# ICAO CIRCULAR

CIRCULAR 27-AN/24

FEBRUARY 1952

# TECHNICAL PRINCIPLES RESPECTING THE ESTABLISHMENT OF THE AERONAUTICAL FIXED TELECOMMUNICATIONS NETWORK

*Published by authority of the Secretary General*

INTERNATIONAL
CIVIL AVIATION
ORGANIZATION
MONTREAL • CANADA

This publication is issued in English, French and Spanish.

Published in Montreal, Canada, by the
*International Civil Aviation Organization.*
Correspondence concerning publications
should be addressed to the Secretary General
of ICAO, International Aviation Building,
1080 University Street, Montreal, Canada.

Orders for ICAO publications should be sent, on payment:

*In Canadian currency ($), to*

Secretary General, ICAO,
International Aviation Building,
1080 University Street,
Montreal, Canada.
(*Cable address:* ICAO MONTREAL)

*In Sterling or Irish currency (s/d), to*

His Majesty's Stationery Office,
P.O. Box 569,
London, S. E. 1,
England.
(*Cable address:*
WHOLECORN, SEDIST, LONDON);

*In French currency (fr), to*

ICAO Representative,
European and African Office,
60bis, avenue d'Iéna,
Paris (16e), France.
(*Cable address:* ICAOREP PARIS);

*In Egyptian currency ( L.E. ), to*

ICAO Representative,
Middle East Office,
Wadie Saad Building,
Sharia Salah el Dine,
Zamalek, Cairo, Egypt.
(*Cable address:* ICAOREP CAIRO);

*In Peruvian currency (soles), to*

ICAO Representative,
South American Office,
Apartado 680,
Lima, Peru.
(*Cable address:* ICAOREP LIMA);

*In Australian currency (s/d), to*

ICAO Representative,
Far East and Pacific Office,
17 Robe Street,
St. Kilda,
Melbourne, Australia.
(*Cable address:* ICAOREP MELBOURNE)

# ICAO CIRCULAR

CIRCULAR 27-AN/24

FEBRUARY 1952

# TECHNICAL PRINCIPLES RESPECTING THE ESTABLISHMENT OF THE AERONAUTICAL FIXED TELECOMMUNICATIONS NETWORK

*Published by authority of the Secretary General*

INTERNATIONAL CIVIL AVIATION ORGANIZATION
MONTREAL • CANADA

THIS PAGE INTENTIONALLY LEFT BLANK

## TABLE OF CONTENTS

THIS PAGE INTENTIONALLY LEFT BLANK

# F O R E W O R D

This circular contains principles and guidance material on the Aeronautical Fixed Telecommunications Network (AFTN), that have been approved by the Council for world-wide application. The material in the circular was developed at the Third and Fourth Sessions of the COM Division. Marginal notations indicate the original paragraph numbers in the report from which the information was taken. In the case of Doc 6625, COM/521 the paragraphs refer to Part IV, Chapter 3 and for Doc 7171, COM/544 to Part IV, Chapter 5.

THIS PAGE INTENTIONALLY LEFT BLANK

## PRINCIPLES RESPECTING THE ESTABLISHMENT OF THE AERONAUTICAL FIXED TELECOMMUNICATIONS NETWORK (AFTN)

Doc 6625-COM/521
2.1 1. The AFTN should be organized in accordance with the following principles.

2.1.1 2. - Responsibility Principle

2.1.1.1 2.1 Council recommends that States assume their responsibility in accordance with the Convention for the provision and operation within its territories of all facilities of the AFTN recommended by the Council, whether established and operated directly by a State Administration or by an Agency sponsored, licensed or otherwise permitted by the State to establish or operate such facilities.

Note 1. - The principle of responsibility is not to be interpreted in any way as governing the financial arrangements for the provision and operation of facilities.

Note 2. - The responsibility assumed by a State includes responsibility for ensuring that the facilities are provided and operated in accordance with ICAO Standards and Recommended Practices.

Note 3. - The Council normally recommends the facilities required and their locations on the recommendation of Regional Air Navigation Meetings.

Doc 6625-
COM/521
2.1.2

## 3.- Network Principles

2.1.2.1

3.1 The world shall be divided into a number of separate specified communication areas within each of which shall be established one or more area communication centres provided with means for direct communication with at least one area communication centre in another specified communication area and through such centre(s) with all other area communication centres either directly or by further relay. It is desirable that only one communication centre be established in any specified communication area. If more than one area communication centre is necessary either to provide for alternative routing or to meet special requirements the area communication centres should be provided with means of inter-communication and their communication services co-ordinated so that these services are equivalent to that provided by a single area communication centre.

Note 1.- The specified area may be a portion of a State, a whole State, or may include territory of more than one State.

Note 2.- Area communication centres and the direct circuits between them constitute the primary AFTN.

2.1.2.2

3.2 Each specified communication area shall be divided, if required, into a number of communication sub-areas within each of which shall be established at least one sub-area communication centre provided with means for communication with the appropriate area communication centre, either directly or through a network of sub-area communication centres in the specified area.

2.1.2.3

3.3 The communication circuits provided in accordance with these principles need not necessarily be established on a direct aerodrome-to-aerodrome basis along an air route, provided the communication services available meet operational requirements.

Doc 7171-COM/544
5.16
5.16.1

3.4 Provisions for alternative routing are desirable but requirements should be met, in so far as possible, without recommending special or separate circuits for the purpose.

Doc 6625-COM/521
2.1.3

## 4. - Circuit Principles

2.1.3.1

4.1 The circuits inter-connecting all stations of the AFTN shall be, whenever practicable, landline, cable or highly directional non-interfering radio link circuits. Other radio circuits shall be employed only where the use of landline, cable or highly directional non-interfering radio link circuits is not practicable.

2.1.3.2

4.2 Circuits inter-connecting area communication centres and connecting these centres to sub-area communication centres should be teletypewriter circuits or such other types of circuit as may replace them in the progressive development of normal telecommunication practice.

2.1.3.3

4.3 The circuits inter-connecting area communication centres, and connecting these centres to sub-area communication centres, should employ semi-automatic tape relay or automatic tape relay.

Note 1. - Semi-automatic tape relay. The method of communication whereby messages are received and retransmitted in teletypewriter tape form involving manual intervention in transfer of the tape from receiving reperforator to automatic transmitter.

Note 2. - Automatic tape relay. The method of communication whereby messages are received and retransmitted in teletypewriter tape form without manual intervention.

4.4 The circuits between area communication centres and between these centres and sub-area communication centres should be capable of meeting the needs dictated by communication traffic load at all times. These circuits should be planned to provide for expansion to meet foreseeable communication traffic requirements.

Doc 7171-COM/544 5.7.1

4.5 The circuits inter-connecting sub-area communication centres and connecting these centres to communication centres serving air traffic control centres and aerodromes open to international air services should, whenever practicable and economical, employ teletypewriter circuits.

Doc 6625-COM/521 2.1.3.5

4.6 All teletypewriter terminal equipment (landline, or cable and radio) used in the AFTN shall be standardized to the extent necessary to permit complete interworking.

Note.- An objective of ICAO should be the promotion of the degree of standardization necessary to permit the interworking of teletypewriter terminal equipment (landline, or cable and radio) employed in all fixed telecommunications. ICAO should collaborate with the ITU in any action intended to further the achievement of this objective.

## 5.- Centre Principles

Doc 7171-COM/544 5.7.2

5.1 Each communication centre should be so organized as to permit the rapid transfer of messages from one circuit to another by physical or electrical means.

5.7.3

5.2 Circuits terminating at a centre should, whenever practicable, be grouped in the same or adjacent premises, so as to permit rapid transfer of messages.

5.2.1 When the terminal equipment at a communication centre cannot be grouped together, all necessary steps should be taken to connect them by means of high capacity electrical devices or mechanical message carriers, so as to permit the rapid transfer of communications between the terminal installations associated with different groups of circuits.

Doc 7171
COM/544

## 6.- The Linkage of the Aeronautical Mobile Service with the AFTN

5.1.5.1 6.1 When an Aeronautical Telecommunication Station is responsible for Aeronautical Fixed and Aeronautical Mobile Services all the terminal installations should be so arranged as to permit rapid transfer of messages from the Mobile Service to the Fixed Service and vice versa.

5.1.5.2 6.2 In cases where the Aeronautical Mobile Station and the Aeronautical Fixed Station are not immediately adjacent, the transfer of messages should be effected by electrical or mechanical means.

5.1.5.3 6.3 The interval between the time of receipt of the messages at the Aeronautical Station and the time of receipt of the same messages at the associated Aeronautical Fixed Station in an appropriate form, should be reduced to an absolute minimum by the use of efficient handling technically and, in any case, should not exceed two minutes.

Note.- Copying AF/Ground Communications directly on the teletypewriter with associated reperforations provides a satisfactory method of integration between the Aeronautical Mobile Service and the Aeronautical Fixed Service and, in addition, facilitates local delivery, but the adoption of such a method depends upon the use of appropriate procedures.

## 7.- Equipment and Operating Principles

5.7.4 7.1 Equipment

7.1.1 The following sub-paragraphs list a number of means which would improve the efficiency of the stations:

a) terminal equipment associated with circuits requiring heavy volume of relays may be grouped together in such a manner as to permit an operator to transfer tape from one circuit to another without moving from his position, or at the most a very few steps;

Doc 7171
COM/544

b) multiple units of terminal equipment may be used to great advantage on a circuit that is known to generate a heavy volume of multiple addressed traffic. For example, two reperforators will provide tape copy for simultaneous transmission on a local distribution and a long-line circuit;

c) paralleled automatic transmitting heads would permit tape to be inserted in one head ready for immediate transmission following the completion of a transmission on the associate alternate head;

d) internal switching arrangements may be established to permit simultaneous transmission of a multiple addressed message from one automatic transmitter to several circuits, thus saving time lost by the transfer of tape from one circuit to another;

e) internal switching arrangements making all circuits available at each operating position, together with associated signal lights to show the availability status of each circuit, would increase circuit utilization with a consequent decrease in in-station transfer time;

f) a page printer providing a "hard" copy of all incoming traffic on each circuit, would permit continuous monitoring of traffic to determine that circuits are operating correctly;

g) typing reperforators are preferable to non-typing reperforators as they facilitate correct handling of tape even by less experienced operators without the necessity of making frequent reference to the page copy monitored by the printer.

5.7.5 7.2. Relay operations

5.7.5.1 7.2.1 The responsibility for relaying traffic should be confined to the physical or electrical act of transferring communications from one circuit to another in accordance with established routing procedures. Under

Doc 7171
COM/544
5.7.5.1 (Cont'd)

no circumstances should such communications be delayed for the purpose of administrative accounting, checking for accuracy, re-editing, extraction of information of interest to the relaying station, etc.

5.7.5.2

7.2.2 Centres should be so organized as to permit operators to transfer communications from one circuit to another by physical or electrical means without further reference to supervisory or checking personnel.

5.7.5.3

7.2.3 All circuits should be under constant monitoring by operating personnel so as to enable immediate detection of any garbling attributable to circuit malfunctioning as distinguished from errors, which may have been typed into the original message by the originating station.

7.3 Change of code

5.7.6

7.3.1 Arrangements should be made to retransmit without undue delay communications received in other than the 5-unit code (communications in Morse or in A3), intended for relay over channels of the fixed service. At the present stage of technical development, the direct printing of messages in tape form appears desirable. This refers particularly to the operation of fixed service channels not yet equipped for using the 5-unit code.

## 8.- Transit Time Principles

5.9

8.1 The maximum transit time of Class A messages of high priority should be determined for individual routes on a regional basis after consideration of local conditions and of types of circuits to be used.

Doc 7171
COM/544
5.10

8.2 The requirement for rapid transmission of Class A messages of the highest priority will in all probability be met if:

a) The utilization factor of an existing circuit is kept below 40%.

b) The maximum transit time of Class A messages of lowest priority does not exceed 20% of the direct flight time.

5.11

8.3 In such cases when it is determined as the result of regional consideration that the maximum transit time can be stated as a proportion of the direct flight time, the maximum transit time for Class A messages of the lowest priority should not exceed 20% of the direct flight time.

Note 1.- The direct flight time is computed on the basis of an aircraft speed of 300 (until 1954) or 400 (1954 onwards) knots and the distance from point of departure to point of destination of the flight.

Note 2.- Transit time is the elapsed time from the handing in of a message to the Aeronautical Fixed Telecommunication Network to the time of delivery to the addressee.

5.12

8.4 The following material should be used by Regional Meetings and Contracting States for guidance in planning, engineering and operation of circuits of the AFTN.

5.12.4

8.4.1 In-station Transfer Time. The in-station transfer time is the time spent in transferring the message from the point of receipt to the transmitting or delivery point.

5.12.5

8.4.1.1 Teletypewriter Operation. In teletypewriter operation, in-station transfer time is almost constant for a given station and relatively independent of message length and priority.

Doc 7171
COM/544
5.12.6

8.4.1.2 CW Operation. Transfer of messages between two manual CW circuits or from a teletypewriter circuit to a manual CW circuit requires little re-processing, and it is considered that the in-station transfer time should not exceed two minutes. However, transfer from a manual CW circuit to a teletypewriter circuit involves re-processing and it is considered to be equivalent to two in-station transfer times, i.e., four minutes. When automatic CW is employed, the time for re-processing a message from either "hard copy" or 5-unit code tape into morse tape, assuming an operator's keyboard speed of 50 words per minute, would be just under one minute. Since, however, in most cases the tape is fed from the perforator directly into the transmitting head, it is considered this re-processing could be accommodated within an in-station transfer time of two minutes.

5.12.7

8.4.1.3 Maximum in-station transfer time. The in-station transfer time for messages sent on the AFTN should, therefore, be reduced to an absolute minimum by the use of efficient handling techniques and the objective aimed at should be considered as a maximum in-station transfer time not exceeding two minutes, with the exception of the transfer from manual CW to teletypewriter circuits, in which case the objective aimed at should be an in-station transfer time not exceeding four minutes.

5.12.8

8.4.2 Circuit Transmission Time. The circuit transmission time is the actual time occupied by the transmission of a message on a circuit and is proportional to the message length.

5.12.8.1

8.4.2.1 Teletypewriter Operation. Assuming transmission at 50 bauds (66.6 words per minute with 50% prolonged stop pulse) and an average message length of 37 words the average circuit transmission time is 35 seconds. For purposes of communication system planning, it is desirable to provide a nominal safety margin allowance in addition to the circuit transmission time.

Doc 7171
COM/544
5.12.8.2

8.4.2.2 CW Operation. The average text, preamble and heading remains the same as for teletypewriter operation but instead of non-typing mechanical functions, account has to be made of approximately ten words for operational requirements. This gives an average message length of 42 words.

5.12.8.2.1

8.4.2.2.1 Manual Speeds. It is considered that, whereas individual messages may be trnasmitted at 25 words per minute, the average speed of transmission over a period of time would be reduced by calling and answering procedures, the speed of the slowest operator on the net, etc., to something of the order of 15 words per minute. Hence, assuming transmission at an average speed of 15 words per minute on manual circuits, the circuit transmission time is approximately 3 minutes.

5.12.8.2.2

8.4.2.2.2 Automatic Speeds. Since aeronautical messages contain a high proportion of figures, it is necessary to transmit an average message of approximately 40 words at a speed of 60 words per minute in order to achieve a circuit transmission time of one minute.

5.12.8.3

8.4.2.2.3 Average circuit transmission time. The average circuit transmission time of a message on the Aeronautical Fixed Telecommunication Network, therefore, should be taken for planning purposes as one minute for teletypewriter and automatic CW circuits, and as three minutes for manual CW circuits.

Note. - This circuit transmission time is applied to a message comprising approximately 40 words transmitted in the 5-unit code at a speed of 50 bauds on teletypewriter circuits, of 25 words per minute on manual CW circuits, and 60 words per minute on automatic CW circuits.

5.12.9

8.4.3 Number of Relay Stations

5.12.9.1

8.4.3.1 The number of relays used between two communication centres should be such that the total transit time will not exceed the appropriate total transit time prescribed in paragraph 7.3 or as determined regionally in application of paragraph 7.1.

Doc 7171
COM/544
5.12.10

8.4.4 Circuit Delay

8.4.4.1 The circuit delay is the time a message is waiting at the transmitting point due to occupancy of the circuit and is caused by the loading of the circuit. Since, on a single circuit, the expected proportion of traffic delayed is numerically equal to the "utilization factor /actual traffic - nominal circuit capacity/" of the circuit, it can be appreciated that if, for example, a circuit is operated at a utilization factor of 40% then the expected proportion of undelayed traffic would be 60%.

5.12.10

8.4.4.2 Further, since messages of the "higher priorities" constitute slightly more than 50% of the total message traffic handled, a criterion of 40% utilization factor should be selected in planning circuit efficiency (see paragraph 7.4.5).

5.12.10.1

8.4.4.3 When the utilization factor of an existing circuit exceeds approximately 40%, the competent authority should determine, on the basis of the traffic volume handled by each circuit, the steps to be taken either to increase the capacity of the existing circuit or alternatively to provide additional circuits.

Note 1. - The utilization factor of 40% represents, on a transmission rate of 50 bauds, approximately 1600 words in the peak hour on a simplex teletypewriter circuit and 1600 words in each direction in the peak hour on a duplex teletypewriter circuit.

Note 2. - Assuming a transmission speed of 15 words per minute, the nominal circuit capacity of a manual CW circuit is 900 words per hour. A utilization factor of 40% represents 360 words in the peak hour.

5.12.11

8.4.5 Message Priorities. The effect of message priorities on traffic handling does not increase the average circuit delay suffered by all traffic. Hence, if communication circuits are engineered, not in terms of the average circuit delay, but in terms applicable to

Doc 7171
COM/544
5.12.11
(Cont'd)

Class A messages of the lowest priority and provided the utilization factor (see paragraph 8.4.4) is arranged to make the expected portion of undelayed traffic 60% or more, the "higher priority" messages would not suffer circuit delay due to loading of circuits.

- END -

PRICE: $0.10 (Cdn.) (Montreal)
Equivalents at date of publication:
L.E. 0.035 (Cairo)
1.50 soles (Lima)
8d. (London)
10d. (Melbourne)
35 francs (Paris)