc 4444).

Directory service (DIR). A service, based on the ITU-T X.500 series of recommendations, providing access to and management of structured information relevant to the operation of the ATN and its users.

Required communication performance (RCP). A statement of the performance requirements for operational communication in support of specific ATM functions (see Manual on Required Communication Performance (RCP) (ICAO Doc 9869)).

3.2 Introduction

3.2.1 The ATN is specifically and exclusively intended to provide digital data communications services to air traffic service provider organizations and aircraft operating agencies in support of:

a) air traffic services communications (ATSC) with aircraft;

b) air traffic services communications between ATS units;

c) aeronautical operational control communications (AOC); and

d) aeronautical administrative communications (AAC).

3.3 General

Note — The Standards and Recommended Practices in sections 3.4 to 3.8 define the minimum required protocols and services that will enable the global implementation of the aeronautical telecommunication network (ATN).

3.3.1 ATN communication services shall support ATN applications.

3.3.2 Requirements for implementation of the ATN shall be made on the basis of regional air navigation agreements. These agreements shall specify the area in which the communication standards for the ATN/OSI or the ATN/IPS are applicable.

3.4 General Requirements

3.4.1 The ATN shall either use International Organization for Standardization (ISO) communication standards for open systems interconnection (OSI) or use the Internet Society (ISOC) communications standards for the Internet Protocol Suite (IPS).

Note 1.— ATN/IPS implementation is preferred for ground-ground networks. While ATN/OSI continues to be supported in air-ground networks, particularly when using VDL Mode 2, it is expected that future air-ground implementations will use the ATN/IPS.

Note 2.— Interoperability between interconnecting OSI/IPS networks is expected to be arranged prior to implementation.

Note 3.— Guidance material on interoperability between ATN/OSI and ATN/IPS is contained in ICAO Doc 9896.

3.4.2 The AFTN/AMHS gateway shall ensure the interoperability of AFTN and CIDIN stations and networks with the ATN.

3.4.3 An authorized path(s) shall be defined on the basis of a predefined routing policy.

3.4.4 The ATN shall transmit, relay and deliver messages in accordance with the priority classifications and without discrimination or undue delay.

3.4.5 The ATN shall provide means to define data communications that can be carried only over authorized paths for the traffic type and category specified by the user.

3.4.6 The ATN shall provide communication in accordance with the prescribed required communication performance (RCP).

Note.— The Manual on Required Communication Performance (RCP) *(ICAO Doc 9869) contains the necessary information on RC.*

3.4.7 The ATN shall operate in accordance with the communication priorities defined in Table 3-1 and Table 3-2.

3.4.8 The ATN shall enable exchange of application information when one or more authorized paths exist.

3.4.9 The ATN shall notify the appropriate application processes when no authorized path exists.

3.4.10 The ATN shall make provisions for the efficient use of limited bandwidth sub networks.

3.4.11 The ATN should enable an aircraft intermediate system (router) to connect to a ground intermediate system (router) via different sub networks.

3.4.12 The ATN should enable an aircraft intermediate system (router) to connect to different ground intermediate systems (routers).

3.4.13 The ATN shall enable the exchange of address information between applications.

3.4.14 Where the absolute time of day is used within the ATN, it shall be accurate to within 1 second of coordinated universal time (UTC).

Note.— The time accuracy value results in synchronization errors of up to two seconds.

3.5 ATN Application Requirements

3.5.1 System applications

Note.— System applications provide services that are necessary for operation of the ATN.

3.5.1.1 The ATN shall support the data link initiation capability (DLIC) applications when air-ground data links are implemented.

Note.— The Manual of Air Traffic Services Data Link Applications *(ICAO Doc 9694, Part I) defines the data link initiation capability (DLIC) application.*

3.5.1.2 The ATN/OSI end-system shall support the following directory services (DIR) application functions when AMHS and/or security protocols are implemented:

a) directory information retrieval; and

b) directory information modification.

3.5.2 Air-ground applications

3.5.2.1 The ATN shall be capable of supporting one or more of the following applications:

a) ADS-C;

b) CPDLC; and

c) FIS (including ATIS and METAR).

Note.— See the Manual of Air Traffic Services Data Link Applications *(ICAO Doc 9694).*

3.5.3 Ground-ground applications

3.5.3.1 The ATN shall be capable of supporting the following applications:

a) ATS interfacility data communication (AIDC); and

b) ATS message handling services applications (ATSMHS).

Note.— See the Manual of Air Traffic Services Data Link Applications *(ICAO Doc 9694).*

3.6 ATN Communication Service Requirements

3.6.1 ATN/IPS upper layer communications service

3.6.1.1 An ATN host shall be capable of supporting the ATN/IPS upper layers including an application layer.

3.6.2 ATN/OSI upper layer communications service

3.6.2.1 An ATN/OSI end-system (ES) shall be capable of supporting the OSI upper layer communications service (ULCS) including session, presentation and application layers.

3.6.3 ATN/IPS communications service

3.6.3.1 An ATN host shall be capable of supporting the ATN/IPS including the:

a) transport layer in accordance with RFC 793 (TCP) and RFC 768 (UDP); and

b) network layer in accordance with RFC 2460 (IPv6).

3.6.3.2 An IPS router shall support the ATN network layer in accordance with RFC 2460 (IPv6) and RFC 4271 (BGP), and RFC 2858 (BGP multiprotocol extensions).

3.6.4 ATN/OSI communications service

3.6.4.1 An ATN/OSI end-system shall be capable of supporting the ATN including the:

a) transport layer in accordance with ISO/IEC 8073 (TP4) and optionally ISO/IEC 8602 (CLTP); and

b) network layer in accordance with ISO/IEC 8473 (CLNP).

3.6.4.2 An ATN intermediate system (IS) shall support the ATN network layer in accordance with ISO/IEC 8473 (CLNP) and ISO/IEC 10747 (IDRP).

Note.— The ATN naming and addressing scheme supports the principles of unambiguous identification of intermediate systems (routers) and end-systems (hosts) and provides global address standardization.

3.7 ATN Naming and Addressing Requirements

3.7.1 The ATN shall provide provisions for unambiguous application identification.

3.7.2 The ATN shall provide provisions for unambiguous addressing.

3.7.3 The ATN shall provide means to unambiguously address all ATN end-systems (hosts) and intermediate systems (routers).

3.7.4 The ATN addressing and naming plans shall allow States and organizations to assign addresses and names within their own administrative domains.

3.8 ATN Security Requirements

3.8.1 The ATN shall make provisions whereby only the controlling ATS unit may provide ATC instructions to aircraft operating in its airspace.

Note.— This is achieved through the current and next data authority aspects of the controller-pilot data link communications (CPDLC) application.

3.8.2 The ATN shall enable the recipient of a message to identify the originator of that message.

3.8.3 ATN end-systems supporting ATN security services shall be capable of authenticating the identity of peer end-systems, authenticating the source of messages and ensuring the data integrity of the messages.

Note.— The use of security is the default; however, its implementation is based on local policy.

3.8.4 The ATN services shall be protected against service attacks to a level consistent with the application service requirement.

Table 3-2. Mapping of ATN network priority to mobile subnetwork priority

Message categories	*ATN network layer priority*	*Corresponding mobile subnetwork priority (see Note 4)*					
		AMSS	*VDL Mode 2*	*VDL Mode 3*	*VDL Mode 4*	*SSR Mode S*	*HFDL*
Network/systems Management	14	14	see Note 1	3	14	high	14
Distress communications	13	14	see Note 1	2	13	high	14
Urgent communications	12	14	see Note 1	2	12	high	14
High-priority flight safety Messages	11	11	see Note 1	2	11	high	11
Normal-priority flight safety Messages	10	11	see Note 1	2	10	high	11
Meteorological Communications	9	8	see Note 1	1	9	low	8
Flight regularity Communications	8	7	see Note 1	1	8	low	7
Aeronautical information service messages	7	6	see Note 1	0	7	low	6
Network/systems Administration	6	5	see Note 1	0	6	low	5
Aeronautical administrative Messages	5	5	Not Allowed	not allowed	Not allowed	not allowed	not allowed
<unassigned>	4	unassigned	unassigned	unassigned	unassigned	unassigned	unassigned
Urgent-priority administrative and U.N. Charter communications	3	3	Not Allowed	not allowed	Not allowed	not allowed	not allowed
High-priority administrative and State/Government Communications	2	2	Not Allowed	not allowed	Not allowed	not allowed	not allowed
Normal-priority Administrative Communications	1	1	Not Allowed	not allowed	Not allowed	not allowed	not allowed
Low-priority administrative communications and aeronautical passenger Communications	0	0	Not Allowed	not allowed	not allowed	not allowed	not allowed

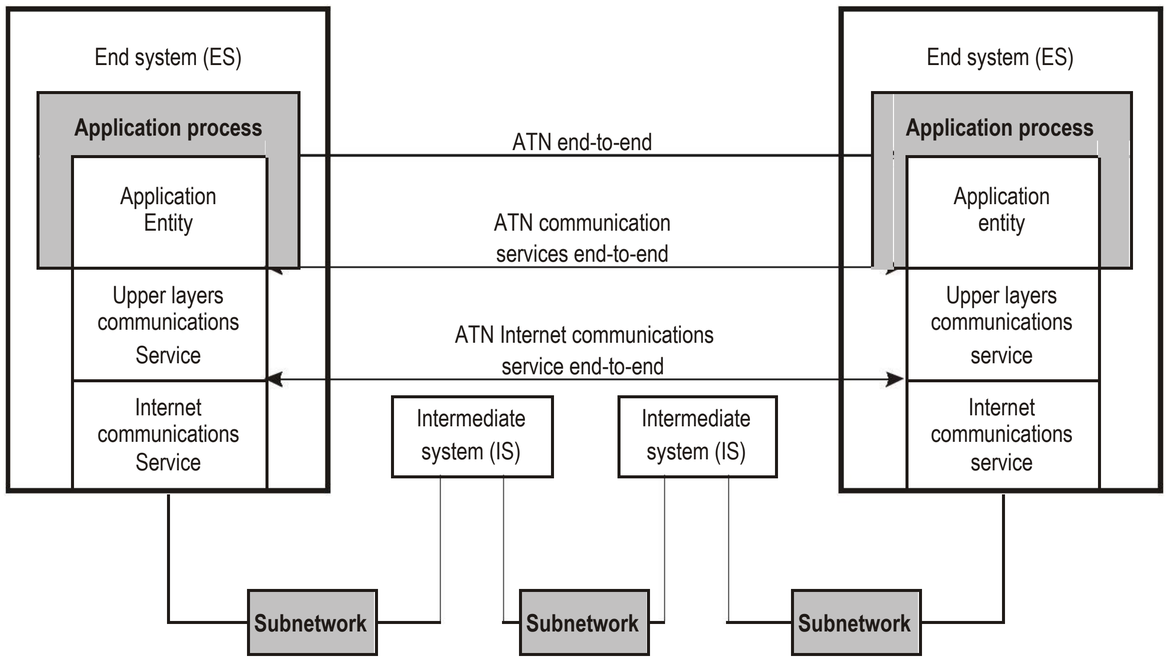
Note 1.— VDL Mode 2 has no specific subnetwork priority mechanisms.

Note 2.— The AMSS SARPs specify mapping of message categories to subnetwork priority without explicitly referencing ATN network layer priority.

Note 3.— The term "not allowed" means that only communications related to safety and regularity of flight are authorized to pass over this subnetwork as defined in the subnetwork SARPs.

Note 4.— Only those mobile subnetworks are listed for which subnetwork SARPs exist and for which explicit support is provided by the ATN boundary intermediate system (BIS) technical provisions.

FIGURE FOR CHAPTER 3



Note 1.— Shading indicates elements outside the scope of these SARPs. User requirements define the interface between the application entity and the user and ensure the functionality and interoperability of the ATN.

Note 2.— The figure represents a simplified model of the ATN and does not depict all of its capabilities (e.g. the store and forward capability which is provided for ATS message handling service).

Note 3.— Various end-to-end points have been defined within the ATN to specify certain end-to-end performance requirements. It may be necessary, however, to define different end-to-end points to facilitate the qualification of implementations to those performance requirements. In such cases, the end-to-end points should be clearly defined and correlated with the end-to-end points shown in the figure.

Note 4.— An IS is a conceptual representation of functionality and does not correspond precisely to a router. A router which implements the system management application requires the protocols of an end system and when using the system management application is also acting as an end system.

Figure 3-1. Conceptual model of the ATN

CHAPTER 4. (RRESERVED) AERONAUTICAL MOBILE-SATELLITE (ROUTE) SERVICE(AMS(R)S)

——————— INTENTIONALLY LEFT BLANK———————

CHAPTER 5. (RESERVED) SSR MODE S AIR-GROUND DATA LINK

——————— INTENTIONALLY LEFT BLANK———————

CHAPTER 6. (RESERVED)VHF AIR-GROUND DIGITAL LINK (VDL)

——————— INTENTIONALLY LEFT BLANK———————

CHAPTER 7. (RESERVED) AERONAUTICAL MOBILE AIRPORT COMMUNICATIONS SYSTEM (AEROMACS)

——————— INTENTIONALLY LEFT BLANK———————

CHAPTER 8. AFTN NETWORK

8.1 Definitions

Data signalling rate. Data signalling rate refers to the passage of information per unit of time, and is expressed in bits/second. Data signalling rate is given by the formula:

$$\sum_{i=1}^{i=m} \frac{1}{T_i} \log_2 n_i$$

where m is the number of parallel channels, T_i is the minimum interval for the ith channel expressed in seconds, n_i is the number of significant conditions of the modulation in the ith channel.

Note 1.—

a) *For a single channel (serial transmission) it reduces to* $(1/T)\log_2 n$; *with a two-condition modulation* (n = 2), *it is* 1/T.

b) *For a parallel transmission with equal minimum intervals and equal number of significant conditions on each channel, it is* $m(1/T)\log_2 n$ (m(1/T) *in case of a two-condition modulation).*

Note 2.— In the above definition, the term "parallel channels" is interpreted to mean: channels, each of which carries an integral part of an information unit, e.g. the parallel transmission of bits forming a character. In the case of a circuit comprising a number of channels, each of which carries information "independently", with the sole purpose of increasing the traffic handling capacity, these channels are not to be regarded as parallel channels in the context of this definition.

Degree of standardized test distortion. The degree of distortion of the restitution measured during a specific period of time when the modulation is perfect and corresponds to a specific text.

Effective margin. That margin of an individual apparatus which could be measured under actual operating conditions.

Low modulation rates. Modulation rates up to and including 300 bauds.

Margin. The maximum degree of distortion of the circuit at the end of which the apparatus is situated which is compatible with the correct translation of all the signals which it may possibly receive.

Medium modulation rates. Modulation rates above 300 and up to and including 3 000 bauds.

Modulation rate. The reciprocal of the unit interval measured in seconds. This rate is expressed in bauds.

Note.— Telegraph signals are characterized by intervals of time of duration equal to or longer than the shortest or unit interval. The modulation rate (formerly telegraph speed) is therefore expressed as the inverse of the value of this unit interval. If, for example, the unit interval is 20 milliseconds, the modulation rate is 50 bauds.

Synchronous operation. Operation in which the time interval between code units is a constant.

8.2 Technical Provisions Relating To Teletypewriter Apparatus And Circuits Used in AFTN

8.2.1 In international teletypewriter circuits of the AFTN, using a 5 -unit code, the International Telegraph Alphabet No. 2 (see Table 8-1) shall be used only to the extent prescribed in 4.1.2 of Volume II.

8.2.2 The modulation rate should be determined by bilateral or multilateral agreement between administrations concerned, taking into account primarily traffic volume.

8.2.3-The nominal duration of the transmitting cycle should be at least 7.4 units (preferably 7.5), the stop element lasting for at least 1.4 units (preferably 1.5).

8.2.3.1 The receiver should be able to translate correctly in service the signals coming from a transmitter with a nominal transmitting cycle of 7 units.

8.2.4 Apparatus in service should be maintained and adjusted in such a manner that its net effective margin is never less than 35 per cent.

8.2.5 The number of characters which the textual line of the page-printing apparatus may contain should be fixed at 69.

8.2.6 In start-stop apparatus fitted with automatic time delay switches, the disconnection of the power supply to the motor should not take place before the lapse of at least 45 seconds after the reception of the last signal.

8.2.7 Arrangements should be made to avoid the mutilation of signals transmitted at the head of a message and received on start-stop reperforating apparatus.

8.2.7.1 If the reperforating apparatus is provided with local means for feeding the paper, not more than one mutilated signal should be tolerated.

8.2.8 Complete circuits should be so engineered and maintained that their degree of standardized test distortion does not exceed 28 per cent on the standardized text:

THE QUICK BROWN FOX JUMPS
OVER THE LAZY DOG

or

VOYEZ LE BRICK GEANT QUE
JEXAMINE PRES DU WHARF

8.2.9 The degree of isochronous distortion on the standardized text of each of the parts of a complete circuit should be as low as possible, and in any case should not exceed 10 per cent.

8.2.10 The overall distortion in transmitting equipment used on teletypewriter channels should not exceed 5 per cent.

8.2.11 AFTN circuits should be equipped with a system of continuous check of channel condition. Additionally, controlled circuit protocols should be applied.

8.3 (Reserved)Terminal Equipment Associated with Aeronautical Radio Teletypewriter Channel Operating in the band 2.5 – 30 MHz.

8.4 (Reserved)Characteristics of Interregional AFS Circuits.

8.5 Technical Provisions relating to ATS Message Transmission

8.5.1 Interconnection by direct or omnibus channels — low modulation rates — 5-unit code.

Note.— See 8.6 for medium modulation rates.

8.5.1.1-AFTN techniques (cf. 8.2) should be used.

8.6 Technical Provisions Relating to International Ground-Ground Data Interchange at Medium and Higher Signalling Rates

Note.— Throughout this section in the context of coded character sets, the term "unit" means the unit of selective information and is essentially equivalent to the term "bit".

8.6.1 General

8.6.1.1 In international data interchange of characters, a 7-unit coded character set providing a repertoire of 128 characters and designated as International Alphabet No. 5 (IA-5) should be used. Compatibility with the 5-unit coded character set of International Telegraph Alphabet No. 2 (ITA-2) should be ensured where applicable.

8.6.1.2 When the provisions of 8.6.1.1 are applied, International Alphabet No. 5 (IA-5) contained in Table 8-2 shall be used.

8.6.1.2.1 The serial transmission of units comprising an individual character of IA-5 shall be with the low order unit (b_1) transmitted first.

8.6.1.2.2 When IA-5 is used, each character should include an additional unit for parity in the eighth level position.

8.6.1.2.3 When the provisions of 8.6.1.2.2 are applied, the sense of the character parity bit shall produce even parity in links which operate on the start-stop principle, and odd parity in links using end-to-end synchronous operations.

8.6.1.2.4 Character-for-character conversion shall be as listed in Tables 8-3 and 8-4 for all characters which are authorized in the AFTN format for transmission on the AFS in both IA-5 and ITA-2.

8.6.1.2.5 Characters which appear in only one code set, or which are not authorized for transmission on the AFS shall be as depicted in the code conversion tables.

8.6.2 Data transmission characteristics

8.6.2.1 The data signalling rate should be chosen from among the following:

600 bits/s	*4 800 bits/s*
1 200 bits/s	*9 600 bits/s*
2 400 bits/s	

8.6.2.2 The type of transmission for each data signalling rate should be chosen as follows:

Data signalling rate	Type of transmission
600 bits/s	*Synchronous or asynchronous serial transmission*
1 200 bits/s	*Synchronous or asynchronous serial transmission*
2 400 bits/s	*Synchronous serial transmission*
4 800 bits/s	*Synchronous serial transmission*
9 600 bits/s	*Synchronous serial transmission*

8.6.2.3 The type of modulation for each data signalling rate should be chosen as follows:

Data signalling rate	Type of modulation
600 bits/s	*Frequency*
1 200 bits/s	*Frequency*
2 400 bits/s	*Phase*
4 800 bits/s	*Phase*
9 600 bits/s	*Phase-amplitude*

Note.— This recommendation does not necessarily apply to ground-ground extensions of air-ground links used exclusively for the transfer of air-ground data, inasmuch as such circuits may be considered as part of the air-ground link.

8.6.2.4 Character Structure on Data links

8.6.2.4.1 Character parity shall not be used for error checking on CIDIN links. Parity appended to IA-5 coded characters per 8.6.1.2.2, prior to entry to the CIDIN shall be ignored. For messages exiting the CIDIN, parity shall be generated in accordance with 8.6.1.2.3.

8.6.2.4.2 Characters of less than eight bits in length shall be padded out to eight bits in length before transmission over any octet-based or bit-oriented communications network. The padding bits shall occupy the higher order end of the octet, i.e. bit 8, bit 7 as required, and shall have the binary values 0.

8.6.2.5 When exchanging data over CIDIN links using bit-oriented procedures, the entry center address, exit center addresses and destination addresses in the Transport and CIDIN Packet Headers shall be in the IA-5 character set contained in Table 8-2.

8.6.2.6 When transmitting messages in AFTN format over CIDIN links using bit-oriented procedures, the messages should be in the IA-5 character set contained in Table 8-2.

8.6.3 Ground-ground character-oriented data link control procedures

Note.— The provisions of this section pertain to ground-ground data interchange applications using IA-5 prescribed by 8.6.1 and which employ the ten transmission control characters (SOH, STX, ETX, EOT, ENQ, ACK, DLE, NAK, SYN, and ETB) for data link control, over synchronous or asynchronous transmission facilities.

8.6.3.1 Descriptions. The following descriptions shall apply to data link applications contained in this section:

a) A master station is that station which has control of the data link at a given instant.

b) A slave station is one that has been selected to receive a transmission from the master station.

c) A control station is the single station on a multipoint link that is permitted to assume master status and deliver messages to one or more individually selected (non-control) tributary stations, or it is permitted to assign temporary master status to any of the other tributary stations.

8.6.3.2 Message Composition

a) A transmission shall consist of characters from IA-5 transmitted in accordance with 8.6.1.2.2 and shall be either an information message or a supervisory sequence.

b) An information message used for the exchange of data shall take one of the following forms:

```
1) S              E  B
   T   ---TEXT--- T  C
   X              X  C

2) S              E  B
   T   ---TEXT--- T  C
   X              B  C

3) S                 S              E  B
   O ---HEADING---   T   ---TEXT--- T  C
   H                 X              X  C

4) S                 S              E  B
   O ---HEADING---   T   ---TEXT--- T  C
   H                 X              B  C

5) S                 E    B
   O ---HEADING---   T    C
   H                 B    C
```

Note 1.— B C C is a block check character (BCC).

Note 2.— In formats 2), 4), and 5) above which end with ETB, some continuation is required.

c) A supervisory sequence shall be composed of either a single transmission control character (EOT, ENQ, ACK or NAK) or a single transmission control (ENQ) preceded by a prefix of up to 15 non-control characters, or the character DLE used in conjunction with other graphic and control characters to provide additional communication control functions.

8.6.3.3 Three system categories are specified in terms of their respective circuit characteristics, terminal configurations, and message transfer procedures as follows:

System category A: two-way alternate, multipoint allowing either centralized or non-centralized operation and single or multiple message-oriented information transfers without replies (but with delivery verification).

System category B: two-way simultaneous, point-to-point employing message associated blocking and modulo 8 numbering of blocks and acknowledgements.

System category C: two-way alternate, multipoint allowing only centralized (computer-to-terminal) operation, single or multiple message transfers with replies.

8.6.3.3.1 In addition to the characteristics prescribed in the paragraphs that follow for both system categories A and B, other parameters that shall be accounted for in order to ensure viable, operationally reliable communications include:

a) the number of SYN characters required to establish and maintain synchronization;

Note.— Normally the transmitting station sends three contiguous SYN characters and the receiving station detects at least two before any action is taken.

b) the values of system time-outs for such functions as “idle line” and “no response” as well as the number of automatic retries that are to be attempted before manual intervention is signalled;

c) the composition of prefixes within a 15 character maximum.

Note.— By agreement between the administrations concerned, it is permissible for supervisory signals to contain a station identification prefix using characters selected from columns 4 through 7 of IA-5.

8.6.3.3.2 For multipoint implementations designed to permit only centralized (computer-to-terminal) operations, the provisions of 8.6.3.7 should be employed.

8.6.3.4 Block Check Character

8.6.3.4.1 Both system category A and B shall utilize a block check character to determine the validity of a transmission.

8.6.3.4.2 The block check character shall be composed of 7 bits plus a parity bit.

8.6.3.4.3 Each of the first 7 bits of the block check character shall be the modulo 2 binary sum of every element in the same bit 1 to bit 7 column of the successive characters of the transmitted block.

8.6.3.4.4 The longitudinal parity of each column of the block, including the block check character, shall be even.

8.6.3.4.5 The sense of the parity bit of the block check character shall be the same as for the information characters (see 8.6.1.2.3).

8.6.3.4.6 Summation

8.6.3.4.6.1 The summation to obtain the block check character shall be started by the first appearance of either SOH (start of heading) or STX (start of text).

8.6.3.4.6.2 The starting character shall not be included in the summation.

8.6.3.4.6.3 If an STX character appears after the summation has been started by SOH, then the STX character shall be included in the summation as if it were a text character.

8.6.3.4.6.4 With the exception of SYN (synchronous idle), all the characters which are transmitted after the start of the block check summation shall be included in the summation, including the ETB (end of transmission/block) or ETX (end of text) control character which signals that the following character is the block check character.

8.6.3.4.7 No character, SYN or otherwise, shall be inserted between the ETB or ETX character and the block check character.

8.6.3.5 Description of System Category A

System category A is one in which a number of stations are connected by a multipoint link and one station is permanently designated as the control station which monitors the link at all times to ensure orderly operation.

8.6.3.5.1 Link Establishment Procedure

8.6.3.5.1.1 To establish the link for transmission, the control station shall either:

a) poll one of the tributary stations to assign it master status; or

b) assume master status and select one or more tributary (slave) stations to receive a transmission.

8.6.3.5.1.2 Polling shall be accomplished by the control station sending a polling supervisory sequence consisting of a prefix identifying a single tributary station and ending in ENQ.

8.6.3.5.1.3 A tributary station detecting its assigned polling supervisory sequence shall assume master status and respond in one of two ways:

a) if the station has a message to send, it shall initiate a selection supervisory sequence as described in 8.6.3.5.1.5;

b) if the station has no message to send, it shall send EOT, and master status shall revert to the control station.

8.6.3.5.1.4 If the control station detects an invalid or no response resulting from a poll, it shall terminate by sending EOT prior to resuming polling or selection.

8.6.3.5.1.5 Selection shall be accomplished by the designated master station sending a selection supervisory sequence consisting of a prefix identifying a single station and ending in ENQ.

8.6.3.5.1.6 A station detecting its assigned selection supervisory sequence shall assume slave status and send one of two replies:

a) if the station is ready to receive, it shall send a prefix followed by ACK. Upon detecting this reply, the master station shall either select another station or proceed with message transfer;

b) if the station is not ready to receive, it shall send a prefix followed by NAK and thereby relinquish slave status. If the master station receives NAK, or no reply, it shall either select another or the same tributary station or terminate;

c) it shall be permissible for N retries ($N \geq 0$) to be made to select a station for which NAK, an invalid reply, or no response has been received.

8.6.3.5.1.7 If one or more stations have been selected and have properly responded with ACK, the master station shall proceed with message transfer.

8.6.3.5.2 Message Transfer Procedure

8.6.3.5.2.1 The master station shall send a message or series of messages, with or without headings to the selected slave station(s).

8.6.3.5.2.2 The transmission of a message shall:

a) begin with:

— SOH if the message has a heading,

— STX if the message has no heading;

b) be continuous, ending with ETX, immediately followed by a block check character (BCC).

8.6.3.5.2.3 After transmitting one or more messages, the master station shall verify successful delivery at each selected slave station.

8.6.3.5.3 Delivery Verification Procedure

8.6.3.5.3.1 The master station shall send a delivery verification supervisory sequence consisting of a prefix identifying a single slave station and ending in ENQ.

8.6.3.5.3.2 A slave station detecting its assigned delivery verification supervisory sequence shall send one of two replies:

a) if the slave station properly received all of the transmission, it shall send an optional prefix followed by ACK;

b) if the slave station did not receive all of the transmission properly, it shall send an optional prefix followed by NAK.

8.6.3.5.3.3 If the master station receives no reply or an invalid reply, it shall request a reply from the same or another slave station until all selected stations have been properly accounted for.

8.6.3.5.3.4 If the master station receives a negative reply (NAK) or, after $N \geq 0$ repeat attempts, no reply, it shall repeat that transmission to the appropriate slave stations at a later opportunity.

8.6.3.5.3.5 After all messages have been sent and delivery verified, the master station shall proceed with link termination.

8.6.3.5.4 Link Termination Procedure

8.6.3.5.4.1 The terminate function, negating the master or slave status of all stations and returning master status to the control station, shall be accomplished by the master station transmitting EOT.

8.6.3.6 Description of System Category B

System category B is one in which two stations are on a point-to -point, full-duplex link and each station has the capability to maintain concurrent master and slave status, i.e. master status on its transmit side and slave status on its receive side and both stations can transmit simultaneously.

8.6.3.6.1 Link Establishment Procedure

8.6.3.6.1.1 To establish the link for message transfers (from the calling to the called station), the calling station shall request the identity of the called station by sending an identification supervisory sequence consisting of a DLE character followed by a colon character, an optional prefix, and ENQ.

8.6.3.6.1.2 The called station, upon detecting ENQ, shall send one of two replies:

a) if ready to receive, it shall send a sequence consisting of a DLE followed by a colon, a prefix which includes its identity and ended by ACK0 (see 8.6.3.6.2.5). This establishes the link for message transfers from the calling to the called station;

b) if not ready to receive, it shall send the above sequence with the ACK0 replaced by NAK.

8.6.3.6.1.3 Establishment of the link for message transfers in the opposite direction can be initiated at any time following circuit connection in a similar manner to that described above.

8.6.3.6.2 Message Transfer Procedure

8.6.3.6.2.1 System category B message transfer provides for message associated blocking with longitudinal checking and modulo 8 numbered acknowledgements.

8.6.3.6.2.2 It is permissible for a transmission block to be a complete message or a portion of a message. The sending station shall initiate the transmission with SOTB N followed by:

a) SOH if it is the beginning of a message that contains a heading;

b) STX if it is the beginning of a message that has no heading;

c) SOH if it is an intermediate block that continues a heading;

d) STX if it is an intermediate block that continues a text.

Note.— SOTB N is the two- character transmission control sequence DLE = (characters 1/0, and 3/13) followed by the block number, N, where N is one of the IA-5 characters 0, 1 ... 7 (characters 3/0, 3/1 ... 3/7).

8.6.3.6.2.3 A block which ends at an intermediate point within a message shall be ended with ETB; a block which ends at the end of a message shall be ended with ETX.

8.6.3.6.2.4 It shall be permissible for each station to initiate and continue to send messages to the other concurrently according to the following sequence.

a) It shall be permissible for the sending station (master side) to send blocks, containing messages or parts of messages, continuously to the receiving station (slave side) without waiting for a reply.

b) It shall be permissible for replies, in the form of slave responses, to be transmitted by the receiving station while the sending station is sending subsequent blocks.

   Note.— By use of modulo 8 numbering of blocks and replies, it shall be permissible for the sending station to send as many as seven blocks ahead of the received replies before being required to stop transmission until six or less blocks are outstanding.

c) If a negative reply is received, the sending station (master side) shall start retransmission with the block following the last block for which the proper affirmative acknowledgement was received.

8.6.3.6.2.5 Slave responses shall be according to one of the following:

a) if a transmission block is received without error and the station is ready to receive another block, it shall send DLE, a colon, an optional prefix, and the appropriate acknowledgement ACKN (referring to the received block beginning with SOTB N, e.g. ACK0, transmitted as DLE0 is used as the affirmative reply to the block numbered SOTB0, DLE1 for SOTB1, etc.);

b) if a transmission block is not acceptable, the receiving station shall send DLE, a colon, an optional prefix, and NAK.

8.6.3.6.2.6 Slave responses should be interleaved between message blocks and transmitted at the earliest possible time.

8.6.3.6.3 Link Termination Procedure

8.6.3.6.3.1 If the link has been established for message transfers in either or both directions, the sending of EOT by a station shall signal the end of message transfers in that direction. To resume message transfers after sending EOT, the link shall be re-established in that direction.

8.6.3.6.3.2 EOT shall only be transmitted by a station after all outstanding slave responses have been received or otherwise accounted for.

8.6.3.6.4 Circuit Disconnection

8.6.3.6.4.1 On switched connections, the data links in both directions shall be terminated before the connection is cleared. In addition, the station initiating clearing of the connection shall first announce its intention to do so by transmitting the two-character sequence DLE EOT, followed by any other signals required to clear the connection.

8.6.3.7 Description of System Category C (CENTRALIZED)

System category C (centralized) is one (like system category A) in which a number of stations are connected by a multipoint link and one station is designated as the control station but (unlike system category A) provides only for centralized (computer-to -terminal) operations where message interchange (with replies) shall be constrained to occur only between the control and a selected tributary station.

8.6.3.7.1 Link Establishment Procedure

8.6.3.7.1.1 To establish the link for transmission the control station shall either:

a) poll one of the tributary stations to assign it master status; or

b) assume master status and select a tributary station to assume slave status and receive a transmission according to either of two prescribed selection procedures:

1) selection with response (see 8.6.3.7.1.5); or

2) fast select (see 8.6.3.7.1.7).

8.6.3.7.1.2 Polling is accomplished by the control station sending a polling supervisory sequence consisting of a prefix identifying a single tributary station and ending in ENQ.

8.6.3.7.1.3 A tributary station detecting its assigned polling supervisory sequence shall assume master status and respond in one of two ways:

a) if the station has a message to send, it shall initiate message transfer. The control station assumes slave status;

b) if the station has no message to send, it shall send EOT and master status shall revert to the control station.

8.6.3.7.1.4 If the control station detects an invalid or no response resulting from a poll, it shall terminate by sending EOT prior to resuming polling or selection.

8.6.3.7.1.5 Selection with response is accomplished by the control station assuming master status and sending a selection supervisory sequence consisting of a prefix identifying a single tributary station and ending in ENQ.

8.6.3.7.1.6 A tributary station detecting its assigned selection supervisory sequence shall assume slave status and send one of two replies:

a) if the station is ready to receive, it shall send an optional prefix followed by ACK. Upon detecting this reply, the master station shall proceed with message transfer;

b) if the station is not ready to receive, it shall send an optional prefix followed by NAK. Upon detecting NAK, it shall be permissible for the master station to again attempt selecting the same tributary station or initiate termination by sending EOT.

Note.— If the control station receives an invalid or no reply, it is permitted to attempt again to select the same tributary or after N *retries* ($N \geq 0$) *either to exit to a recovery procedure or to initiate termination by sending EOT.*

8.6.3.7.1.7 Fast select is accomplished by the control station assuming master status and sending a selection supervisory sequence, and without ending this transmission with ENQ or waiting for the selected tributary to respond, proceeding directly to message transfer.

8.6.3.7.2 Message Transfer Procedure

8.6.3.7.2.1 The station with master status shall send a single message to the station with slave status and wait for a reply.

8.6.3.7.2.2 The message transmission shall:

a) begin with:

— SOH if the message has a heading,

— STX if the message has no heading; and

b) be continuous, ending with ETX, immediately followed by BCC.

8.6.3.7.2.3 The slave station, upon detecting ETX followed by BCC, shall send one of two replies:

a) if the messages were accepted and the slave station is ready to receive another message, it shall send an optional prefix followed by ACK. Upon detecting ACK, the master station shall be permitted either to transmit the next message or initiate termination;

b) if the message was not accepted and the slave station is ready to receive another message, it shall send an optional prefix followed by NAK. Upon detecting NAK, the master station may either transmit another message or initiate termination. Following the NAK reply, the next message transmitted need not be a retransmission of the message that was not accepted.

8.6.3.7.2.4 If the master station receives an invalid or no reply to a message, it shall be permitted to send a delivery verification supervisory sequence consisting of an optional prefix followed by ENQ. Upon receipt of a delivery verification supervisory sequence, the slave station repeats its last reply.

8.6.3.7.2.5 N retries ($N \geq 0$) may be made by the master station in order to get a valid slave reply. If a valid reply is not received after N retries, the master station exits to a recovery procedure.

8.6.3.7.3 Link Termination Procedure

8.6.3.7.3.1 The station with master status shall transmit EOT to indicate that it has no more messages to transmit. EOT shall negate the master/slave status of both stations and return master status to the control station.

8.6.4 Ground-ground bit-oriented data link control procedures

Note.— The provisions of this section pertain to ground-ground data interchange applications using bit-oriented data link control procedures enabling transparent, synchronous transmission that is independent of any encoding; data link control functions are accomplished by interpreting designated bit positions in the transmission envelope of a frame.

8.6.4.1 The following descriptions shall apply to data link applications contained in this section:

a) Bit-oriented data link control procedures enable transparent transmission that is independent of any encoding.

b) A data link is the logical association of two interconnected stations, including the communication control capability of the interconnected stations.

c) A station is a configuration of logical elements, from or to which messages are transmitted on a data link, including those elements which control the message flow on the link via communication control procedures.

d) A combined station sends and receives both commands and responses and is responsible for control of the data link.

e) Data communication control procedures are the means used to control and protect the orderly interchange of information between stations on a data link.

f) A component is defined as a number of bits in a prescribed order within a sequence for the control and supervision of the data link.

g) An octet is a group of 8 consecutive bits.

h) A sequence is one or more components in prescribed order comprising an integral number of octets.

i) A field is a series of a specified number of bits or specified maximum number of bits which performs the functions of data link or communications control or constitutes data to be transferred.

j) A frame is a unit of data to be transferred over the data link, comprising one or more fields in a prescribed order.

k) A common ICAO data interchange network (CIDIN) switching center is that part of an automatic AFTN switching center which provides for the entry, relay, and exit center functions using the bit-oriented link and CIDIN network procedures specified in this section and includes the appropriate interface(s) with other parts of the AFTN and with other networks.

8.6.4.2 Bit -Oriented Data Link Control Procedure for Point-to - Point, Ground - to Ground data Interchange Applications Employing Synchronous Transmission Facilities

Note.— The following link level procedures are the same as the LAPB link level procedures described in ITU CCITT Recommendation X.25, Section 2, Yellow Book (1981 version). Later versions of Recommendation X.25 will be reviewed as they are released to ascertain whether or not they should be adopted.

8.6.4.2.1 *Frame format.* Frames shall contain not less than 32 bits, excluding the opening and closing flags, and shall conform to the following format:

FLAG F	ADDRESS A	CONTROL C	INFORMATION I	FCS	FLAG F

8.6.4.2.1.1 A frame shall consist of an opening flag (F), an address field (A), a control field (C), an optional information field (I), a frame check sequence (FCS), and a closing flag sequence (F), and shall be transmitted in that order.

Note.— In relation to CIDIN, the opening flag, the fields A and C, the FCS and the closing flag form together the Data Link Control Field (DLCF). The field I is denoted as the Link Data Field (LDF).

8.6.4.2.1.1.1 The flag (F) shall be the 8-bit sequence 01111110 which delimits the beginning and ending of each frame. It shall be permissible for the closing flag of a frame to also serve as the opening flag of the next frame.

8.6.4.2.1.1.2 The address (A) field shall consist of one octet, excluding 0 bits added to achieve transparent transmission, which shall contain the link address of the combined station.

8.6.4.2.1.1.3 The control (C) field shall consist of one octet, excluding 0 bits added to achieve transparent transmission, and shall contain the commands, responses, and frame sequence number components for the control of the data link.

8.6.4.2.1.1.4 The information (I) field shall contain digital data which may be presented in any code or sequence but shall not exceed a maximum of 259 octets, excluding 0 bits added to achieve transparent transmission. The I field shall always be a multiple of 8 bits in length.

8.6.4.2.1.1.5 The frame check sequence (FCS) shall consist of two octets, excluding 0 bits added to achieve transparent transmission, and shall contain the error detecting bits.

8.6.4.2.2 A frame check sequence (FCS) shall be included in each frame for the purpose of error checking.

8.6.4.2.2.1 The error checking algorithm shall be a cyclic redundancy check (CRC).

8.6.4.2.2.2 The CRC polynomial ($P(x)$) shall be

$$x^{16} + x^{12} + x^5 + 1.$$

8.6.4.2.2.3 The FCS shall be a 16-bit sequence. This FCS shall be the ones' complement of the remainder, $R(x)$, obtained from the modulo 2 division of

$$x^{16}[G(x)] + x^K(x^{15} + x^{14} + x^{13} + ... + x^2 + x^1 + 1)$$

by the CRC polynomial, $P(x)$.

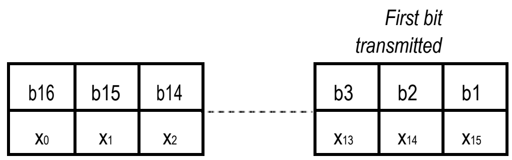
$G(x)$ shall be the contents of the frame existing between, but including neither, the final bit of the opening flag nor the first bit of the FCS, excluding bits inserted for transparent transmission.

K shall be the length of $G(x)$ (number of bits).

8.6.4.2.2.4 The generation and checking of the FCS accumulation shall be as follows:

a) the transmitting station shall initiate the FCS accumulation with the first (least significant) bit of the address (A) field and shall include all bits up to and including the last bit preceding the FCS sequence, but shall exclude all 0 bits (if any) inserted to achieve transparent transmission;

b) upon completion of the accumulation the FCS shall be transmitted, starting with bit b1 (highest order coefficient) and proceeding in sequence to bit b16 (lowest order coefficient) as shown below;



c) the receiving station shall carry out the cyclic redundancy check (CRC) on the content of the frame commencing with the first bit received following the opening flag, and shall include all bits up to and including the last bit preceding the closing flag, but shall exclude all 0 bits (if any) deleted according to the rules for achievement of transparency;

d) upon completion of the FCS accumulation, the receiving station shall examine the remainder. In the absence of transmission error, the remainder shall be 1111000010111000 (x^0 through x^{15}, respectively).

8.6.4.2.3 Achievement of transparency. The frame format contents (A, C, link data field, and FCS) shall be capable of containing any bit configuration.

8.6.4.2.3.1 The following rules shall apply to all frame contents, except flag sequences:

a) the transmitting station shall examine the frame contents before transmission, and shall insert a single 0 bit immediately following each sequence of 5 consecutive 1 bits;

b) the receiving station shall examine the received frame contents for patterns consisting of 5 consecutive 1 bits immediately followed by one (or more) 0 bit(s) and shall remove the 0 bit which directly follows 5 consecutive 1 bits.

8.6.4.2.4 Special transmission sequences and related link states. In addition to employing the prescribed repertoire of commands and responses to manage the interchange of data and control information, stations shall use the following conventions to signal the indicated conditions:

a) Abort is the procedure by which a station in the process of sending a frame ends the frame in an unusual manner such that the receiving station shall ignore the frame. The conventions for aborting a frame shall be:

   1) transmitting at least seven, but less than fifteen, one bits (with no inserted zeros);

   2) receiving seven one bits. Active link state. A link is in an active state when a station is transmitting a frame, an abort sequence, or inter frame time fill. When the link is in the active state, the right of the transmitting station to continue transmission shall be reserved.

b) Inter frame time fill. Inter frame time fill shall be accomplished by transmitting continuous flags between frames. There is no provision for time fill within a frame.

c) Idle link state. A link is in an idle state when a continuous one condition is detected that persists for 15 bit times, or longer. Idle link time fill shall be a continuous one condition on the link.

d) Invalid frame. An invalid frame is one that is not properly bounded by two flags or one which is shorter than 32 bits between flags.

8.6.4.2.5 Modes

8.6.4.2.5.1 Operational mode. The operational mode shall be the asynchronous balanced mode (ABM).

8.6.4.2.5.1.1 It shall be permissible for a combined station in ABM to transmit without invitation from the associated station.

8.6.4.2.5.1.2 A combined station in ABM shall be permitted to transmit any command or response type frame except DM.

8.6.4.2.5.2 Non-operational mode. The non-operational mode shall be the asynchronous disconnected mode (ADM) in which a combined station is logically disconnected from the data link.

8.6.4.2.5.2.1 It shall be permissible for a combined station in ADM to transmit without invitation from the associated station.

8.6.4.2.5.2.2 A combined station in ADM shall transmit only SABM, DISC, UA and DM frames. (See 8.6.4.2.7 for a description of the commands and responses to which these frame types refer.)

8.6.4.2.5.2.3 A combined station in ADM shall transmit a DM when a DISC is received, and shall discard all other received command frames except SABM. If a discarded command frame has the P bit set to “1”, the combined station shall transmit a DM with the F bit set to “1”.

8.6.4.2.6 Control field functions and parameters. Control fields contain a command or a response and sequence numbers where applicable. Three types of control fields shall be used to perform:

a) numbered information transfer (I-frames);

b) numbered supervisory functions (S-frames); and

c) unnumbered control functions (U-frames).

The control field formats shall be as shown in Table 8-5. The functional frame designation associated with each type control field as well as the control field parameters employed in performing these functions shall be described in the following paragraphs.

8.6.4.2.6.1 The I-frame type is used to perform information transfers. Except for some special cases it is the only format which shall be permitted to contain an information field.

8.6.4.2.6.2 The S-frame type is used for supervisory commands and responses that perform link supervisory control functions such as acknowledge information frames, request transmission or retransmission of information frames, and to request a temporary suspension of transmission of I-frames. No information field shall be contained in the S-frame.

8.6.4.2.6.3 The U-frame type is used for unnumbered commands and responses that provide additional link control functions. One of the U-frame responses, the frame reject (FRMR) response, shall contain an information field; all other frames of the U-frame type shall not contain an information field.

8.6.4.2.6.4 The station parameters associated with the three control field types shall be as follows:

a) Modulus. Each I-frame shall be sequentially numbered with a send sequence count, *N(S),* having value 0 through modulus minus one (where modulus is the modulus of the sequence numbers). The modulus shall be 8. The maximum number of sequentially numbered I-frames that a station shall have outstanding (i.e. unacknowledged) at any given time shall never exceed one less than the modulus of the sequence numbers. This restriction on the number of outstanding frames is to prevent any ambiguity in the association of transmission frames with sequence numbers during normal operation and/or error recovery.

b) The send state variable *V*(*S*) shall denote the sequence number of the next in-sequence I-frame to be transmitted.

   1) The send state variable shall take on the value 0 through modulus minus one (modulus is the modulus of the sequence numbering and the numbers cycle through the entire range).

   2) The value of *V*(*S*) shall be incremented by one with each successive in-sequence I-frame transmission, but shall not exceed the value of *N*(*R*) contained in the last received frame by more than the maximum permissible number of outstanding I-frames (*k*). See i) below for the definition of *k*.

c) Prior to transmission of an in-sequence I-frame, the value of *N*(*S*) shall be updated to equal the value of *V*(*S*).

d) The receive state variable *V*(*R*) shall denote the sequence number of the next in-sequence I-frame to be received.

   1) *V*(*R*) shall take on the values 0 through modulus minus one.

   2) The value of *V*(*R*) shall be incremented by one after the receipt of an error-free, in-sequence I-frame whose send sequence number *N*(*S*), equals *V*(*R*).

e) All I-frames and S-frames shall contain *N*(*R*), the expected sequence number of the next received frame. Prior to transmission of either an I or an S type frame, the value of *N*(*R*) shall be updated to equal the current value of the receive state variable. *N*(*R*) indicates that the station transmitting the *N*(*R*) has correctly received all I-frames numbered up to and including *N*(*R*) – 1.

f) Each station shall maintain an independent send state variable, *V*(*S*), and receive state variable, *V*(*R*), on the I-frames it sends and receives. That is, each combined station shall maintain a *V*(*S*) count on the I-frames it transmits and a *V*(*R*) count on the I-frames it has correctly received from the remote combined station.

g) The poll (P/F) bit shall be used by a combined station to solicit (poll) a response or sequence of responses from the remote combined station.

h) The final (P/F) bit shall be used by the remote combined station to indicate the response frame transmitted as the result of a soliciting (poll) command.

i) The maximum number (*k*) of sequentially numbered I-frames that a station may have outstanding (i.e. unacknowledged) at any given time is a station parameter which shall never exceed the modulus.

Note.— k *is determined by station buffering limitations and should be the subject of bilateral agreement at the time of circuit establishment.*

8.6.4.2.7 Commands and responses. It shall be permissible for a combined station to generate either commands or responses. A command shall contain the remote station address while a response shall contain the sending station address. The mnemonics associated with all of the commands and responses prescribed for each of the three frame types (I, S, and U) and the corresponding encoding of the control field are as shown in Table 8-6.

8.6.4.2.7.1 The I-frame command provides the means for transmitting sequentially numbered frames, each of which shall be permitted to contain an information field.

8.6.4.2.7.2 The S-frame commands and responses shall be used to perform numbered supervisory functions (such as acknowledgement, polling, temporary suspension of information transfer, or error recovery).

8.6.4.2.7.2.1 The receive ready command or response (RR) shall be used by a station to:

a) indicate that it is ready to receive an I-frame;

b) acknowledge previously received I-frames numbered up to and including $N(R) - 1$;

c) clear a busy condition that was initiated by the transmission of RNR.

Note.— It is permissible for a combined station to use the RR command to solicit a response from the remote combined station with the poll bit set to "1".

8.6.4.2.7.2.2 It shall be permissible to issue a reject command or response (REJ) to request retransmission of frames starting with the I-frame numbered $N(R)$ where:

a) I-frames numbered $N(R) - 1$ and below are acknowledged;

b) additional I-frames pending initial transmission are to be transmitted following the retransmitted I-frame(s);

c) only one REJ exception condition, from one given station to another station, shall be established at any given time: another REJ shall not be issued until the first REJ exception condition has been cleared;

d) the REJ exception condition is cleared (reset) upon the receipt of an I-frame with an $N(S)$ count equal to the $N(R)$ of the REJ command/response.

8.6.4.2.7.2.3 The receive not ready command or response (RNR) shall be used to indicate a busy condition, i.e. temporary inability to accept additional incoming I-frames, where:

a) frames numbered up to and including $N(R) – 1$ are acknowledged;

b) frame $N(R)$ and any subsequent I-frames received, if any, are not acknowledged (the acceptance status of these frames shall be indicated in subsequent exchanges);

c) the clearing of a busy condition shall be indicated by the transmission of an RR, REJ, SABM, or UA with or without the P/F bit set to “1”.

8.6.4.2.7.2.3.1

a) A station receiving an RNR frame when in the process of transmitting should stop transmitting I-frames at the earliest possible time.

b) Any REJ command or response which was received prior to the RNR should be actioned before the termination of transmission.

c) It should be permissible for a combined station to use the RNR command with the poll bit set to “1” to obtain a supervisory frame with the final bit set to “1” from the remote combined station.

8.6.4.2.7.2.4 It shall be permissible for the selective reject command or response (SREJ) to be used to request retransmission of the single I-frame numbered $N(R)$ where:

a) frames numbered up to $N(R) – 1$ are acknowledged; frame $N(R)$ is not accepted; the only I-frames accepted are those received correctly and in sequence following the I-frame requested; the specific I-frame to be retransmitted is indicated by the $N(R)$ in the SREJ command/response;

b) the SREJ exception condition is cleared (reset) upon receipt of an I-frame with an $N(S)$ count equal to the $N(R)$ of the SREJ;

c) after a station transmits a SREJ it is not permitted to transmit SREJ or REJ for an additional sequence error until the first SREJ error condition has been cleared;

d) I-frames that have been permitted to be transmitted following the I-frame indicated by the SREJ are not retransmitted as the result of receiving a SREJ; and

e) it is permissible for additional I-frames pending initial transmission to be transmitted following the retransmission of the specific I-frame requested by the SREJ.

8.6.4.2.7.3 The U-frame commands and responses shall be used to extend the number of link control functions. Transmitted U-frames do not increment the sequence counts at either the transmitting or receiving station.

a) The U-frame mode-setting commands (SABM, and DISC) shall be used to place the addressed station in the appropriate response mode (ABM or ADM) where:

1) upon acceptance of the command, the station send and receive state variables, $V(S)$ and $V(R)$, are set to zero;

2) the addressed station confirms acceptance at the earliest possible time by transmission of a single unnumbered acknowledgement, UA;

3) previously transmitted frames that are unacknowledged when the command is actioned remain unacknowledged;

4) the DISC command is used to perform a logical disconnect, i.e. to inform the addressed combined station that the transmitting combined station is suspending operation. No information field shall be permitted with the DISC command.

b) The unnumbered acknowledge response (UA) shall be used by a combined station to acknowledge the receipt and acceptance of an unnumbered command. Received unnumbered commands are not actioned until the UA response is transmitted. No information field shall be permitted with the UA response.

c) The frame reject response (FRMR), employing the information field described below, shall be used by a combined station in the operational mode (ABM) to report that one of the following conditions resulted from the receipt of a frame without an FCS error:

1) a command/response that is invalid or not implemented;

2) a frame with an information field that exceeds the size of the buffer available;

3) a frame having an invalid $N(R)$ count.

Note.— An invalid N(R) *is a count which points to an I-frame which has previously been transmitted and acknowledged or to an I-frame which has not been transmitted and is not the next sequential I-frame pending transmission.*

d) The disconnected mode response (DM) shall be used to report a non-operational status where the station is logically disconnected from the link. No information field shall be permitted with the DM response.

Note.— The DM response shall be sent to request the remote combined station to issue a mode-setting command or, if sent in response to the reception of a mode-setting command, to inform the remote combined station that the transmitting station is still in ADM and cannot action the mode-setting command.

8.6.4.3 Exception Condition Reporting and Recovery

This section specifies the procedures that shall be employed to effect recovery following the detection or occurrence of an exception condition at the link level. Exception conditions described are those situations that may occur as the result of transmission errors, station malfunction, or operational situations.

8.6.4.3.1 Busy condition. A busy condition occurs when a station temporarily cannot receive or continue to receive I-frames due to internal constraints, e.g. due to buffering limitations. The busy condition shall be reported to the remote combined station by the transmission of an RNR frame with the *N*(*R*) number of the next I-frame that is expected. It shall be permissible for traffic pending transmission at the busy station to be transmitted prior to or following the RNR.

Note.— The continued existence of a busy condition must be reported by retransmission of RNR at each P/F frame exchange.

8.6.4.3.1.1 Upon receipt of an RNR, a combined station in ABM shall cease transmitting I-frames at the earliest possible time by completing or aborting the frame in process. The combined station receiving an RNR shall perform a time-out operation before resuming asynchronous transmission of I-frames unless the busy condition is reported as cleared by the remote combined station. If the RNR was received as a command with the P bit set to “1”, the receiving station shall respond with an S-frame with the F bit set to “1”.

8.6.4.3.1.2 The busy condition shall be cleared at the station which transmitted the RNR when the internal constraint ceases. Clearance of the busy condition shall be reported to the remote station by transmission of an RR, REJ, SABM, or UA frame (with or without the P/F bit set to “1”).

8.6.4.3.2 N(S) sequence error. An *N*(*S*) sequence exception shall be established in the receiving station when an I-frame that is received error free (no FCS error) contains an *N*(*S*) sequence number that is not equal to the receive variable *V*(*R*) at the receiving station. The receiving station shall not acknowledge (shall not increment its receive variable *V*(*R*)) the frame causing the sequence error, or any I-frames which may follow, until an I-frame with the correct *N*(*S*) number is received. A station that receives one or more I-frames having sequence errors, but which are otherwise error free, shall accept the control information contained in the *N*(*R*) field and the P/F bit to perform link control functions, e.g. to receive acknowledgement of previously transmitted I-frames (via the *N*(*R*)), to cause the station to respond (P bit set to “1”).

8.6.4.3.2.1 The means specified in 8.6.4.3.2.1.1 and 8.6.4.3.2.1.2 shall be available for initiating the retransmission of lost or errored I-frames following the occurrence of a sequence error.

8.6.4.3.2.1.1 Where the REJ command/response is used to initiate an exception recovery following the detection of a sequence error, only one “sent REJ” exception condition, from one station to another station, shall be established at a time. A “sent REJ” exception shall be cleared when the requested I-frame is received. A station receiving REJ shall initiate sequential (re)transmission of I-frames starting with the I-frame indicated by the *N*(*R*) contained in the REJ frame.

FRMR INFORMATION FIELD BITS FOR BASIC (SABM) OPERATION

First bit transmitted

1 8	9	10 12	13	14 16	17	18	19	20	21 24
rejected basic control field	0	*V(S)*	*v*	*V(R)*	*w*	*x*	*y*	*z*	set to zero

where:

rejected basic control field is the control field of the received frame which caused the frame reject;

V(*S*) is the current value of the send state variable at the remote combined station reporting the error condition (bit 10 = low order bit);

V(*R*) is the current value of the receive state variable at the remote combined station reporting the error condition (bit 14 = low order bit);

v set to “1” indicates that the received frame which caused rejection was a response;

w set to “1” indicates that the control field received and returned in bits 1 through 8 are invalid or not implemented;

x set to “1” indicates that the control field received and returned in bits 1 through 8 was considered invalid because the frame contained an information field which is not permitted with this command. Bit *w* must be set to “1” in conjunction with this bit;

y set to “1” indicates that the information field received exceeded the maximum information field length which can be accommodated by the station reporting the error condition. This bit is mutually exclusive with bits *w* and *x* above;

z set to “1” indicates that the control field received and returned in bits 1 through 8 contained an invalid *N(R)* count. This bit is mutually exclusive with bit *w*.

8.6.4.3.2.1.2 In the event a receiving station, due to a transmission error, does not receive (or receives and discards) a single I-frame or the last I-frame(s) in a sequence of I-frames, it shall not detect an out-of-sequence exception and, therefore, shall not transmit REJ. The station which transmitted the unacknowledged I-frame(s) shall, following the completion of a system-specified time-out period, take appropriate recovery action to determine the sequence number at which retransmission must begin.

8.6.4.3.2.1.3A combined station which has timed out waiting for a response should not retransmit all unacknowledged frames immediately. The station may enquire about status with a supervisory frame.

Note 1.— If a station does retransmit all unacknowledged I-frames after a time-out, it must be prepared to receive a subsequent REJ frame with an N(R) *greater than its send variable* V(S).
Note 2.— Since contention may occur in the case of two-way alternate communications in ABM or ADM, the time-out interval employed by one combined station must be greater than that employed by the other combined station so as to permit contention to be resolved.

8.6.4.3.3 FCS error. Any frame with an FCS error shall not be accepted by the receiving station and will be discarded. No action shall be taken by the receiving station as the result of that frame.

8.6.4.3.4 Frame reject exception condition. A frame reject exception condition shall be established upon the receipt of an error-free frame which contains an invalid or unimplemented control field, an invalid *N(R)*, or an information field which has exceeded the maximum established storage capability. If a frame reject exception condition occurs in a combined station, the station shall either:

a) take recovery action without reporting the condition to the remote combined station; or

b) report the condition to the remote combined station with a FRMR response. The remote station will then be expected to take recovery action; if, after waiting an appropriate time, no recovery action appears to have been taken, the combined station reporting the frame reject exception condition may take recovery action.

Recovery action for balanced operation includes the transmission of an implemented mode-setting command. Higher level functions may also be involved in the recovery.

8.6.4.3.5 Mode-setting contention. A mode-setting contention situation exists when a combined station issues a mode-setting command and, before receiving an appropriate response (UA or DM), receives a mode-setting command from the remote combined station. Contention situations shall be resolved in the following manner:

a) when the send and receive mode-setting commands are the same, each combined station shall send a UA response at the earliest respond opportunity. Each combined station shall either enter the indicated mode immediately or defer entering the indicated mode until receiving a UA response. In the latter case, if the UA response is not received:

    1) the mode may be entered when the response timer expires; or

    2) the mode-setting command may be reissued;

b) when the mode-setting commands are different, each combined station shall enter ADM and issue a DM response at the earliest respond opportunity. In the case of DISC contention with a different mode-setting command, no further action is required.

8.6.4.3.6 Time-out functions. Time-out functions shall be used to detect that a required or expected acknowledging action or response to a previously transmitted frame has not been received. Expiration of the time-out function shall initiate appropriate action, e.g. error recovery or reissuance of the P bit. The duration of the following time-out functions is system dependent and subject to bilateral agreement:

a) combined stations shall provide a time-out function to determine that a response frame with F bit set to "1" to a command frame with the P bit set to "1" has not been received. The time-out function shall automatically cease upon receipt of a valid frame with the F bit set to "1";

b) a combined station which has no P bit outstanding, and which has transmitted one or more frames for which responses are anticipated shall start a time-out function to detect the no-response condition. The time-out function shall cease when an I- or S-frame is received with the *N*(*R*) higher than the last received *N*(*R*) (actually acknowledging one or more I-frames).

8.6.5 Common ICAO data interchange network (CIDIN)

8.6.5.1 Introduction

Note 1.— The common ICAO data interchange network (CIDIN) is an element of the aeronautical fixed service (AFS) which uses bit-oriented procedures, store and forward techniques and packet switching techniques based on CCITT Recommendation X.25 to carry messages of specific applications of the AFS such as AFTN and operational meteorological information (OPMET).

Note 2.— The CIDIN provides a reliable common network service for the conveyance of application messages in binary or text form to air traffic service providers and aircraft operating agencies.

8.6.5.1.1 CIDIN entry and exit centers or stations shall be used to connect application entities to the CIDIN.

Note.— The interfacing between CIDIN and application entities is a matter for local implementation.

8.6.5.1.2 CIDIN relay centers shall be used to forward packets between CIDIN entry and exit centers or stations which are not directly connected.

8.6.5.2 General

8.6.5.2.1 There shall be four protocol levels defined to control the transfer of messages between CIDIN switching centers:

— the data link protocol level

— the X.25 packet protocol level

— the CIDIN packet protocol level

— the CIDIN transport protocol level.

Note 1.— The relationship of the terms used is shown in Figures 8-1 and 8-2.
Note 2.— The details of CIDIN communication procedures and system specifications, as implemented in Europe, are shown in the EUR CIDIN Manual *(EUR Doc 005).*

8.6.5.2.2 The Data link Protocol level

8.6.5.2.2.1 X.25 packets to be transferred between two CIDIN switching centers or a CIDIN switching center and a packet switched data network, shall be formatted into data link frames.

8.6.5.2.2.2 Each data link frame shall consist of a data link control field (DLCF), possibly followed by a link data field, and shall be terminated by a frame check sequence and flag (being the second part of the DLCF). If a link data field is present, the frame shall be denoted as an information frame.

8.6.5.2.2.3 X.25 packets shall be transmitted within the link data field of information frames. Only one packet shall be contained in the link data field.

8.6.5.2.3 The X.25 Packet Protocol Level

8.6.5.2.3.1 Each CIDIN packet to be transferred on CIDIN circuits between CIDIN switching centers shall be formatted into one X.25 packet. When a packet switched data network is used, it shall be permissible to format the CIDIN packet into more than one X.25 packet.

8.6.5.2.3.2 The integrity of each CIDIN packet shall be preserved by the X.25 packet protocol by mapping each CIDIN packet onto one complete X.25 packet sequence, as defined in CCITT Recommendation X.25.

8.6.5.2.3.3 Each X.25 packet shall consist of an X.25 packet header, possibly followed by a user data field (UDF).

8.6.5.2.3.4 The X.25 packet protocol is based on the application of virtual circuit procedures. A virtual circuit shall be defined as a logical path between two CIDIN switching centers. If a packet switched data network is used to interconnect two CIDIN switching centers, the procedure shall provide full compatibility with the procedures to be followed for virtual circuits according to CCITT Recommendation X.25.

8.6.5.2.4 The CIDIN Packet Protocol Level

8.6.5.2.4.1 Each transport header and the associated segment shall be preceded by a CIDIN packet header. No further segmentation of the CIDIN message shall be used between transport protocol level and CIDIN packet protocol level. Both headers, therefore, shall be used in combination. Together they shall be referred to as the communications control field (CCF). Together with the message segment they form CIDIN packets that shall be transmitted from entry center to exit center(s), when necessary through one or more relay centers, as an entity.

8.6.5.2.4.2 CIDIN packets of one CIDIN message shall be relayed independently via predetermined routes through the network thus allowing alternative routing on a CIDIN packet basis as necessary.

8.6.5.2.4.3 The CIDIN packet header shall contain information to enable relay centers to handle CIDIN packets in the order of priority, to transmit the CIDIN packets on the proper outgoing circuit(s) and to duplicate or multiplicate CIDIN packets when required for multiple dissemination purposes. The information shall be sufficient to apply address stripping on the exit addresses as well as on the addressee indicators of messages in AFTN format.

8.6.5.2.5 The Transport Protocol level

8.6.5.2.5.1 Information exchanged over the CIDIN shall be transmitted as CIDIN messages.

8.6.5.2.5.2 The length of a CIDIN message shall be defined by the CIDIN packet sequence number (CPSN). The maximum permissible length is 2^{15} packets which in effect results in no practical limitation.

8.6.5.2.5.3 If the length of a CIDIN message and its transport and packet headers (as defined below) exceeds 256 octets, the message shall be divided into segments and placed in the CIDIN user data field of CIDIN packets. Each segment shall be preceded by a transport header containing information to enable the re-assembly of the CIDIN message at the exit center(s) from individually received segments and to determine further handling of the received complete CIDIN message.

8.6.5.2.5.4 All segments of one CIDIN message shall be provided with the same message identification information in the transport header. Only the CPSN and final CIDIN packet (FCP) indicator shall be different.

8.6.5.2.5.5 Recovery of messages shall be performed at the transport level.

——————— INTENTIONALLY LEFT BLANK———————

TABLES FOR CHAPTER 8

Table 8-1. International Telegraph Alphabets No. 2 and No. 3

Number of Signal	*Letter Case*	*Figure case*	*Impulses 5-unit code*		
			Start	*12345*	*Stop*
				International Code No. 2	
1	A	—	A	ZZAAA	Z
2	B	?	A	ZAAZZ	Z
3	C	:	A	AZZZA	Z
4	D	Note 1	A	ZAAZA	Z
5	E	3	A	ZAAAA	Z
6	F		A	ZAZZA	Z
7	G		A	AZAZZ	Z
8	H		A	AAZAZ	Z
9	I	8	A	AZZAA	Z
10	J	Attention signal	A	ZZAZA	Z
11	K	(	A	ZZZZA	Z
12	L	)	A	AZAAZ	Z
13	M	.	A	AAZZZ	Z
14	N	,	A	AAZZA	Z
15	O	9	A	AAAZZ	Z
16	P	0	A	AZZAZ	Z
17	Q	1	A	ZZZAZ	Z
18	R	4	A	AZAZA	Z
19	S	’	A	ZAZAA	Z
20	T	5	A	AAAAZ	Z
21	U	7	A	ZZZAA	Z
22	V	=	A	AZZZZ	Z
23	W	2	A	ZZAAZ	Z
24	X	/	A	ZAZZZ	Z
25	Y	6	A	ZAZAZ	Z
26	Z	+	A	ZAAAZ	Z
27	carriage return		A	AAAZA	Z
28	line feed		A	AZAAA	Z
29	letters		A	ZZZZZ	Z
30	figures		A	ZZAZZ	Z
31	space		A	AAZAA	Z
32	unperforated tape		A	AAAAA	Z
33	signal repetition				
34	signal α				
35	signal ß				

Sign	*Closed circuit*	*Double current*
A	No current	Negative current
Z	Positive current	Positive current

Note 1.— Used for answer-back facility.

`

Table 8-2. International Alphabet No. 5 (IA-5)
(international reference version)

				b7	0	0	0	0	1	1	1	1
				b6	0	0	1	1	0	0	1	1
				b5	0	1	0	1	0	1	0	1
b4	b3	b2	b1		0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	TC_7 (DLE)	SP	0	@	P	`	p
0	0	0	1	1	TC_1 (SOH)	DC_1	!	1	A	Q	A	q
0	0	1	0	2	TC_2 (STX)	DC_2	" ④	2	B	R	B	r
0	0	1	1	3	TC_3 (ETX)	DC_3	#	3	C	S	C	s
0	1	0	0	4	TC_4 (EOT)	DC_4	¤ ②	4	D	T	d	t
0	1	0	1	5	TC_5 (ENQ)	TC_8 (NAK)	%	5	E	U	e	u
0	1	1	0	6	TC_6 (ACK)	TC_9 (SYN)	&	6	F	V	f	v
0	1	1	1	7	BEL	TC_{10} (ETB)	' ④	7	G	W	g	w
1	0	0	0	8	FE_0 (BS)	CAN	(	8	H	X	h	x
1	0	0	1	9	FE_1 (HT)	EM	)	9	I	Y	i	y
1	0	1	0	10	$FE_2$① (LF)	SUB	*	:	J	Z	j	z
1	0	1	1	11	FE_3 (VT)	ESC	+	;	K	[	k	{
1	1	0	0	12	FE_4 (FF)	IS_4 (FS)	④ ,	<	L	\	l	|
1	1	0	1	13	$FE_5$① (CR)	IS_3 (GS)	–	=	M	]	m	}
1	1	1	0	14	SO	IS_2 (RS)	.	>	N	^ ④	n	¯ ③
1	1	1	1	15	SI	IS_1 (US)	/	?	O	__	o	DEL

NOTES

Note 1.—The format effectors are intended for equipment in which horizontal and vertical movements are effected separately. If equipment requires the action of CARRIAGE RETURN to be combined with a vertical movement, the format effector for that vertical movement may be used to effect the combined movement. Use of FE 2 for a combined CR and LF operation is not allowed for international transmission on AFS networks.

Note 2.—The symbol ¤ does not designate the currency of a specific country.

Note 3.—Position 7/14 is used for graphic character ¯ (OVERLINE), the graphical representation of which may vary according to national use to represent (TILDE) or another diacritical sign provided that there is no risk of confusion with another graphic character included in the table.

Note 4.—The graphic characters in position 2/2, 2/7, 2/12 and 5/14 have respectively the significance of QUOTATION MARK, APOSTROPHE, COMMA and UPWARD ARROW HEAD; however, these characters take on the significance of the diacritical signs DIAERESIS, ACUTE ACCENT, CEDILLA and CIRCUMFLEX ACCENT when they are preceded or followed by the BACKSPACE character (0/8).

CONTROL CHARACTERS

Abbreviation	*Meaning*	*Position in the code table*
ACK	Acknowledge	0/6
BEL	Bell	0/7
BS	Backspace	0/8
CAN	Cancel	1/8
CR	Carriage return*	0/13
DC	Device control	–
DEL	Delete	7/15
DLE	Data link escape	1/0
EM	End of medium	1/9
ENQ	Enquiry	0/5
EOT	End of transmission	0/4
ESC	Escape	1/11
ETB	End of transmission block	1/7
ETX	End of text	0/3
FE	Format effector	–
FF	Form feed	0/12
FS	File separator	1/12
GS	Group separator	1/13
HT	Horizontal tabulation	0/9
IS	Information separator	–
LF	Line feed*	0/10
NAK	Negative acknowledge	1/5
NUL	Null	0/0
RS	Record separator	1/14
SI	Shift-in	0/15
SO	Shift-out	0/14
SOH	Start of heading	0/1
SP	Space	2/0
STX	Start of text	0/2
SUB	Substitute character	1/10
SYN	Synchronous idle	1/6
TC	Transmission control	–
US	Unit separator	1/15
VT	Vertical tabulation	0/11

GRAPHIC CHARACTERS

Graphic	*Note*	*Name*	*Position in the code table*
(space)		Space (*see* 7.2)	2/0
!		Exclamation mark	2/1
"	4	Quotation mark, Diaeresis	2/2
#		Number sign	2/3
¤	2	Currency sign	2/4
%		Percent sign	2/5
&		Ampersand	2/6
'	4	Apostrophe, Acute accent	2/7
(		Left parenthesis	2/8
)		Right parenthesis	2/9
*		Asterisk	2/10
+		Plus sign	2/11
,	4	Comma, Cedilla	2/12
–		Hyphen, Minus sign	2/13
.		Full stop (period)	2/14
/		Solidus	2/15
:		Colon	3/10
;		Semi-colon	3/11
<		Less-than sign	3/12
=		Equal sign	3/13
>		Greater-than sign	3/14
?		Question mark	3/15
@		Commercial 'at'	4/0
[		Left square bracket	5/11
\		Reverse solidus	5/12
]		Right square bracket	5/13
^	4	Upward arrow head, Circumflex accent	5/14
__		Underline	5/15
`		Grave accent	6/0
{		Left curly bracket	7/11
|		Vertical line	7/12
}		Right curly bracket	7/13
‾	3	Overline, Tilde	7/14

* See Note 1.

DIACRITICAL SIGNS

In the character set, some printing symbols may be designed to permit their use for the composition of accented letters when necessary for general interchange of information. A sequence of three characters, comprising a letter, BACKSPACE and one of these symbols, is needed for this composition, and the symbol is then regarded as a diacritical sign. It should be noted that these symbols take on their diacritical significance only when they are preceded or followed by the BACKSPACE character: for example, the symbol corresponding to the code combination 2/7 (') normally has the significance of APOSTROPHE, but becomes the diacritical sign ACUTE ACCENT when it precedes or follows the BACKSPACE character.

NAMES, MEANINGS AND FONTS OF GRAPHIC CHARACTERS

At least one name is assigned to denote each of the graphic characters. These names are intended to reflect their customary meanings and are not intended to define or restrict the meanings of graphic characters. No particular style or font design is specified for the graphic characters.

UNIQUENESS OF CHARACTER ALLOCATION

A character allocated to a position in the table may not be placed elsewhere in the table.

FUNCTIONAL CHARACTERISTICS RELATED TO CONTROL CHARACTERS

Some definitions given below are stated in general terms and more explicit definitions of use may be needed for specific implementation of the code table on recording media or on transmission channels. These more explicit definitions and the use of these characters are the subject of ISO publications.

General designations of control characters

The general designation of control characters involves a specific class name followed by a subscript number. They are defined as follows:

TC — *Transmission control characters* — Control characters intended to control or facilitate transmission of information over telecommunication networks.
The use of the TC characters on the general telecommunication networks is the subject of ISO publications.
The transmission control characters are:
ACK, DLE, ENQ, EOT, ETB, ETX, NAK, SOH, STX and SYN.

FE — *Format effectors* — Control characters mainly intended for the control of the layout and positioning of information on printing and/or display devices. In the definitions of specific format effectors, any reference to printing devices should be interpreted as including display devices. The definitions of format effectors use the following concept:

a) a page is composed of a number of lines of characters;

b) the characters forming a line occupy a number of positions called character positions;

c) the active position is that character position in which the character about to be processed would appear if it were to be printed. The active position normally advances one character position at a time.

The format effector characters are:
BS, CR, FF, HT, LF and VT.

DC — *Device control characters* — Control characters for the control of a local or remote ancillary device (or devices) connected to a data processing and/or telecommunication system. These control characters are not intended to control telecommunication systems; this should be achieved by the use of TCs.
Certain preferred uses of the individual DCs are given below under *Specific control characters*.

IS — *Information separators* — Control characters that are used to separate and qualify data logically. There are four such characters. They may be used either in hierarchical order or non-hierarchically; in the latter case their specific meanings depend on their applications.
When they are used hierarchically, the ascending order is:
US, RS, GS, FS.
In this case data normally delimited by a particular separator cannot be split by a higher order separator but will be considered as delimited by any higher order separator.

Specific control characters

Individual members of the classes of controls are sometimes referred to by their abbreviated class name and a subscript number (e.g. TC_5) and sometimes by a specific name indicative of their use (e.g. ENQ).

Different but related meanings may be associated with some of the control characters but in an interchange of data this normally requires agreement between the sender and the recipient.

ACK — *Acknowledge* — A transmission control character transmitted by a receiver as an affirmative response to the sender.

BEL — *Bell* — A control character that is used when there is a need to call for attention; it may control alarm or attention devices.

BS — *Backspace* — A format effector which moves the active position one character position backwards on the same line.

CAN — *Cancel* — A character, or the first character of a sequence, indicating that the data preceding it are in error. As a result these data are to be ignored. The specific meaning of this character must be defined for each application and/or between sender and recipient.

CR — *Carriage return* — A format effector which moves the active position to the first character position on the same line.

Device controls

DC_1 — A device control character which is primarily intended for turning on or starting an ancillary device. If it is not required for this purpose, it may be used to restore a device to the basic mode of operation (*see also* DC_2 and DC_3), or for any other device control function not provided by other DCs.

DC_2 — A device control character which is primarily intended for turning on or starting an ancillary device. If it is not required for this purpose, it may be used to set a device to a special mode of operation (in which case DC_1 is used to restore the device to the basic mode), or for any other device control function not provided by other DCs.

DC_3 — A device control character which is primarily intended for turning off or stopping an ancillary device. This function may be a secondary level stop, e.g. wait, pause, stand-by or halt (in which case DC_1 is used to restore normal operation). If it is not required for this purpose, it may be used for any other device control function not provided by other DCs.

DC_4 — A device control character which is primarily intended for turning off, stopping or interrupting an ancillary device. If it is not required for this purpose, it may be used for any other device control function not provided by other DCs.

Examples of use of the device controls

1) One switching
on — DC_2 off — DC_4

2) Two independent switchings
First one on — DC_2 off — DC_4
Second one on — DC_1 off — DC_3

3) Two dependent switchings
General on — DC_2 off — DC_4
Particular on — DC_1 off — DC_3

4) Input and output switching
Output on — DC_2 off — DC_4
Input on — DC_1 off — DC_3

DEL — *Delete* — A character used primarily to erase or obliterate an erroneous or unwanted character in punched tape. DEL characters may also serve to accomplish media-fill or time-fill. They may be inserted into or removed from a stream of data without affecting the information content of that stream, but then the addition or removal of these characters may affect the information layout and/or the control of equipment.

DLE — *Data link escape* — A transmission control character which will change the meaning of a limited number of contiguously following characters. It is used exclusively to provide supplementary data transmission control functions. Only graphic characters and transmission control characters can be used in DLE sequences.

EM — *End of medium* — A control character that may be used to identify the physical end of a medium, or the end of the used portion of a medium, or the end of the wanted portion of data recorded on a medium. The position of this character does not necessarily correspond to the physical end of the medium.

ENQ — *Enquiry* — A transmission control character used as a request for a response from a remote station — the response may include station identification and/or station status. When a "Who are you?" function is required on the general switched transmission network, the first use of ENQ after the connection is established shall have the meaning "Who are you?" (station identification). Subsequent use of ENQ may, or may not, include the function "Who are you?", as determined by agreement.

EOT — *End of transmission* — A transmission control character used to indicate the conclusion of the transmission of one or more texts.

ESC — *Escape* — A control character which is used to provide an additional control function. It alters the meaning of a limited number of contiguously following bit combinations which constitute the escape sequence.
Escape sequences are used to obtain additional control functions which may provide among other things graphic sets outside the standard set. Such control functions must not be used as additional transmission controls.
The use of the character ESC and of the escape sequences in conjunction with code extension techniques is the subject of an ISO Standard.

ETB — *End of transmission block* — A transmission control character used to indicate the end of a transmission block of data where data are divided into such blocks for transmission purposes.

ETX — *End of text* — A transmission control character which terminates a text.

FF — *Form feed* — A format effector which advances the active position to the same character position on a predetermined line of the next form or page.

HT — *Horizontal tabulation* — A format effector which advances the active position to the next predetermined character position on the same line.

Information separators

IS_1 (US) — A control character used to separate and qualify data logically; its specific meaning has to be defined for each application. If this character is used in hierarchical order as specified in the general definition of IS, it delimits a data item called a UNIT.

IS_2 (RS) — A control character used to separate and qualify data logically; its specific meaning has to be defined for each application. If this character is used in hierarchical order as specified in the general definition of IS, it delimits a data item called a RECORD.

IS_3 (GS) — A control character used to separate and qualify data logically; its specific meaning has to be defined for each application. If this character is used in hierarchical order as specified in the general definition of IS, it delimits a data item called a GROUP.

IS_4 (FS) — A control character used to separate and qualify data logically; its specific meaning has to be defined for each application. If this character is used in hierarchical order as specified in the general definition of IS, it delimits a data item called a FILE.

LF — *Line feed* — A format effector which advances the active position to the same character position of the next line.

NAK — *Negative acknowledge* — A transmission control character transmitted by a receiver as a negative response to the sender.

NUL — *Null* — A control character used to accomplish media-fill or time-fill. NUL characters may be inserted into or removed from a stream of data without affecting the information content of that stream, but then the addition or removal of these characters may affect the information layout and/or the control of equipment.

SI	—	*Shift-in* — A control character which is used in conjunction with SHIFT-OUT and ESCAPE to extend the graphic character set of the code. It may reinstate the standard meanings of the bit combinations which follow it. The effect of this character when using code extension techniques is described in an ISO Standard.
SO	—	*Shift-out* — A control character which is used in conjunction with SHIFT-IN and ESCAPE to extend the graphic character set of the code. It may alter the meaning of the bit combinations of columns 2 to 7 which follow it until a SHIFT-IN character is reached. However, the characters SPACE (2/0) and DELETE (7/15) are unaffected by SHIFT-OUT. The effect of this character when using code extension techniques is described in an ISO Standard.
SOH	—	*Start of heading* — A transmission control character used as the first character of a heading of an information message.
SP	—	*Space* — A character which advances the active position one character position on the same line. This character is also regarded as a non-printing graphic.
STX	—	*Start of text* — A transmission control character which precedes a text and which is used to terminate a heading.
SUB	—	*Substitute character* — A control character used in the place of a character that has been found to be invalid or in error. SUB is intended to be introduced by automatic means.
SYN	—	*Synchronous idle* — A transmission control character used by a synchronous transmission system in the absence of any other character (idle condition) to provide a signal from which synchronism may be achieved or retained between data terminal equipment.
VT	—	*Vertical tabulation* — A format effector which advances the active position to the same character position on the next predetermined line.

——————— INTENTIONALLY LEFT BLANK———————

Table 8-3. Conversion from the International Telegraph Alphabet No. 2 (ITA-2) to the International Alphabet No. 5 (IA-5)

ITA-2 letter case of signal No.		*IA-5 column/row*		*ITA-2 figure case of signal No.*		*IA-5 column/row*	
1	A	4/1	A	1	–	2/13	–
2	B	4/2	B	2	?	3/15	?
3	C	4/3	C	3	:	3/10	:
4	D	4/4	D	4		3/15	?
5	E	4/5	E	5	3	3/3	3
6	F	4/6	F	6		3/15	?
7	G	4/7	G	7		3/15	?
8	H	4/8	H	8		3/15	?
9	I	4/9	I	9	8	3/8	8
10	J	4/10	J	10	Attention Signal *(Note 3)*	0/7	Bel
11	K	4/11	K	11	(	2/8	(
12	L	4/12	L	12	)	2/9	)
13	M	4/13	M	13	.	2/14	.
14	N	4/14	N	14	,	2/12	,
15	O	4/15	O	15	9	3/9	9
16	P	5/0	P	16	0	3/0	0
17	Q	5/1	Q	17	1	3/1	1
18	R	5/2	R	18	4	3/4	4
19	S	5/3	S	19	’	2/7	’
20	T	5/4	T	20	5	3/5	5
21	U	5/5	U	21	7	3/7	7
22	V	5/6	V	22	=	3/13	=
23	W	5/7	W	23	2	3/2	2
24	X	5/8	X	24	/	2/15	/
25	Y	5/9	Y	25	6	3/6	6
26	Z	5/10	Z	26	+	2/11	+
27	CR	0/13	CR	27	CR	0/13	CR
28	LF	0/10	LF	28	LF	0/10	LF
29	LTRS	*		29	LTRS	*	
30	FIGS	*		30	FIGS	*	
31	SP	2/0	SP	31	SP	2/0	SP
32		*		32		*	

** No conversion shall be made for these positions and the signal/character shall be removed from the data.*

Note 1.— The end-of-message signal NNNN (in letter and figure case) shall convert to ETX (0/3).

Note 2.— The start-of-message signal ZCZC (in letter and figure case) shall convert to SOH (0/1).

Note 3.— Figures case of Signal No. 10 shall only be converted upon detection of the AFTN priority alarm which shall convert to five occurrences of BEL (0/7).

Note 4.— When converting from ITA-2, a STX (0/2) character shall be inserted once at the beginning of the next line following detection of CR LF or LF CR at the end of the Origin Line.

Note 5.— The sequence of seven signal 28 (LF) shall convert to one VT (0/11) character.

Table 8-4. Conversion from the International Alphabet No. 5 (IA-5) to the International Telegraph Alphabet No. 2 (ITA-2)

Col. / Row	0	1	2	3	4	5	6	7
0	*	*	31FL	16F	2F	16L	2F	16L
1	Note 5	*	2F	17F	1L	17L	1L	17L
2	*	*	2F	23F	2L	18L	2L	18L
3	Note 1	*	2F	5F	3L	19L	3L	19L
4	*	*	2F	18F	4L	20L	4L	20L
5	*	*	2F	20F	5L	21L	5L	21L
6	*	*	2F	25F	6L	22L	6L	22L
7	Note 2	*	19F	21F	7L	23L	7L	23L
8	*	*	11F	9F	8L	24L	8L	24L
9	*	*	12F	15F	9L	25L	9L	25L
10	28 FL	*	2F	3F	10L	26L	10L	26L
11	Note 3	*	26F	2F	11L	2F	11L	2F
12	*	*	14F	2F	12L	2F	12L	2F
13	27FL	*	1F	22F	13L	2F	13L	2F
14	*	*	13F	2F	14L	2F	14L	2F
15	*	*	24F	2F	15L	2F	15L	*

** No conversion shall be made for these positions and the signal/character shall be removed from the data.*

Example: To find the ITA-2 signal to which the character 3/6 of IA-5 is to be converted, look at column 3, row 6. 25F means figure case of signal No. 25 (L = letter case, FL = either case designation).

Note 1.— The character 0/3 (ETX) shall convert to the ITA-2 sequence signals 14L, 14L, 14L, 14L (NNNN).

Note 2. — The signal 0/7 (BEL) shall only be converted when a sequence of 5 occurrences is detected, which shall convert to the ITA-2 sequence signals 30, 10F, 10F, 10F, 10F, 10F, 29.

Note 3. — The character sequence CR CR LF VT (0/11) ETX (0/3) shall convert to the ITA-2 sequence signals 29, 27, 27, 28, 28, 28, 28, 28, 28, 28, 28, 14L, 14L, 14L, 14L.

Note 4. — To prevent redundant generation of figure and letter characters in ITA-2 when converting from IA-5, no case designation shall be assigned to ITA-2 non-printing functions (signals No. 27, 28, 29, 30, 31).

Note 5. — The character 0/1 (SOH) shall convert to the ITA-2 sequence signals 26L, 3L, 26L, 3L (ZCZC)

Table 8-5. Control field formats

Control field format for	Control field bits							
	1	2	3	4	5	6	7	8
Information transfer (I frame)	0		*N(S)*		*P*		*N(R)*	
Supervisory commands/responses (S frame)	1	0	*S*	*S*	*P/F*		*N(R)*	
Unnumbered commands/responses	1	1	*M*	*M*	*P/F*	*M*	*M*	*M*

where:

N(*S*) = send sequence count (bit 2 = low order bit)
N(*R*) = receive sequence count (bit 6 = low order bit)
S = supervisory function bits
M = modifier function bits
P = poll bit (in commands)
F = final bit (in responses)

Table 8-6. Commands and responses

Type	*Commands*		*Responses*		*C field encoding* 1	2	3	4	5	6	7	8
Information transfer	I	(information)			0		*N(S)*		*P*		*N(R)*	
Supervisory	RR	(receive ready)	RR	(receive ready)	1	0	0	0	*P/F*		*N(R)*	
	RNR	(receive not ready)	RNR	(receive not ready)	1	0	1	0	*P/F*		*N(R)*	
	REJ	(reject)	REJ	(reject)	1	0	0	1	*P/F*		*N(R)*	
Unnumbered			DM	(disconnected mode)	1	1	1	1	*P/F*	0	0	0
	SABM	(set asynchronous balanced mode)			1	1	1	1	*P*	1	0	0
	DISC	(disconnect)			1	1	0	0	*P*	0	1	0
			UA	(unnumbered acknowledgement)	1	1	0	0	*F*	1	1	0
			FRMR	(frame reject)	1	1	1	0	*F*	0	0	1

FIGURES FOR CHAPTER 8

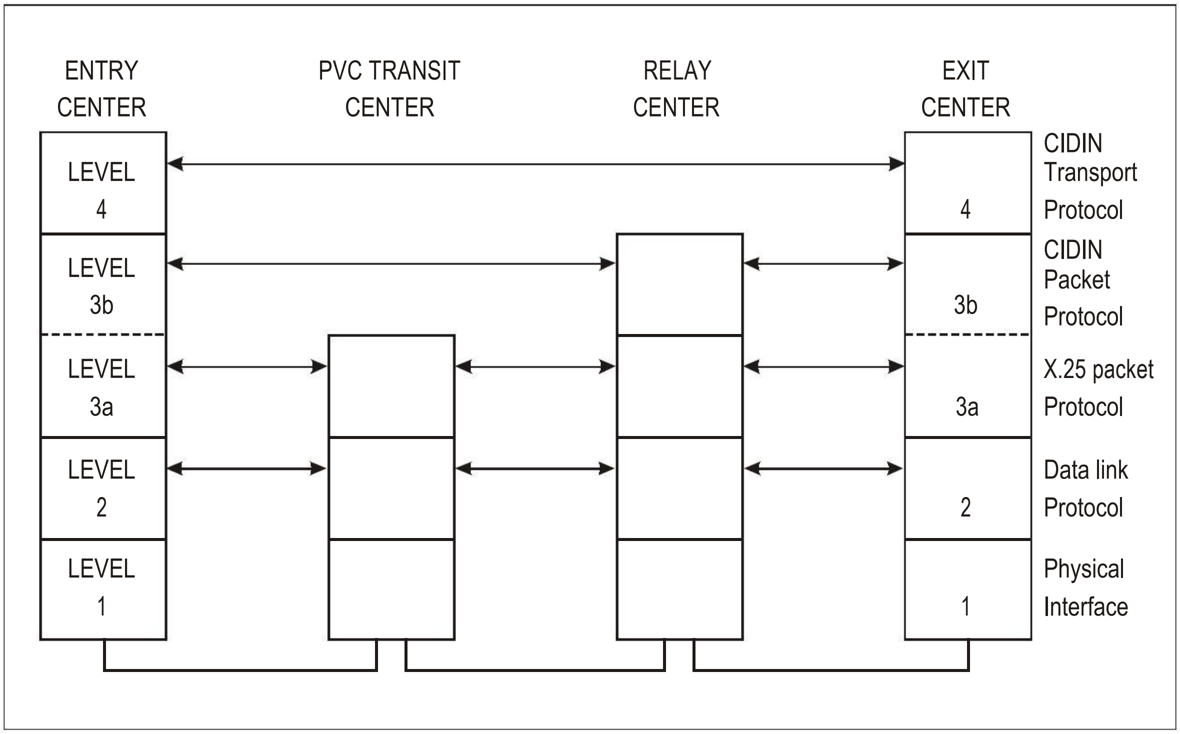


Figure 8-1. CIDIN protocol levels

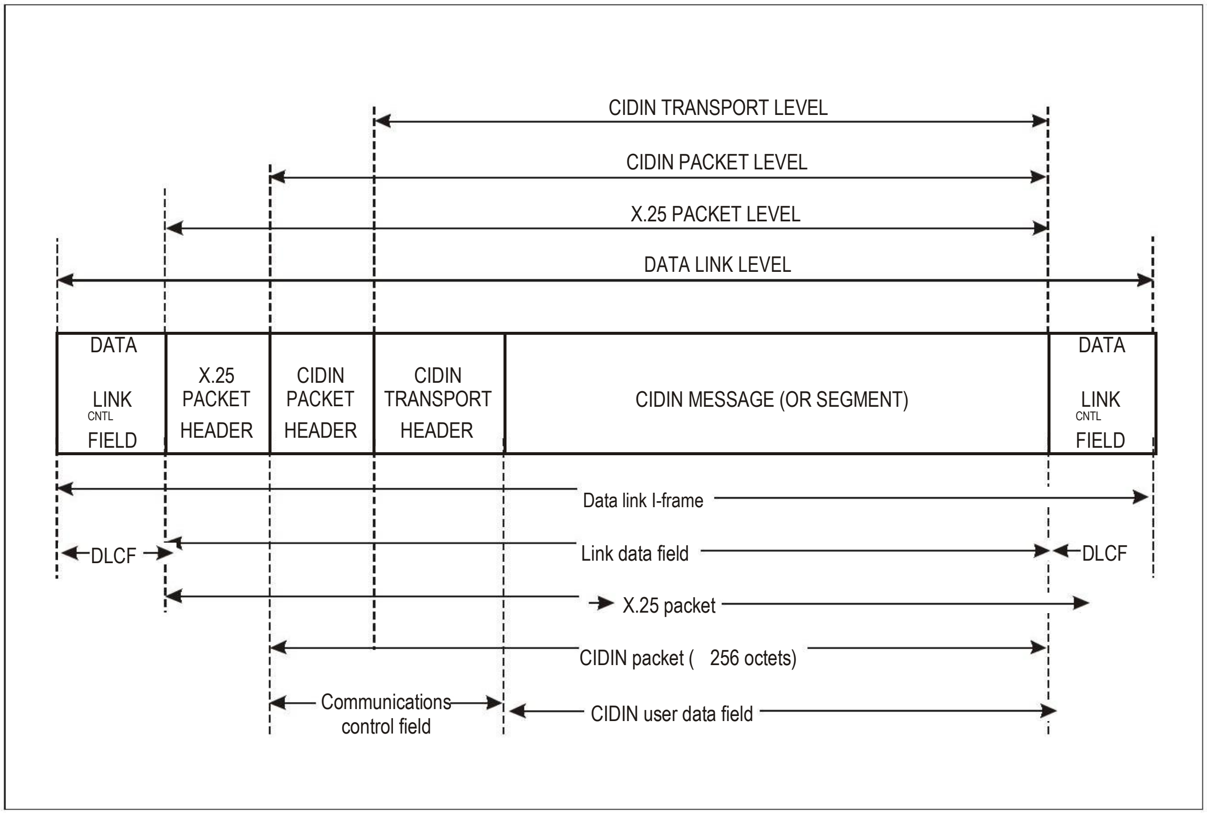


Figure 8-2. CIDIN terminology

CHAPTER 9. AIRCRAFT ADDRESSING SYSTEM

9.1 The aircraft address shall be one of 16 777 214 twenty-four-bit aircraft addresses allocated by ICAO to the State of Registry or common mark registering authority and assigned as prescribed in the Appendix to this chapter.

9.1.1 Non-aircraft transponders that are installed on aerodrome surface vehicles, obstacles or fixed Mode S target detection devices for surveillance and/or radar monitoring purposes shall be assigned 24-bit aircraft addresses.

Note.— Under such specific conditions, the term "aircraft" can be understood as "aircraft (or pseudo-aircraft) or vehicle (A/V)" where a limited set of data is generally sufficient for operational purposes.

9.1.1.1 Mode S transponders used under specific conditions stated in 9.1.1 should not have any negative impact on the performance of existing ATS surveillance systems and ACAS.

APPENDIX TO CHAPTER 9. A WORLDWIDE SCHEME FOR THE ALLOCATION, ASSIGNMENT AND APPLICATION OF AIRCRAFT ADDRESSES

1. General

1.1 Global communications, navigation and surveillance systems shall use an individual aircraft address composed of 24 bits. At any one time, no address shall be assigned to more than one aircraft. The assignment of aircraft addresses requires a comprehensive scheme providing for a balanced and expandable distribution of aircraft addresses applicable worldwide.

2. Description of the Scheme

2.1 Table 9-1 provides for blocks of consecutive addresses available to States for assignment to aircraft. Each block is defined by a fixed pattern of the first 4, 6, 9, 12 or 14 bits of the 24-bit address. Thus, blocks of different sizes (1 048 576, 262 144, 32 768, 4 096 and 1 024 consecutive addresses, respectively) are made available.

3. Management of the Scheme

3.1 The International Civil Aviation Organization (ICAO) shall administer the scheme so that appropriate international distribution of aircraft addresses can be maintained.

4. Allocation of The Aircraft addresses

4.1 Blocks of aircraft addresses shall be allocated by ICAO to the State of Registry or common mark registering authority. Address allocations to States shall be as shown in Table 9-1.

4.2 A State of Registry or common mark registering authority shall notify ICAO when allocation to that State of an additional block of addresses is required for assignment to aircraft.

4.3 In the future management of the scheme, advantage shall be taken of the blocks of aircraft addresses not yet allocated. These spare blocks shall be distributed on the basis of the relevant ICAO region:

Addresses starting with bit combination 00100: AFI region

Addresses starting with bit combination 00101: SAM region

Addresses starting with bit combination 0101: EUR and NAT regions

Addresses starting with bit combination 01100: MID region

Addresses starting with bit combination 01101: ASIA region

Addresses starting with bit combination 1001: NAM and PAC regions

Addresses starting with bit combination 111011: CAR region
In addition, aircraft addresses starting with bit combinations 1011, 1101 and 1111 have been reserved for future use.

4.4 Any future requirement for additional aircraft addresses shall be accommodated through coordination between ICAO and the States of Registry or common mark registering authority concerned. A request for additional aircraft addresses shall only be made by a registering authority when at least 75 per cent of the number of addresses already allocated to that registering authority have been assigned to aircraft.

4.5 ICAO shall allocate blocks of aircraft addresses to non-Contracting States upon request.

5. Assignment of Aircraft address

5.1 Using its allocated block of addresses, the State of Registry or common mark registering authority shall assign an individual aircraft address to each suitably equipped aircraft entered on a national or international register (Table 9-1).

Note.— For an aircraft delivery, the aircraft operator is expected to inform the airframe manufacturer of an address assignment. The airframe manufacturer or other organization responsible for a delivery flight is expected to ensure installation of a correctly assigned address supplied by the State of Registry or common mark registering authority. Exceptionally, a temporary address may be supplied under the arrangements detailed in paragraph 7.

5.2 Aircraft addresses shall be assigned to aircraft in accordance with the following principles:

a) at any one time, no address shall be assigned to more than one aircraft with the exception of aerodrome surface vehicles on surface movement areas. If such exceptions are applied by the State of Registry, the vehicles which have been allocated the same address shall not operate on aerodromes separated by less than 1 000 km;

b) only one address shall be assigned to an aircraft, irrespective of the composition of equipment on board. In the case when a removable transponder is shared by several light aviation aircraft such as balloons or gliders, it shall be possible to assign a unique address to the removable transponder. The registers 08_{16}, 20_{16}, 21_{16}, 22_{16} and 25_{16} of the removable transponder shall be correctly updated each time the removable transponder is installed in any aircraft;

c) the address shall not be changed except under exceptional circumstances and shall not be changed during flight;

d) when an aircraft changes its State of Registry, the new registering State shall assign the aircraft a new address from its own allocation address block, and the old aircraft address shall be returned to the allocation address block of the State that previously registered the aircraft;

e) the address shall serve only a technical role for addressing and identification of aircraft and shall not be used to convey any specific information; and

f) the addresses composed of 24 ZEROS or 24 ONES shall not be assigned to aircraft.

5.2.1 Any method used to assign aircraft addresses should ensure efficient use of the entire address block that is allocated to that State.

6. Application of Aircraft addresses

6.1 The aircraft addresses shall be used in applications which require the routing of information to or from individual suitably equipped aircraft.

Note 1.— Examples of such applications are the aeronautical telecommunication network (ATN), SSR Mode S and airborne collision avoidance system (ACAS).

Note 2.— This Standard does not preclude assigning the aircraft addresses for special applications associated with the general applications defined therein. Examples of such special applications are the utilization of the 24-bit address in a pseudo-aeronautical earth station to monitor the aeronautical mobile-satellite service ground earth station and in the fixed Mode S transponders (reporting the on-the-ground status as specified in BCAR 10, Volume IV, 3.1.2.6.10.1.2) to monitor the Mode S ground station operation. Address assignments for special applications are to be carried out in conformance with the procedure established by the State to manage the 24-bit address assignments to aircraft.

6.2 An address consisting of 24 ZEROs shall not be used for any application.

7.Adminitration of the Temporary Aircraft Address Assignment

7.1 Temporary addresses shall be assigned to aircraft in exceptional circumstances, such as when operators have been unable to obtain an address from their individual States of Registry or Common Mark Registering Authority in a timely manner. ICAO shall assign temporary addresses from the block "ICAO[1]" shown in Table 9-1.

7.2 When requesting a temporary address, the aircraft operator shall supply to ICAO: aircraft identification, type and make of aircraft, name and address of the operator, and an explanation of the reason for the request.

7.2.1 Upon issuance of the temporary address to the aircraft operators, ICAO shall inform the State of Registry of the issuance of the temporary address, reason and duration.

7.3 The aircraft operator shall:

a) inform the State of Registry of the temporary assignment and reiterate the request for a permanent address; and

b) inform the airframe manufacturer.

7.4 When the permanent aircraft address is obtained from the State of Registry, the operator shall:

a) inform ICAO without delay;

b) relinquish his/her temporary address; and

c) arrange for encoding of the valid unique address within 180 calendar days.

7.5 If a permanent address is not obtained within one year, the aircraft operator shall reapply for a new temporary aircraft address. Under no circumstances shall a temporary aircraft address be used by the aircraft operator for over one year.

——————— INTENTIONALLY LEFT BLANK———————

Table 9-1. Allocation of aircraft addresses to States

Note.— The left-hand column of the 24-bit address patterns represents the most significant bit (MSB) of the address.

State	*Number of addresses in block*					*Allocation of blocks of addresses (a dash represents a bit value equal to 0 or 1)*
	1 024	*4 096*	*32 768*	*262 144*	*1 048 576*	
Afghanistan		*				0 1 1 1 0 0 0 0 0 0 0 0 - - - - - - - - - - - -
Albania	*					0 1 0 1 0 0 0 0 0 0 0 1 0 0 - - - - - - - - - -
Algeria			*			0 0 0 0 1 0 1 0 0 - - - - - - - - - - - - - - -
Angola		*				0 0 0 0 1 0 0 1 0 0 0 0 - - - - - - - - - - - -
Antigua and Barbuda	*					0 0 0 0 1 1 0 0 1 0 1 0 0 0 - - - - - - - - - -
Argentina				*		1 1 1 0 0 0 - - - - - - - - - - - - - - - - - -
Armenia	*					0 1 1 0 0 0 0 0 0 0 0 0 0 0 - - - - - - - - - -
Australia				*		0 1 1 1 1 1 - - - - - - - - - - - - - - - - - -
Austria			*			0 1 0 0 0 1 0 0 0 - - - - - - - - - - - - - - -
Azerbaijan	*					0 1 1 0 0 0 0 0 0 0 0 0 1 0 - - - - - - - - - -
Bahamas		*				0 0 0 0 1 0 1 0 1 0 0 0 - - - - - - - - - - - -
Bahrain		*				1 0 0 0 1 0 0 1 0 1 0 0 - - - - - - - - - - - -
Bangladesh		*				0 1 1 1 0 0 0 0 0 0 1 0 - - - - - - - - - - - -
Barbados	*					0 0 0 0 1 0 1 0 1 0 1 0 0 0 - - - - - - - - - -
Belarus	*					0 1 0 1 0 0 0 1 0 0 0 0 0 0 - - - - - - - - - -
Belgium			*			0 1 0 0 0 1 0 0 1 - - - - - - - - - - - - - - -
Belize	*					0 0 0 0 1 0 1 0 1 0 1 1 0 0 - - - - - - - - - -
Benin	*					0 0 0 0 1 0 0 1 0 1 0 0 0 0 - - - - - - - - - -
Bhutan	*					0 1 1 0 1 0 0 0 0 0 0 0 0 0 - - - - - - - - - -
Bolivia		*				1 1 1 0 1 0 0 1 0 1 0 0 - - - - - - - - - - - -
Bosnia and Herzegovina	*					0 1 0 1 0 0 0 1 0 0 1 1 0 0 - - - - - - - - - -
Botswana	*					0 0 0 0 0 0 1 1 0 0 0 0 0 0 - - - - - - - - - -
Brazil				*		1 1 1 0 0 1 - - - - - - - - - - - - - - - - - -
Brunei Darussalam	*					1 0 0 0 1 0 0 1 0 1 0 1 0 0 - - - - - - - - - -
Bulgaria			*			0 1 0 0 0 1 0 1 0 - - - - - - - - - - - - - - -
Burkina Faso		*				0 0 0 0 1 0 0 1 1 1 0 0 - - - - - - - - - - - -
Burundi		*				0 0 0 0 0 0 1 1 0 0 1 0 - - - - - - - - - - - -
Cambodia		*				0 1 1 1 0 0 0 0 1 1 1 0 - - - - - - - - - - - -
Cameroon		*				0 0 0 0 0 0 1 1 0 1 0 0 - - - - - - - - - - - -
Canada				*		1 1 0 0 0 0 - - - - - - - - - - - - - - - - - -
Cape Verde	*					0 0 0 0 1 0 0 1 0 1 1 0 0 0 - - - - - - - - - -
Central African Republic		*				0 0 0 0 0 1 1 0 1 1 0 0 - - - - - - - - - - - -
Chad		*				0 0 0 0 1 0 0 0 0 1 0 0 - - - - - - - - - - - -
Chile		*				1 1 1 0 1 0 0 0 0 0 0 0 - - - - - - - - - - - -
China				*		0 1 1 1 1 0 - - - - - - - - - - - - - - - - - -
Colombia		*				0 0 0 0 1 0 1 0 1 1 0 0 - - - - - - - - - - - -
Comoros	*					0 0 0 0 0 0 1 1 0 1 0 1 0 0 - - - - - - - - - -
Congo		*				0 0 0 0 0 0 1 1 0 1 1 0 - - - - - - - - - - - -
Cook Islands	*					1 0 0 1 0 0 0 0 0 0 0 1 0 0 - - - - - - - - - -
Costa Rica		*				0 0 0 0 1 0 1 0 1 1 1 0 - - - - - - - - - - - -
Côte d'Ivoire		*				0 0 0 0 0 0 1 1 1 0 0 0 - - - - - - - - - - - -
Croatia	*					0 1 0 1 0 0 0 0 0 0 0 1 1 1 - - - - - - - - - -
Cuba		*				0 0 0 0 1 0 1 1 0 0 0 0 - - - - - - - - - - - -
Cyprus	*					0 1 0 0 1 1 0 0 1 0 0 0 0 0 - - - - - - - - - -
Czech Republic			*			0 1 0 0 1 0 0 1 1 - - - - - - - - - - - - - - -

State	Number of addresses in block 1 024	4 096	32 768	262 144	1 048 576	Allocation of blocks of addresses (a dash represents a bit value equal to 0 or 1)
Democratic People's Republic of Korea			*			0111 00 100 --- -- ----------
Democratic Republic of the Congo		*				0000 10 001 100 -- ----------
Denmark			*			0100 01 011 --- -- ----------
Djibouti	*					0000 10 011 000 00 ----------
Dominican Republic		*				0000 11 000 100 -- ----------
Ecuador		*				1110 10 000 100 -- ----------
Egypt			*			0000 00 010 --- -- ----------
El Salvador		*				0000 10 110 010 -- ----------
Equatorial Guinea		*				0000 01 000 010 -- ----------
Eritrea	*					0010 00 000 010 00 ----------
Estonia	*					0101 00 010 001 00 ----------
Ethiopia		*				0000 01 000 000 -- ----------
Fiji		*				1100 10 001 000 -- ----------
Finland			*			0100 01 100 --- -- ----------
France				*		0011 10 --- --- -- ----------
Gabon		*				0000 00 111 110 -- ----------
Gambia		*				0000 10 011 010 -- ----------
Georgia	*					0101 00 010 100 00 ----------
Germany				*		0011 11 --- --- -- ----------
Ghana		*				0000 01 000 100 -- ----------
Greece			*			0100 01 101 --- -- ----------
Grenada	*					0000 11 001 100 00 ----------
Guatemala		*				0000 10 110 100 -- ----------
Guinea		*				0000 01 000 110 -- ----------
Guinea-Bissau	*					0000 01 001 000 00 ----------
Guyana		*				0000 10 110 110 -- ----------
Haiti		*				0000 10 111 000 -- ----------
Honduras		*				0000 10 111 010 -- ----------
Hungary			*			0100 01 110 --- -- ----------
Iceland		*				0100 11 001 100 -- ----------
India				*		1000 00 --- --- -- ----------
Indonesia			*			1000 10 100 --- -- ----------
Iran, Islamic Republic of			*			0111 00 110 --- -- ----------
Iraq			*			0111 00 101 --- -- ----------
Ireland		*				0100 11 001 010 -- ----------
Israel			*			0111 00 111 --- -- ----------
Italy				*		0011 00 --- --- -- ----------
Jamaica		*				0000 10 111 110 -- ----------
Japan				*		1000 01 --- --- -- ----------
Jordan			*			0111 01 000 --- -- ----------
Kazakhstan	*					0110 10 000 011 00 ----------
Kenya		*				0000 01 001 100 -- ----------
Kiribati	*					1100 10 001 110 00 ----------
Kuwait		*				0111 00 000 110 -- ----------
Kyrgyzstan	*					0110 00 000 001 00 ----------
Lao People's Democratic Republic		*				0111 00 001 000 -- ----------
Latvia	*					0101 00 000 010 11 ----------

State	*Number of addresses in block*					*Allocation of blocks of addresses (a dash represents a bit value equal to 0 or 1)*					
	1 024	*4 096*	*32 768*	*262 144*	*1 048 576*						
Lebanon			*			0 1 1 1	0 1	0 0 1	– – –	– –	– – – – – – – – – –
Lesotho	*					0 0 0 0	0 1	0 0 1	0 1 0	0 0	– – – – – – – – – –
Liberia		*				0 0 0 0	0 1	0 1 0	0 0 0	– –	– – – – – – – – – –
Libyan Arab Jamahiriya			*			0 0 0 0	0 0	0 1 1	– – –	– –	– – – – – – – – – –
Lithuania	*					0 1 0 1	0 0	0 0 0	0 1 1	1 1	– – – – – – – – – –
Luxembourg	*					0 1 0 0	1 1	0 1 0	0 0 0	0 0	– – – – – – – – – –
Madagascar		*				0 0 0 0	0 1	0 1 0	1 0 0	– –	– – – – – – – – – –
Malawi		*				0 0 0 0	0 1	0 1 1	0 0 0	– –	– – – – – – – – – –
Malaysia			*			0 1 1 1	0 1	0 1 0	– – –	– –	– – – – – – – – – –
Maldives	*					0 0 0 0	0 1	0 1 1	0 1 0	0 0	– – – – – – – – – –
Mali		*				0 0 0 0	0 1	0 1 1	1 0 0	– –	– – – – – – – – – –
Malta	*					0 1 0 0	1 1	0 1 0	0 1 0	0 0	– – – – – – – – – –
Marshall Islands	*					1 0 0 1	0 0	0 0 0	0 0 0	0 0	– – – – – – – – – –
Mauritania	*					0 0 0 0	0 1	0 1 1	1 1 0	0 0	– – – – – – – – – –
Mauritius	*					0 0 0 0	0 1	1 0 0	0 0 0	0 0	– – – – – – – – – –
Mexico			*			0 0 0 0	1 1	0 1 0	– – –	– –	– – – – – – – – – –
Micronesia, Federated States of	*					0 1 1 0	1 0	0 0 0	0 0 1	0 0	– – – – – – – – – –
Monaco	*					0 1 0 0	1 1	0 1 0	1 0 0	0 0	– – – – – – – – – –
Mongolia	*					0 1 1 0	1 0	0 0 0	0 1 0	0 0	– – – – – – – – – –
Montenegro	*					0 1 0 1	0 0	0 1 0	1 1 0	0 0	– – – – – – – – – –
Morocco			*			0 0 0 0	0 0	1 0 0	– – –	– –	– – – – – – – – – –
Mozambique		*				0 0 0 0	0 0	0 0 0	1 1 0	– –	– – – – – – – – – –
Myanmar		*				0 1 1 1	0 0	0 0 0	1 0 0	– –	– – – – – – – – – –
Namibia	*					0 0 1 0	0 0	0 0 0	0 0 1	0 0	– – – – – – – – – –
Nauru	*					1 1 0 0	1 0	0 0 1	0 1 0	0 0	– – – – – – – – – –
Nepal		*				0 1 1 1	0 0	0 0 1	0 1 0	– –	– – – – – – – – – –
Netherlands, Kingdom of the			*			0 1 0 0	1 0	0 0 0	– – –	– –	– – – – – – – – – –
New Zealand			*			1 1 0 0	1 0	0 0 0	– – –	– –	– – – – – – – – – –
Nicaragua		*				0 0 0 0	1 1	0 0 0	0 0 0	– –	– – – – – – – – – –
Niger		*				0 0 0 0	0 1	1 0 0	0 1 0	– –	– – – – – – – – – –
Nigeria		*				0 0 0 0	0 1	1 0 0	1 0 0	– –	– – – – – – – – – –
Norway			*			0 1 0 0	0 1	1 1 1	– – –	– –	– – – – – – – – – –
Oman	*					0 1 1 1	0 0	0 0 1	1 0 0	0 0	– – – – – – – – – –
Pakistan			*			0 1 1 1	0 1	1 0 0	– – –	– –	– – – – – – – – – –
Palau	*					0 1 1 0	1 0	0 0 0	1 0 0	0 0	– – – – – – – – – –
Panama		*				0 0 0 0	1 1	0 0 0	0 1 0	– –	– – – – – – – – – –
Papua New Guinea		*				1 0 0 0	1 0	0 1 1	0 0 0	– –	– – – – – – – – – –
Paraguay		*				1 1 1 0	1 0	0 0 1	0 0 0	– –	– – – – – – – – – –
Peru		*				1 1 1 0	1 0	0 0 1	1 0 0	– –	– – – – – – – – – –
Philippines			*			0 1 1 1	0 1	0 1 1	– – –	– –	– – – – – – – – – –
Poland			*			0 1 0 0	1 0	0 0 1	– – –	– –	– – – – – – – – – –
Portugal			*			0 1 0 0	1 0	0 1 0	– – –	– –	– – – – – – – – – –
Qatar	*					0 0 0 0	0 1	1 0 1	0 1 0	0 0	– – – – – – – – – –
Republic of Korea			*			0 1 1 1	0 0	0 1 1	– – –	– –	– – – – – – – – – –
Republic of Moldova	*					0 1 0 1	0 0	0 0 0	1 0 0	1 1	– – – – – – – – – –
Romania			*			0 1 0 0	1 0	1 0 0	– – –	– –	– – – – – – – – – –
Russian Federation					*	0 0 0 1	– –	– – –	– – –	– –	– – – – – – – – – –
Rwanda		*				0 0 0 0	0 1	1 0 1	1 1 0	– –	– – – – – – – – – –

State	*Number of addresses in block*					*Allocation of blocks of addresses (a dash represents a bit value equal to 0 or 1)*
	1 024	*4 096*	*32 768*	*262 144*	*1 048 576*	
Saint Lucia	*					1100 10 001 100 00 ----------
Saint Vincent and the Grenadines	*					0000 10 111 100 00 ----------
Samoa	*					1001 00 000 010 00 ----------
San Marino	*					0101 00 000 000 00 ----------
Sao Tome and Principe	*					0000 10 011 110 00 ----------
Saudi Arabia			*			0111 00 010 --- -- ----------
Senegal		*				0000 01 110 000 -- ----------
Serbia			*			0100 11 000 --- -- ----------
Seychelles	*					0000 01 110 100 00 ----------
Sierra Leone	*					0000 01 110 110 00 ----------
Singapore			*			0111 01 101 --- -- ----------
Slovakia	*					0101 00 000 101 11 ----------
Slovenia	*					0101 00 000 110 11 ----------
Solomon Islands	*					1000 10 010 111 00 ----------
Somalia		*				0000 01 111 000 -- ----------
South Africa			*			0000 00 001 --- -- ----------
Spain				*		0011 01 --- --- -- ----------
Sri Lanka			*			0111 01 110 --- -- ----------
Sudan		*				0000 01 111 100 -- ----------
Suriname		*				0000 11 001 000 -- ----------
Swaziland	*					0000 01 111 010 00 ----------
Sweden			*			0100 10 101 --- -- ----------
Switzerland			*			0100 10 110 --- -- ----------
Syrian Arab Republic			*			0111 01 111 --- -- ----------
Tajikistan	*					0101 00 010 101 00 ----------
Thailand			*			1000 10 000 --- -- ----------
The former Yugoslav Republic of Macedonia	*					0101 00 010 010 00 ----------
Togo		*				0000 10 001 000 -- ----------
Tonga	*					1100 10 001 101 00 ----------
Trinidad and Tobago		*				0000 11 000 110 -- ----------
Tunisia			*			0000 00 101 --- -- ----------
Turkey			*			0100 10 111 --- -- ----------
Turkmenistan	*					0110 00 000 001 10 ----------
Uganda		*				0000 01 101 000 -- ----------
Ukraine			*			0101 00 001 --- -- ----------
United Arab Emirates		*				1000 10 010 110 -- ----------
United Kingdom				*		0100 00 --- --- -- ----------
United Republic of Tanzania		*				0000 10 000 000 -- ----------
United States					*	1010 -- --- --- -- ----------
Uruguay		*				1110 10 010 000 -- ----------
Uzbekistan	*					0101 00 000 111 11 ----------
Vanuatu	*					1100 10 010 000 00 ----------
Venezuela			*			0000 11 011 --- -- ----------
Viet Nam			*			1000 10 001 --- -- ----------
Yemen		*				1000 10 010 000 -- ----------
Zambia		*				0000 10 001 010 -- ----------
Zimbabwe	*					0000 00 000 100 00 ----------

State	*Number of addresses in block* 1 024	4 096	32 768	262 144	1 048 576	*Allocation of blocks of addresses (a dash represents a bit value equal to 0 or 1)*
Other allocations						
ICAO[1]			*			1 1 1 1 0 0 0 0 0 – – – – – – – – – – – – – –
ICAO[2]	*					1 0 0 0 1 0 0 1 1 0 0 1 0 0 – – – – – – – – – –
ICAO[2]	*					1 1 1 1 0 0 0 0 1 0 0 1 0 0 – – – – – – – – – –

1. ICAO administers this block for assigning temporary aircraft addresses as described in section 7.

2. Block allocated for special use in the interest of flight safety.

CHAPTER 10. (RESERVED) POINT-TO-MULTIPOINT COMMUNICATIONS

———— INTENTIONALLY LEFT BLANK————

CHAPTER 11. (RESERVED)HF DATA LINK

——————— INTENTIONALLY LEFT BLANK———————

CHAPTER 12. (RESERVED)UNIVERSAL ACCESS TRANSCEIVER (UAT)

———— INTENTIONALLY LEFT BLANK————

PART II -VOICE COMMUNICATION SYSTEMS:
CHAPTER 1. DEFINITIONS

Note.— Material on secondary power supply and guidance material concerning reliability and availability for communication systems is contained in BCAR-10, Volume I, 2.9 and Volume I, Attachment F, respectively.

———— INTENTIONALLY LEFT BLANK————

CHAPTER 2. AERONAUTICAL MOBILE SERVICE

2.1 Air -Ground VHF Communication System Characteristics

Note.— In the following text the channel spacing for 8.33 kHz channel assignments is defined as 25 kHz divided by 3 which is 8.3333 ... kHz.

2.1.1 The characteristics of the air-ground VHF communication system used in the International Aeronautical Mobile Service shall be in conformity with the following specifications:

2.1.1.1 Radiotelephone emissions shall be double sideband (DSB) amplitude modulated (AM) carriers. The designation of emission is A3E, as specified in the ITU Radio Regulations.

2.1.1.2 Spurious emissions shall be kept at the lowest value which the state of technique and the nature of the service permit.

Note.— Appendix S3 to the ITU Radio Regulations specifies the levels of spurious emissions to which transmitters must conform.

2.1.1.3 The radio frequencies used shall be selected from the radio frequencies in the band 117.975 – 137 MHz. The separation between assignable frequencies (channel spacing) and frequency tolerances applicable to elements of the system shall be as specified in Volume V.

Note.— The band 117.975 – 132 MHz was allocated to the Aeronautical Mobile (R) Service in the ITU Radio Regulations (1947). By subsequent revisions at ITU World Administrative Radio Conferences the bands 132 – 136 MHz and 136 – 137 MHz were added under conditions which differ for ITU Regions, or for specified countries or combinations of countries (see RRs S5.203, S5.203A and S5.203B for additional allocations in the band 136 – 137 MHz, and S5.201 for the band 132 – 136 MHz).

2.1.1.4 The design polarization of emissions shall be vertical.

2.2 System Characteristics of the Ground Installation

2.2.1 Transmitting function

2.2.1.1 Frequency stability. The radio frequency of operation shall not vary more than plus or minus 0.005 per cent from the assigned frequency. Where 25 kHz channel spacing is introduced in accordance with Volume V, the radio frequency of operation shall not vary more than plus or minus 0.002 per cent from the assigned frequency. Where 8.33 kHz channel spacing is introduced in accordance with Volume V, the radio frequency of operation shall not vary more than plus or minus 0.0001 per cent from the assigned frequency.

Note.— The above frequency stability requirements will not be sufficient for offset carrier systems using 25 kHz channel spacing or higher.

2.2.1.1.1 Offset carrier systems in 8.33 kHz, 25 kHz, 50 kHz and 100 kHz channel spaced environments. The stability of individual carriers of an offset carrier system shall be such as to prevent first-order heterodyne frequencies of less than 4 kHz and, additionally, the maximum frequency excursion of the outer carrier frequencies from the assigned carrier frequency shall not exceed 8 kHz. Offset carrier systems for 8.33 kHz channel spacing shall be limited to two-carrier systems using a carrier offset of plus and minus 2.5 kHz.

Note.— Examples of the required stability of the individual carriers of offset carrier systems may be found at the Attachment to Part II.

2.2.1.2 Power

On a high percentage of occasions, the effective radiated power should be such as to provide a field strength of a least 75 microvolts per metre (minus 109 dBW/m^2) within the defined operational coverage of the facility, on the basis of free-space propagation.

2.2.1.3 Modulation. A peak modulation factor of at least 0.85 shall be achievable.

2.2.1.4 Means should be provided to maintain the average modulation factor at the highest practicable value without over modulation.

2.2.2 Receiving function

2.2.2.1 Frequency stability. Where 8.33 kHz channel spacing is introduced in accordance with Volume V, the radio frequency of operation shall not vary more than plus or minus 0.0001 per cent from the assigned frequency.

2.2.2.2 Sensitivity. After due allowance has been made for feeder loss and antenna polar diagram variation, the sensitivity of the receiving function shall be such as to provide on a high percentage of occasions an audio output signal with a wanted/unwanted ratio of 15 dB, with a 50 per cent amplitude modulated (A3E) radio signal having a field strength of 20 microvolts per metre (minus 120 dBW/m^2) or more.

2.2.2.3 Effective acceptance bandwidth. When tuned to a channel having a width of 25 kHz, 50 kHz or 100 kHz, the receiving system shall provide an adequate and intelligible audio output when the signal specified at 2.2.2.2 has a carrier frequency within plus or minus 0.005 per cent of the assigned frequency. When tuned to a channel having a width of 8.33 kHz, the receiving system shall provide an adequate and intelligible audio output when the signal specified at 2.2.2.2 has a carrier frequency within plus or minus 0.0005 per cent of the assigned frequency. Further information on the effective acceptance bandwidth is contained in the Attachment to Part II.

Note.— The effective acceptance bandwidth includes Doppler shift.

2.2.2.4 Adjacent channel rejection. The receiving system shall ensure an effective rejection of 60 dB or more at the next assignable channel.

Note.— The next assignable frequency will normally be plus or minus 50 kHz. Where this channel spacing will not suffice, the next assignable frequency will be plus or minus 25 kHz, or plus or minus 8.33 kHz, implemented in accordance with the provisions of Volume V. It is recognized that in certain areas of the world receivers designed for 25 kHz, 50 kHz or 100 kHz channel spacing may continue to be used.

2.3 System Characteristics of the Airborne Installation

2.3.1 Transmitting function

2.3.1.1 Frequency stability. The radio frequency of operation shall not vary more than plus or minus 0.005 per cent from the assigned frequency. Where 25 kHz channel spacing is introduced, the radio frequency of operation shall not vary more than plus or minus 0.003 per cent from the assigned frequency. Where 8.33 kHz channel spacing is introduced, the radio frequency of operation shall not vary more than plus or minus 0.0005 per cent from the assigned frequency.

2.3.1.2 Power. On a high percentage of occasions, the effective radiated power shall be such as to provide a field strength of at least 20 microvolts per meter (minus 120 dBW/m^2) on the basis of free space propagation, at ranges and altitudes appropriate to the operational conditions pertaining to the areas over which the aircraft is operated.

2.3.1.3 Adjacent channel power. The amount of power from a 8.33 kHz airborne transmitter under all operating conditions when measured over a 7 kHz channel bandwidth centered on the first 8.33 kHz adjacent channel shall not exceed -45 dB below the transmitter carrier power. The above adjacent channel power shall take into account the typical voice spectrum.

Note.— The voice spectrum is assumed to be a constant level between 300 and 800 Hz and attenuated by 10 dB per octave above 800 Hz.

2.3.1.4 Modulation. A peak modulation factor of at least 0.85 shall be achievable.

2.3.1.5 Means should be provided to maintain the average modulation factor at the highest practicable value without overmodulation.

2.3.2 Receiving function

2.3.2.1 Frequency stability. Where 8.33 kHz channel spacing is introduced in accordance with Volume V, the radio frequency of operation shall not vary more than plus or minus 0.0005 per cent from the assigned frequency.

2.3.2.2 Sensitivity

2.3.2.2.1 After due allowance has been made for aircraft feeder mismatch, attenuation loss and antenna polar diagram variation, the sensitivity of the receiving function should be such as to provide on a high percentage of occasions an audio output signal with a wanted/unwanted ratio of 15 dB, with a 50 per cent amplitude modulated (A3E) radio signal having a field strength of 75 microvolts per metre (minus 109 dBW/m^2).

Note.— For planning extended range VHF facilities, an airborne receiving function sensitivity of 30 microvolts per metre may be assumed.

2.3.2.3 *Effective acceptance bandwidth for 100 kHz, 50 kHz and 25 kHz channel spacing receiving installations.* When tuned to a channel designated in Volume V as having a width of 25 kHz, 50 kHz or 100 kHz, the receiving function shall ensure an effective acceptance bandwidth as follows:

a) in areas where offset carrier systems are employed, the receiving function shall provide an adequate audio output when the signal specified at 2.3.2.2 has a carrier frequency within 8 kHz of the assigned frequency;

b) in areas where offset carrier systems are not employed, the receiving function shall provide an adequate audio output when the signal specified at 2.3.2.2 has a carrier frequency of plus or minus 0.005 per cent of the assigned frequency.

2.3.2.4 Effective acceptance bandwidth for 8.33 kHz channel spacing receiving installations. When tuned to a channel designated in Volume V, as having a width of 8.33 kHz, the receiving function shall ensure an effective acceptance bandwidth as follows:

a) in areas where offset carrier systems are employed, the receiving function shall provide an adequate audio output when the signal specified in 2.3.2.2 has a carrier frequency of plus or minus 2.5 kHz of the assigned frequency; and

b) in areas where offset carrier systems are not employed, the receiving function shall provide an adequate audio output when the signal specified in 2.3.2.2 has a carrier frequency within plus or minus 0.0005 per cent of the assigned frequency. Further information on the effective acceptance bandwidth is contained in Part II, Attachment A.

Note 1.— The effective acceptance bandwidth includes Doppler shift.

Note 2.— When using offset carrier systems (ref. 2.3.2.3 and 2.3.2.4), receiver performance may become degraded when receiving two or more similar strength offset carrier signals. Caution is therefore advised with the implementation of offset carrier systems.

2.3.2.5 Adjacent channel rejection. The receiving function shall ensure an effective adjacent channel rejection as follows:

a) 8.33 kHz channels: 60 dB or more at plus or minus 8.33 kHz with respect to the assigned frequency, and 40 dB or more at plus or minus 6.5 kHz;

Note.— The receiver local oscillator phase noise should be sufficiently low to avoid any degradation of the receiver capability to reject off carrier signals. A phase noise level better than minus 99 dBc/Hz 8.33 kHz away from the carrier is necessary to comply with 45 dB adjacent channel rejection under all operating conditions.

b) 25 kHz channel spacing environment: 50 dB or more at plus or minus 25 kHz with respect to the assigned frequency and 40 dB or more at plus or minus 17 kHz;

c) 50 kHz channel spacing environment: 50 dB or more at plus or minus 50 kHz with respect to the assigned frequency and 40 dB or more at plus or minus 35 kHz;

d) 100 kHz channel spacing environment: 50 dB or more at plus or minus 100 kHz with respect to the assigned frequency.

2.3.2.6 Whenever practicable, the receiving system should ensure an effective adjacent channel rejection characteristic of 60 dB or more at plus or minus 25 kHz, 50 kHz and 100 kHz from the assigned frequency for receiving systems intended to operate in channel spacing environments of 25 kHz, 50 kHz and 100 kHz, respectively.

Note.— Frequency planning is normally based on an assumption of 60 dB effective adjacent channel rejection at plus or minus 25 kHz, 50 kHz or 100 kHz from the assigned frequency as appropriate to the channel spacing environment.

2.3.2.7 In the case of receivers complying with 2.3.2.3 or 2.3.2.4 used in areas where offset carrier systems are in force, the characteristics of the receiver should be such that:

a) the audio frequency response precludes harmful levels of audio heterodynes resulting from the reception of two or more offset carrier frequencies;

b) the receiver muting circuits, if provided, operate satisfactorily in the presence of audio heterodynes resulting from the reception of two or more offset carrier frequencies.

2.3.2.8 VDL — Interference Immunity Performance

2.3.2.8.1 For equipment intended to be used in independent operations of services applying DSB-AM and VDL technology on board the same aircraft, the receiving function shall provide an adequate and intelligible audio output with a desired signal field strength of not more than 150 microvolts per metre (minus 102 dBW/m^2) and with an undesired VDL signal field strength of at least 50 dB above the desired field strength on any assignable channel 100 kHz or more away from the assigned channel of the desired signal.

Note.— This level of VDL interference immunity performance provides a receiver performance consistent with the influence of the VDL RF spectrum mask as specified in Volume III, Part I, 6.3.4 with an effective transmitter/receiver isolation of 68 dB. Better transmitter and receiver performance could result in less isolation required.

2.3.2.8.2 After 1 January 2002, the receiving function of all new installations intended to be used in independent operations of services applying DSB-AM and VDL technology on board the same aircraft shall meet the provisions of 2.3.2.8.1.

2.3.2.8.3 After 1 January 2005, the receiving function of all installations intended to be used in independent operations of services applying DSB-AM and VDL technology on board the same aircraft shall meet the provisions of 2.3.2.8.1, subject to the conditions of 2.3.2.8.4.

2.3.2.8.4 Requirements for mandatory compliance of the provisions of 2.3.2.8.3 shall be made on the basis of regional air navigation agreements which specify the airspace of operation and the implementation timescales.

2.3.2.8.4.1 The agreement indicated in 2.3.2.8.4 shall provide at least two years' notice of mandatory compliance of airborne systems.

2.3.3 Interference immunity performance

2.3.3.1 After 1 January 1998, the VHF communications receiving system shall provide satisfactory performance in the presence of two signal, third-order intermodulation products caused by VHF FM broadcast signals having levels at the receiver input of minus 5 dBm.

2.3.3.2 After 1 January 1998, the VHF communications receiving system shall not be desensitized in the presence of VHF FM broadcast signals having levels at the receiver input of minus 5 dBm.

Note.— Guidance material on immunity criteria to be used for the performance quoted in 2.3.3.1 and 2.3.3.2 is contained in the Attachment to Part II, 1.3.

2.3.3.3 After 1 January 1995, all new installations of airborne VHF communications receiving systems shall meet the provisions of 2.3.3.1 and 2.3.3.2.

2.3.3.4 Airborne VHF communications receiving systems meeting the immunity performance Standards of 2.3.3.1 and 2.3.3.2 should be placed into operation at the earliest possible date.

2.4 Single Sideband (SSB) HF Communication System Characteristics for use in the Aeronautical mobile service

2.4.1 The characteristics of the air-ground HF SSB system, where used in the Aeronautical Mobile Service, shall be in conformity with the following specifications.

2.4.1.1 Frequency Range

2.4.1.1.1 HF SSB installations shall be capable of operation at any SSB carrier (reference) frequency available to the Aeronautical Mobile (R) Service in the band 2.8 MHz to 22 MHz and necessary to meet the approved assignment plan for the region(s) in which the system is intended to operate, and in compliance with the relevant provisions of the Radio Regulations.

Note 1.— See Introduction to Volume V, Chapter 3, and Figures 2-1 and 2-2[*].

Note 2.— The ITU World Administrative Radio Conference, Aeronautical Mobile (R) Service, Geneva, 1978, established a new Allotment Plan (Appendix 27, Aer to the Radio Regulations) based on single sideband replacing the earlier double sideband Allotment Plan. The World Radio communication Conference 1995 redesignated it as Appendix S.27. Minor editorial changes were made at the World Radio communication Conference 1997.

2.4.1.1.2 The equipment shall be capable of operating on integral multiples of 1 kHz.

2.4.1.2 Sideband Selection

2.4.1.2.1 The sideband transmitted shall be that on the higher frequency side of its carrier (reference) frequency.

2.4.1.3 Carrier (Reference) Frequency

2.4.1.3.1 Channel utilization shall be in conformity with the table of carrier (reference) frequencies at 27/16 and the Allotment Plan at 27/186 to 27/207 inclusive (or frequencies established on the basis of 27/21, as may be appropriate) of Appendix S27.

Note.— It is intended that only the carrier (reference) frequency be promulgated in Regional Plans and Aeronautical Publications

2.4.1.4 Classes of Emission and Carrier Suppression.

2.4.1.4.1 The system shall utilize the suppressed carrier class of emission J3E (also J7B and J9B as applicable). When SELCAL is employed as specified in Chapter 3 of Part II, the installation shall utilize class H2B emission.

2.4.1.4.2 By 1 February 1982 aeronautical stations and aircraft stations shall have introduced the appropriate class(es) of emission prescribed in 2.4.1.4.1. Effective this date the use of class A3E emission shall be discontinued except as provided in 2.4.1.4.4.

2.4.1.4.3 Until 1 February 1982 aeronautical stations and aircraft stations equipped for single sideband operations shall also be equipped to transmit class H3E emission where required to be compatible with reception by double sideband equipment. Effective this date the use of class H3E emission shall be discontinued except as provided in 2.4.1.4.4.

2.4.1.4.4 For stations directly involved in coordinated search and rescue operations using the frequencies 3 023 kHz and 5 680 kHz, the class of emission J3E should be used; however, since maritime mobile and land mobile services may be involved, A3E and H3E classes of emission may be used.

2.4.1.4.5 After 1 April 1981 no new DSB equipment shall be installed.

2.4.1.4.6 Aircraft station transmitters shall be capable of at least 26 dB carrier suppression with respect to peak envelope power (P_p) for classes of emission J3E, J7B or J9B.

2.4.1.4.7 Aeronautical station transmitters shall be capable of 40 dB carrier suppression with respect to peak envelope power (P_p) for classes of emission J3E, J7B or J9B.

2.4.1.5 Audio Frequency Bandwidth

2.4.1.5.1 For radiotelephone emissions the audio frequencies shall be limited to between 300 and 2 700 Hz and the occupied bandwidth of other authorized emissions shall not exceed the upper limit of J3E emissions. In specifying these limits, however, no restriction in their extension shall be implied in so far as emissions other than J3E are concerned, provided that the limits of unwanted emissions are met (see 2.4.1.7).

Note.— For aircraft and aeronautical station transmitter types first installed before 1 February 1983 the audio frequencies will be limited to 3 000 Hz.

2.4.1.5.2 For other authorized classes of emission the modulation frequencies shall be such that the required spectrum limits of 2.4.1.7 will be met.

2.4.1.6 Frequency Tolerance

2.4.1.6.1 The basic frequency stability of the transmitting function for classes of emission J3E, J7B or J9B shall be such that the difference between the actual carrier of the transmission and the carrier (reference) frequency shall not exceed:

— 20 Hz for airborne installations;

— 10 Hz for ground installations.

2.4.1.6.2 The basic frequency stability of the receiving function shall be such that, with the transmitting function stabilities specified in 2.4.1.6.1, the overall frequency difference between ground and airborne functions achieved in service and including Doppler shift, does not exceed 45 Hz. However, a greater frequency difference shall be permitted in the case of supersonic aircraft.

2.4.1.7 Spectrum Limits

2.4.1.7.1 For aircraft station transmitter types and for aeronautical station transmitters first installed before 1 February 1983 and using single sideband classes of emission H2B, H3E, J3E, J7B or J9B the mean power of any emission on any discrete frequency shall be less than the mean power (P_m) of the transmitter in accordance with the following:

— on any frequency removed by 2 kHz or more up to 6 kHz from the assigned frequency: at least 25 dB;

— on any frequency removed by 6 kHz or more up to 10 kHz from the assigned frequency: at least 35 dB;

— on any frequency removed from the assigned frequency by 10 kHz or more:

a) aircraft station transmitters: 40 dB;

b) aeronautical station transmitters:

$$[43 + 10 \log_{10} P_m \, (W)] \, dB$$

2.4.1.7.2 For aircraft station transmitters first installed after 1 February 1983 and for aeronautical station transmitters in use as of 1 February 1983 and using single sideband classes of emission H2B, H3E, J3E, J7B or J9B, the peak envelope power (P_p) of any emission on any discrete frequency shall be less than the peak envelope power (P_p) of the transmitter in accordance with the following:

— on any frequency removed by 1.5 kHz or more up to 4.5 kHz from the assigned frequency: at least 30 dB;

— on any frequency removed by 4.5 kHz or more up to 7.5 kHz from the assigned frequency: at least 38 dB;

— on any frequency removed from the assigned frequency by 7.5 kHz or more:

a) aircraft station transmitters: 43 dB;

b) aeronautical station transmitters: for transmitter power up to and including 50 W:

$$[43 + 10 \log_{10} P_p \, (W)] \, dB$$

For transmitter power more than 50 W: 60 dB.

Note.— See Figures 2-1 and 2-2.

2.4.1.8 Power

2.4.1.8.1 Aeronautical station installations. Except as permitted by the relevant provisions of Appendix S27 to the ITU Radio Regulations, the peak envelope power (P_p) supplied to the antenna transmission line for H2B, H3E, J3E, J7B or J9B classes of emissions shall not exceed a maximum value of 6 kW.

2.4.1.8.2 Aircraft station installations. The peak envelope power supplied to the antenna transmission line for H2B, H3E, J3E, J7B or J9B classes of emission shall not exceed 400 W except as provided for in Appendix S27 of the ITU Radio Regulations as follows:

S27/68 It is recognized that the power employed by aircraft transmitters may, in practice, exceed the limits specified in No. 27/60. However, the use of such increased power (which normally should not exceed 600 *W* P_p) shall not cause harmful interference to stations using frequencies in accordance with the technical principles on which the Allotment Plan is based.

S27/60 Unless otherwise specified in Part II of this Appendix, the peak envelope powers supplied to the antenna transmission line shall not exceed the maximum values indicated in the table below; the corresponding peak effective radiated powers being assumed to be equal to two-thirds of these values:

Class of emission	*Stations*	*Max. peak envelope power (P_p)*
H2B, J3E, J7B, J9B, A3E*, H3E* (100% modulation)	Aeronautical stations Aircraft stations	6 kW 400 W
Other emission such as A1A, F1B	Aeronautical stations Aircraft stations	1.5 kW 100 W

* A3E and H3E to be used only on 3 023 kHz and 5 680 kHz.

2.4.1.9 Method of operation. Single channel simplex shall be employed.

2.5 (Reserved) Satellite Voice Communication (SATVOICE) System Characteristics

TABLE FOR CHAPTER 2

Table 2-1. Priority levels for SATVOICE calls (air-to-ground/ground-to-air)

Priority level	Application category
1 / EMG / Q15 Emergency (highest) Safety of flight	Distress and urgency. For use by flight crew, when appropriate.
2 / HGH / Q12 Operational high (second highest) Safety of flight	Flight safety. Typically assigned to calls between aircraft and ANSPs.
3 / LOW / Q10 Operational low (third highest) Safety of flight	Regularity of flight, meteorological, administrative. Typically assigned to calls between aircraft operators and their aircraft.
4 / PUB / Q9 Non-operational (lowest) Non safety	Public correspondence.

FIGURES FOR CHAPTER 2

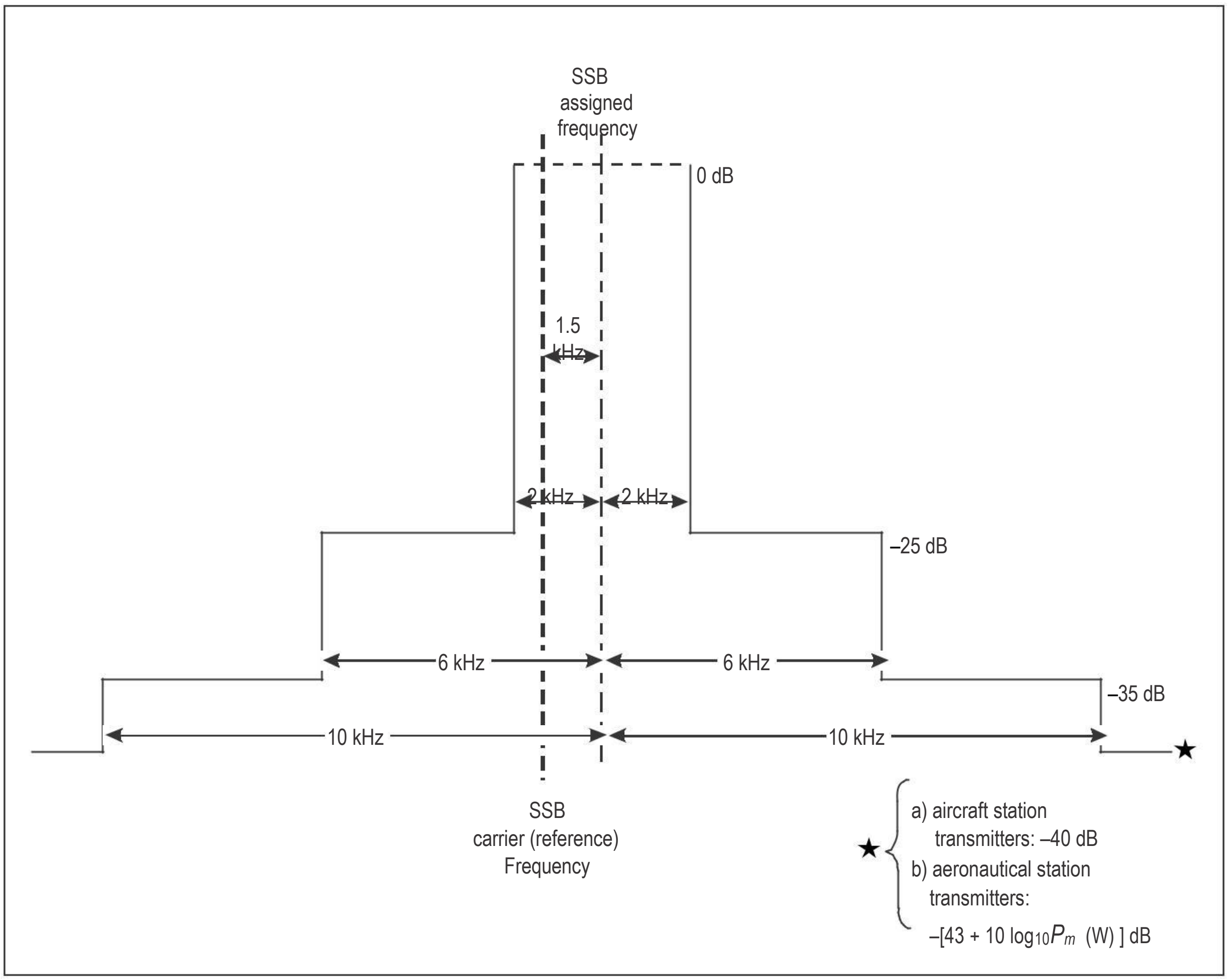


Figure 2-1. Required spectrum limits (in terms of mean power) for aircraft station transmitter types and for aeronautical station transmitters first installed before 1 February 1983

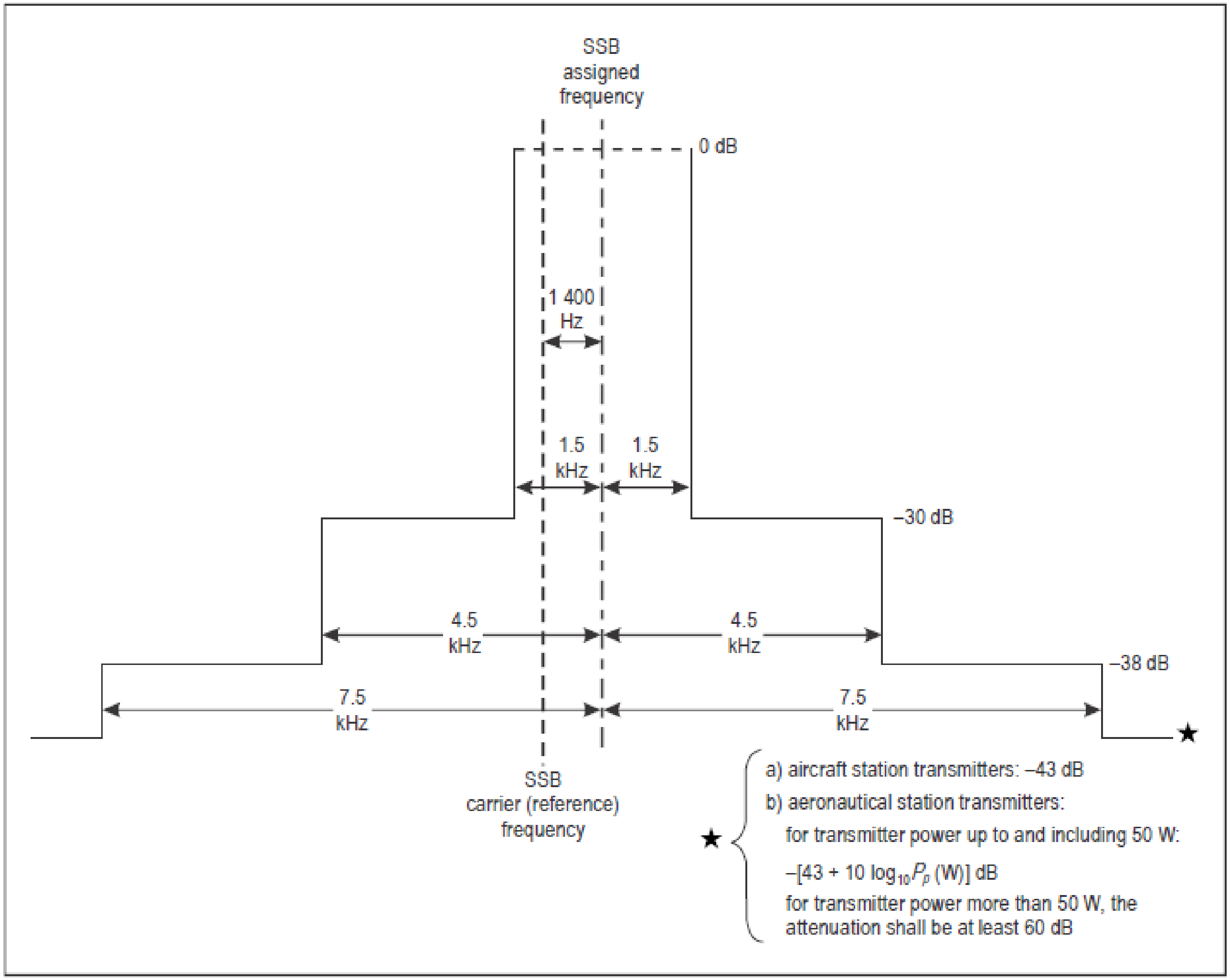


Figure 2-2. Required spectrum limits (in terms of peak power) for aircraft station transmitters first installed after 1 February 1983 and aeronautical station transmitters in use after 1 February 1983

CHAPTER 3. (RESERVED) SELCAL SYSTEM

——————— INTENTIONALLY LEFT BLANK———————

CHAPTER 4. AERONAUTICAL SPEECH CIRCUITS

4.1 Technical provisions Relating to International Aeronautical Speech Circuit Switching and Signalling for Ground-Ground Applications

Note.— Guidance material on the implementation of aeronautical speech circuit switching and signalling for ground-ground applications is contained in the Manual on Air Traffic Services (ATS) Ground-Ground Voice Switching and Signaling *(ICAO Doc 9804). The material includes explanation of terms, performance parameters, guidance on basic call types and additional functions, references to appropriate ISO/IEC international standards and ITU-T recommendations, guidance on the use of signalling systems, details of the recommended numbering scheme and guidance on migration to future schemes.*

4.1.1 The use of circuit switching and signalling to provide speech circuits to interconnect ATS units not interconnected by dedicated circuits shall be by agreement between the Administrations concerned.

4.1.2 The application of aeronautical speech circuit switching and signalling shall be made on the basis of regional air navigation agreements.

4.1.3 The ATC communication requirements defined in BCAR 11, Section 6.2 should be met by implementation of one or more of the following basic three call types:

a) instantaneous access;

b) direct access; and

c) indirect access.

4.1.4 In addition to the ability to make basic telephone calls, the following functions should be provided in order to meet the requirements set out in BCAR 11:

a) means of indicating the calling/called party identity;

b) means of initiating urgent/priority calls; and
c) conference capabilities.

4.1.5 The characteristics of the circuits used in aeronautical speech circuit switching and signalling should conform to appropriate ISO/IEC international standards and ITU-T recommendations.

4.1.6 Digital signalling systems should be used wherever their use can be justified in terms of any of the following:

a) improved quality of service;

b) improved user facilities; or

c) reduced costs where quality of service is maintained.

4.1.7 The characteristics of supervisory tones to be used (such as ringing, busy, number unobtainable) should conform to appropriate ITU-T recommendations.

4.1.8 To take advantage of the benefits of interconnecting regional and national aeronautical speech networks, the international aeronautical telephone network numbering scheme should be used.

CHAPTER 5. EMERGENCY LOCATOR TRANSMITTER (ELT) FOR SEARCH AND RESCUE

5.1 General

5.1.1 Until 1 January 2005, emergency locator transmitters shall operate either on both 406 MHz and 121.5 MHz or on 121.5 MHz.

Note.— From 1 January 2000, ELTs operating on 121.5 MHz will be required to meet the improved technical characteristics contained in 5.2.1.8.

5.1.2 All installations of emergency locator transmitters operating on 406 MHz shall meet the provisions of 5.3.

5.1.3 All installations of emergency locator transmitters operating on 121.5 MHz shall meet the provisions of 5.2.

5.1.4 From 1 January 2005, emergency locator transmitters shall operate on 406 MHz and 121.5 MHz simultaneously.

5.1.5 All emergency locator transmitters installed on or after 1 January 2002 shall operate simultaneously on 406 MHz and 121.5 MHz.

5.1.6 The technical characteristics for the 406 MHz component of an integrated ELT shall be in accordance with 5.3.

5.1.7 The technical characteristics for the 121.5 MHz component of an integrated ELT shall be in accordance with 5.2.

5.1.8 States shall make arrangements for a 406 MHz ELT register. Register information regarding the ELT shall be immediately available to search and rescue authorities. States shall ensure that the register is updated whenever necessary.

5.1.9 ELT register information shall include the following:

a) transmitter identification (expressed in the form of an alphanumerical code of 15 hexadecimal characters);

b) transmitter manufacturer, model and, when available, manufacturer's serial number;

c) COSPAS-SARSAT* type approval number;

d) name, address (postal and e-mail) and emergency telephone number of the owner and operator;

e) name, address (postal and e-mail) and telephone number of other emergency contacts (two, if possible) to whom the owner or the operator is known;

f) aircraft manufacturer and type; and

g) color of the aircraft.

*COSPAS = Space system for search of vessels in distress;
SARSAT = Search and rescue satellite-aided tracking.

Note 1.— Various coding protocols are available to States. Depending on the protocol adopted, States may, at their discretion, include one of the following as supplementary identification information to be registered:

a) aircraft operating agency designator and operator's serial number; or

b) 24-bit aircraft address; or

c) aircraft nationality and registration marks.

The aircraft operating agency designator is allocated to the operator by ICAO through the State administration, and the operator's serial number is allocated by the operator from the block 0001 to 4096.

Note 2.— At their discretion, depending on arrangements in place, States may include other relevant information to be registered such as the last date of register, battery expiry date and place of ELT in the aircraft (e.g. "primary ELT" or "life-raft No. 1").

5.2 Specification for the 121.5 MHz Component of Emergency Locator Transmitter (ELT) Search and Rescue

Note 1.— Information on technical characteristics and operational performance of 121.5 MHz ELTs is contained in RTCA Document DO-183 and European Organization for Civil Aviation Equipment (EUROCAE) Document ED.62.

Note 2.— Technical characteristics of emergency locator transmitters operating on 121.5 MHz are contained in ITU-R Recommendation M.690-1. The ITU designation for an ELT is Emergency Position — Indicating Radio Beacon (EPIRB).

5.2.1 Technical characteristics

5.2.1.1 Emergency locator transmitters (ELT) shall operate on 121.5 MHz. The frequency tolerance shall not exceed plus or minus 0.005 per cent.

5.2.1.2 The emission from an ELT under normal conditions and attitudes of the antenna shall be vertically polarized and essentially omnidirectional in the horizontal plane.

5.2.1.3 Over a period of 48 hours of continuous operation, at an operating temperature of minus 20°C, the peak effective radiated power (PERP) shall at no time be less than 50 mW.

5.2.1.4 The type of emission shall be A3X. Any other type of modulation that meets the requirements of 5.2.1.5, 5.2.1.6 and 5.2.1.7 may be used provided that it will not prejudice precise location of the beacon by homing equipment.

Note.— Some ELTs are equipped with an optional voice capability (A3E) in addition to the A3X emission.

5.2.1.5 The carrier shall be amplitude modulated at a modulation factor of at least 0.85.

5.2.1.6 The modulation applied to the carrier shall have a minimum duty cycle of 33 per cent.

5.2.1.7 The emission shall have a distinctive audio characteristic achieved by amplitude modulating the carrier with an audio frequency sweeping downward over a range of not less than 700 Hz within the range 1 600 Hz to 300 Hz and with a sweep repetition rate of between 2 Hz and 4 Hz.

5.2.1.8 After 1 January 2000, the emission shall include a clearly defined carrier frequency distinct from the modulation sideband components; in particular, at least 30 per cent of the power shall be contained at all times within plus or minus 30 Hz of the carrier frequency on 121.5 MHz.

5.3 Specification for the 406 MHz Component of Emergency locator Transmitter (ELT) for Search and Rescue

5.3.1 Technical characteristics

Note 1.— Transmission characteristics for 406 MHz emergency locator transmitters are contained in ITU-R M.633.

Note 2.— Information on technical characteristics and operational performance of 406 MHz ELTs is contained in RTCA Document DO-204 and European Organization for Civil Aviation Equipment (EUROCAE) Document ED-62.

5.3.1.1 Emergency locator transmitters shall operate on one of the frequency channels assigned for use in the frequency band 406.0 to 406.1 MHz.

Note.— The COSPAS-SARSAT 406 MHz channel assignment plan is contained in COSPAS-SARSAT Document C/S T.012.

5.3.1.2 The period between transmissions shall be 50 seconds plus or minus 5 per cent.

5.3.1.3 Over a period of 24 hours of continuous operation at an operating temperature of –20°C, the transmitter power output shall be within the limits of 5 W plus or minus 2 dB.

5.3.1.4 The 406 MHz ELT shall be capable of transmitting a digital message.

5.3.2 Transmitter identification coding

5.3.2.1 Emergency locator transmitters operating on 406 MHz shall be assigned a unique coding for identification of the transmitter or aircraft on which it is carried.

5. 3.2.2 The emergency locator transmitter shall be coded in accordance with either the aviation user protocol or one of the serialized user protocols described in the Appendix to this chapter, and shall be registered with the appropriate authority.

APPENDIX TO CHAPTER 5. EMERGENCY LOCATOR TRANSMITTER CODING

(see Chapter 5, 5.3.2)

Note.— A detailed description of beacon coding is contained in Specification for COSPAS-SARSAT 406 MHz Distress Beacons (C/S T.001). The following technical specifications are specific to emergency locator transmitters used in aviation.

1. General

1.1 The emergency locator transmitter (ELT) operating on 406 MHz shall have the capacity to transmit a programmed digital message which contains information related to the ELT and/or the aircraft on which it is carried.

1.2 The ELT shall be uniquely coded in accordance with 1.3 and be registered with the appropriate authority.

1.3 The ELT digital message shall contain either the transmitter serial number or one of the following information elements:

a) aircraft operating agency designator and a serial number;

b) 24-bit aircraft address;

c) aircraft nationality and registration marks.

1.4 All ELTs shall be designed for operation with the COSPAS-SARSAT* system and be type approved.

Note.— Transmission characteristics of the ELT signal can be confirmed by making use of the COSPAS-SARSAT Type Approval Standard (C/S T.007).

2.ELT Coding

2.1 The ELT digital message shall contain information relating to the message format, coding protocol, country code, identification data and location data, as appropriate.

2.2 For ELTs with no navigation data provided, the short message format C/S T.001 shall be used, making use of bits 1 through 112. For ELTs with navigation data, if provided, the long message format shall be used, making use of bits1 through 144.

2.3 Protected data Ffeld

2.3.1 The protected data field consisting of bits 25 through 85 shall be protected by an error correcting code and shall be the portion of the message which shall be unique in every distress ELT.

2.3.2 A message format flag indicated by bit 25 shall be set to “0” to indicate the short message format or set to “1” to indicate the long format for ELTs capable of providing location data.
COSPAS = Space system for search of vessels in distress;

SARSAT = Search and rescue satellite-aided tracking.

2.3.3 A protocol flag shall be indicated by bit 26 and shall be set to "1" for user and user location protocols, and "0" for location protocols.

2.3.4 A country code, which indicates the State where additional data are available on the aircraft on which the ELT is carried, shall be contained in bits 27 through 36 which designate a three-digit decimal country code number expressed in binary notation.

Note.— Country codes are based on the International Telecommunication Union (ITU) country codes shown in Table 4 of Part I, Volume I of the ITU List of Call Signs and Numerical Identities.

2.3.5 Bits 37 through 39 (user and user location protocols) or bits 37 through 40 (location protocols) shall designate one of the protocols where values "001" and "011" or "0011", "0100", "0101", and "1000" are used for aviation as shown in the examples contained in this appendix.

2.3.6 The ELT digital message shall contain either the transmitter serial number or an identification of the aircraft or operator as shown below.

2.3.7 In the serial user and serial user location protocol (designated by bit 26=1 and bits 37 through 39 being "011"), the serial identification data shall be encoded in binary notation with the least significant bit on the right. Bits 40 through 42 shall indicate type of ELT serial identification data encoded where:

— "000" indicates ELT serial number (binary notation) is encoded in bits 44 through 63;

— "001" indicates aircraft operator (3 letter encoded using modified Baudot code shown in Table 5-1) and a serial number (binary notation) are encoded in bits 44 through 61 and 62 through 73, respectively;

— "011" indicates the 24-bit aircraft address is encoded in bits 44 through 67 and each additional ELT number (binary notation) on the same aircraft is encoded in bits 68 through 73.

Note.— States will ensure that each beacon, coded with the country code of the State, is uniquely coded and registered in a database. Unique coding of serialized coded beacons can be facilitated by including the COSPAS-SARSAT Type Approval Certificate Number which is a unique number assigned by COSPAS-SARSAT for each approved ELT model, as part of the ELT message.

2.3.8 In the aviation user or user location protocol (designated by bit 26=1 and bits 37 through 39 being "001"), the aircraft nationality and registration marking shall be encoded in bits 40 through 81, using the modified Baudot code shown in Table 5-1 to encode seven alphanumeric characters. This data shall be right justified with the modified Baudot "space" ("100100") being used where no character exists.

2.3.9 Bits 84 and 85 (user or user location protocol) or bit 112 (location protocols) shall indicate any homing transmitter that may be integrated in the ELT.

2.3.10 In standard and national location protocols, all identification and location data shall be encoded in binary notation with the least significant bit right justified. The aircraft operator designator (3 letter code) shall be encoded in 15 bits using a modified Baudot code (Table 5-1) using only the 5 right most bits per letter and dropping the left most bit which has a value of 1 for letters.

Table 5-1. Modified Baudot code

Letter	*Code* *MSB LSB*	*Figure*	*Code* *MSB LSB*
A	111000	(-)*	011000
B	110011		
C	101110		
D	110010		
E	110000	3	010000
F	110110		
G	101011		
H	100101		
I	101100		
J	111010	8	001100
K	111110		
L	101001		
M	100111		
N	100110		
O	100011	9	000011
P	101101	0	001101
Q	111101	1	011101
R	101010	4	001010
S	110100		
T	100001	5	000001
U	111100	7	011100
V	101111		
W	111001	2	011001
X	110111	/	010111
Y	110101	6	010101
Z	110001		
( )**	100100		

MSB = most significant bit
LSB = least significant bit
* = hyphen
** = spac

EXAMPLES OF CODING

ELT serial number

25		27 36	37			40				44 63	64 73	74 83		85
F	1	COUNTRY	0	1	1	T	T	T	C	SERIAL NUMBER DATA (20 BITS)	SEE NOTE 1	SEE NOTE 2	A	A

Aircraft address

25		27 36	37			40				44 67	68 73	74 83		85
F	1	COUNTRY	0	1	1	T	T	T	C	AIRCRAFT ADDRESS (24 BITS)	SEE NOTE 3	SEE NOTE 2	A	A

Aircraft operator designator and serial number

25		27 36	37			40				44 61	62 73	74 83		85
F	1	COUNTRY	0	1	1	T	T	T	C	OPERATOR 3-LETTER DESIGNATOR	SERIAL NUMBER 1-4096	SEE NOTE 2	A	A

Aircraft registration marking

25		27 36	37			40 81		83		85
F	1	COUNTRY	0	0	1	AIRCRAFT REGISTRATION MARKING (UP TO 7 ALPHANUMERIC CHARACTERS) (42 BITS)	0	0	A	A

T = Beacon type TTT: = 000 indicates ELT serial number is encoded;
= 001 indicates operating agency and serial number are encoded;
= 011 indicates 24-bit aircraft address is encoded.

C = Certificate flag bit: 1 = to indicate that COSPAS-SARSAT Type Approval Certificate number is encoded in bits 74 through 83 and
0 = otherwise

F = Format flag: 0 = Short Message
1 = Long Message

A = Auxiliary radio-locating device: 00 = no auxiliary radio-locating device
01 = 121.5 MHz
11 = other auxiliary radio-locating device

Note 1.— 10 bits, all 0s or National use.

Note 2.— COSPAS-SARSAT Type Approval Certificate number in binary notation with the least significant bit on the right, or National use.

Note 3.— Serial number, in binary notation with the least significant bit on the right, of additional ELTs carried in the same aircraft or default to 0s when only one ELT is carried.

EXAMPLE OF CODING (USER LOCATION PROTOCOL)

25	26	←27 36→	←37 39→	←40 83→	85→	←86 106→	←107 112→	←113					132→	←133 144→
1	1	10	3	44	2	21	1	12			13			12
1	1	CC	T	IDENTIFICATION DATA (AS IN ANY OF USER PROTOCOLS ABOVE)	A	21-BIT BCH ERROR CORRECTING CODE	E	LATITUDE			LONGITUDE			12-BIT BCH ERROR CORRECTING CODE
								1	7	4	1	8	4	
								N / S	DEG 0–90 (1 d)	MIN 0–56 (4m)	E / W	DEG 0–180 (1 d)	MIN 0–56 (4m)	

CC = Country Code;
E = Encoded position data source:
1 = Internal navigation device,
0 = External navigation device

EXAMPLE OF CODING (STANDARD LOCATION PROTOCOL)

25	26	←27 36→	←37 40→	←41					85→	←86 106→	107 112	←113					132→	←133 144→
61 BITS											26 BITS							
1	1	10	4	45						21	6	20						12
1	0	CC	PC	IDENTIFICATION DATA		LATITUDE		LONGITUDE		21-BIT BCH CODE	SD	LATITUDE			LONGITUDE			12-BIT BCH CODE
				24		1	9	1	10			1	5	4	1	5	4	
			0011	AIRCRAFT 24 BIT ADDRESS		N = 0 S = 1	LAT DEG 0–90 (1/4 d)	E = 0 W = 1	LON DEG 0–180 (1/4 d)			— = 0 + = 1	MINUTES 0–30 (1 m)	SECONDS 0–56 (4 s)	— = 0 + = 1	MINUTES 0–30 (1 m)	SECONDS 0–56 (4 s)	
			0101	15 AIRCRAFT OPER. DESIGNATOR	9 SERIAL No 1–511													
			0100	10 C/STA No 1–1023	14 SERIAL No 1–16383													

CC = Country Code;
PC = Protocol Code 0011 indicates 24-bit aircraft address is encoded;
0101 indicates operating agency and serial number are encoded;
0100 indicates ELT serial number is encoded.
SD = Supplementary Data bits 107 – 110 = 1101;
bit 111 = Encoded Position Data Source (1 = internal; 0 = external)
bit 112: 1 = 121.5 MHz auxiliary radio locating device;
0 = other or no auxiliary radio locating device.

Note 1.— Further details on protocol coding can be found in Specification for COSPAS-SARSAT 406 MHz Distress Beacon (C/S T.001).

Note 2. — All identification and location data are to be encoded in binary notation with the least significant bit on the right except for the aircraft operator designator (3 letter code).

Note 3. — For details on BCH error correcting code see Specification for COSPAS-SARSAT 406 MHz Distress Beacon (C/S T.001).

EXAMPLE OF CODING (NATIONAL LOCATION PROTOCOL)

25	26	←27 36→	←37 40→	←41						85→	←86 106→	107 112	←113						132→	←133 144→
61 BITS PDF-1											BCH-1	26 BITS PDF-2								BCH-2
1	1	10	4	45							21	6	7			7			6	12
1	0	CC	1000	18 bits ID	27 bits LATITUDE			LONGITUDE			21-BIT BCH CODE	SD	LATITUDE			LONGITUDE				12-BIT BCH CODE
				18	1	7	5	1	8	5			1	2	4	1	2	4	NU	
				NATIONAL ID NUMBER	N = 0 S = 1	DEGREES 0–90 (1 d)	MINUTES 0–58 (2 m)	E = 0 W = 1	DEGREES 0–180 (1 d)	MINUTES 0–58 (2 m)			– = 0 + = 1	MINUTES 0–3 (1 m)	SECONDS 0–56 (4 s)	– = 0 + = 1	MINUTES 0–3 (1 m)	SECONDS 0–56 (4 s)		

CC = Country Code;
ID = Identification Data = 8-bit identification data consisting of a serial number assigned by the appropriate national authority
SD = Supplementary Data = bits 107 – 109 = 110;
bit 110 = Additional Data Flag describing the use of bits 113 to 132:
1 = Delta position; 0 = National assignment;
bit 111 = Encoded Position Data Source: 1 = internal, 0 = external;
bit 112: 1 = 121.5 MHz auxiliary radio locating device;
0 = other or no device
NU = National use = 6 bits reserved for national use (additional beacon type identification or other uses).

Note 1.— Further details on protocol coding can be found in Specification for COSPAS-SARSAT 406 MHz Distress Beacon (C/S T.001).

Note 2.— All identification and location data are to be encoded in binary notation with the least significant bit on the right.

Note 3.— For details on BCH error correcting code see Specification for COSPAS-SARSAT 406 MHZ Distress Beacon (C/S T.001).

ATTACHMENT TO PART I. (RESERVED)GUIDANCE MATERIAL FOR THE VHF DIGITAL LINK (VDL)

——————— INTENTIONALLY LEFT BLANK———————

ATTACHMENT TO PART II. GUIDANCE MATERIALFOR COMMUNICATION SYSTEMS

1. VHF Communications

1.1 Audio characteristics of VHF communication equipment

1.1.1 The aeronautical radiotelephony services represent a special case of the application of radiotelephony, in that the requirement is for the transmission of messages in such a way that fidelity of wave form is of secondary importance, emphasis being upon fidelity of basic intelligence. This means that it is not necessary to transmit those parts of the wave form which are solely concerned with individuality, accent and emphasis.

1.1.2 The effective acceptance bandwidth for 8.33 kHz equipment is required to be at least plus and minus 3 462 Hz. This value considers the general case, i.e. air-to-ground transmissions and consists of 2 500 Hz audio bandwidth, 685 Hz for an aircraft transmitter instability of 5 ppm, 137 Hz for a ground receiver instability of 1 ppm and 140 Hz due to Doppler shift (2.2.2.4 and 2.3.2.6 of Part II refer).

1.2 Offset carrier system in 25 kHz, 50 kHz and 100 kHz spaced channels

The following are examples of offset carrier systems which meet the requirements of Part II, 2.2.1.1.1.

a) 2-carrier system. Carriers should be spaced at plus and minus 5 kHz. This requires a frequency stability of plus or minus 2 kHz (15.3 parts per million at 130 MHz).

b) 3-carrier system. Carriers should be spaced at zero and plus and minus 7.3 kHz. This requires a frequency stability of plus or minus 0.65 kHz (5 parts per million at 130 MHz).

The following are examples or 4- and 5-carrier systems which meet the requirements of Part II, 2.2.1.1.1.

c) 4-carrier system. Carriers should be spaced at plus and minus 2.5 kHz and plus and minus 7.5 kHz. This requires a frequency stability of plus or minus 0.5 kHz (3.8 parts per million at 130 MHz).

d) 5-carrier system. Carriers should be spaced at zero, plus and minus 4 kHz and plus and minus 8 kHz. A frequency stability in the order of plus or minus 40 Hz (0.3 parts per million at 130 MHz) is an achievable and practicable interpretation of the requirement in this case.

Note 1.— The carrier frequency spacings referred to above are with respect to the assigned channel frequency.

Note 2.— In aircraft receivers which employ a measurement of the received carrier-to-noise ratio to operate the mute, the audio heterodynes caused by the reception of two or more off-set carriers can be interpreted as noise and cause the audio output to be muted even when an adequate wanted signal is present. In order that the airborne receiving system can conform with the sensitivity recommendations contained in Part II, 2.3.2.2, the design of the receivers may need to ensure that their sensitivity is maintained at a high level when receiving off-set carrier transmissions. The use of a carrier level override is an unsatisfactory solution to this requirement, but where it is employed, setting the override level as low as possible can ameliorate the problem.

1.3 Immunity performance of COM receiving systems in the presence of VHF FM broadcast interference

1.3.1 With reference to the Note of 2.3.3.2 of Part II, the immunity performance defined there must be measured against an agreed measure of derogation of the receiving system's normal performance, and in the presence of, and under standard conditions for the input wanted signal. This is necessary to ensure that the checking of receiving station equipment on bench test can be performed to a repeatable set of conditions, and results, and to facilitate their subsequent approval. An adequate measure of immunity performance may be obtained by the use of wanted signal of minus 87 dBm into the receiving equipment and the signal modulated with a 1 kHz tone at 30 per cent modulation depth. The signal-to-noise ratio should not fall below 6 dB when the interfering signals specified at Part II, 2.3.3.1 and 2.3.3.2 are applied. The broadcast signals should be selected from frequencies in the range between 87.5 and 107.9 MHz and should be modulated with a representative broadcast type signal.

Note 1.— The signal level of minus 87 dBm assumes a combined antenna and feeder gain of 0 dB.

Note 2.— The reduction in the signal-to-noise ratio quoted above is for the purpose of standardization when checking that receiving station equipment on bench measurements meet the required immunity. In the planning of frequencies and in the assessment of protection from FM broadcast interference, a value not less than this, and in many cases higher, depending on the operational circumstances in individual cases, should be chosen as the basis of the interference assessment.

2. SELCAL System

2.1 This material is intended to provide information and guidance relating to the operation of the SELCAL system. It is associated with the Recommended Practices contained in Part II, Chapter 3.

a) Function. The purpose of the SELCAL system is to permit the selective calling of individual aircraft over radiotelephone channels linking the ground station with the aircraft, and is intended to operate on en-route frequencies with existing HF and VHF ground-to-air communications transmitters and receivers with a minimum of electrical and mechanical modification. The normal functioning of the ground-to-air communications link should be unaffected, except at such time as the selective calling function is being formed.

b) Principles of operation. Selective calling is accomplished by the coder of the ground transmitter sending a single group of coded tone pulses to the aircraft receiver and decoder. The airborne receiver and decoder equipment is capable of receiving and interpreting, by means of an indicator, the correct code and rejecting all other codes in the presence of random noise and interference. The ground portion of the coding device (ground selective calling unit) supplies coded information to the ground-to-air transmitter. The airborne selective calling unit is the special airborne equipment which operates with existing communications receivers on the aircraft to permit decoding of the ground-to-air signals for display on the signal indicator. The type of signal indicator can be chosen to suit operational requirements of the user and may consist of a lamp, a bell, a chime or any combination of such indicating devices.

—— END ——