Manual on the Global Telecommunication System

Annex III to the WMO Technical Regulations

2023 edition

WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

WMO-No. 386

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EDITORIAL NOTE

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INTRODUCTION

Purpose

1. The *Manual on the Global Telecommunication System* is issued in accordance with the decision of the Sixth World Meteorological Congress.

2. This Manual is designed:

(a) To facilitate cooperation in respect of meteorological telecommunications between Members;
(b) To specify obligations of Members in the implementation of the World Weather Watch (WWW) Global Telecommunication System (GTS);
(c) To ensure uniformity and standardization in the practices and procedures employed in achieving (a) and (b) above.

3. The Manual contains the regulatory material for the WWW Global Telecommunication System.

4. The Manual forms part of the Technical Regulations and is referred to as Annex III to the *Technical Regulations* (WMO-No. 49).

5. A number of detailed guidelines in respect of meteorological telecommunication practices and procedures are included in attachments to the Manual.

Notes:

1. The *Manual on the Global Telecommunication System* replaces the regulatory material contained in Chapters I and II of *Weather Reporting* (WMO-No. 9), Volume C, with effect from 15 January 1975, in accordance with Recommendation 17 (CBS-VI) approved by Resolution 3 (EC-XXVI).
2. The General Provisions to the Technical Regulations, formerly reproduced as a part of the present manual, can be found in the publication *Technical Regulations* (WMO-No. 49), Volume I – General Meteorological Standards and Recommended Practices.
3. The former appendix to the General Provisions, entitled "Procedures for amending WMO manuals and guides that are the responsibility of the Commission for Basic Systems", previously a part of the present manual, has been updated and can be found in the publication *Rules of Procedure for Technical Commissions* (WMO-No. 1240), Annex VII.

PART I. ORGANIZATION OF THE GLOBAL TELECOMMUNICATION SYSTEM

1. FUNCTIONS, ORGANIZATION AND PRINCIPLES OF THE GLOBAL TELECOMMUNICATION SYSTEM

1.1 Functions

The functions of the Global Telecommunication System (GTS) as a key component within the WMO Information System (WIS) shall be to facilitate the flow of data and processed products to meet the WWW requirements in a timely, reliable and cost-effective way, ensuring that all Members have access to data and products in accordance with approved procedures and within the limits of the agreed WWW system.

Note: It also gives telecommunication support to other programmes as a part of WIS and as decided by the WMO Congress or the Executive Council, within the limits of its primary objectives.

1.2 Organizational principles of the GTS

1.2.1 The Global Telecommunication System shall be so organized as to accommodate the volume of meteorological information and its transmission within the required time limits as the core network of WIS and to meet the needs of World, Regional Specialized and National Meteorological Centres, resulting from the implementation of the WWW.

1.2.2 The GTS shall be organized on a three-level basis, namely:

(a) The Main Telecommunication Network (MTN), linking together the WMCs as well as designated Regional Telecommunication Hubs (RTHs);
(b) The regional telecommunication networks; and
(c) The national telecommunication networks.

Note: The components of the MTN connecting the WIS Global Information System Centres is also referred to as the WIS Core Network (see the *Manual on the WMO Information System* (WMO-No. 1060), Volume I).

1.3 Design principles of the GTS

The design principles for the planning of the GTS shall be as follows:

Principle 1

The Global Telecommunication System shall be designed as an integrated network for the collection, exchange and distribution of information on a worldwide basis, with a view to meeting, efficiently and effectively, the requirements of all National Meteorological Services and also the requirements of World and Regional Specialized Meteorological Centres, within the agreed WWW system.

Principle 2

The system shall comprise an integrated network of point-to-point circuits, point-to-multipoint circuits, broadcast and multipoint-to-point circuits which are reliable and have suitable technical and operational characteristics. These circuits may be established via a combination of terrestrial and satellite telecommunication links, and data-communication network services.

Notes:

1. In this Manual, the word circuit is traditionally understood to represent a physical link between two Centres, but in today's modern telecommunication systems could also be understood to represent a logical stream of data between two Centres that are interconnected using a network. In this latter situation, several circuits could be implemented from a given Centre over a single physical connection to a network.
2. A GTS circuit is a specialized form of a WMO Information System (WIS) circuit and, for convenience, the status of any WIS link between WIS Centres may be recorded as being in one of four states:
   B1 – Negotiating
   B2 – Circuit operational
   B3 – Pending GTS status
   B4 – GTS circuit.

Principle 3

The circuits to be provided and the techniques to be employed shall be adequate to accommodate the volume of meteorological and related information and its transmission within the required time limits to meet the needs of World, Regional Specialized and National Meteorological Centres.

Principle 4

In the planning of the circuits and transmission schedules, daily volume of traffic to be passed over any one circuit shall not exceed 80% of its theoretical capacity. The circuits shall be designated to ensure the highest practicable reliability and availability.

Principle 5

The system shall be based mainly on the interconnection of a number of centres, namely, National Meteorological Centres (NMCs), Regional Specialized Meteorological Centres (RSMCs), Regional Telecommunication Hubs (RTHs) and World Meteorological Centres (WMCs). The WMCs, RSMCs and RTHs shall be provided with suitable equipment for selection, switching and editing in order to provide NMCs with the data selected to meet the NMCs' specified needs.

Principle 6

Provision shall be made for alternative routings where practicable, to ensure the reliability and efficiency of the system, particularly the reliability and efficiency of the MTN.

1.4 Responsibilities for the GTS

1.4.1 *General responsibilities of regional associations*

The following shall be the general responsibilities of regional associations:

(a) Each regional association shall assume responsibility for the establishment and maintenance of an effective telecommunication system which shall include the optimal and appropriate use of terrestrial and/or satellite telecommunication means. The system shall be adequate to meet the developing requirements stipulated by the former Commission for Basic Systems for the interchange of meteorological and related information within the Region and with adjacent Regions;

(b) To ensure rapid and reliable collection of meteorological data from all observing stations, each regional association shall, when adopting its telecommunication plan, comply with the design and operational principles given in this Manual. These principles apply to those centres and circuits within its Region which are situated on the MTN;

(c) Each regional association shall decide on the implementation within its Region of the regional options provided for in the global specifications and procedures;

(d) For data dissemination systems (either terrestrial or via satellite), each regional association shall establish, after consultation with known or probable recipients inside and outside the Region and the Member responsible for the operation of such systems, the content, schedule, and other coordinated aspects of operations.

1.4.2 *General responsibilities of Members*

In addition to the responsibilities stated explicitly in the *Technical Regulations* (WMO-No. 49), Volume I, Part II, 1.3.1, the following principles shall apply:

(a) Members shall ensure that their national collecting system for observational reports allows both national and international needs to be met;
(b) When adopting international and regional telecommunication plans, Members shall ensure that technical characteristics and operational methods are compatible with the regional telecommunication networks.

Note: The contents and schedules of meteorological transmission programmes are published in *Weather Reporting* (WMO-No. 9), Volume C.

2. FUNCTIONS AND RESPONSIBILITIES OF THE METEOROLOGICAL TELECOMMUNICATION CENTRES

2.1 The WMCs (as regards telecommunications) and the RTHs shall be responsible for:

(a) Collecting the bulletins from their associated NMCs and transmitting them in the appropriate form on the MTN, either directly or through the appropriate WMC/RTH;
(b) Transmitting on the MTN, either directly or through the appropriate RTH, as internationally agreed and in the appropriate form, the processed meteorological information produced by the WMC or RSMC associated with them;
(c) Relaying selectively on the circuits of the MTN, as agreed, the bulletins which they receive from these circuits and/or from RTHs not situated on the MTN;
(d) Ensuring the selective distribution of bulletins to the associated NMCs and to the RTHs not situated on the MTN which they serve;
(e) Before relaying a message issued from their zones of responsibility (as an RTH in a Region and/or as an RTH located on the MTN) on the GTS, checking the parts related to the telecommunications of the message in order to maintain standard telecommunication procedures. The RTH informs the associated centre originating or compiling the message of any correction to be made to the message. The RTH and its associated centres make arrangements for the insertion of the message without telecommunication errors on the GTS. Messages issued from outside the zone of responsibility of an RTH shall not be corrected by the RTH except in case of special arrangements for inserting data into the GTS;
(f) Establishing data dissemination systems (terrestrial and/or via satellite) as required in accordance with regional plans;
(g) Carrying out the monitoring of the operation of the GTS of the WWW;
(h) For WMCs/RTHs on the MTN, maintaining the Catalogue of Meteorological Bulletins as regards bulletins issued from the zone for which they are responsible for the collection, exchange and distribution of data, as given in paragraph 1, Attachment I-3, and also including data from the Antarctica, as appropriate. WMCs/RTHs on the MTN may share their responsibility with the RTHs (not on the MTN) included in their zone of responsibility through regional arrangements.

Note: The plan for monitoring the operation of the WWW is given in Attachment I-5.

2.2 RSMCs not combined with RTHs should ensure distribution of their products by agreement with an appropriate GTS centre or centres.

2.3 **With regard to telecommunications, the NMCs shall be responsible for:**

(a) Collecting observational data from their own territory or that of one or more Members according to bilateral agreements, as well as observational data from aircraft and ships received by centres located within the area of responsibility. This collection shall take place as soon as possible and shall be completed within 15 minutes of the observing station's filing time;

Notes:

1. The observing station's filing time is defined as the time at which the coded meteorological report is first presented to the telecommunication system. For an aircraft or ship weather report, it is the time when it is received by the appropriate communication station (land station/coast station).
2. Under normal conditions, the report should be presented to the telecommunication system not later than five minutes after the completion of its coding.

(b) Compiling such data into bulletins and transmitting them to the associated RTH, in compliance with standard telecommunications procedures;

Note: NMCs may be associated with more than one RTH.

(c) Receiving and distributing for their benefit and that of Members that request them, in accordance with bilateral agreements, observational data and processed meteorological information, to meet the requirements of the Members concerned;

(d) Carrying out the relevant monitoring of the operation of the GTS of the WWW.

Notes:

1. Checking of meteorological content of national observational data is to be accomplished by the responsible NMCs, or the other originating centres as appropriate (see paragraph 2.4 below), before such data are compiled into bulletins for further transmission on the GTS.
2. The plan for monitoring the operation of the WWW is given in Attachment I-5.

2.4 **Each member shall designate an NMC, or other centre as appropriate, for performing the functions mentioned in paragraph 2.3 above, as well as for the meteorological checking of national observational data before such data are presented for further transmission on the GTS.**

2.5 General responsibility for the collection of meteorological reports

Members shall operate centres responsible for the assembly of reports from individual land stations, as well as meteorological reports from stations at sea and aircraft.

2.6 Responsibility for the collection of meteorological reports from stations at sea through coast stations and coast Earth stations

2.6.1 Members should make the necessary arrangements with telecommunication authorities or appropriate telecommunication administrations to establish procedures for the collection of meteorological reports from ships through coast stations and coast Earth stations (INMARSAT), in order to ensure an effective transmission link between a coast station/coast Earth station and a collecting centre.

2.6.2 Members should be encouraged to develop the use of automatic transmission from ships to the designated collecting centres without relay by operators.

2.6.3 **Members responsible for the collection of meteorological reports from ships shall provide the Secretariat with a list of their coast stations and coast Earth stations designated for this purpose, including information on location, call signs, working transmission and reception frequencies.**

Note: The list of coast stations and coast Earth stations accepting ships' weather reports is published in *Weather Reporting* (WMO-No. 9), Volume D, Part B.

2.6.4 **Members shall send necessary amendments to the information supplied under paragraph 2.6.3 above to the Secretariat.**

2.6.5 **Each Member designating a coast station for reception of meteorological reports from ships or designating a coast Earth station for reception of meteorological reports from ships in a defined geographical area of interest to the Member shall confirm to the Secretariat that the Member will be responsible for any transmission cost of such reports being sent to its collecting centre.**

2.6.6 **Members shall provide their designated ship stations and ship Earth stations with details of the procedures for addressing and routing meteorological reports in different sea areas.**

Note: Details of these procedures are given in Attachment I-1.

2.6.7 **Members responsible for the insertion into the GTS of meteorological reports from ships shall ensure that the reports are in conformity with WMO standards and that they are transmitted under appropriate bulletin headings.**

2.6.8 Members responsible for the reception of meteorological reports from ships should arrange that coast stations adequate in number, staffing and telecommunication capacity are available to discharge this responsibility.

2.6.9 Members should request ships to transmit their meteorological reports to a coast station or a coast Earth station as soon as possible after the time of observation.

2.6.10 **Each Member shall arrange with the services responsible for operating coast stations designated to accept meteorological reports from ships so that those stations:**

(a) Accept such reports with the least possible delay;
(b) Transmit them immediately to the designated collecting centres.

2.6.11 Members should ask ships not to send the same meteorological report to more than one address.

2.6.12 **Each Member, in consultation with its telecommunication administration, shall arrange that the service indicator OBS is used in the original call from observing ships to the coast stations for securing the appropriate priority of answer by the coast station. The abbreviation OBS shall also be included as a paid service indicator in the preamble of ships' weather messages transmitted from observing ships to coast stations for securing appropriate priority handling of messages by coast stations.** This does not apply in cases where automatic access codes over satellites or automatic radiotelex are employed.

2.6.13 Members should arrange for the word METEO to be employed as the first word in the address of ships' weather reports. This does not apply in cases where automatic access codes over satellites or automatic radiotelex are employed.

2.6.14 Members should arrange with their telecommunication administrations for the inclusion of call signs of ships, when available, in the preamble of meteorological reports from selected, supplementary and auxiliary ship stations when transmitted from coast stations to collecting centres.

2.6.15 Meteorological reports from ships, when included in collective transmissions, should include the call sign of the ship.

2.6.16 Whenever meteorological reports from ships received at collecting centres are insufficient or unduly delayed, the Member responsible for the collection should first take local or regional action in an endeavour to correct the deficiency and, if such action is not effective, notify the Secretariat.

2.6.17 Members should make every effort to encourage ships in ocean areas where shipping is relatively sparse to relay weather messages through other ships when the reporting ship is unable to communicate with coast stations or coast Earth stations or when communication conditions are difficult.

2.6.18 Members should encourage ships to exchange radio weather messages for the benefit of each other when in areas where shipping is sparse or where no regular weather bulletin is issued.

2.7 Responsibility for collection (reception) of reports from aircraft

2.7.1 **Collecting centres designated in the ICAO Regional Air Navigation Plans for the collection of aircraft weather reports shall send all available aircraft weather reports to the NMC situated in the respective country or to other meteorological centres designated by agreement between the aeronautical and meteorological authorities concerned.**

2.7.2 **RTHs shall collect the aircraft weather reports from the NMCs in their respective zones of responsibility.**

2.8 Responsibility for meteorological reports from automatic surface synoptic stations

2.8.1 Messages from automatic surface synoptic stations put in international code form by an editing station should be transmitted expeditiously to appropriate collecting centres.

2.8.2 Messages directly transmitted by automatic surface synoptic stations in code form for international exchange should be transmitted with sufficient strength to ensure reception at appropriate collecting centres.

2.8.3 Members operating automatic synoptic surface stations on drifting buoys should make every effort to communicate to other interested Members all of the necessary information (e.g. radio frequencies and code forms) to enable them to receive the transmissions from those drifting automatic stations which may have moved beyond the range of the receiving stations of the Members that launched the station.

2.8.4 Other observational data from drifting buoys available at satellite data-processing centres should be made available to the appropriate WMCs/RTHs for regional and global distribution over the GTS, using the appropriate code form for international exchange.

Note: Additional guidance concerning the functions and capabilities of meteorological telecommunication centres is given in Part III of this volume.

2.9 Responsibilities for exchange and distribution of processed meteorological information

The GTS should be capable of exchanging and distributing the output products of WMCs and RSMCs as well as World Area Forecast Centres (WAFCs) and Regional Area Forecast Centres (RAFCs), as required.

3. FUNCTIONS AND CHARACTERISTICS OF THE NETWORKS OF THE GLOBAL TELECOMMUNICATION SYSTEM

3.1 The Main Telecommunication Network (MTN)

3.1.1 The MTN shall be an integrated system of circuits linking together the GISCs on the WIS Core Network and designated RTHs.

Note: The names of these centres, together with a diagram indicating the configuration of the MTN, are given in Attachment I-2.

3.1.2 The MTN shall be designed in such a way that the traffic originating from each centre (WMC, designated RTH) will be routed selectively towards the addressee centre(s). Each centre on the MTN shall ensure selective relay of the traffic which it receives towards the circuit(s) which it serves.

3.1.3 The MTN shall have the function of providing an efficient, reliable communication service between the designated centres, in order to ensure:

(a) Rapid and reliable exchange of observational data required to meet the WMO Integrated Processing and Prediction System (WIPPS, formerly GDPFS) requirements;
(b) Exchange of processed information between the WMCs, including data received from meteorological satellites;
(c) Transmission of processed information produced by the WMCs, to meet the requirements of RSMCs and NMCs;
(d) Transmission of other observational data and processed information required for interregional exchange.

Note: Responsibilities of RTHs, including those located on the MTN for the transmission of observational data and processed information are given in Attachment I-3.

3.2 Regional meteorological telecommunication networks (RMTNs)

3.2.1 The regional meteorological telecommunication networks shall consist of an integrated network of point-to-point circuits, point-to-multipoint circuits and multipoint-to-point circuits which interconnects RTHs, NMCs, and in some regions WMCs and/or RSMCs and also, where needed, radio broadcasts in accordance with the regional meteorological telecommunication plans for WWW established by the regional associations. These networks shall be designed so as to enable the WMCs, RTHs and NMCs to perform the functions defined in section 2 above.

Note: The centres which are situated on the regional meteorological telecommunication networks are specified by the regional associations.

3.2.2 The regional meteorological telecommunication networks comprise the following meteorological transmission systems and circuits:

(a) The circuits of the MTN which pass through the Region;
(b) The main regional circuits, consisting of point-to-point circuits (either landline or satellite) interconnecting the RTHs in the Region;
(c) The regional circuits, consisting of point-to-point circuits, point-to-multipoint circuits and multipoint-to-point circuits (landline, satellite or radio) connecting the NMCs to the RTHs or other NMCs in the Region;
(d) Interregional circuits, consisting of point-to-point circuits (landline, satellite or radio) interconnecting RTHs or WMCs to RTHs in different Regions;

(e) Supplementary interregional circuits, consisting of point-to-point circuits (landline, satellite or radio) which connect WMCs, RTHs and NMCs to RSMCs or NMCs located in other Regions;
(f) Radio broadcasts and other radio facilities.

3.2.3 *Functions specified within the framework of the GTS*

In order to obtain rapid collection and distribution of observational data or processed information for all National Meteorological Services, the regional meteorological telecommunication networks shall be engineered so as to ensure:

(a) Exchange and distribution of observational data within the Region, as required to meet the needs of Members of the Region;
(b) Collection of observational data originating in, or being received by, stations located in the Region (e.g. reports from aircraft and ships);
(c) Collection of observational data from associated NMCs in adjacent Regions provided that this is found to be of use to the GTS and provided that this is agreed upon by the Members concerned and the corresponding regional associations;
(d) Exchange and distribution of processed (conventional and satellite) information as required to meet the needs of Members of the Region;
(e) Interchange of observational data and processed information with other Regions.

3.2.4 *Contents of meteorological transmissions by point-to-point circuits*

3.2.4.1 **The contents of meteorological transmissions on main regional circuits and regional circuits shall be determined by the regional associations to meet the requirements of the Members of the Region concerned.**

3.2.4.2 **The contents of meteorological transmissions on interregional circuits and supplementary interregional circuits shall be established by interregional and/or bilateral agreements between Members.**

3.3 National meteorological telecommunication networks (NMTNs)

3.3.1 *General functions within the framework of the WWW*

3.3.1.1 **The national meteorological telecommunication networks shall be engineered so as to enable the NMCs to perform the functions defined in paragraph 2.3 above.**

3.3.1.2 **The choice of telecommunication networks and facilities for the collection of information from stations located within a country or territory shall be a matter for decision by the Member concerned.**

3.3.1.3 The arrangements for national collections should comply at least with the WWW requirements as regards maximum tolerable delay and reliability of reception.

3.3.1.4 In order to meet the needs of the WWW for timely and reliable transmission and reception, telecommunication networks intended solely for meteorological requirements should be established.

3.3.1.5 Where facilities mentioned in paragraph 3.3.1.4 above are not available or are not practicable, arrangements should be made for the use of other facilities, such as:

(a) Special-purpose telecommunication systems (e.g. aeronautical circuits);
(b) Commercial telecommunication services available to the public.

3.3.1.6 Provision should be made, whenever possible, for a mutilated or erroneous report to be repeated by the observing station at the request of the NMC concerned.

3.3.2 *Programmes of transmissions from NMCs to RTHs*

Transmissions from NMCs to the appropriate RTH or RTHs shall include at least the following information:

(a) Surface and upper-air synoptic reports from land stations and fixed ship stations required by regional agreement for regional and interregional exchange;
(b) All reports from mobile ship stations and aircraft received either directly or from other collecting centres, within the area covered by the NMC transmission;
(c) Other information as required by regional agreement.

Note: In order that the observational data may reach the centres of the GTS in time, priority is first given to:
(a) The collection of the required observational data on a national basis;
(b) The transmission of the data so collected to the associated RTHs.

3.4 Satellite-based data collection and dissemination systems

3.4.1 *Introduction*

3.4.1.1 Satellite-based data collection and distribution systems are integrated in the GTS as an essential element of the global, regional and national levels of the GTS.

3.4.1.2 They should comply with the organization and principles of the GTS, particularly with respect to the functions and responsibilities of meteorological telecommunication centres.

3.4.1.3 They operate through communication functions of meteorological satellites and through public telecommunication services via satellite.

3.4.1.4 The principles for the planning of satellite-based data distribution should be as follows:

(a) A satellite-based distribution system should be a telecommunication technique complementing the point-to-point GTS circuits;
(b) RSMCs, RTHs and NMCs should have the capacity to insert meteorological information (either directly or indirectly) into the regional/multiregional satellite-based distribution system.

3.4.2 *Data collection systems via meteorological satellite*

3.4.2.1 Data collection systems and associated data retransmission systems, when available, operated via geostationary or near-polar orbiting meteorological satellites constitute an integral part of the GTS for the collection of observations. Basic meteorological data collected in this way normally requires validation by the NMC before it is disseminated on the GTS for general use. By agreement, data not subject to verification may be inserted onto the GTS via a nominated NMC.

3.4.2.2 **Data collection platforms (DCPs) shall be maintained by the DCP operators. Quality control of the output from these platforms is the responsibility of the operator and the nominated NMC.**

3.4.2.3 **Unless agreed upon otherwise, the meteorological satellite operator shall ensure the prompt transmission of the received DCP message to the NMC responsible for quality control and verification prior to its general dissemination on the GTS.**

3.4.2.4 The data collection platforms must operate in accordance with the parameters as defined by the meteorological satellite operator.

3.4.3 *Data distribution systems via meteorological satellites*

3.4.3.1 Data distribution systems operated via geostationary meteorological satellites constitute an integral part of the GTS for the point-to-multipoint transmission of observational data and processed information in character, binary, graphical and pictorial form, within the agreed WWW system.

3.4.3.2 **The point-to-multipoint service to be provided by the meteorological satellite operator shall be subject to agreement between the NMCs concerned and the agencies participating in the programmes. The NMC acting as data provider to the meteorological satellite operator whether they originate the data or not shall be responsible for relaying the input data.**

3.4.3.3 **The contents and schedules of transmission, as well as frequencies, orbital data and area coverage of meteorological satellites shall be provided by satellite operators.**

Notes:

1. The contents and schedules of transmission by meteorological satellites are published in *Weather Reporting* (WMO-No. 9), Volume C.
2. Information on meteorological satellite programmes operated by Members and organizations is available at https://space.oscar.wmo.int.

3.4.4 *Point-to-multipoint and multipoint-to-point transmission via telecommunication satellites*

3.4.4.1 Point-to-multipoint telecommunication service via satellite provided by telecommunication administrations/agencies may be used as an integral part of the GTS for the direct distribution to NMCs of observational data and processed information from WMCs, RSMCs and NMCs at the global, multiregional or regional level.

3.4.4.2 Multipoint-to-point telecommunications service via satellite provided by telecommunication administrations/agencies may be used as an integral part of the GTS for the implementation of regional meteorological telecommunications networks, in accordance with the plans established by the regional associations.

3.5 HF-radio broadcasts of meteorological information

3.5.1 *General*

Until the integrated network, as defined in principle 2 (see paragraph 1.3 above), is completed, HF-radio broadcasts may be used in order to meet the requirements of the WWW for the dissemination of meteorological information.

3.5.2 *Responsibilities of Members*

3.5.2.1 **When a Member establishes within its territory a routine meteorological broadcast intended for use by other Members, the Member shall send the following information, as appropriate, to the Secretariat:**

(a) Name and call sign, or other identification, of transmitting station;
(b) Power supplied to the antenna;

(c) Class of emission, necessary band width;
(d) Frequencies;
(e) Contents, detailed time schedules and WMO category of the broadcast;
(f) Index of cooperation and drum speed(s) of facsimile transmitter;
(g) Specific point(s) or area(s) in which the broadcast is intended to be received.

3.5.2.2 **Amendments to the information supplied under paragraph 3.5.2.1 above shall be sent to the Secretariat at least two months before a routine meteorological broadcast is established or a change is made in an existing routine broadcast.**

3.5.2.3 **In addition to the information supplied to the Secretariat under paragraph 3.5.2.2 above, notification of impending changes in frequencies or in time schedules of any routine meteorological radio broadcasts shall be included by the Member concerned in the broadcasts for main synoptic hours for at least three days immediately prior to the change.**

3.5.2.4 **When it is necessary to discontinue a broadcast intended primarily for reception by other Members, provision shall be made to continue to meet the requirements of all recipients of the broadcast.**

Note: Broadcasts by a Member intended primarily for its own use are not affected by the above, even if they are used by other Members.

3.5.2.5 **When it is necessary or desirable to change the mode of a broadcast intended primarily for reception by other Members, notice of a duration agreed regionally or multilaterally shall be given to the recipients.**

Notes:
1. On expiry of this notice it will be assumed that the requirements of the recipients are met by the broadcasts in the new mode.
2. Broadcasts by a Member intended primarily for its own use are not affected by the above, even if they are used by other Members.

3.5.2.6 A Member experiencing difficulties in receiving or observing any deficiencies in a broadcast intended for its reception, as agreed, should first take corrective action of a local nature and, if unsuccessful, notify in detail the Member making this broadcast and also keep the president of the relevant regional association informed as necessary.

3.5.3 **The system of radio broadcasts shall be as follows:**

3.5.3.1 RTT broadcasts

Classification	*Content*	*Intended reception area*	*Responsibility for operations*
A. Territorial broadcasts	**Meteorological information from the territory or territories of one or more Members and ship and aircraft reports as received in this territory or territories**	**(a) At one or more designated RTHs (b) Within the area of origin of the information (c) In adjacent countries as regionally or interregionally agreed**	**Mandatory for NMCs until a reliable point-to-point system is available to the associated RTH. Otherwise optional for national purposes**
B. Regional broadcasts	**Selection of meteorological information as agreed regionally and coordinated interregionally as necessary**	**Within a specified area in a Region and in an interregionally agreed area**	**WMCs and RTHs in accordance with the regional meteorological telecommunication plans**

3.5.3.2 Radio-facsimile broadcasts

Classification	*Content*	*Intended reception area*	*Responsibility for operations*
Regional broadcasts*	**Products of the RSMCs in the Region, products of WMCs and other RSMCs as agreed regionally and coordinated interregionally as necessary**	**Within a specified area in a Region and in an interregionally agreed area**	**WMCs, RSMCs and RTHs in accordance with the regional meteorological telecommunication plans**

* This classification does not preclude the establishment of facsimile broadcasts by NMCs.

ATTACHMENT I-1. ARRANGEMENTS FOR THE COLLECTION OF SHIPS' WEATHER REPORTS AND OCEANOGRAPHIC REPORTS (BATHY/TESAC)

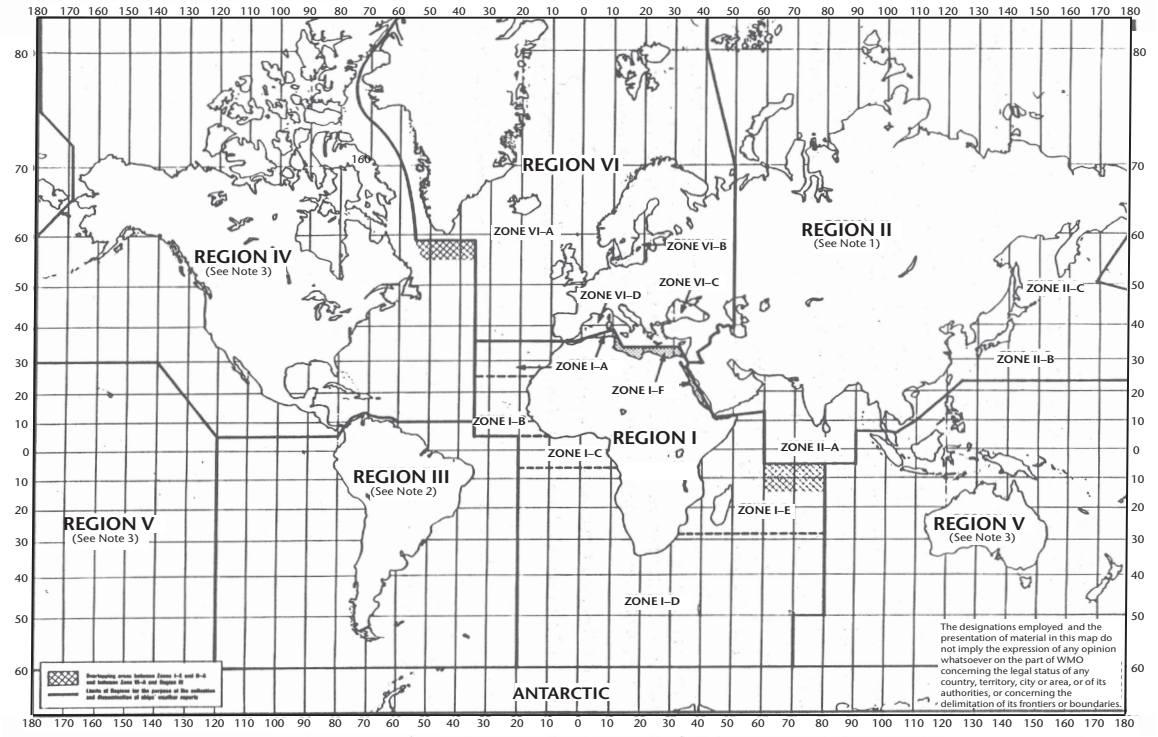
Note: This attachment is designated as technical specifications in accordance with Resolution 12 (EC-68).

1. ZONES FOR THE COLLECTION OF SHIPS' WEATHER REPORTS

Oceanic and sea areas are divided first into WMO Regions and the Antarctic and then, within each Region, into a small number of zones determined by the regional associations concerned in accordance with the following principles:

(a) As a rule, zones should be linked to RTHs responsible for the international dissemination of the reports collected by coast stations and coast earth stations in the zone;
(b) By way of exception, zones pertaining to one Region may extend into the sea area of an adjacent Region, if so agreed between the two regional associations concerned;
(c) Along the border line between two Regions, zones pertaining to each Region may overlap each other, if so agreed between the two regional associations concerned.

The zones for the collecting of ships' weather reports, as agreed by regional associations and the Executive Council, are shown in Figure 1.



Notes:

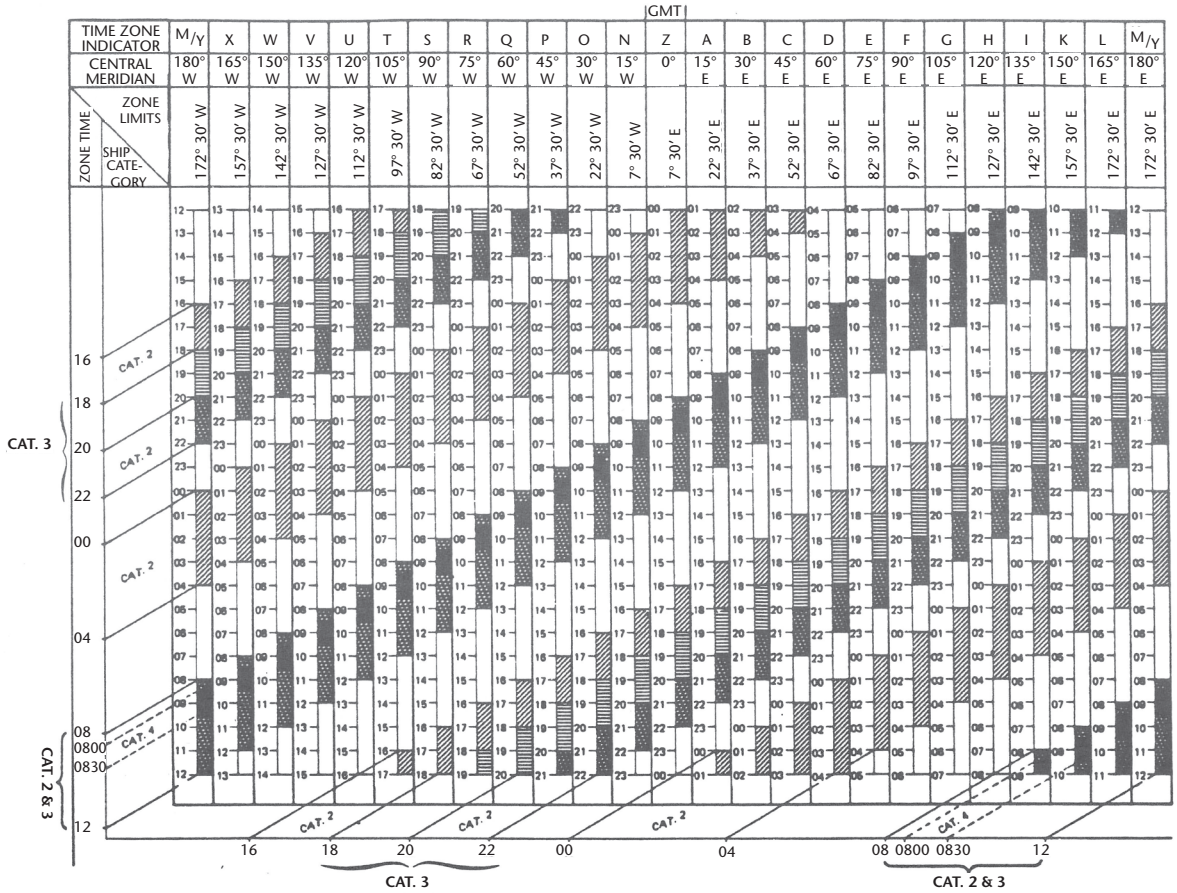
1. While Zone II–C should comprise the northern part of the Sea of Japan and other portions of the North Pacific in Region II, and Zone II–B should comprise the southern part of the Sea of Japan and the southern part of the Pacific in Region II, a strict boundary has not been defined between Zones II–B and II–C.
2. For the collection of ships' weather reports, Region III is a single zone. Ships navigating in Region III should therefore transmit their weather reports through the nearest coastal radio station within the Region. As a temporary measure, ships plying the Pacific waters of the Region should continue to clear their weather reports through the coastal radio station Balboa – NBA, if unable to contact other HF coastal radio stations within Region III.
3. No subdivision of Regions IV and V into zones has been found necessary. Ships navigating in Region IV or V should therefore transmit their weather reports through the nearest coastal radio station within the Region concerned.
4. The border lines between Regions VI and IV shall be considered flexible in order to facilitate the transmission of ships' weather reports from the sea areas near these borders to a coastal station in one or the other Region.

Figure 1. Broad outline of zones for the collection and dissemination of ships' weather reports

2. TRANSMISSION OF SHIPS' WEATHER REPORTS TO COAST STATIONS AND COAST EARTH STATIONS

2.1 Weather reports from ship stations and ship earth stations should be transmitted to a coast station or a coast earth station as soon as possible after the time of observation.

2.2 Weather reports from ship stations should be compiled in 10-figure groups, where desirable and appropriate. The ship's call sign should appear alone at the beginning of the report. Thereafter, the groups are simply run together to form 10-figure groups. If a 5-figure group is left over, it is sent as a 5-figure group. If the identifier 333 appears, it will run together with the adjacent five figures to form an 8-figure group. The restoration to 5-figure groups should be carried out not later than at the point of insertion in the GTS – usually at the NMC involved. The above arrangements do not apply to the parts of ships' weather reports prepared in plain language.



Notes:

1. The above figure indicates the fixed and elected hours of service maintained by ships of the second and third categories in terms of zone time. (The hours of service shown exclude those which are determined by the administration, master, or person responsible.)
   The fixed hours of watch are shown thus:
   (a) For ships of the second category;
   (b) For ships of the second and third categories;
   (c) For ships of the third category, period over which two continuous hours of service may be elected.
2. Also shown (in black) is the specific service period 0830–0930 that ships of the fourth category are encouraged to provide.

Figure 2. Time zones and hours of service of ship stations

Example:

WLGT 0518499568 7020141498 5231410083 2001640198 5301270282 8323222200
0010320303 3263040907 50805333 8381583360

2.3 Weather reports from ship stations and ship earth stations should (without special request) be transmitted to the nearest available coast station or appropriate coast earth station situated in the zone in which the ship is navigating.

2.4 In a case where no ship earth station is available or if it is difficult, owing to radio propagation conditions or other circumstances, to contact promptly the nearest coast station in the zone in which the ship is navigating, the weather messages should be cleared by applying the following procedures in the order given below:

(a) Transmission to any other coast station in the zone in which the ship is navigating;
(b) Transmission to any coast station in an adjacent zone within the same Region;
(c) Transmission to any coast station in any other zone within the same Region;
(d) Transmission to a coast station in an adjacent zone in a neighbouring Region or, failing that, to any other station in a neighbouring Region;
(e) Transmission to another ship or an ocean weather station with the function of, or willing to act, as a relay station.

2.5 In zones situated along the border line between two Regions, the order of procedures for the transmission of ships' weather reports to coast stations, as laid down in subparagraphs (a), (b), (c), (d) and (e) of paragraph 2.4 above, may be interchanged subject to agreement between the two regional associations involved. Any agreement reached on this matter should specify the limits of the area concerned.

2.6 Members may issue instructions to their ship stations to the effect that their weather reports may be transmitted via one of their home coast stations designated for the collection of reports from the zone, if the application of such procedures may facilitate efficient contact with coast stations and the clearing of weather messages. Members may also issue instructions to their ship stations to transmit weather reports via particular coast earth stations through which the Member will be responsible for the transmission costs.

3. CRITERIA AND PERFORMANCE OF COAST STATIONS AND COAST EARTH STATIONS ACCEPTING SHIPS' WEATHER REPORTS

3.1 Members should ensure that the coast stations designated to receive ships' weather messages satisfy the following criteria:

(a) Accept ships' weather reports free of charge to ships;
(b) For the purpose of receiving ships' weather reports;
  (i) Keep a continuous 24-hour watch; or
  (ii) Keep a watch for at least 30 minutes beginning at 0000, 0600, 1200 and 1800 UTC daily; watch should also be kept for a similar minimum time at the beginning of the nearest "single-operator period" following those standard synoptic hours;* or
  (iii) Keep watch for shorter periods (stations with limited hours of operations) than those mentioned under (ii) above, when those stations are considered of particular value.

3.2 If any particular coast station is shown to consistently fail to accept ships' weather reports promptly or if the subsequent retransmission is deficient the president of the regional association concerned should take steps with a view to improving the situation and, if such

* A table showing the international watch keeping hours on board ships is given in Figure 2.

action does not succeed, action should be taken to remove that station from the list of designated coast stations.

3.3 Members whose ships repeatedly encounter difficulties in clearing ships' weather reports with coast stations in certain reporting areas should communicate promptly with the Members concerned giving full particulars as to dates and times; the presidents of the relevant technical commissions and the Secretary-General should also be informed.

3.4 Members should ensure that coast earth stations designated to receive ships' weather messages accept these reports free of charge to ships.

4. ADDITIONAL PROCEDURES FOR SINGLE-OPERATOR SHIPS

4.1 Owing to the difficulties resulting from fixed radio watch hours, single-operator ships, in making weather observations and in transmitting messages, should be guided by the procedures in the order given below.

4.2 When operational difficulties on board ship make it impracticable to make and/or transmit a surface synoptic observation at a main standard time (0000, 0600, 1200 and 1800 UTC), the actual time of observation should be as near as possible to the main standard time to ensure transmission of a message to a coast station before the radio officer goes off duty. Alternatively, in special cases, observations may be taken one full hour earlier than the main standard time and be timed accordingly (i.e. 2300, 0500, 1100 or 1700 UTC, respectively). However, it is emphasized that these departures should be regarded only as an exception.

4.3 When an observation is made at 0300, 0900, 1500 or 2100 UTC, in order to ensure its transmission to a coast station, the observation at the next main standard synoptic time, i.e. 0600, 1200, 1800 or 0000 UTC, should be made for climatological purposes and, if possible, transmitted as indicated in paragraph 4.4 below.

4.4 Observations made at any of the standard times 0000, 0600, 1200 and 1800 UTC should be transmitted even after a period of delay after the time of observation and:

(a) In most parts of the world they should be transmitted up to 12 hours after the time of observation if it is not possible to do so earlier;
(b) In the southern hemisphere and other areas where few ships' weather reports are available, they should be transmitted up to 24 hours after the time of observation.

It is important that this procedure be followed even if an observation for a more recent time is also being transmitted.

5. COLLECTION OF OCEANOGRAPHIC REPORTS (BATHY/TESAC)

5.1 BATHY and TESAC reports should be transmitted to METEO or METEOCEAN addresses through specified coast stations and coast earth stations.

Note: The list of coast stations and coast earth stations accepting BATHY and TESAC reports free of charge to ships together with their radio addresses is given in *Weather Reporting* (WMO-No. 9), Volume D, Part B and in the *Guide to Operational Procedures for the Collection and Exchange of JCOMM Oceanographic Data* (IOC Manuals and Guides No. 3).

5.2 When reports are relayed by operators to coast stations, the abbreviation OBS should be included as a paid service indicator before the address in BATHY and TESAC messages transmitted from observing ships to coast stations. This does not apply in cases where automatic access codes over satellites or automatic radio telex are employed.

5.3 BATHY and TESAC reports should be transmitted separately from meteorological (surface or upper-air) reports. They should be transmitted to a specified coast station at times which do not interfere with the transmission of meteorological reports, avoiding as far as possible the following periods:

2330 UTC–0200 UTC; 0530 UTC–0800 UTC;
1130 UTC–1400 UTC; 1730 UTC–2000 UTC

5.4 BATHY and TESAC reports should be transmitted from ships to coast stations as soon as possible after the time of observation. However, the reports may be transmitted up to 30 days after the time of observation in cases where operational difficulties do not permit their earlier transmission. The international date-time group in the abbreviated heading of the bulletins should be the time of origin of these bulletins in UTC (see Part II, paragraph 2.3.2.2 of this volume).

Note: The time of origin of bulletins refers to the time of compilation of bulletins by the GTS centres.

5.5 Geographical designators of the abbreviated heading of BATHY/TESAC bulletins should be in accordance with Table C2 of Attachment II-5.

Note: All BATHY/TESAC bulletins should be notified to the WMO Secretariat for inclusion in *Weather Reporting* (WMO-No. 9), Volume C1 – Catalogue of Meteorological Bulletins.

5.6 Specific monitoring of a BATHY/TESAC exchange over the MTN should be carried out in conjunction with the internationally coordinated monitoring on a non-real-time basis as prescribed in Attachment I-5.

ATTACHMENT I-2. RESPONSIBILITIES IN THE WMO INFORMATION SYSTEM FOR THE MAIN TELECOMMUNICATION NETWORK

Note: This attachment is designated as technical specifications in accordance with Resolution 12 (EC-68).

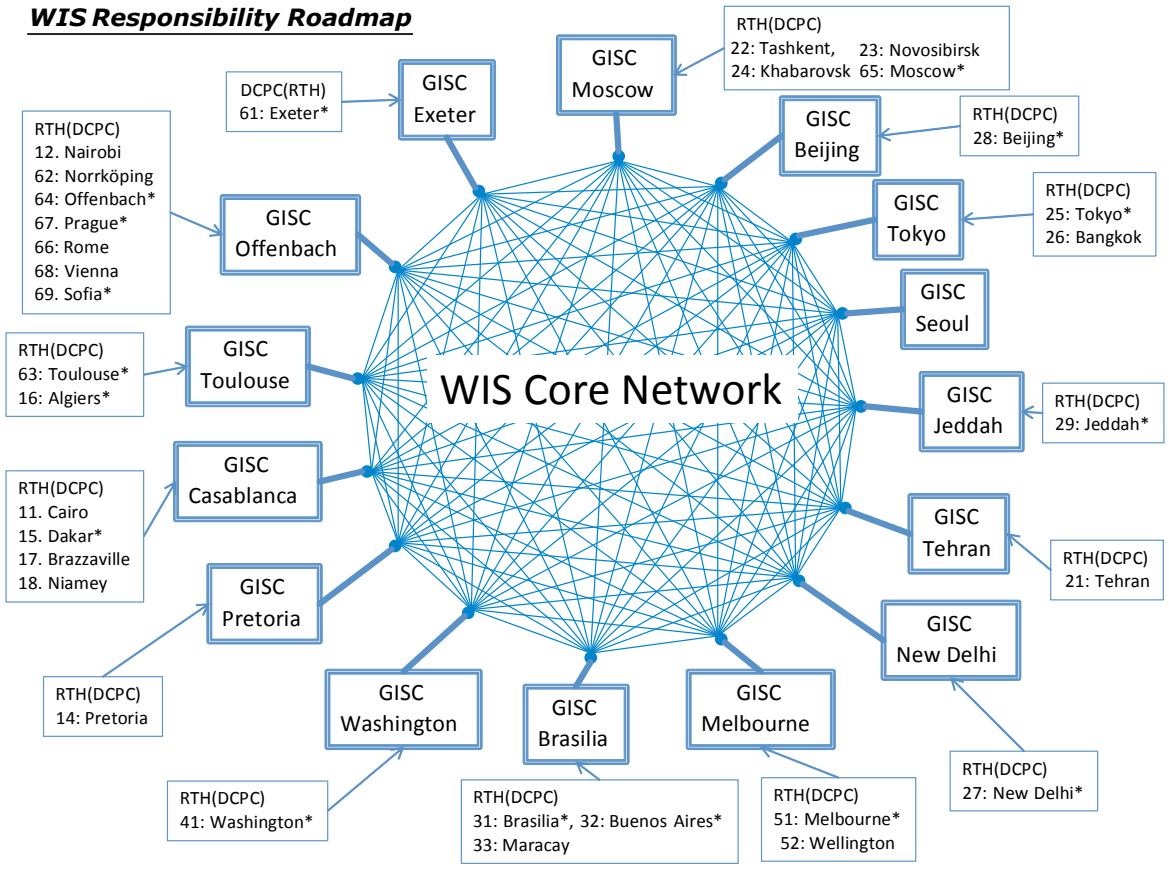


Figure. WMO Information System Regional Telecommunication Hubs responsibility plan

Note: Data flow does not always follow the same path as the responsibilities.

ATTACHMENT I-3. RESPONSIBILITIES OF REGIONAL TELECOMMUNICATION HUBS FOR THE TRANSMISSION OF OBSERVATIONAL DATA AND PROCESSED INFORMATION

1. RESPONSIBILITIES FOR THE COLLECTION, EXCHANGE AND DISTRIBUTION OF OBSERVATIONAL DATA OF REGIONAL TELECOMMUNICATION HUBS

The responsibilities are given in the following table:

RTH region	*RTH reference number*	*RTH city (country)* (*=RTH/MTN)	*RTH's principal GISC*	*RTH's backup GISC*	*RTH's area of responsibility*
1	11	Cairo* (Egypt)	Casablanca	Toulouse	Egypt, Libya, Sudan, adjacent sea areas
1	12	Nairobi* (Kenya)	Offenbach	Moscow/ Tokyo	Burundi, Djibouti, Ethiopia, Kenya, La Réunion, Rwanda, Somalia, Uganda, United Republic of Tanzania, adjacent ocean areas
1	13	Lusaka (Zambia)	Pretoria	Exeter	Malawi, Zambia, Zimbabwe
1	14	Pretoria (South Africa)	Pretoria	Exeter	Angola, Botswana, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Eswatini, La Réunion, South Africa, Zimbabwe, and the following centres via La Réunion: Antananarivo, Comoros, Mauritius, Seychelles, Amsterdam Island, Kerguelen, adjacent ocean areas
1	15	Dakar* (Senegal)	Casablanca	Toulouse	Ascension Island, Cabo Verde, Canary Islands, Cote d'Ivoire, Gambia, Guinea, Guinea-Bissau, Liberia, Madeira, Mali, Mauritania, Morocco, Nigeria, Senegal, Sierra Leone, St. Helena, adjacent ocean areas
1	16	Algiers* (Algeria)	Toulouse	Exeter	Algeria, Lebanon, Morocco, Tunisia, adjacent sea areas
1	17	Brazzaville (Congo)	Casablanca	Toulouse	Cameroon, Central African Republic, Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, São Tomé and Príncipe, adjacent ocean areas
1	18	Niamey (Niger)	Casablanca	Toulouse	Benin, Burkina Faso, Chad, Ghana, Niger, Nigeria, Togo
2	21	Tehran (Islamic Republic of Iran)	Tehran	To be decided	Iran (Islamic Republic of), Iraq, Pakistan, Yemen, other territories in the Arabian Peninsula, adjacent sea and ocean areas

RTH region	*RTH reference number*	*RTH city (country)* (*=RTH/MTN)	*RTH's principal GISC*	*RTH's backup GISC*	*RTH's area of responsibility*
2	22	Tashkent (Uzbekistan)	Moscow	To be decided	Afghanistan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
2	23	Novosibirsk (Russian Federation)	Moscow	Offenbach/ Toulouse	Mongolia, Russian Federation (in Region II)
2	24	Khabarovsk (Russian Federation)	Moscow	Offenbach/ Toulouse	Democratic People's Republic of Korea, Russian Federation (in Region II), adjacent sea and ocean areas
2	25	Tokyo* (Japan)	Tokyo	Beijing/ Offenbach/ Melbourne	Hong Kong (China), Japan, Macao (China), Republic of Korea, adjacent sea and the Pacific Ocean areas
2	26	Bangkok (Thailand)	Tokyo	Beijing/ Offenbach/ Melbourne	Cambodia, Lao People's Democratic Republic, Myanmar, Thailand, Viet Nam, adjacent sea and ocean areas
2	27	New Delhi* (India)	New Delhi	To be decided	Bangladesh, Bhutan, India, Maldives, Myanmar, Nepal, Pakistan, Sri Lanka, adjacent sea and ocean areas
2	28	Beijing* (China)	Beijing	Tokyo	China, Democratic People's Republic of Korea, Viet Nam, adjacent sea and ocean areas
2	29	Jeddah* (Saudi Arabia)	Jeddah	To be decided	Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, Yemen, other territories in the Arabian Peninsula, adjacent sea and ocean areas
3	31	Brasilia* (Brazil)	Brasilia	Washington/ Pretoria	Brazil, Colombia, Ecuador, French Guyana, Guyana, Suriname, Venezuela (Bolivarian Republic of), ships' and aircraft reports
3	32	Buenos Aires* (Argentina)	Brasilia	Washington/ Pretoria	Argentina, Bolivia (Plurinational State of), Chile, Paraguay, Peru, Uruguay, ships' and aircraft reports
3	33	Maracay (Venezuela)	Brasilia	Washington/ Pretoria	Colombia, Ecuador, French Guyana, Guyana, Suriname, Venezuela (Bolivarian Republic of), ships' and aircraft reports

RTH region	*RTH reference number*	*RTH city (country)* (*=RTH/MTN)	*RTH's principal GISC*	*RTH's backup GISC*	*RTH's area of responsibility*
4	41	Washington* (United States of America)	Washington	Brasilia	Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, British Caribbean Territories, Canada, Cayman Islands, Colombia, Costa Rica, Cuba, Curaçao and Sint Maarten, Dominica, Dominican Republic, El Salvador, Grenada, Guatemala, Haiti, Honduras, Jamaica, Mexico, Monserrat, Nevis, Nicaragua, Panama, Saint Kitts, Saint Lucia, Trinidad and Tobago, United States
5	51	Melbourne* (Australia)	Melbourne	Tokyo/Seoul	Australia and outlying islands, Brunei Darussalam, Fiji, French Polynesia, Indonesia, Kiribati, Malaysia, Micronesia (Federated States of), New Caledonia, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Timor-Leste, Tonga, Tuvalu, Vanuatu, Wallis and Futuna
5	52	Wellington (New Zealand)	Melbourne	Tokyo/Seoul	New Zealand and outlying islands, Cook Islands, Niue, Pitcairn, Tokelau
6	61	Exeter* (United Kingdom of Great Britain and Northern Ireland)	Exeter	Toulouse	Gibraltar, Greenland, Iceland, Ireland, Netherlands, United Kingdom, ocean weather stations (OWS)
6	62	Norrköping (Sweden)	Offenbach	Moscow/ Tokyo	Denmark, Estonia, Finland, Latvia, Lithuania, Norway, Sweden
6	63	Toulouse* (France)	Toulouse	Exeter	Belgium, France, Luxembourg, Monaco, Portugal, Spain
6	64	Offenbach* (Germany)	Offenbach	Moscow/ Tokyo	Germany, Israel, Jordan, Switzerland
6	65	Moscow* (Russian Federation)	Moscow	Offenbach/ Toulouse	Armenia, Azerbaijan, Belarus, Georgia, Republic of Moldova, Russian Federation (in Region VI), Ukraine
6	66	Rome (Italy)	Offenbach	Moscow/ Tokyo	Greece, Italy, Lebanon, Malta, Türkiye
6	67	Prague* (Czechia)	Offenbach	Moscow/ Tokyo	Czechia, Poland
6	68	Vienna (Austria)	Offenbach	Moscow/ Tokyo	Austria, Croatia, Hungary, Slovakia, Slovenia
6	69	Sofia* (Bulgaria)	Offenbach	Moscow/ Tokyo	Albania, Bosnia and Herzegovina, Bulgaria, Cyprus, Montenegro, Romania, Serbia, Syrian Arab Republic, the former Yugoslav Republic of Macedonia

Note: RTH – Regional Telecommunication Hub; MTN – main telecommunication network.

2. PRINCIPLES FOR THE ESTABLISHMENT OF THE EXCHANGE PROGRAMME FOR OBSERVATIONAL DATA ON THE MAIN TELECOMMUNICATION NETWORK

The types of meteorological messages containing observational data to be exchanged on the Main Telecommunication Network are given below.

2.1 Type of information

(a) Surface observations on land and sea, including data from ships and buoys;
(b) Upper-air observations including data from aircraft;
(c) Climatological data;
(d) Selected satellite data;
(e) Seismic data (level 1), tsunami and other types of data as agreed.

Note: Items (a) to (e) do not indicate priorities.

2.2 Stations/areas from which reports should be included in the bulletins that are to be exchanged

The list of stations from which reports should be included in the bulletins that are to be exchanged are established as follows:

(a) All surface stations. The SYNOP reports from land stations exchanged on the MTN shall include at least Sections 0 and 1 of the SYNOP code form. As an interim measure, Section 3 of the SYNOP code form shall also be included in the global exchange on the MTN;
(b) All stations (on land or at sea) making radiosonde/radiowind observations;
(c) All aircraft;
(d) All climatological stations;
(e) All oceanographical stations;

3. RESPONSIBILITIES OF CENTRES LOCATED ON THE MAIN TELECOMMUNICATION NETWORK FOR THE EXCHANGE AND DISTRIBUTION OF PROCESSED INFORMATION AND SATELLITE DATA

The exchange of processed information and satellite data on the MTN should be arranged between the MTN centres to meet the requirements of the WWW centres.

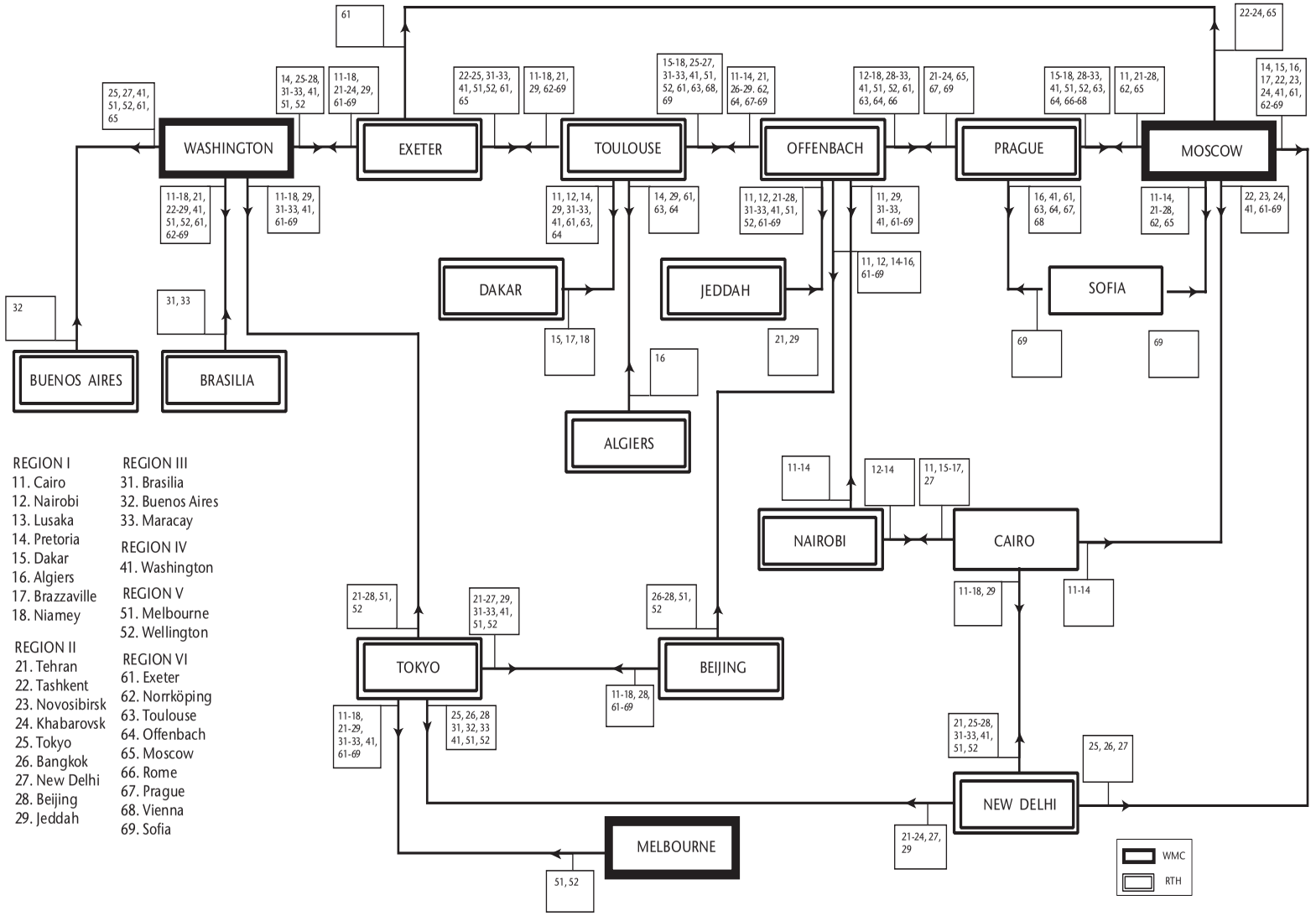


Figure 1. Plan for routing observational data on the Main Telecommunication Network

Note: The responsibilities of centres and routing arrangements for the exchange of processed information on the MTN are the same as for observational data.

ATTACHMENT I-4 (NOT USED)

ATTACHMENT I-*5*. PLAN FOR MONITORING THE OPERATION OF THE WORLD WEATHER WATCH

Note: The present attachment is obsolete as per Decision 22 (INFCOM-1) which indicates that "The Commission for Observation, Infrastructure and Information Systems decides: (1) To suspend the operation of the Integrated World Weather Watch Monitoring (IWM) and to adopt the WMO Integrated Global Observing System (WIGOS) Data Quality Monitoring System (WDQMS) as an operational replacement;" (*Commission for Observation, Infrastructure and Information Systems Abridged Final Report of the First Session* (WMO-No. 1251), p. 245).

1. OBJECTIVES

1.1 The objectives of the monitoring effort are to improve the performance of the World Weather Watch (WWW), in particular the efficiency and effectiveness of the operation of the WWW Global Observing System (GOS), the WMO Integrated Processing and Prediction System (WIPPS) (formerly the Global Data-processing and Forecasting System (GDPFS)) and the Global Telecommunication System (GTS) on a national, a regional and a global level. As the operation of these three elements of the WWW (GOS, WIPPS (formerly GDPFS) and GTS) is so interrelated, each element cannot be monitored independently; therefore, for efficient monitoring of the operation of the WWW as an integrated system, close coordination between all the centres concerned, as well as with the WMO Secretariat, is essential in order to identify the deficiencies and initiate corrective action as quickly as possible.

1.2 The implementation of the monitoring plan involves all three sub-systems of the WWW. Thus, in the context of monitoring, the GOS is responsible for ensuring that the observations are made according to the prescribed standards, are encoded correctly and are presented for transmission at the times laid down; in addition, the GOS responds in timely fashion to requests for checks, corrections, etc. The GTS is responsible for ensuring the regular flow of meteorological information, both raw and processed. This involves keeping a close watch on the receipt and transmission of information, generating requests for missing bulletins and other products when necessary, checking telecommunication formats, arranging for the re-routing of traffic in case of outages and other difficulties, and so on. The WIPPS provides processed information for timely distribution and also has an important role in the quality control of data.

1.3 An important objective of any monitoring activity must include provision for the identification of deficiencies and also for corrective action to improve the efficiency and effectiveness of the WWW. Success is measured in terms of how many deficiencies are corrected.

1.4 In accordance with the decision of Seventh Congress, the following items should be included in the monitoring programme:

(a) Regularity of observations;
(b) Quality of observational data and correct coding;
(c) Completeness and timeliness of collection of observational data at the NMC concerned;
(d) Adherence to WMO standard codes and telecommunication procedures;
(e) Collection of observational data at RTHs and WMCs;
(f) Exchange of data and processed information on the regional meteorological telecommunication networks and the MTN;
(g) Evaluation of the observations and processed information received at NMCs, RSMCs and WMCs in respect of their data needs.

2. BASIC COMPONENTS

2.1 Real-time monitoring

2.1.1 Real-time monitoring is the term used to describe monitoring which is carried out quickly enough to allow remedial action to be taken in time to be of value in day-to-day meteorological work. Ideally, it should be carried out within the times specified in the

appropriate manuals and guides as the maximum acceptable time delays for the receipt of meteorological information, but in practice it is still valuable if it can be carried out before similar subsequent information is received.

2.1.2 In view of the short time available, corrective action on real-time monitoring should be restricted to departures from the normal, e.g. bulletins or observations which are not received in time, obvious or suspected errors, and so on. Thus real-time monitoring requires the provision of information concerning:

- Bulletins not received by the specified time;
- Observations not received by the specified time, or which are incorrect or suspect, or cannot be interpreted with confidence;
- Inadequacies in receipt of processed information.

2.2 Non-real-time monitoring

Non-real-time monitoring is the term used to describe monitoring which is carried out over a specific time period. The purpose of non-real-time monitoring is to keep under review the general performance of the WWW and to identify shortcomings which may persist after real-time monitoring has been carried out. Non-real-time monitoring requires the preparation of summaries and various statistics which become available after a certain time, which may vary from a few hours to several months.

2.3 Follow-up action for coordination and assistance

In the real-time mode, the initial corrective action will be immediate and will be taken at the centres concerned or at the point of observation. In the non-real-time mode, follow-up action will be taken by the Members concerned to remedy any deficiencies with respect to the WWW plan. In some cases, this might involve obtaining advice on the procedures for obtaining external assistance and information on the maintenance and operation of their WWW facilities. In addition, the Secretary-General will take action, as indicated in paragraph 5.6 below.

3. DEFINITIONS AND STANDARDS

In the monitoring context, the terms used and the minimum standards to be attained should be as defined in the present Manual and in the *Manual on the Global Observing System* (WMO-No. 544), the *Manual on Codes* (WMO-No. 306), the *Manual on the WMO Integrated Processing and Prediction System* (WMO-No. 485) (formerly the *Manual on the Global Data-processing and Forecasting System* (WMO-No. 485)) and relevant parts of the *Technical Regulations* (WMO-No. 49).

4. PRIORITIES

4.1 The monitoring scheme should concentrate, in the order of priority given below, on the establishment of checks on the following information:

(a) TEMP, TEMP SHIP and TEMP MOBIL, Parts A and B;
(b) PILOT, PILOT SHIP and PILOT MOBIL, Parts A and B;
(c) SYNOP (global exchange);
(d) SHIP and AIREP/AMDAR (global exchange);
(e) CLIMAT;
(f) All other observational data and processed information, regularly exchanged.

Note: Reference to report types includes any WWW code form representation of that information.

4.2 Monitoring of satellite data presents a special case. There are only a few operators and their standards for monitoring, including quality control of satellite data, are already high. Monitoring of satellite data bulletins and GRIB-code bulletins shall be a special event for a limited time as designated by the WMO Secretariat.

4.3 In implementing this monitoring plan, it is important to establish the capability for quick responses at the observing points and at all centres to requests for checks and repetition in real time. It will also be found useful to give particular attention to ensuring the following elements of the monitoring plan:

(a) The correct telecommunication formats of messages in the GTS;
(b) The correct coding of messages and reports;
(c) The timely availability of data;
(d) The quality of the meteorological content of messages.

5. RESPONSIBILITIES

5.1 The basic responsibilities for monitoring the operation of the WWW rest with the Members.

5.2 The responsibilities for carrying out the real-time and non-real-time monitoring activities are given in Tables A and B. An essential part of the monitoring plan is that information should be exchanged between adjacent centres on the GTS in order that telecommunication problems in particular may be readily identified. A special aspect of the exchange of information is that procedures should be developed to ensure that no doubts exist that a bulletin contains all the observations available for inclusion in it. In the case of standard bulletins containing routine observations, the contents of the bulletins should always conform to the list included in the appropriate WMO publication, as amended. When the observations from some stations included in the publication are not available for any reason, the reports should be properly encoded as NIL reports. As a further check on completeness, NMCs should send messages to the associated RTH, preferably in advance, when it is known that observations from listed stations are not (or will not be) available. It is important that all WWW centres (NMCs, RSMCs, RTHs and WMCs) make a contribution to the overall monitoring effort. Obviously, centres having a multiple role will make more than one contribution. In the contributions, the following points should be taken into account:

(a) For the monitoring at bulletin level, additional or subsequent (RRx) and corrected (CCx) bulletins should be included;
(b) For the monitoring at report level, corrected reports should not be counted as additional reports, but retard reports should be counted;
(c) Duplicated reports and duplicated bulletins should be counted only once;
(d) The contributions should clearly indicate the data base used for monitoring (telecommunications or data-processing);
(e) The contributions should also report any outages of centres and/or circuits occurring during the monitoring period;
(f) In the contributions every possible effort should be made to adhere to the times included in the headings of the tables.

5.3 The frequency with which monitoring reports should be prepared and/or exchanged is illustrated in the following table:

Every day	– Every centre carries out continuous real-time monitoring;
At intervals of not more than one month	– NMCs should prepare a summary of relevant information on monitoring for use on a national and international level as appropriate;
At least once every three months	– RTHs/RSMCs send a summary of monitoring information to their associated NMCs;

At least once every three months	– RTHs/RSMCs send a summary of monitoring information to adjacent RTHs which supply them with data;
Once every six months	– WMCs send a summary of monitoring information to adjacent RTHs/RSMCs.

Reports called for at intervals of three months or more should always be forwarded to the Secretary-General in an agreed format for further action. As regards content, reports should include as many items for Table B as are practical and useful.

5.4 Members should implement the plan for monitoring the operation of the WWW at the earliest possible date, in particular the real-time monitoring.

5.5 In order to keep under review the efficient operation of the WWW, internationally coordinated monitoring on a non-real-time basis should be carried out four times a year, in October, January, April, and July, on the full range of global observational data and with the participation of a limited number of major WWW centres. During other periods, particular problem areas should be monitored, in respect of either selected information only or limited parts of the world. The Secretary-General will arrange, in consultation with the appropriate centres, details of the special monitoring exercises and the periods during which they should be carried out, and will provide adequate notice well in advance.

5.6 The Secretariat will carry out the necessary analyses of the non-real-time monitoring reports from WWW centres and will make the results of the analyses available to the centres concerned. The Secretary-General will coordinate and advise on assistance necessary to rectify the deficiencies revealed from the results of the monitoring. The Secretary-General will also arrange (as required) for the specific monitoring exercises mentioned in paragraph 5.5 above to be carried out.

6. PROCEDURES

6.1 As far as real-time monitoring is concerned, each centre should develop the necessary detailed procedures for this purpose. These procedures will vary from centre to centre, but should be designed to facilitate the real-time checking of the receipt of bulletins and observations as appropriate. At fully automated centres, these procedures may include the use of telecommunication system records. At manual centres, check lists or sheets may be developed for the same purposes using ticks, crosses or the entry of times to indicate when selected bulletins and/or reports have been received. Some further guidance on the operation of real-time monitoring, together with examples of the kind of forms which might be developed, are given in Table C.

6.2 As far as non-real-time monitoring is concerned, when special exercises are requested by the Secretariat, an indication of the form in which contributions should be made will be provided at the time the request is made. It is important that, as far as possible, centres should follow closely the procedures indicated in order that results from various centres be directly comparable with each other. It is particularly important that this should be the case when the annual global monitoring exercise is carried out. The procedures, together with the standard formats to be used for the provision of results, are given in Table D.

6.3 It is emphasized that nothing in the formal monitoring procedures prescribed in the attachment is intended to replace the normal day-to-day exchange of information and advice between adjacent centres. As far as possible, all problems should be resolved in this way and, after a time, only serious difficulties will be reflected in the formal monitoring reports.

Table A. Real-time monitoring

(Items are indicative rather than mandatory)

Item	*National units*	*NMC*	*RTH/RSMC*	*RTH/WMC*
1. Bulletins not received in time	←	↔	↔	→
2. Observations not received in time	←			
3. Processed information not received in time		→		→
4. Errors in observations	←	(←	)	
5. Special bilateral checks	↔	↔	↔	→

Notes:

1. Bulletins not received in time are bulletins which appear on the transmission schedule and have not been received by a time agreed bilaterally between two adjacent centres.
2. Observations not received in time are observations which appear in the published contents of the bulletins listed for transmission but which have not been received by the time agreed.
3. Processed information not received in time refers to data not received by the time agreed but known to be in the transmission schedule.
4. Errors in observations are errors detected or suspected in the coding and/or meteorological content of messages.
5. Special bilateral checks are checks on any of the previous elements 1–4 or other elements which may have been arranged temporarily or on a more continuous basis by the centres concerned.

Table B. Non-real-time monitoring

(Items are indicative rather than mandatory)

	Items	*NMC*	*RTH/RSMC*	*WMC*
1.	Bulletins not received	x	x	x
2.	Bulletins received late	x	x	x
3.	Observations not received	x	x	x
4.	Observations received late	x	x	x
5.	Processed information not received	x	x	
6.	Processed information received late	x	x	
7.	Non-adherence to telecommunication format	x	x	x
8.	Completeness of observational data	x	x	x
9.	Quality of observational data	x	x	x
10.	Deficiencies in processed information	x	x	x
11.	Statistical verification of numerical weather prediction	x	x	x
12.	Special bilateral or multilateral checks	x	x	x
13.	Notes on recurrent problems	x	x	x
14.	Monitoring reports	x	x	x

Notes:

1. Bulletins not received are bulletins scheduled for transmission but not received.
2. Bulletins received late are bulletins received later than the time periods specified by WMO or agreed bilaterally.
3. Observations not received are observations scheduled for transmission but not received.
4. Observations received late are defined in a similar way as “bulletins received late” in Note 2 above.
5. Processed information not received is products in alphanumeric or pictorial form scheduled for transmission but not received.
6. Processed information received late is defined in a similar way as “bulletins received late” in Note 2 above.
7. Non-adherence to telecommunication format refers to errors made consistently or frequently by transmitting stations which interfere with the regular transmission of messages.

8. Completeness of observational data.
9. Quality of observational data.
10. Deficiencies in processed information are shortcomings (e.g. data missing, messages garbled, facsimile products unreadable) which seriously interfere with the operational value of the products.
11. Statistical verification of numerical weather prediction would be supplied only by centres having a special interest in, and capability for, this type of information.
12. Special bilateral or multilateral checks means supplementary checks arranged between two or more centres by mutual agreement, on either a temporary or a continuous basis, to deal with special problems.
13. Notes on recurrent problems indicate areas of difficulty not covered by Notes 1–12 inclusive.
14. Monitoring reports are reports in the format to be developed by the Secretary-General, in consultation with the president of CBS and the chairs of the appropriate working groups.

The phrase national units is understood in this context to mean national observing, collecting and dissemination systems.

The arrows indicate the direction in which messages concerning monitoring will normally be sent. Thus, for example, messages concerning suspected errors in observations will normally be sent only by NMCs to the observing network – unless a special bilateral agreement has been made between an NMC and an appropriate RSMC to carry out real-time quality control on its behalf. To cover this possibility, an entry in parentheses has been made under RSMC.

The crosses in the various columns indicate the centres at which these functions would normally be carried out.

Table C. Guidance for real-time monitoring

Note: In this table, reference to report types (such as SYNOP) refers to any WWW code form representation of that information.

1. CHECK ON THE RECEPTION OF OBSERVATIONAL REPORTS FROM LAND STATIONS

In order to implement real-time monitoring, suitable forms should be used for checking the reception of observational reports from land stations. Separate tables may be prepared for SYNOPs for global exchange, for TEMP/PILOTs for global exchange, for SYNOPs for regional exchange, and so on in order to check the availability of various types of observational data. If an observation from a particular station has not been received within the appropriate time, a request should be made to the station. Detailed procedures must be developed to meet the needs of centres of various kinds.

2. CHECK ON THE RECEPTION OF AIRCRAFT AND SHIPS' WEATHER REPORTS FROM COASTAL RADIO STATIONS OR AERONAUTICAL RADIO STATIONS

Each centre should ensure that all bulletins have been received, and procedures to ensure that this is the case (for example by introducing the use of channel sequence numbers and similar ideas) should be developed to meet local needs.

3. CHECK ON CODING OF OBSERVATIONAL REPORTS

Observational reports should be checked before transmission of bulletins, in order to eliminate coding errors. This check should be made by the observer when the observation is first made and by suitably qualified staff when the bulletins are prepared. Such checking procedures, however, must not result in appreciable delays in the transmission of bulletins.

4. CHECK ON THE STANDARD FORMAT OF METEOROLOGICAL MESSAGES

Meteorological messages shall be checked to ensure that the standard format has been used and corrections shall be made as required. In particular, the following points shall be checked:

(a) The starting line, the abbreviated heading and the end-of-message signal of messages shall be completely free of error;
(b) Reports included in a bulletin shall be separated by the report separation signal.

It is emphasized that messages which can be handled without difficulty at manual centres may still give serious problems at automated centres, unless the procedures are scrupulously observed. Even a single incorrect character can lead to difficulties in some cases.

5. CHECK ON THE RECEPTION OF SCHEDULED BULLETINS WITHIN SPECIFIED TIMES

Each RTH should check the reception of bulletins form the NMCs in the zone of responsibility. For this purpose, forms such as Examples 1 and 2 below may be useful. If channel sequence numbers (nnn) have not been received in sequential order, queries should be made of the centre concerned immediately. Where no channel sequence number procedures are in operation, other measures must be taken to ensure that no transmissions have been missed, and no individual observations missed because of garbling, radio fading, or other causes.

Example 1. Real-time monitoring

(Check for individual meteorological bulletins, not received, incorrect format or mutilated)

CENTRE:	*DATE:*	*CIRCUIT:*			*PAGE:*
Abbreviated heading	*Description of fault*	*Time of receipt*	*Time of request*	*Time of receipt of report*	*Remarks (e.g. circuit outage times)*

Example 2. Monitoring of the reception of SHIP/AIREP bulletins and number of reports

SHIP			*AIREP*		
Abbreviated heading	*Time of receipt*	*Number of reports*	*Abbreviated heading*	*Time of receipt*	*Number of reports*

Table D. Procedures for internationally coordinated non-real-time monitoring

1. MONITORING PERIODS

The internationally coordinated monitoring of data for global exchange will be carried out four times a year, in October, January, April and July, with a view to check periodically the efficiency of the operation of the WWW. Statistics should be compiled for the periods 1–15 October, 1–15 January, 1–15 April and 1–15 July.

2. TYPES OF DATA TO BE MONITORED

The types of data listed in the following table should be monitored:

Types of data	*Abbreviated headings of bulletins* $T_1T_2A_1A_2$	*Reference format for presentation of results (see http://wis.wmo.int/iwm)*
SYNOP reports	$SMA_1A_2/ISMA_2/ISNA_2$	5.1/6.1
Parts A and B of TEMP reports	$USA_1A_2/UKA_1A_2/IUKA_2$	5.2/6.2
Parts A and B of PILOT reports	$UPA_1A_2/UGA_1A_2/IUJA_2$	5.2/6.2
SHIP reports	$SMA_1A_2/ISSA_2$	5.4/6.4
Parts A and B of TEMP SHIP reports	$USA_1A_2/UKA_1A_2/IUKA_2$	5.4/6.4
Parts A and B of PILOT SHIP reports	$UPA_1A_2/UGA_1A_2/IUJA_2$	5.4/6.4
BUOY reports	$SSA_1A_2/IOBA_2$	5.5/6.5
AIREP reports	$UAA_1A_2/IUAA_2$	5.5/6.5
AMDAR reports	$UDA_1A_2/IUAA_2/IUOA_2$	5.5/6.5
BATHY/TESAC/TRACKOB reports	$SOA_1A_2/IOSA_2$	5.5/6.5
CLIMAT reports	$CSA_1A_2/ISCA_2$	5.3/6.3

(a) *Monitoring of SYNOP reports*
For each monitored station identified by the WMO Integrated Global Observing System (WIGOS) station identifier and, if it exists, the WWW station index number (IIiii), the number of SYNOP reports available during the monitoring period within one hour, 2 hours and 6 hours of the standard bulletin times should be recorded in the relevant file defined in http://wis.wmo.int/iwm;

(b) *Monitoring of Parts A and B of TEMP and PILOT reports (or reports up to 100 hPa in Table Driven Code Forms (TDCF))*
For each monitored station identified by the WIGOS station identifier and, if it exists, the WWW station index number (IIiii), the number of Parts A and B of TEMP and PILOT reports or reports up to 100 hPa in TDCF (made by tracking a free balloon by electronic or optical means) available during the monitoring period within 2 hours and 12 hours of the standard bulletin times should be recorded in the relevant file defined in http://wis.wmo.int/iwm;

(c) *Monitoring of SHIP reports*
The number of bulletins identified by their abbreviated headings ($T_1T_2A_1A_2$ii CCCC) including SHIP reports and available during the monitoring period within 2 hours and 12 hours of the standard bulletin times, as well as the number of reports included in these bulletins, should be recorded in the relevant file defined in http://wis.wmo.int/iwm;

(d) *Monitoring of Parts A and B of TEMP SHIP and PILOT SHIP reports (or reports up to 100 hPa in TDCF)*
The number of bulletins identified by their abbreviated headings ($T_1T_2A_1A_2$ii CCCC) including Parts A and B of TEMP SHIP and PILOT SHIP reports (or reports up to 100 hPa in TDCF) and available during the monitoring period within 12 hours and 24 hours of the standard bulletin times, as well as the number of reports included in these bulletins, should be recorded in the relevant file defined in http://wis.wmo.int/iwm;

(e) *Monitoring of BUOY, AIREP and AMDAR reports*
The number of bulletins identified by their abbreviated headings ($T_1T_2A_1A_2$ii CCCC) including BUOY, AIREP and AMDAR reports compiled between 2100 to 0259 UTC, 0300 to 0859 UTC, 0900 to 1459 UTC and 1500 to 2059 UTC and available during the monitoring

period before 0500, 1100, 1700 and 2300 UTC, respectively, as well as the number of reports included in these bulletins, should be recorded in the relevant file defined in http://wis.wmo.int/iwm;

(f) *Monitoring of BATHY/TESAC/TRACKOB*
The time of receipt of bulletins identified by their complete abbreviated headings ($T_1T_2A_1A_2$ii CCCC YYGGgg (BBB)) containing BATHY/TESAC/TRACKOB reports, as well as the number of reports included in these bulletins, should be recorded in the relevant file defined in http://wis.wmo.int/iwm;

(g) *Monitoring of CLIMAT reports*
For each station monitored and identified by the WIGOS station identifier and, if it exists, the WWW station index number (IIiii), "I" should be recorded in the relevant file defined in http://wis.wmo.int/iwm.

3. GLOBAL DATASET TO BE MONITORED

3.1 The global dataset to be monitored is determined by:

(a) The list of surface stations comprising the Regional Basic Synoptic Networks (RBSNs) for SYNOP and CLIMAT reports; the list of radiowind/radiosonde stations comprising the RBSNs for Parts A and B of TEMP reports; the lists of radiowind stations comprising the RBSNs for Parts A and B of PILOT reports;
(b) The lists of abbreviated headings of bulletins containing SHIP, TEMP SHIP, PILOT SHIP, BUOY, AIREP/AMDAR and BATHY/TESAC/TRACKOB reports which have to be globally exchanged according to the Catalogue of Meteorological Bulletins. For ease of reference, the Secretariat will compile these lists of abbreviated headings which will be attached to the relevant format for each monitoring.

3.2 The references of the lists mentioned (including the references to the relevant amendment to the present Manual and of the edition of the Catalogue of Meteorological Bulletins) are given in the formats prepared by the Secretariat for each monitoring.

4. GEOGRAPHICAL AREA IN WHICH DATA SHOULD BE MONITORED

GTS centres should monitor the global dataset or part of it as follows:

(a) NMCs or centres with similar functions should monitor at least the availability of the data from the zone for which they are responsible for the data collection and their insertion into the GTS;
(b) RTHs not located on the MTN should monitor at least the availability of the observational data from their zone of responsibility for the collection of observational data. RTHs should also monitor the availability of observational data from the Region in which they are located and from any other Region to which they are linked by an interregional circuit;
(c) WMCs and RTHs located on the MTN should monitor the availability of the complete set of data for global exchange.

5. IMPLEMENTATION OF MONITORING PROCEDURES AND QUESTIONNAIRE

5.1 A questionnaire related to the procedures implemented at the centres is provided in the section "Questionnaire on the implementation of the monitoring procedures" in http://wis.wmo.int/iwm.

5.2 Monitoring procedures should be implemented at centres in such a way that all replies to the questions included in the questionnaire should be positive (reply: 1).

6. STANDARD FORMAT FOR STATISTICS

6.1 With a view to enabling the easy comparison of results of internationally coordinated monitoring carried out by the different centres, the standard formats specified in http://wis.wmo.int/iwm should be used. All centres carrying out monitoring should state clearly the period covered. In each format, centres should present the results Region by Region as well as for the Antarctic and give totals of the number of bulletins or reports received within the specified time Region by Region and for the Antarctic.

6.2 The statistics should be sent to the adjacent centres concerned and to the WMO Secretariat at the earliest possible date after the end of the monitoring period but not later than the fifteenth day of the following month.

7. ROLE OF THE WMO SECRETARIAT

The Secretariat will ensure that the Members are aware of their respective responsibilities and will collect the statistical results of internationally coordinated monitoring from the Members concerned. The Secretariat will make a summary of the statistics and will evaluate the deficiencies and effectiveness of the operation of the WWW as a whole and in part. In this connection, the Secretariat will check the observing programme of individual observing stations. The results of the monitoring will be made available to the Executive Council and the CBS by correspondence or at sessions as appropriate. The Secretariat will take up the possibility or remedial action with Members concerned in order to eliminate shortcomings in the operation of the GOS and the GTS as quickly as possible.

8. SPECIAL TYPES OF NON-REAL-TIME MONITORING OF THE WWW

If necessary, monitoring of the WWW may be undertaken in different regions and for various types of observational data. The purpose of such monitoring is to identify, in greater detail, deficiencies in the collection and exchange of data in different parts of the GTS and the reason for such deficiencies. Special types of monitoring should be initiated by the Secretary-General or by some of the Members concerned. The dates and duration of such monitoring would have to be agreed upon by those Members.

PART II. OPERATIONAL PROCEDURES FOR THE GLOBAL TELECOMMUNICATION SYSTEM

Explanations of terms used

Terms used frequently throughout this section, and their meanings, are listed below.

Meteorological information	Meteorological information that may be in alpha-numeric, binary or pictorial form.
Meteorological data	Meteorological information presented in alphanumeric or binary form.
Meteorological message	A message comprising a single meteorological bulletin, preceded by a starting line and followed by end-of-message signals.
Routine meteorological message	A meteorological message transmitted according to a predetermined distribution plan.
Non-routine meteorological message	A meteorological message for which there is no predetermined distribution plan.

1. OPERATIONAL PRINCIPLES FOR THE GLOBAL TELECOMMUNICATION SYSTEM

Principle 1

On the Main Telecommunication Network and the regional meteorological telecommunication networks of the Global Telecommunication System, meteorological data shall be collected, exchanged and distributed in the meteorological bulletin format.

Principle 2

The meteorological message format shall depend on the mode of operation and engineering of circuits and centres.

Principle 3

The formats of messages shall meet the requirement for automatic switching, selection and editing processes and for manual operations at telecommunication centres, and shall take account of the requirement for automatic processing of the contents of bulletins.

Principle 4

Transmission of meteorological information over the GTS shall be in accordance with agreed distribution plans.

Principle 5

Non-routine meteorological messages and service messages shall be transmitted as addressed messages.

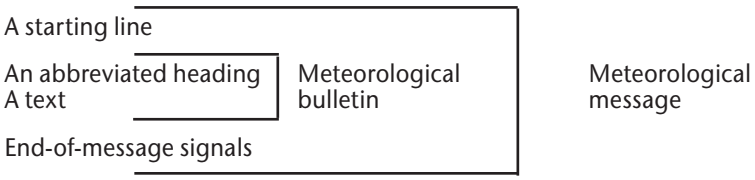
Principle 6

Scheduling of transmissions shall be made on the basis of four levels of priority.

2. OPERATIONAL PROCEDURES APPLICABLE TO THE TRANSMISSION OF METEOROLOGICAL DATA ON THE GLOBAL TELECOMMUNICATION SYSTEM

2.1 Format of meteorological messages

2.1.1 A routine meteorological message transmitted on the Global Telecommunication System shall comprise:



2.1.2 There shall be only one meteorological bulletin per meteorological message.

2.1.3 A non-routine meteorological message shall have the format of an addressed message (see section 2.4 below).

2.1.4 The starting line, abbreviated heading and end-of-message signals shall be in alphanumeric form.

2.2 Alphanumeric character set used on the GTS

2.2.1 The alphabets to be used on the GTS shall be the following:

(a) International Telegraph Alphabet No. 2;
(b) International Alphabet No. 5.

Note: International Telegraph Alphabet No. 2 and International Alphabet No. 5 are reproduced in Attachments II-1 and II-2, respectively.

2.2.2 Only printed characters for which corresponding characters exist in both alphabets shall be used. The conversion shall be made in accordance with the conversion table approved for use on the GTS. The control characters from International Alphabet No. 5 which are approved for use on the GTS shall be used.

Note: The conversion table and the control characters from International Alphabet No. 5 which are approved for use on the GTS are given in Attachment II-3.

2.2.3 When it is required to convert characters of Alphabet No. 5 which do not appear in the conversion table (Attachment II-3) to Alphabet No. 2, the Signal No. 2 in the latter alphabet shall be used.

2.2.4 International Alphabet No. 5 shall be used for the starting line, abbreviated heading and end-of-message signals of a meteorological message containing information in binary representation.

2.3 Message format for routine meteorological messages

The procedures outlined below shall apply to transmission of routine meteorological messages on the GTS.

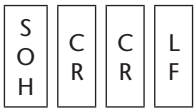
2.3.1 ***Starting line***

2.3.1.1 **The starting line shall have the following format:**

(a) International Telegraph Alphabet No. 2:

←← ≡ ↓ ZCZC → ↑nnn → → → → →

(b) International Alphabet No. 5:



Note: Examples of routine meteorological messages and the meaning of the symbols used for the signals in both International Telegraph Alphabet No. 2 and International Alphabet No. 5 are given in Attachment II-4.

2.3.1.2 The symbols have the following meanings:

nnn Transmission sequence number. It is a three-digit group giving the transmission sequence of messages from one centre over a particular channel to the receiving centre on that channel. Numbers 000 to 999 inclusive must be used in a cyclic manner. (When International Alphabet No. 5 is used, the group nnn may be a fixed combination of three characters, if agreed between the centres concerned.)

Note: A five digit-group could be used by bilateral agreement; it should be used on circuits with a speed of 64 Kbit/s or above to enable appropriate recovery procedures.

2.3.2 ***Abbreviated heading***

2.3.2.1 **The abbreviated heading shall have the following format:**

(a) International Telegraph Alphabet No. 2:

←← ≡ ↓ $T_1T_2A_1A_2$ ↑ ii → ↓ CCCC → ↑YYGGgg (→ ↓ BBB)

(b) International Alphabet No. 5:

Note: Examples of routine meteorological messages used for the signals in both International Telegraph Alphabet No. 2 and International Alphabet No. 5 are given in Attachment II-4.

2.3.2.2 **The symbols shall have the following meanings:**

$T_1T_2A_1A_2$ii Data designators.

Note: The WMO standard data designators are given in Attachment II-5.

T_1T_2 Data type and/or form designators.

A_1A_2 Geographical and/or data type and/or time designators.

ii It shall be a number with two digits. When an originator or compiler of bulletins issues two or more bulletins with the same $T_1T_2A_1A_2$ and CCCC the ii shall be used to differentiate the bulletins and will be unique to each bulletin.

Alphanumeric bulletins containing reports prepared at the main synoptic hours for the stations included in the Regional Basic Synoptic Networks or stations included in the Regional Basic Climatological Networks shall be compiled into bulletins with ii in the series 01 to 19. This does not apply to bulletins compiled in CREX code.
Alphanumeric bulletins containing "additional" data as defined in Resolution 40 (Cg-XII) shall be compiled into bulletins with ii above 19. This does not apply to bulletins compiled in CREX code.
For bulletins compiled in GRIB, BUFR or CREX code or containing pictorial information, the use of ii is defined in the tables contained in Attachment II-5. Originators or compilers of bulletins shall use the ii values from these tables when they are defined for the purpose for which a bulletin is being intended.
For all bulletins ii shall only be used to designate "additional" data as defined in Resolution 40 (Cg-XII) if the same heading is never used for essential data and it complies with all the requirements above. If this is not the case, a unique CCCC shall be used as described below.

CCCC **International four-letter location indicator of the station or centre originating or compiling the bulletin, as agreed internationally, and published in *Weather Reporting* (WMO-No. 9), Volume C1 – Catalogue of Meteorological Bulletins.**
In order to differentiate sets of bulletins that cannot be distinguished using the $T_1T_2A_1A_2$ii allocations, a centre may establish additional CCCCs where the final two characters differ from its original CCCC. The two first letters of any additional CCCCs established by a centre shall remain the same as the original CCCC. For instance, the additional CCCCs could be used to indicate different satellites, different models or to differentiate between bulletins containing "additional" or "essential" data as defined in Resolution 40 (Cg-XII)). All CCCCs established by any centre shall be published and defined in *Weather Reporting* (WMO-No. 9), Volume C1 – Catalogue of Meteorological Bulletins.
Once a bulletin has been originated or compiled, the CCCC must not be changed. If the contents of a bulletin is changed or recompiled for any reason, the CCCC should be changed to indicate the centre or station making the change.
When Traditional Alphanumeric Code (TAC) bulletins from one centre (NMHS1) are converted to Table Driven Code Form (TDCF) by another centre (NMHS2):
(a) The location indicator CCCC of NMHS1 (the producer of TAC bulletins) shall be used in the abbreviated headings of the converted bulletins;
(b) For each bulletin converted, the RTH responsible for NMHS1 shall ensure that the "remarks" column in *Weather Reporting* (WMO-No. 9), Volume C1 – Catalogue of Meteorological Bulletins shows that the data are converted by NMHS2;
(c) In the case that NMHS1 and NMHS2 are in the zones of responsibility of two different RTHs, the RTH responsible for NMHS1 (the producer of TAC bulletins) shall send the required Advanced Notification form to the WMO Secretariat.

YYGGgg **International date-time group.**

YY **Day of the month.**

GGgg **For bulletins containing meteorological reports intended for standard times of observation, the time shall be the standard time of observation in UTC.**
For aerodrome, route and area (aeronautical) forecasts: the full hour in UTC (the last two digits shall be 00) preceding the transmission time.
For other forecasts and analyses: standard time of observation in UTC on which forecast or analysis is based.
For other messages the time shall be the time of compilation in UTC.

BBB **An abbreviated heading defined by $T_1T_2A_1A_2$ ii CCCC YYGGgg shall be used only once. Consequently, if this abbreviated heading has to be used again for an addition, a correction or an amendment, it shall be mandatory to add an**

appropriate BBB indicator, identified by a three-letter indicator which shall be added after the date-time group.
The BBB indicator shall have the following forms:
RR_x for additional or subsequent issuance of bulletins;
CC_x for corrections to previously relayed bulletins;
AA_x for amendments to previously relayed bulletins;
where x is an alphabetic character of A through as described in Attachment II-12. Bulletins containing observational or climatic data (surface or upper-air) from land stations will be compiled from a defined list of stations. The abbreviated headings and the contents of bulletins shall be published in *Weather Reporting* (WMO-No. 9), Volume C1 – Catalogue of Meteorological Bulletins.

2.3.3 ***Contents of meteorological bulletins***

2.3.3.1 **The following procedures shall apply to the compilation of the text of a meteorological bulletin:**

(a) Text of a bulletin shall be in one code form only;
(b) The text of a bulletin shall not contain both "essential" and "additional" data as defined in Resolution 40 (Cg-XII);
(c) The text of a bulletin shall be in alphanumeric or binary representation. It shall start by the following sequence:
(i) When International Alphabet No. 5 is used:

C	C	L
R	R	F

(ii) When International Telegraph Alphabet No. 2 is used:

←← ≡ ↑ or ← ← ≡ ↓ as appropriate

(d) When all the reports normally contained in a routine message are not available at the normal time of transmission, the text NIL shall be sent.

2.3.3.2 Text of meteorological bulletins in alphanumeric representation

2.3.3.2.1 **Each individual meteorological report shall start at the beginning of a new line.**

2.3.3.2.2 **Signal No. 22 (figure case position) of the International Telegraph Alphabet No. 2 or Signal 3/13 of International Alphabet No. 5 shall be used as a meteorological report separation signal. The signal shall follow the last figure of the last group of each report, with no intervening space.**

2.3.3.2.3 *Format of SYNOP and SHIP bulletins*

(a) The presentation of bulletins containing SYNOP reports and SHIP reports, in the code forms FM 12 and FM 13 respectively, should be in one of the formats (a) or (b) as given in Attachment II-4, paragraph 4;
(b) When using format (a), all Sections 1, 2, 3 and 4 shall be transmitted consecutively without any insertion of spaces and solidus in the identifier groups of Sections 3 and 4. If format (b) is used, Sections 1, 2, 3 and 4 shall start at the beginning of a line but identifiers of Sections 3 and 4 shall begin with two spaces.

Note: For examples of presentation of formats, see Attachment II-4.

2.3.3.2.4 **In upper-air bulletins (TEMP and PILOT), each successive part (A, B, C and D) shall be preceded immediately by an alignment function (see paragraph 2.6.1 below) and followed by a separation signal.** In upper-air bulletins (TEMP and PILOT), each report relating to one station is

separated from the preceding report by an additional line-feed signal. **Additionally, whenever Parts A and B or Parts C and D are transmitted together, they shall be separated by eight carriage return signals.**

2.3.3.2.5 **AMDAR and AIREP reports shall correspond to the information relating to each single point of observation during a flight.**

2.3.3.2.6 **Whenever practicable, and unless special provisions exist to the contrary, the text of a meteorological bulletin shall be transmitted in such a manner that full use is made of the capacity of a teleprinter line (69 characters per line).**

2.3.3.2.7 **NIL – In the case of routine messages containing meteorological reports, NIL shall be inserted following the appropriate station index number (which should however retain its proper place in the coded message) when the report from that station is included in the published contents of the bulletin (in the Catalogue of Meteorological Bulletins and elsewhere) but is not available at the time of transmission.** The same procedures also apply to other coded information (such as CLIMAT).

2.3.3.2.8 **The solidus (/) shall be used to indicate missing figures or letters in the text of meteorological bulletins.** The solidus is represented in International Telegraph Alphabet No. 2 by the figure case position of Signal No. 24, and in International Alphabet No. 5 by Signal 2/15.

2.3.3.2.9 **The procedures given above which refer to bulletins containing meteorological reports shall also apply to bulletins containing other coded information (such as TAF, CLIMAT) from specified locations.**

2.3.3.3 Text of meteorological bulletins in binary representation

2.3.3.3.1 **The text of meteorological bulletins in binary representation shall consist of one single message and start by the sequence**

C R	C R	L F

followed by the code indicator coded in International Alphabet No. 5.

2.3.3.3.2 **NIL – In the case of BUFR routine bulletins containing meteorological reports, all fields in the relevant subsets within Section 4 (Data Section) of the BUFR message, other than the station identifier and delayed replication factors, shall be set to the appropriate missing value, when the report from that station is included in the published contents of the bulletin (in the Catalogue of Meteorological Bulletins and elsewhere) but is not available at the time of transmission.**

2.3.4 ***End-of-message signals***

The format for the end-of-message signals shall be as follows:

(a) International Telegraph Alphabet No. 2:

↓ ←← ≡ ≡ ≡ ≡ ≡ ≡ ≡ ≡ NNNN ↓↓↓↓↓↓↓↓↓↓↓↓

Note: The end-of-message signals are used for ensuring page-feed and tape-feed.

(b) International Alphabet No. 5:

C R	C R	L F	E T X

2.4 Addressed messages

2.4.1 *Categories of addressed messages*

2.4.1.1 Service messages

Priority: 1
Messages concerning the operation of the system, e.g. breakdown, resumption after breakdown, etc.

2.4.1.2 Request for GTS messages

Priority: 2
Messages used for a request for bulletins normally available on the GTS, including request for repetition.

2.4.1.3 Administrative messages

Priority: 4
Messages used for communicating between one administration and another. In exceptional circumstances a very urgent administrative message could be transmitted as a service message.

2.4.1.4 Data messages

Priority: 2
Messages consisting of meteorological data. These messages may be either replies to requests for GTS messages in the case when the reply is in the form of an addressed message, or replies to requests to databases, or data in accordance with a special agreement.

2.4.1.5 Request-to-database

Priority: 2
Messages used for a request for data addressed to a database.

2.4.2 *Abbreviated headings for addressed messages*

The specifications of the abbreviated headings of addressed messages are the following:

$T_1T_2A_1A_2$ii $C_aC_aC_aC_a$ YYGGgg (BBB)
T_1T_2 = BM, designator for addressed messages in alphanumeric form;
T_1T_2 = BI, designator for addressed messages in binary form;
A_1A_2 = AA, administrative message
BB, service message
RR, request of GTS messages
RQ, request-to-database
DA, data message
ii = 01

$C_aC_aC_aC_a$ = location indicator of the addressed centre
YYGGgg = time of insertion on the GTS.

2.4.3 *Text of addressed messages*

The first line of the text of an addressed message shall contain the international location indicator of the centre originating the message. The actual content of the addressed message shall start at the second line of the text.

2.5 Requests for GTS messages

2.5.1 **An existing GTS message shall be the smallest unit requested. All requests for GTS messages, and in particular requests for repetition, shall be made as soon as possible; otherwise the requested message(s) may no longer be available (see also paragraph 2.10.2.2 below).**

2.5.2 *Request messages*

2.5.2.1 **Requests for GTS messages shall be made by addressed message-requests for GTS messages (see paragraphs 2.4.1.2, 2.4.2 for abbreviated headings and paragraph 2.4.3 above for the first line of the text of the message).**

2.5.2.2 **The requested messages shall be identified by their abbreviated headings, and all designators shall be used to specify a particular message. One request message shall not contain more than eight requests, when addressed to a centre beyond an adjacent centre.**

2.5.2.3 **Each line of the text of the message shall begin with the indicator AHD (except the first line, see paragraph 2.4.3 above).** Each line will end with the report separation signal. Each line should contain a single abbreviated heading of a requested message.

2.5.3 *Request for repetition*

2.5.3.1 **Requests for repetition of GTS messages shall be made by addressed messages as requests for GTS messages, transmitted to the adjacent centre upstream.**

2.5.3.2 In addition to the procedures for request messages as defined in paragraphs 2.5.2.2 and 2.5.2.3 above, the messages requested for repetition may be identified in the request by their transmission sequence numbers on the circuit concerned. **In this case, the second line of the text of the message shall begin with the indicator SQN, followed by the transmission sequence number or a series of sequence numbers separated by "/", or consecutive sequence numbers (nnn – nnn).**

2.5.3.3 **One request-for-repetition message shall only contain a single type of identification for requested messages, i.e. abbreviated headings (see paragraph 2.5.2.3 above) or transmission sequence numbers (see paragraph 2.5.3.2 above).** The maximum number of messages requested in one single request message and identified by abbreviated headings may be agreed upon on a bilateral basis between adjacent centres.

2.5.4 *Replies to requests for GTS messages*

2.5.4.1 **A reply shall use the format for addressed data messages (see paragraph 2.4.1.4 above).** By bilateral agreement between adjacent centres, in particular for replies to requests for repetition, replies may be made in the format of a routine message.

2.5.4.2 **An addressed data message in reply to a request for GTS messages shall contain a single GTS message.**

2.5.4.3 **Requests shall be answered in all cases. If a requested message is not available, an addressed data message (see paragraph 2.4.1.4 above) shall be sent to the originator of the request with the indicator NIL followed by the identifier of the message concerned.** If a request for GTS messages is incorrect, an addressed data message should be sent to the originator of the request with the indicator ERR followed by the incorrect identifier, when possible.

2.5.4.4 **Replies to messages requesting repetitions shall be transmitted within 30 minutes of the filing time of the requests.**

Note: If all the requests cannot be met at one time, the remainder of the replies may be transmitted later.

2.5.5 *Requests for repetition of analogue facsimile transmissions*

2.5.5.1 **Requests for repetition of analogue facsimile transmissions shall be made by addressed messages (see paragraph 2.4.1.2 above).**

2.5.5.2 **A request shall contain a unique identification of the required document.** The request should preferably be made in the same format as requests for meteorological messages, but using the abbreviated heading as the identifier.

2.5.5.3 Before making a request for repetition of an analogue facsimile transmission, account should be taken of probable limiting factors such as established transmission schedules and priorities of other products.

Note: When a point-to-point link is used, a centre requesting a repetition might indicate to the transmitting centre that the desired product could be substituted for a specified document for that one occasion.

2.5.6 *Replies to requests for repetition of analogue facsimile transmissions*

Before starting the repetition of an analogue facsimile transmission an addressed data message should be sent to the originator of the request indicating the expected time of repetition.

2.5.7 *Acknowledgment messages*

Acknowledgment procedures from a centre receiving a bulletin to its originating centre or to other centre (e.g. a relaying centre) should comply with standard GTS addressed messages (see section 2.4 above, as very urgent administrative messages transmitted as a service message. The format for the content of an addressed message for acknowledgment of receipt of bulletin should be as follows:

BMBB01 $C_aC_aC_aC_a$ YYGGgg (BBB)
CCCC
QSL TTAAii YYGGgg $C_oC_oC_oC_o$ (BBB) (DDHHMM)
(optional text)

Notes:
$C_aC_aC_aC_a$ = location indicator of the destination centre, usually the originating centre of the message being acknowledged.
CCCC = international location indicator of the centre sending the acknowledgement.
TTAAii $C_oC_oC_oC_o$ YYGGgg (BBB) is the abbreviated heading of the message being acknowledged, prefixed by the word QSL.
DDHHMM is the day-time group (day, hour, minute in UTC) of actual reception of the acknowledged message at the centre CCCC and is inserted when required.
The third line of the text of the message is added as necessary.

Example:

BMBB01 PHEB 051132
AMMC
QSL WEIO21 PHEB 051130 051132

2.6 Additional procedures applicable to both routine and addressed messages in alphanumeric form

2.6.1 *Alignment function*

2.6.1.1 The alignment function shall ensure correct placement of the components of messages on the page copy of teleprinters and shall consist of the following signals:

Two "carriage return"; One "line feed".

2.6.1.2 The signals for the alignment functions shall be transmitted before each line of text.

2.6.1.3 When using International Telegraph Alphabet No. 2, in order to render ineffective any accidental shifts from figure to letter case and vice versa on transmission of the alignment function, one figure shift (Signal No. 30) or one letter shift (Signal No. 29), as appropriate, shall immediately follow the alignment function.

2.6.2 *Procedures for correction*

The following procedures for correction shall be applicable for both International Telegraph Alphabet No. 2 and International Alphabet No. 5:

(a) Errors made and immediately detected during the preparation of a tape shall be corrected by backspacing the tape, where possible, and eliminating the error by overpunching the incorrect portion with the letter shift in International Telegraph Alphabet No. 2 and Signal 7/15 (DEL) in International Alphabet No. 5;
(b) Where equipment is incapable of backspacing, corrections shall be made immediately by making the error sign: letter E and space repeated alternately three times, transmitting the last correct word or group, and then continuing with the tape preparation;
(c) The starting line, the abbreviated heading and the end of message of a routine meteorological message shall be completely free from all telecommunication errors. Any form of correction, such as use of the error sign or overpunching of errors by use of the letter-shift character (Signal No. 29 of Alphabet No. 2), is prohibited.

2.7 Length of meteorological messages

2.7.1 The length of meteorological bulletins shall be determined according to the following:

(a) Alphanumerical messages for transmission on the GTS should not exceed 15 000 octets;
(b) Sets of information, transmitted using segmentation into a series of bulletins, shall not exceed 250 000 octets;
(c) The limit for meteorological bulletins for binary data representation or pictorial form shall be 500 000 octets;
(d) Sets of information may be exchanged using the file transfer technique described in Attachment II-15, particularly where sets larger than 250 000 octets are concerned.

2.7.2 Observational data should not be unnecessarily held up for transmission merely for the purpose of retention until a message of appropriate length can be compiled.

2.7.3 **It is to be noted that, for messages that might possibly be transmitted in transit over the AFTN, the length of the text shall not exceed 200 groups.**

2.8 Procedures applicable to the transmission of reports from ships and other marine stations

2.8.1 **Reports from ships and other marine stations in the SHIP code form shall start with the call sign of the ship, or with a suitable alternative designator.**

2.8.2 **In case of ocean station vessels while on station, the indicator for the ocean station shall precede the report on a separate line.**

2.8.3 **In the case of mobile ships, the call sign shall be placed at the beginning of the first line of each report. If the call sign is not known, the word SHIP shall be used in its place.**

2.9 Time accuracy in telecommunication centres

Each centre shall take steps to ensure that the difference between the actual time at the telecommunication centre and the universal time shall never exceed the following limits:

(a) Thirty seconds in manual centres and automated centres using the hardware system;
(b) Five seconds in automated centres using the software system.

2.10 Procedures relating to the telecommunication processing functions of centres

The procedures outlined below are given in the form of guidance in order that the telecommunication processing functions of centres may be executed in an efficient manner.

2.10.1 *Time delays*

2.10.1.1 The functions of meteorological telecommunication centres (see Part I, section 2) should include speed and alphabet conversion, procedure checking, and bulletin editing.

Note: The execution of these functions will take time and result in delays. The delay is defined as the interval between completion of receipt of a message and availability for retransmission on an outgoing channel.

2.10.1.2 For the automatic switching of messages the acceptable time delay should not exceed 15 seconds when no speed or alphabet conversion is involved and three minutes when speed or alphabet conversion is required.

2.10.1.3 For procedure checking, composition and editing of bulletins, the time spent by centres should be in the order of 15 seconds when only high-speed circuits are involved, and in the order of two minutes when a low-speed circuit is involved.

2.10.2 *Storage capability*

With respect to storage capability for retransmission purposes, the procedures outlined below should be applied.

2.10.2.1 Centres should store data until the onward transmission of the data to the next centre is completed. For this purpose, where the onward transmission is over a circuit on which acknowledgement procedures are used, storage of a message on a short-time access memory is required only until acknowledgement of the message is received. For circuits on which

acknowledgement procedures are not used, storage of a message on a short-time access memory for 30 minutes is sufficient. Acknowledgement of reception of a message should be assumed if no request for retransmission is received within this time period.

2.10.2.2 With respect to storage capability to meet requests for messages, WMC and RTHs should store messages they exchange over the GTS for a period of 24 hours.

2.10.3 *Routing catalogues*

2.10.3.1 The procedures described here are recommended for the exchange of the routing catalogues of GTS Centres. The routing catalogue is exchanged in the form of a file which can be directly ingested into most database software packages to help in GTS data flow analysis. The files containing "routing catalogues" should be obtained using FTP file transfer over the Internet where possible and should be either available at each Centre or from the WMO server. The WMO server should contain a list (with hyperlinks) of all Centres who have routing catalogues available for exchange. All Centres should provide the WMO Secretariat with URL addresses of where their respective files are located.

2.10.3.2 The routing catalogue of a GTS centre should provide the following information for each bulletin identified by its abbreviated heading TTAAii CCCC:

(a) The GTS circuit on which the bulletin is received;
(b) The list of the GTS circuits on which the bulletin is sent.

2.10.3.3 Each RTH should prepare a routing catalogue and make it accessible by the other GTS centres, in particular by its associated NMCs. The routing directory should be updated monthly if possible, but not less than every three months.

2.10.3.4 A GTS centre should include in its routing catalogue the abbreviated headings of all bulletins received and/or transmitted on any GTS circuit connected to this GTS centre (GTS point-to-point circuits, GTS point-to-multipoint circuits such as satellite distribution systems, including the remaining HF broadcasts). Any bulletin scheduled to be received by the GTS centre, even if not actually forwarded on the GTS, should be included in the routing catalogue.

2.10.3.5 The bulletins received and/or transmitted on a circuit established under a bilateral agreement for meteorological data exchange should also be included in the routing catalogue.

2.10.3.6 The format of the routing catalogue and the procedures for the access to the routing catalogues are given in the Attachment II-7.

2.10.4 *Review of the content of switching directories*

In addition to the regular updating of the switching directories, all automated GTS centres should clean regularly (e.g. once every six months) their switching directories thereby removing all abbreviated headings of bulletins which are no longer expected for exchange on the GTS.

2.11 Procedures for store-and-forward data transmissions

2.11.1 *Priorities for store-and-forward data transmission*

2.11.1.1 **The messages shall be forwarded on the basis of four levels of priority. The level of priority shall be allocated according to the data type (T_1T_2) and is indicated in Table A of Attachment II-5.**

2.11.1.2 **Within a level of priority, the messages shall be forwarded according to the "first in, first out" principle.**

2.11.1.3 **The messages of a higher level of priority shall be forwarded before those of a lower level of priority. However, the forwarding of a message of a higher level of priority shall not interrupt the transmission of a message already started.**

2.11.2 *Detection and cancellation of duplicated messages*

Duplicated messages received within at least three hours of the original message should be detected and eliminated.

2.12 Data communication protocols for the Global Telecommunication System

2.12.1 *Transmission protocols on the GTS*

The transmission protocols for use on the GTS shall be elements of procedures as specified in the Transmission Control Protocol/Internet Protocol (TCP/IP).

2.12.2 *TCP/IP protocol*

The recommended practices and procedures for the implementation, use and application of the Transmission Control Protocol/Internet Protocol (TCP/IP) on the GTS are as given in Attachment II-15.

2.13 Transmission and collection of meteorological bulletins on the Internet

The Internet may be used for transmitting and collecting meteorological bulletins on the Internet. The purpose is to serve as a complementary communication system to be used in test and special cases, or when a dedicated GTS link is unavailable. The practices for electronic mail (e-mail) and/or web data ingest as given in Attachment II-16 should be used with a view to minimizing inherent security risks.

2.14 Supplementary procedures applicable to radioteleprinter transmissions

In addition to the general telecommunication procedures given above, there are special procedures applicable to radioteleprinter transmissions.

2.14.1 *Identification*

A radioteleprinter broadcast shall be preceded by the transmission of call signals.

2.14.1.1 **The call signals shall comprise: the general call to all stations (transmitted three times), the conventional signal DE, the identification of the broadcasting station, consisting of the radio call sign followed by the frequency reference index or indices (transmitted three times), and the letters RY repeated without separation for one line (69 characters).**

Example:

CQ CQ CQ DE WSY21/22 WSY21/22 WSY21/22
RYRY ----------RYRYRYR
← 69 characters →

2.14.1.2 Transmission of call signals

Call signals shall be transmitted:

(a) For at least the two minutes preceding the official starting time of broadcasts that begin at a fixed time;
(b) Each time the station has no traffic during assigned broadcast periods;
(c) For the five minutes preceding the first broadcast following a change of frequency.

2.14.2 ***Special procedures for relay centres***

2.14.2.1 **In radioteleprinter exchanges where a communication centre is responsible for the relay of bulletins originating from another centre, the abbreviated heading shall not be altered when the bulletin is retransmitted.**

2.14.2.2 **When a message is received with some of the text garbled, the relay centre shall retransmit the message as received and, if possible, obtain a retransmission from the originating centre.**

2.14.2.3 National instructions should cover the case of the measures to be taken when extensive garbling occurs, in order to ensure that all usable data are relayed with the minimum delay and with the elimination, where possible, of completely garbled portions. Whenever elimination of part of the text is performed, the abbreviation INC should be added at the end to indicate that the bulletin is incomplete; the relay centre should take all necessary steps to receive from the originating centre those parts of the bulletin which were garbled and retransmit them as soon as possible.

3. PROCEDURES APPLICABLE TO THE TRANSMISSION OF METEOROLOGICAL INFORMATION IN PICTORIAL FORM OVER THE GLOBAL TELECOMMUNICATION SYSTEM

3.1 Format of meteorological information in pictorial form

The details which should appear in the panel for identification of pictorial information (to be placed in the lower left-hand corner of the chart and also, if possible, in the upper right-hand corner) are determined nationally. They should be easy to identify, read and understand and should therefore include at least the abbreviated heading of the pictorial information.

3.2 Requirements for relay of facsimile (analogue) transmissions

3.2.1 The relay of facsimile (analogue) transmissions should be accomplished by store-and-forward operation or by direct transmission (through-switching) of the signals.

3.2.2 In all cases, the relay of facsimile transmissions should be accomplished with the minimum possible delay.

3.2.3 High-quality recording/storage devices, such as magnetic tape recorders, should be used in the store-and-forward system of analogue facsimile relay in order to maintain the picture quality throughout the storage and retransmission process. **All the technical transmission characteristics specified in Part III, section 5 shall be maintained during the store-and-forward procedure.**

3.2.4 At some centres facsimile storage may be possible and convenient using a computer equipped with analogue/digital conversion of received signals and digital/analogue reconversion for relayed signals.

3.2.5 In some cases the transmission of facsimile signals in analogue form could be performed without storage in relay centres, thereby providing a minimum delay in transit through several consecutive segments of a telecommunication network.

3.2.6 **Centres not equipped to perform the store-and-forward operation within three minutes, nor for direct through-switching transmission, shall provide adequate storage, using a conventional magnetic tape system or equivalent methods, to accommodate the facsimile (analogue) relay transmissions. The storage shall be sufficient for at least one complete frame.**

3.2.7 For emergency backup purposes only, page copy from chart recorders should be used to facilitate the store-and-forward mode of operation.

3.3 Periodic transmission of the WMO test chart

The WMO standardized test chart should be transmitted periodically, in accordance with requests made, on all parts of the GTS for which facsimile (analogue) transmissions are regularly provided.

Note: The WMO standardized test chart is given in Attachment II-8.

3.4 Coded and non-coded digital facsimile transmission procedures

Coded or non-coded digital facsimile transmission should be carried out by one of the following procedures:

(a) Alphanumeric data and digital facsimile information should be transmitted, on a time-sharing basis, on a single data link;
(b) Alphanumeric data and digital facsimile information should be transmitted on separate channels, multiplexed by a modem in accordance with ITU-T Recommendation V.29.

Note: The procedures to be applied are given in Attachment II-9.

4. QUALITY OF METEOROLOGICAL TRANSMISSIONS

4.1 Monitoring and control

All transmissions of meteorological information shall be monitored periodically by the originator to ensure adherence to the recommended procedures and specifications, thereby permitting satisfactory performance of the GTS.

4.2 Reports of reception conditions

4.2.1 **The code form RECEP shall be used for the reporting of reception conditions of meteorological radio transmissions.**

Note: The code form RECEP is given in Attachment II-10.

4.2.2 **Reports of reception conditions shall be made periodically by recipients to the originators of the radio transmissions.**

5. PROCEDURES FOR AMENDING WMO PUBLICATIONS AND METHODS OF NOTIFICATION

5.1 Responsibility for notification of amendments

Information for WMO publications shall be kept current. Notification of amendments shall be sent to the Secretariat at least two months in advance of the effective date of the change.

5.2 METNO and WIFMA

5.2.1 **The code name METNO shall be used to identify messages concerning information relating to *Weather Reporting* (WMO-No. 9), Volumes A (Observing stations) and C (Catalogue of Meteorological Bulletins and Transmission Programmes); the code name WIFMA shall be used to identify messages concerning information relating to Volume D (Information for Shipping). METNO messages shall also contain, as appropriate, information on important changes in international meteorological codes and telecommunication procedures.**

Note: METNO and WIFMA messages issued by the Secretariat will provide advance notification of changes in *Weather Reporting* (WMO-No. 9), Volumes A, C and D, in addition to the normal supplement service.

5.2.2 **METNO and WIFMA messages shall be transmitted from Geneva to Zurich and thence to the associated RTH for global dissemination through the Global Telecommunication System.**

5.2.3 **METNO and WIFMA messages shall be compiled in the standard format for routine meteorological messages using the abbreviated heading NOXX02 LSSW for changes related to *Weather Reporting* (WMO-No. 9), Volume C1 – Catalogue of Meteorological Bulletins – and NOXX01 LSSW for the changes to the other Volumes.**

ATTACHMENT II-1. INTERNATIONAL TELEGRAPH ALPHABET No. 2[1]

1. INTRODUCTION

1.1 This Recommendation defines the repertoire of the graphic and control characters used in International Telegraph Alphabet No. 2 (ITA2) and the coded representation of these characters for communication purposes. It also contains provisions concerning the use of certain specific combinations.

1.2 The coded character set of ITA2 is based on a 5-unit structure.

1.3 ITA2 is also defined in Recommendation F.1 for the international public telegram service, and it is specified in Recommendation F.60 that it should also be used for the telex service. It may also be used for other applications, such as specialized or leased circuits.

1.4 For definitions concerning alphabetic telegraphy, see definitions in Recommendation R.140 and the International Electrotechnical Vocabulary (IEV), Chapter 721.

2. CHARACTER REPERTOIRE

2.1 Graphic characters that have a corresponding signal in ITA2 are:

the 26 Latin alphabetic characters:
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z;
decimal figures: 0 1 2 3 4 5 6 7 8 9;
punctuation marks and miscellaneous signs:

Full stop	.
Comma	,
Colon or division sign	:
Question mark	?
Apostrophe	’
Cross or addition sign	+
Hyphen or dash or subtraction sign	–
Fraction bar or division sign	/
Equal sign or double hyphen	=
Left-hand bracket (parenthesis)	(
Right-hand bracket (parenthesis)	)

2.2 Three graphic characters (such as accented letters and currency signs) may be applied for national or private use (see paragraph 4.2 below).

2.3 This Recommendation does not define the particular printing style, font or case (capital or small letters) of graphic characters, nor does it define the layout of keyboards in teleprinters or similar terminal devices.

2.4 The control characters provided in ITA2 are:

“Who are you?” (operation of the answerback unit of the corresponding installation);
operation of an audible signal of the corresponding installation;
carriage return;
line-feed;
letter shift;
figure-shift;

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[1] Extract from the *CCITT Blue Book*, Fascicle VII.1. Recommendation S.1 is reproduced with the permission of the International Telecommunication Union, which holds the copyright.

space or blank;
all-space or null (no tape perforation).

3. CODING

3.1 The 32 combinations available in ITA2 are produced by a sequence of five units, each of which may assume one of two significant conditions (A or Z), as shown in Table 1/S.1.

3.2 Condition A corresponds to start polarity, no perforation in paper type and symbol 0 of the binary notation. Condition Z corresponds to stop polarity, perforation in paper tape and symbol 1 in binary notation.

For the equivalent frequency and amplitude modulations corresponding to conditions A and Z in voice-frequency telegraph equipment, see Recommendation V.1 and the relevant Series R Recommendations.

Note 1: The level and polarity of voltage and current corresponding to conditions A and Z (e.g. in the local end with its termination) are national options and hence are not defined internationally.
Note 2: The terms "start" and "stop", "space" and "mark" have also been used to describe conditions A and Z respectively (see definition 31.37 in Recommendation R.140).

4. PARTICULAR COMBINATIONS

4.1 In accordance with Recommendation S.8 and the Series U Recommendations, "WRU" (who are you? combination No. 4 in figure case), is used to operate the answerback unit of the corresponding instrument in the international telex and gentex services, and may also provide a printed symbol (as in Table 2/S.1)

4.2 Since some Administrations assign combination Nos. 6, 7 and 8 in figure case for internal use whereas others do not, it is desirable to avoid varying interpretation in these circumstances that might result if they were used freely in international services. Consequently the use of combination Nos. 6, 7 and 8 in figure case is not defined and therefore should not be used in international services, except by direct agreement between Administrations; and it is recommended:

that, in all services, they should be shown in some special manner on the keyboards, and that services in which they are not used should place on the secondary position on the printing blocks (or on the equivalent mechanism) an arbitrary sign, for the letters F, G and H such as, for instance, a square. The appearance of such sign on the paper is to indicate an abnormal impression.

4.3 Combination No. 10 "audible signal", may also provide a printed symbol (as in Table 2/S.1)

4.4 Combination Nos. 29 and 30, "letter-shift" and "figure-shift", respectively, are used to place the terminal installation in the "letter" or "figure" position, so that:

any combination Nos. 1 to 26 received engenders a printed signal in the "letter" case (second column of Table 1/S.1) if the last shift signal received is a "letter-shift" signal;
any combination Nos. 1 to 26 received engenders a printed signal in the "figure" case (third column of Table 1/S.1) if the last shift signal received is a "figure-shift" signal", except as noted for combinations Nos. 4 and 10 in paragraphs 4.1 and 4.3 above.

4.5 Combinations Nos. 29 (letter-shift), 30 (figure-shift) and 32 (all-space, null or no tape perforation) shall not affect the spacing movement of terminal machines, except where their reception is indicated by printing a symbol, as mentioned in paragraph 5 below.

Table 1/S.1 – International Telegraph Alphabet No. 2 (ITA2)

Combination number	*Letter case*	*Figure case*	*Coding*				
			1	2	3	4	5
1	A	-	Z	Z	A	A	A
2	B	?	Z	A	A	Z	Z
3	C	:	A	Z	Z	Z	A
4	D	See paragraph 4.1	Z	A	A	Z	A
5	E	3	Z	A	A	A	A
6	F	See paragraph 4.2	Z	A	Z	Z	A
7	G	See paragraph 4.2	A	Z	A	Z	Z
8	H	See paragraph 4.2	A	A	Z	A	Z
9	I	8	A	Z	Z	A	A
10	J	Audible signal	Z	Z	A	Z	A
11	K	(	Z	Z	Z	Z	A
12	L	)	A	Z	A	A	Z
13	M	.	A	A	Z	Z	Z
14	N	,	A	A	Z	Z	A
15	O	9	A	A	A	Z	Z
16	P	0	A	Z	Z	A	Z
17	Q	1	Z	Z	Z	A	Z
18	R	4	A	Z	A	Z	A
19	S	‘	Z	A	Z	A	A
20	T	5	A	A	A	A	Z
21	U	7	Z	Z	Z	A	A
22	V	=	A	Z	Z	Z	Z
23	W	2	Z	Z	A	A	Z
24	X	/	Z	A	Z	Z	Z
25	Y	6	Z	A	Z	A	Z
26	Z	+	Z	A	A	A	Z
27	Carriage-return		A	A	A	Z	A
28	Line-feed		A	Z	A	A	A
29	Letter-shift See paragraph 4.5		Z	Z	Z	Z	Z
30	Figure-shift See paragraph 4.5		Z	Z	A	Z	Z
31	Space		A	A	Z	A	A
32	See paragraph 4.7		A	A	A	A	A

4.6 Use of capital and small letters

4.6.1 In ITA2, it is possible to use teleprinters with two series of letter characters, capital and small letters.

4.6.2 It is possible to use sequences of the shift combinations of ITA2 for transfer from one series to the other.

4.6.3 If this possibility is used, it is essential to obtain compatibility with teleprinters having only one series of letter characters.

4.7 Use of combination No. 32

4.7.1 Combination No. 32 can be used in certain sequences of switching signals; these uses are set out in Recommendations U.11, U.20, U.22 and S.4.

4.7.2 Combination No. 32 must not be used during the phase of communication (after a call is set up) in the international telex service.

4.7.3 Combination No. 32 can be used during the phase of communication after a call is set up in domestic national service or by bilateral agreement between two Administrations, as a command signal for certain functions, e.g. transfer to a national alphabet other than ITA2.

4.7.4 Combination No. 32 must not be used for transfer from one form of characters to another while remaining within ITA2, nor for transfer from one international telegraph alphabet to another.

5. GRAPHIC REPRESENTATION OF CONTROL CHARACTERS

Where a graphic indication of the reception or transmission of certain control characters is required, this should be effected by printing the symbols shown in Table 2/S.1.

Table 2/S.1. Printed symbols for control characters

Function	*Combination No.*	*Case*	*Symbol*	*Alphabetic representation*
Who are you? (WRU)	4	Figure	⊠ (see Note 1)	EQ
Audible signal (bell)	10	Figure	☊	BL
Carriage-return	27	Either	←	CR
Line-feed	28	Either	≡	LF
Letter-shift	29	Either	↓	SL or LS
Figure-shift	30	Either	↑	SF or FS
Space	31	Either	Δ	SP
All/space: Null	32	Either	□	NU

Note 1: The pictorial representation shown is a schematic of ✠ which may also be used when equipment allows.

Note 2: Each alphabetic representation is to be considered as a single symbol. It may occupy one position on a printed or displayed line.

ATTACHMENT II-2. INTERNATIONAL ALPHABET No. 5[1]

INTRODUCTION

A seven-unit alphabet capable of meeting the requirements of private users on leased circuits and of users of data transmission by means of connections set up by switching on the general telephone network or on telegraph networks has been established jointly by the CCITT and the International Organization for Standardization (ISO).

This alphabet – International Alphabet No. 5 (IA5) – is not intended to replace International Telegraph Alphabet No. 2 (ITA2). It is a supplementary alphabet for the use of those who might not be satisfied with the more limited possibilities of International Telegraph Alphabet No. 2. In such cases it is considered as the alphabet to be used as common basic language for data transmission and for elaborated message systems.

International Alphabet No. 5 does not exclude the use of any other alphabet that might be better adapted to special needs.

1. SCOPE AND FIELD OF APPLICATION

1.1 This Recommendation specifies a set of 128 characters (control characters and graphic characters such as letters, digits and symbols) with their coded representation. Most of these characters are mandatory and unchangeable, but provision is made for some flexibility to accommodate national and other requirements.

1.2 This Recommendation specifies a 7-bit coded character set with a number of options. It also provides guidance on how to exercise the options to define specific national versions and application-oriented versions. Furthermore it specifies the International Reference Version (IRV) in which such options have been exercised.

1.3 This character set is primarily intended for the interchange of information among data processing systems and associated equipment, and within data communication systems. The need for graphic characters and control functions in data processing has also been taken into account in determining this character set.

1.4 This character set is applicable to all alphabets of Latin letters.

1.5 This character set includes control characters for code extension where its 128 characters are insufficient for particular applications. Procedures for the use of these control characters are specified in ISO Standard 2022.

1.6 The definitions of some control characters in this Recommendation assume that data associated with them are to be processed serially in a forward direction. When they are included in strings of data which are processed other than serially in a forward direction or when they are included in data formatted for fixed-record processing they may have undesirable effects or may require additional special treatment to ensure that they result in their desired function.

2. CONFORMANCE AND IMPLEMENTATION

2.1 Conformance

A coded character set is in conformance with this Recommendation if it is a version in accordance with section 6 below. Equipment claimed to implement this Recommendation shall be able to

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[1] Extract from the *CCITT Blue Book*, Fascicle VII.3. Recommendation T.50 is reproduced with the permission of the International Telecommunication Union, which holds the copyright.

interchange information by means of a version of the 7-bit coded character set, this version shall be identified in any such claim.

2.2 Implementation

The use of this character set requires definitions of its implementation in various media. For example, these could include punched tapes, punched cards, magnetic media and transmission channels, thus permitting interchange of data to take place either indirectly by means of an intermediate recording in a physical medium, or by local connection of various units (such as input and output devices and computers) or by means of data transmission equipment.

The implementation of this coded character set in physical media and for transmission, taking into account the need for error checking, is the subject of ISO publications.

3. DEFINITIONS

For the purpose of this Recommendation the following definitions apply:

3.1 bit combination

An ordered set of bits used for the representation of characters.

3.2 character

A member of a set of elements used for the organization, control or representation of data.

3.3 coded character set; code

A set of unambiguous rules that establishes a character set and the one-to-one relationship between the characters of the set and their bit combinations.

3.4 code extension

The techniques for the encoding of characters that are not included in the character set of a given code.

3.5 code table

A table showing the character allocated to each bit combination in a code.

3.6 control character

A control function the coded representation of which consists of a single bit combination.

3.7 control function

An action that affects the recording, processing, transmission or interpretation of data and that has a coded representation consisting of one or more bit combinations.

3.8 **graphic character**

A character, other than a control function, that has a visual representation normally handwritten, printed or displayed.

3.9 **position**

That part of a code table identified by its column and row co-ordinates.

4. SPECIFICATION OF THE CODED CHARACTER SET

The bits of the bit combinations of the 7-bit code are identified by b_7, b_6, b_5, b_4, b_3, b_2 and b_1, where b_7 is the highest-order, or the most-significant, bit and b_1 is the lowest-order, or least-significant, bit.

The bit combinations may be interpreted to represent integers in the range 0 to 127 in binary notation by attributing the following weights to the individual bits:

Bit:	b_7	b_6	b_5	b_4	b_3	b_2	b_1
Weight	64	32	16	8	4	2	1

In this Recommendation, the bit combinations are identified by notation of the form x/y, where x is a number in the range 0 to 7 and y is a number in the range 0 to 15. The correspondence between the notations of the form x/y and the bit combinations consisting of the bits b_7 to b_1 is as follows:

x is the number represented by b_7, b_6 and b_5 where these bits are given the weights 4, 2 and 1 respectively;
y is the number represented by b_4, b_3, b_2 and b_1, where these bits are given the weights 8, 4, 2 and 1 respectively.

The notations of the form x/y are the same as those used to identify code table positions, where x is the column number and y the row number (see paragraph 7 below).

The 128 bit combinations of the 7-bit code represent control characters and graphic characters. The allocation of characters to bit combinations is based on the following principles:

the bit combinations 0/0 to 1/15 represent 32 control characters;
the bit combination 2/0 represents the character SPACE, which is interpreted both as a control character and as a graphic character;
the bit combinations 2/1 to 7/14 represent up to 94 graphic characters as one or more of these bit combinations may be declared to be unused (see paragraph 4.3 below);
the bit combination 7/15 represents the control character DELETE.

The allocation of individual characters to the bit combinations of the 7-bit code is specified in paragraphs 4.1, 4.2 and 4.3 below.

This Recommendation assigns at least one name to each character. In addition, it specifies an acronym for each control character and for the character SPACE, and a graphic symbol for each graphic character. By convention, only capital letters and hyphens are used for writing the names of the characters, except for small letters. For acronyms only capital letters and digits are used. It is intended that the acronyms and this convention be retained in all translations of the text.

The names chosen to denote graphic characters are intended to reflect their customary meaning. However, this Recommendation does not define and does not restrict the meanings of graphic characters. Neither does it specify a particular style or font design for the graphic characters when imaged.

4.1 Control characters

The control characters of the 7-bit coded character set are classified in the following categories:

(a) *Transmission control characters*
Transmission control characters are intended to control or facilitate transmission or information over telecommunication networks. Procedures for the use of the transmission control characters on telecommunication networks are the subject of other ISO publications.

(b) *Format effectors*
Format effectors are mainly intended for the control of the layout and positioning of information on character-imaging devices such as printing and display devices.

(c) *Code extension control characters*
Code extension control characters are used to extend the character set of the code. They may alter the meaning of one or more bit combinations that follow them in the data stream. Procedures for the use of the code extension control characters are specified in ISO Standard 2022.

(d) *Device control characters*
Device control characters are intended for the control of local or remote devices or ancillary devices connected to a data processing or data communication system. These control characters are not intended to control data communication systems; this should be achieved by the use of transmission control characters.

(e) *Information separators*
Information separators 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 the application.

(f) *Other control characters*
These are the control characters that fall outside the preceding categories.

The composition of each category, and the allocation of the individual control characters in each category to bit combinations of the 7-bit code are specified in paragraphs 4.1.1 to 4.1.6 below. Each of these sub-clauses contains a table consisting of three columns. The first column specifies the acronym of each control character, the second column specifies the standard name of the control character and the third column, labelled "Coded representation", specifies the bit combination representing the control character concerned.

Detailed functional descriptions of all control characters are given in section 8 below.

4.1.1 *Transmission control characters*

The transmission control characters and their coded representations are specified in Table 1/T.50.

Table 1/T.50. Transmission control characters – coded representation

Acronym	*Name*	*Coded representation*
SOH	Start of heading	0/1
STX	Start of text	0/2
ETX	End of text	0/3
EOT	End of transmission	0/4
ENQ	Enquiry	0/5
ACK	Acknowledge	0/6
DLE	Data link escape	1/0
NAK	Negative acknowledge	1/5
SYN	Synchronous idle	1/6
ETB	End of transmission block	1/7

4.1.2 ***Format effectors***

The format effectors and their coded representations are specified in Table 2/T.50.

Table 2/T.50. Format effectors – coded representation

Acronym	*Name*	*Coded representation*
RS	Backspace	0/8
HT	Horizontal tabulation	0/9
LF	Line feed	0/10
VT	Vertical tabulation	0/11
FF	Form feed	0/12
CR	Carriage return	0/13

4.1.2.1 Concepts

The definitions of the format effectors use the following concepts:

(a) A page is composed of a number of lines, each being composed of a number of character positions;
(b) Each character position is capable of imaging SPACE or a graphic symbol;
(c) The graphic symbol imaged at a character position represents a graphic character, a control function, or a combination of one or more graphic characters and/or control functions;
(d) The active position is the character position at which the action required by the next character in the data stream is to be effected. If the next character is a graphic character, it is imaged at that position; if it is a control character, the corresponding function is performed relative to that position;
(e) Movements of the active position are effected as follows:
  (i) The active position is advanced one character position immediately after imaging a SPACE or a graphic character, and upon the execution of the function corresponding to a control character for which a graphic symbol is required to be imaged;
  (ii) The active position is moved to a specified character position upon the execution of the function corresponding to a control character that is defined to cause a movement of the active position (i.e., a format effector);
(f) The active position is not moved upon execution of the function corresponding to a control character that is neither required to be imaged by a graphic symbol nor defined to cause a movement of the active position;
(g) The effect of an attempt to move the active position beyond the boundaries of a line or a page is not defined by this Recommendation.

4.1.2.2 Combined horizontal and vertical movements of the active position

The format effectors are defined for applications in which horizontal and vertical movements of the active position are effected separately. If a single control character is required to effect the action of CARRIAGE RETURN in combination with a vertical movement, the format effector for that vertical movement shall be used. For example, if the function “new line” (equivalent to the combination of CARRIAGE RETURN and LINE FEED) is required as a single control character, bit combination 0/10 shall be used to represent it. This substitution requires agreement between the sender and the recipient of the data, and the format effectors (LINE FEED, VERTICAL TABULATION and/or FORM FEED) that are affected shall be identified (see section 6 below).

In order to avoid the need for such prior agreement, to facilitate interchange and to avoid conflicts with specifications in other ISO publications, the use of format effectors for vertical movements is deprecated. It is strongly recommended to use two control characters, for example CARRIAGE RETURN (CR) and LINE FEED (LF) to obtain the effect of “new line”.

4.1.3 *Code extension control characters*

The code extension control characters and their coded representations are specified in Table 3/T.50.

Table 3/T.50. Coded extension control characters – coded representation

Acronym	*Name*	*Coded representation*
SO	Shift-out	0/14
SI	Shift-in	0/15
ESC	Escape	0/11

4.1.4 *Device control characters*

The device control characters and their coded representations are specified in Table 4/T.50.

Table 4/T.50. Device control characters – coded representation

Acronym	*Name*	*Coded representation*
DC1	Device control one	1/1
DC2	Device control two	1/2
DC3	Device control tree	1/3
DC4	Device control four	1/4

4.1.5 *Information separators*

The information separators and their coded representations are specified in Table 5/T.50.

Table 5/T.50. Information separators – coded representation

Acronym	*Name*	*Coded representation*
IS4 (FS)	Information separator four (file separator)	1/12
IS3 (GS)	Information separator three (group separator)	1/13
IS2 (RS)	Information separator two (record separator)	1/14
IS1 (US)	Information separator one (unit separator)	1/15

Each information separator is given two names. The names INFORMATION SEPARATOR FOUR, INFORMATION SEPARATOR THREE, INFORMATION SEPARATOR TWO and INFORMATION SEPARATOR ONE are the general names. The names FILE SEPARATOR, GROUP SEPARATOR, RECORD SEPARATOR and UNIT SEPARATOR are the specific names and are intended mainly for applications where the information separators are used hierarchically. The ascending order is then 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.

4.1.6 *Other control characters*

The control characters outside the categories in paragraphs 4.1.1 to 4.1.5 above and their coded representation, are specified in Table 6/T.50.

Table 6/T.50. Other control characters – coded representation

Acronym	*Name*	*Coded representation*
NUL	Null	0/0
BEL	Bell	0/7
CAN	Cancel	1/8
EM	End of medium	1/9
SUB	Substitute character	1/10
DEL	Delete	7/15

4.2 Character SPACE

The acronym of the character SPACE is SP and its coded representation is 2/0. This character is interpreted both as a graphic character and as a control character. As a graphic character, it has a visual representation consisting of the absence of a graphic symbol. As a control character, it acts as a format effector that causes the active position to be advanced one character position.

4.3 Graphic characters

The 94 bit combinations 2/1 to 7/14 are used for the representation of graphic characters as specified in paragraphs 4.3.1, 4.3.2 and 4.3.3 below. Paragraphs 4.3.1 and 4.3.2 below contain each a table consisting of three columns. The first column is labelled "Graphic" and specifies the graphic symbol of each graphic character, the second column specifies the standard name of the graphic character and the third column, labelled "Coded representation", specifies the bit combination representing the graphic character concerned.

All graphic characters of any version of the 7-bit coded character set are spacing characters, i.e. they cause the active position to advance.

4.3.1 *Unique graphic character allocations*

A unique graphic character is allocated to each of the 82 bit combinations 2/1, 2/2, 2/5 to 3/15, 4/1 to 5/10, 5/15 and 6/1 to 7/10. These characters are specified in Table 7/T.50.

4.3.2 *Alternative graphic character allocations*

Two alternative graphic characters are allocated to each of the bit combinations 2/3 and 2/4. These characters are specified in Table 8/T.50.

Either the character POUND SIGN or the character NUMBER SIGN shall be allocated to bit combination 2/3 and either the character DOLLAR SIGN or the character CURRENCY SIGN shall be allocated to bit combination 2/4 (see section 6 below).

Unless otherwise agreed between sender and recipient, the graphic symbols £, $, ¤ and € do not designate the currency of a specific country.

Table 7/T.50. Unique graphic character allocations

Graphic	*Name*	*Coded representation*	*Graphic*	*Name*	*Coded representation*
!	Exclamation mark	2/1	M	Capital letter M	4/13
“	Quotation mark	2/2	N	Capital letter N	4/14
%	Percent sign	2/5	O	Capital letter O	4/15
&	Ampersand	2/6	P	Capital letter P	5/0
’	Apostrophe	2/7	Q	Capital letter Q	5/1
(	Left parenthesis	2/8	R	Capital letter R	5/2
)	Right parenthesis	2/9	S	Capital letter S	5/3
*	Asterisk	2/10	T	Capital letter T	5/4
+	Plus sign	2/11	U	Capital letter U	5/5
,	Comma	2/12	V	Capital letter V	5/6
–	Hyphen, minus sign	2/13	W	Capital letter W	5/7
.	Full stop	2/14	X	Capital letter X	5/8
/	Solidus	2/15	Y	Capital letter Y	5/9
0	Digit zero	3/0	Z	Capital letter Z	5/10
1	Digit one	3/1	—	Low line, underline	5/15
2	Digit two	3/2	a	Small letter a	6/1
3	Digit three	3/3	b	Small letter b	6/2
4	Digit four	3/4	c	Small letter c	6/3
5	Digit five	3/5	d	Small letter d	6/4
6	Digit six	3/6	e	Small letter e	6/5
7	Digit seven	3/7	f	Small letter f	6/6
8	Digit eight	3/8	g	Small letter g	6/7
9	Digit nine	3/9	h	Small letter h	6/8
:	Colon	3/10	i	Small letter i	6/9
;	Semicolon	3/11	j	Small letter j	6/10
<	Less-than sign	3/12	k	Small letter k	6/11
=	Equal sign	3/13	l	Small letter l	6/12
>	Greater-than sign	3/14	m	Small letter m	6/13
?	Question mark	3/15	n	Small letter n	6/14
A	Capital letter A	4/1	o	Small letter o	6/15
B	Capital letter B	4/2	p	Small letter p	7/0
C	Capital letter C	4/3	q	Small letter q	7/1
D	Capital letter D	4/4	r	Small letter r	7/2
E	Capital letter E	4/5	s	Small letter s	7/3
F	Capital letter F	4/6	t	Small letter t	7/4
G	Capital letter G	4/7	u	Small letter u	7/5
H	Capital letter H	4/8	v	Small letter v	7/6
I	Capital letter I	4/9	w	Small letter w	7/7
J	Capital letter J	4/10	x	Small letter x	7/8
K	Capital letter K	4/11	y	Small letter y	7/9
L	Capital letter L	4/12	z	Small letter z	7/10

Table 8/T.50. Alternative graphic character allocations

Graphic	*Name*	*Coded representation*
£	Pound sign	2/3
#	Number sign	2/3
$	Dollar sign	2/4
¤	Currency sign	2/4

4.3.3 *National or application-oriented graphic character allocations*

No specific graphic character is allocated to the ten bit combinations 4/0, 5/11 to 5/14, 6/0, and 7/11 to 7/14. These bit combinations are available for national or application-oriented use. A unique graphic character shall be allocated to each of these bit combinations, or bit combination shall be declared unused (see section 6 below).

5. COMPOSITE GRAPHIC CHARACTERS

In any version of the 7-bit coded character set specified according to this Recommendation, all graphic characters are spacing characters which cause the active position to move forward. However, by using BACK-SPACE or CARRIAGE RETURN, it is possible to image two or more graphic characters at the same character position.

For example, SOLIDUS and EQUALS SIGN can be combined to image "not equals". The character LOW LINE, that may be used as a free-standing character, can also be associated with other character(s) to represent the graphic rendition "underlined".

Diacritical marks may be allocated to the bit combinations specified in paragraph 4.3.3 above and be available for composing accented letters. For such composition, it is recommended to use a sequence of three characters, the first or last of which is the letter to be accented and the second of which is BACKSPACE. Furthermore, QUOTATION MARK, APOSTROPHE or COMMA can be associated with a letter by means of BACKSPACE for the composition of an accented letter with a diaeresis, an acute accent or a cedilla, respectively.

6. VERSIONS OF THE CODED CHARACTER SET

6.1 General

In order to use the 7-bit coded character set for information interchange, it is necessary to exercise the options left open in paragraph 4 above:

- to each of the bit combinations 2/3 and 2/4 one of the alternative graphic characters specified in paragraph 4.3.2 above shall be allocated;
- each of the bit combinations 4/0, 5/11 to 5/14, 6/0 and 7/11 to 7/14 shall have a unique graphic character allocated to it, or be declared unused;
- the format effectors, if any, to which the facility of paragraph 4.1.2.2 above applies, shall be identified.

A graphic character allocated to a bit combination specified in paragraphs 4.3.1 and 4.3.2 above shall not be allocated to any other bit combination. For example the POUND SIGN, if not allocated to bit combination 2/3, shall not be allocated to any other bit combination.

A character set completed in this way is called a "version of ISO Standard 646/CCITT T.50" (see Appendix I).

6.2 National versions

6.2.1 The responsibility for defining national versions lies with the national standardization bodies. These bodies shall exercise the options available and make the required selection (see Appendix I).

6.2.2 If so required, more than one national version can be defined within a country. The different versions shall be separately identified. In particular when for a given bit combination, for example 5/12, alternative graphic characters are required, two different versions shall be identified, even if they differ only by this single character.

6.2.3 If there is in a country no special demand for specific graphic characters, it is strongly recommended that the characters of the International Reference Version (IRV) (see paragraph 6.4 below) be selected and allocated to the same bit combinations as in the IRV.

However, when graphic characters that are different from the characters of the IRV are required, they shall have distinct forms and be given distinctive names which are not in conflict with any of the forms or the names of any of the graphic characters in the IRV.

6.3 Application-orientated versions

Within national or international industries, organizations or professional groups, application-oriented versions can be used. They require precise agreement among the interested parties, who will have to exercise the options available and to make the required selection.

6.4 International Reference Version (IRV)

This version is available for use when there is no requirement to use a national or an application-oriented version. In information interchange, the IRV is assumed unless a particular agreement exists between sender and recipient of the data. The graphic characters allocated to the IRV are specified in Table 9/T.50.

Table 9/T.50. IRV graphic character allocations

Graphic	*Name*	*Coded representation*
#	Number sign	2/3
◯	Currency sign	2/4
@	Commercial at	4/0
[	Left square bracket	5/11
\	Reverse solidus	5/12
]	Right square bracket	5/13
^	Circumflex accent	5/14
`	Grave accent	6/0
{	Left curly bracket	7/11
|	Vertical line	7/12
}	Right curly bracket	7/13
-	Tilde, overline	7/14

It should be noted that no substitution is allowed when using the IRV and that the facility of paragraph 4.1.2.2 above does not apply to any format effector.

According to paragraph 5 above it is permitted to use composite graphic characters and there is no limit to their number. Because of this freedom, their processing and imaging may cause difficulties at the receiving end. Therefore agreement between sender and recipient of the data is recommended if composite characters are used.

7. CODE TABLES

A 7-bit code table consists of 128 positions arranged in 8 columns and 16 rows. The columns are numbered 0 to 7, and the rows are numbered 0 to 15.

The code table positions are identified by notations of the form x/y, where x is the column number and y is the row number.

The 128 positions of the code table are in one-to-one correspondence with the bit combinations of the 7-bit code. The notation of a code table position, of the form x/y, is the same as that of the corresponding bit combination (see paragraph 4 above).

Each code table position contains a symbol and/or a reference to a clause of this Recommendation. When a code table position corresponds to a bit combination that represents a control character or the character SPACE, the symbol is the acronym of the character allocated; otherwise it is the graphic symbol representing the character allocated, if any. A reference to paragraphs 4.1.2.2, 4.3.2 or 4.3.3 above is denoted by ①, ② or ③ respectively.

Table 10/T.50 is the basic 7-bit code table. It shows the 7-bit coded character set specified in paragraph 4 above and indicates the options related to format effectors (paragraph 4.1.2.2 above), alternative graphic characters (paragraph 4.3.2 above) and national or application-oriented use (paragraph 4.3.3 above).

Table 11/T.50 is the code table for the IRV of the 7-bit coded character set. It shows the result of exercising the three identified options in the manner specified in paragraph 6.4 above.

8. DESCRIPTION OF THE CONTROL CHARACTERS

The control characters are listed below in the alphabetic order of their acronyms.

8.1 ACK Acknowledge

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

8.2 BEL Bell

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

8.3 BS Backspace

A format effector which causes the active position to move one character position backwards.

Table 10/T.50. Basic 7-bit code table

				B_7	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1
B_4	B_3	B_2	B_1		**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
0	0	0	0	**0**	NUL	DLE	SP	0	③	P	③	p
0	0	0	1	**1**	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	**2**	STX	DC2	"	2	B	R	b	r
0	0	1	1	**3**	ETX	DC3	# / £ ②	3	C	S	c	s
0	1	0	0	**4**	EOT	DC4	□ / $ ②	4	D	T	d	t
0	1	0	1	**5**	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	**6**	ACK	SYN	&	6	F	V	f	v
0	1	1	1	**7**	BEL	ETB	'	7	G	W	g	w
1	0	0	0	**8**	BS	CAN	(	8	H	X	h	x
1	0	0	1	**9**	HT	EM	)	9	I	Y	i	y
1	0	1	0	**10**	LF①	SUB	*	:	J	Z	j	z
1	0	1	1	**11**	VT①	ESC	+	;	K	③	k	③
1	1	0	0	**12**	FF①	IS4	,	<	L	③	l	③
1	1	0	1	**13**	CR①	IS3	–	=	M	③	m	③
1	1	1	0	**14**	S0	IS2	.	>	N	③	n	③
1	1	1	1	**15**	SI	IS1	/	?	O	_	o	DEL

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① See paragraph 4.1.2.2 above
② See paragraph 4.3.2 above
③ See paragraphs 4.3.3 and 6.2.3 above

8.4 CAN Cancel

A character, or the first character of a sequence, indicating that the data preceding it is in error. As a result, this data shall be ignored. The specific meaning of this character shall be defined for each application and/or between sender and recipient.

8.5 CR Carriage Return

A format effector which causes the active position to move to the first character position on the same line.

Table 11/T.50. International Reference Version (IFV)

				B_7	0	0	0	0	1	1	1	1
				B_6	0	0	1	1	0	0	1	1
				B_5	0	1	0	1	0	1	0	1
					0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
B_4	B_3	B_2	B_1									
0	0	0	0	**0**	NUL	DLE	SP	0	@	P	`	p
0	0	0	1	**1**	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	**2**	STX	DC2	"	2	B	R	b	r
0	0	1	1	**3**	ETX	DC3	#	3	C	S	c	s
0	1	0	0	**4**	EOT	DC4	◯	4	D	T	d	t
0	1	0	1	**5**	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	**6**	ACK	SYN	&	6	F	V	f	v
0	1	1	1	**7**	BEL	ETB	'	7	G	W	g	w
1	0	0	0	**8**	BS	CAN	(	8	H	X	h	x
1	0	0	1	**9**	HT	EM	)	9	I	Y	i	y
1	0	1	0	**10**	LF	SUB	*	:	J	Z	j	z
1	0	1	1	**11**	VT	ESC	+	;	K	[	k	{
1	1	0	0	**12**	FF	IS4	,	<	L	\	l	|
1	1	0	1	**13**	CR	IS3	–	=	M	]	m	}
1	1	1	0	**14**	S0	IS2	.	>	N	^	n	¯
1	1	1	1	**15**	SI	IS1	/	?	O	_	o	DEL

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8.6 DC1 Device Control One

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 DC2 and DC3), or for any other device control function not provided by other DCs.

8.7 DC2 Device Control Two

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 DC1 is used to restore the device to the basic mode), or for any other device control function not provided by other DCs.

8.8 DC3 Device Control Three

A device control character which is primarily intended for turning off or stopping an ancillary device. This function may be a secondary level stop, for example wait, pause, stand-by or halt (in which case DC1 is used to restore normal operation). If it is not required for this purpose, it may be used for any other ancillary device control function not provided by other DCs.

8.9 DC4 Device Control Four

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.

8.10 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 such action may affect the information layout and/or the control equipment.

8.11 DLE Data Link Escape

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

8.12 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 portion of this character does not necessarily correspond to the physical end of the medium.

8.13 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.

8.14 EOT End of Transmission

A transmission control character used to indicate the conclusion of the transmission of one or more texts.

8.15 ESC Escape

A control character which is used to provide additional characters. It alters the meaning of a limited number of contiguously following bit combinations. The use of this character is specified in ISO Standard 2022.

8.16 ETB End of Transmission Block

A transmission control character used to indicate the end of a transmission block of data where data is divided into such blocks for transmission purposes.

8.17 EXT End of Text

A transmission control character which terminates a text.

8.18 FF Form Feed

A format effector which causes the active position to advance to the corresponding character position on a pre-determined line of the next form or page.

8.19 HT Horizontal Tabulation

A format effector which causes the active position to advance to the next pre-determined character position.

8.20 IS1 (US) Information Separator One (Unit Separator)

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.

8.21 IS2 (RS) Information Separator Two (Record Separator)

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.

8.22 IS3 (GS) Information Separator Three (Group Separator)

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.

8.23 IS4 (FS) Information Separator Four (File Separator)

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.

8.24 LF Line Feed

A format effector which causes the active position to advance to the corresponding character position of the next line.

8.25 **NAK Negative Acknowledge**

A transmission control character transmitted by a receiver as a negative response to the sender.

8.26 **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 such action may affect the information layout and/or the control of equipment.

8.27 **SI Shift-In**

A control character which is used in conjunction with SO and ESC 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 ISO Standard 2022.

8.28 **SO Shift-Out**

A control character which is used in conjunction with SI and ESC to extend the graphic character set of the code. It may alter the meaning of the bit combinations 2/1 to 7/14 which follow it until an SI character is reached. The effect of this character when using code extension techniques is described in ISO 2022.

8.29 **SOH Start Of Heading**

A transmission control character used as the first character of a heading of an information message.

8.30 **STX Start of Text**

A transmission control character which precedes a text and which is used to terminate a heading.

8.31 **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.

8.32 **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.

8.33 **VT Vertical Tabulation**

A format effector which causes the active position to advance to the corresponding character position on the next pre-determined line.

APPENDIX I – (to Recommendation T.50). Guidelines for standards derived from Recommendation T.50 (ISO Standard 646)

I.1 GENERAL

When national or application-oriented standards based on Recommendation T.50/ISO 646 are drafted, it is recommended to take account of the following considerations.

I.2 STRUCTURE OF A STANDARD

It is recommended to adopt the same structure and editorial style as implemented for Recommendation T.50/ISO 646. All facilities, restrictions and specifications of the standard should be stated clearly in sentences using plain language, rather than be summarized by tables with notes.

I.2.1 Control functions

The standard should contain explicit descriptions of the control functions. Even where those descriptions are identical to the descriptions in paragraph 8 above, they should be explicit descriptions, not just referenced to Recommendation T.50/ISO 646. For application-oriented standards specific meanings of the Information Separators and of the Device Controls should be defined.

I.2.2 Graphic characters (see paragraph 6.2.3 above)

Where there is no need for particular characters, the graphic characters of the International Reference Version (IRV) should be allocated to the same positions and with the same name as in Recommendation T.50/ISO 646.

I.2.3 Composite graphic characters and repertoire (see paragraph 5 above)

Recommendation T.50/ISO 646 permits the construction of composite graphic characters by using the control characters BACKSPACE and CARRIAGE RETURN so as to image two or more graphic characters at the same character position.

The total number of graphic characters which can be obtained from any version of the character set, with or without using this facility, is called the repertoire. Recommendation T.50/ISO 646 does not define a particular repertoire. However, as the interpretation and/or the imaging of composite characters may cause difficulties, agreement between sender and recipient of the data may be required. In order to avoid the necessity of such agreement and to facilitate interchange, national or application-oriented standards may specify a standard repertoire of graphic characters and thus recognize only a limited number of composite graphic characters. Such limitations are considered fully compatible with Recommendation T.50/ISO 646.

I.2.4 Versions

In a standard one or more versions can be specified. It should be noted that a version is not a standard but only part of a standard. The standard itself consists of the well defined version or versions and a set of clauses as mentioned above. The definition of a version requires that the options mentioned in paragraph 6.1 above be accurately exercised.

ATTACHMENT II-3. CONVERSION TABLE BETWEEN INTERNATIONAL ALPHABETS No. 2 AND No. 5 AND CONTROL CHARACTERS OF ALPHABET No. 5, NOT CONTAINED IN THE FIRST PART OF THE TABLE, USED FOR METEOROLOGICAL TRANSMISSIONS

Part I. Conversion table between International Alphabets No. 2 and No. 5

Symbols or commands	*Alphabet No. 2*		*Alphabet No. 5*	
	Letter case	*Figure case*	*Column*	*Row*
A	1		4	1
V	2		4	2
C	3		4	3
D	4		4	4
E	5		4	5
F	6		4	6
G	7		4	7
H	8		4	8
I	9		4	9
J	10		4	10
K	11		4	11
L	12		4	12
M	13		4	13
N	14		4	14
O	15		4	15
P	16		5	0
Q	17		5	1
R	18		5	2
S	19		5	3
T	20		5	4
U	21		5	5
V	22		5	6
W	23		5	7
X	24		5	8
Y	25		5	9
Z	26		5	10
Carriage return	27	27	0	13
Lime feed	28	28	0	10
Letters	29	29		
Figures	30	30		
Space	31	31	2	0
–		1	2	13
?		2	3	15
:		3	3	10
ENQ – WRU		4	0	5
3		5	3	3
8		9	3	8
Bell		10	0	7

Symbols or commands	*Alphabet No. 2*		*Alphabet No. 5*	
	Letter case	*Figure case*	*Column*	*Row*
(		11	2	8
)		12	2	9
.		13	2	14
,		14	2	12
9		15	3	9
0		16	3	0
1		17	3	1
4		18	3	4
’		19	2	7
5		20	3	5
7		21	3	7
=		22	3	13
2		23	3	2
/		24	2	15
6		25	3	6
+		26	2	11

Note: Signal No. 32 of Alphabet No. 2 has been omitted because it is not used.

Part II. Control characters of Alphabet No. 5, not contained in the first part of the table, used for meteorological transmissions

Symbols	*Code of Alphabet No. 5*	
	Column	*Line*
NUL	0	0
SOH	0	1
STX	0	2
ETX	0	3
EOT	0	4
ACK	0	6
DLE	1	0
DC1	1	1
DC2	1	2
NAK	1	5
SYN	1	6
ETB	1	7
ESC	1	11
FS	1	12
GS	1	13
RS	1	14
DEL	7	15

ATTACHMENT II-4. FORMAT OF METEOROLOGICAL MESSAGES

1. EXAMPLE OF SURFACE OBSERVATIONS (SYNOP)

(a) Use of International Telegraph Alphabet No. 2

Starting line ←←≡↓ZCZC→↑345→→→→→→

Abbreviated heading ←←≡↓SMYG↑10→↓LYBM→↑280000

Text ←←≡AAXX→↑28001

←←≡↑13131→.....→.....→.....→.....→ etc.*.....=

←←≡↑13272→.....→.....→.....→.....→ etc.*.....=

←←≡↑13333→.....→.....→.....→.....→ etc.*.....=

←←≡↑13462→.....→.....→.....→.....→ etc.*.....=

←←≡↑13586→↓NIL↑=

End-of-message signals ↓←←≡≡≡≡≡≡≡≡≡NNNN↓↓↓↓↓↓↓↓↓↓↓↓

Legend:
← Carriage return (Signal No. 27)
≡ Line feed (Signal No. 28)
→ Space (Signal No. 31)
↓ Letter shift (Signal No. 29)
↑ Figure shift (Signal No. 30)
= Signal No. 22 (figure case position)

(b) Use of International Alphabet No. 5

Starting line	SOH	CR	CR	LF	345										
Abbreviated heading	CR	CR	LF	SMYG 10	SP	LYBM	SP	280000							
Text	CR	CR	LF	AAXX	SP	28001									
	CR	CR	LF	13131	SP	.....	SP	.....	SP	.....	SP	.....	SP	etc.*.....=	
	CR	CR	LF	13272	SP	.....	SP	.....	SP	.....	SP	.....	SP	etc.*.....=	
	CR	CR	LF	13333	SP	.....	SP	.....	SP	.....	SP	.....	SP	etc.*.....=	
	CR	CR	LF	13462	SP	.....	SP	.....	SP	.....	SP	.....	SP	etc.*.....=	
	CR	CR	LF	13586	SP	NIL=									
End-of-message signals	CR	CR	LF	ETX											

* Full use should be made of the teleprinter line (69 characters per line). See also Part II, paragraph 2.3.3.2.6.

Legend:

SOH	Start of heading (Signal 0/1)
CR	Carriage return (Signal 0/13)
LF	Line feed (Signal 0/10)
SP	Space (Signal 2/0)
ETX	End of text (Signal 3/13)
=	Separator (Signal 3/13)

2. EXAMPLE OF SURFACE OBSERVATIONS (SHIP)

(a) Use of International Telegraph Alphabet No. 2

Starting line	←←≡↓ZCZC→↑234→→→→→
Abbreviated heading	←←≡↓SMVD↑01→↓KWBC→↑280000
Text	←←≡↓BBXX**
	←←≡↓WLGT**→↓28004→99510→70428→41595
	←←≡↑.....→.....→.....→.....→.....etc*
	←←≡↑.....→.....=
End-of-message signals	↓←←≡≡≡≡≡≡≡≡≡NNNN↓↓↓↓↓↓↓↓↓↓↓↓

(b) Use of International Alphabet No. 5

Starting line	SOH CR CR LF 234
Abbreviated heading	CR CR LF SMVD 01 SP KWBC SP 280000
Text	CR CR LF BBXX**
	CR CR LF WLGT** SP 28004 SP 99510 SP 70428 SP 41595 SP etc.*.....=
	CR CR LF ..... SP ..... SP .....=
End-of-message signals	CR CR LF ETX

* Full use should be made of the teleprinter line (69 characters per line). See also Part II, paragraph 2.3.3.2.6.

** In a bulletin of SHIP reports from sea stations, the group $M_iM_iM_jM_j$ shall be included only as the first line of the text, and the ship call sign or buoy identification and the group $YYGGi_w$ shall be included in every individual report.

3. EXAMPLE OF UPPER-AIR OBSERVATIONS (TEMP)

(a) Use of International Telegraph Alphabet No. 2

Starting line	←←≡↓ZCZC→↑248→→→→→→
Abbreviated heading	←←≡↓USSN↑01→↓ESWI→↑011200
Text	←←≡↓TTAA→↑51111→02185→99...→.....→.....etc*
	←←≡↑.....→.....→.....→.....→.....=
	←←≡
	←←≡↓TTAA→↑51111→↓NIL↑=
End-of-message signals	↓←←≡≡≡≡≡≡≡≡≡NNNN↓↓↓↓↓↓↓↓↓↓↓↓

(b) Use of International Alphabet No. 5

Starting line	[SOH] [CR] [CR] [LF] 248
Abbreviated heading	[CR] [CR] [LF] USSN 01 [SP] ESWI [SP] 011200
Text	[CR] [CR] [LF] TTAA [SP] 51111 [SP] 02185 [SP] 99... [SP] ..... [SP] etc.*.....=
	[CR] [CR] [LF] ..... [SP] ..... [SP] ..... [SP] ..... [SP] .....=
	[CR] [CR] [LF]
	[CR] [CR] [LF] TTAA [SP] 51111 [SP] 02180 [SP] NIL=
End-of-message signals	[CR] [CR] [LF] [ETX]

* Full use should be made of the teleprinter line (69 characters per line). See also Part II, paragraph 2.3.3.2.6.

4. EXAMPLES OF PRESENTATION OF FORMATS FOR SYNOP BULLETINS

(a) All Sections 1, 2, 3 and 4 shall be consecutively transmitted without any insertion of spaces and solidi in the identifier groups of Sections 3 and 4.

Example:

ZCZC 007
SMRS 10 RUMS 220600
AAXX 22061
26298 21/50 82503 11054 21058 40333 57010 71022 8807/ 333 21068 69902 =
26477 21335 82503 11049 21052 40247 57004 77777 886// 333 21049 69902 88706 =
26781 31296 82301 11050 21060 40248 52004 71022 887// 333 21057 88706 =
26997 21450 80000 11068 21/86 40310 52009 72070 886// 333 21146 60002 88712 =
27595 22997 93008 11077 21196 40158 52010 333 21191 69932 =
27612 31950 20000 11132 21145 40233 52002 71000 80001 333 21141 =
27731 22998 62902 11119 21154 40234 52013 80002 333 21117 69902 =
27947 32998 23602 11148 21178 40217 52020 80002 =
27962 22997 03404 11136 21171 40197 52027 333 21126 69992 =
NNNN

(b) Sections 1, 2, 3 and 4 shall start at the beginning of a line but identifiers of Sections 3 and 4 shall start with two spaces at the beginning.

Example:

```
ZCZC 055
SMDD 01 ETPD 110600
AAXX 11061
09393 32996 31704 10015 21027 40244 57005 83030
  333 20015 34101 =
09543 32950 11401 11018 21034 40274 53002 81030
  333 21018 3/103 41999 =
09184 32960 71905 10038 21006 40215 56003 8707/
  333 20038 31003 =
09385 32960 51704 10018 21018 40243 5/005 83046
  333 20017 34000 =
NNNN
```

5. EXAMPLES OF PRESENTATION OF NIL TEXTS

(a) SYNOP bulletin

```
SMRS10 RUMS 220600
NIL
```

(b) TEMP bulletin

```
USSN01 ESW1 011200
NIL
```

(c) CREX bulletin

```
KOMS10 FAPR 220600
NIL
```

(d) BUFR bulletin

```
IUKN01 EGRR 221200
NIL
```

ATTACHMENT II-5. DATA DESIGNATORS $T_1T_2A_1A_2$ii IN ABBREVIATED HEADINGS

Note: This attachment is designated as technical specifications in accordance with Resolution 12 (EC-68).

Table A : Data type designator T_1 Matrix Table for $T_2A_1A_2$ii definitions
Table B1 : Data type designator T_2 (when T_1 = A, C, F, N, S, T, U or W)
Table B2 : Data type designator T_2 when T_1 = D, G, H, X or Y)
Table B3 : Data type designator T_2 (when T_1 = I or J)
Table B4 : Data type designator T_2 (when T_1 = O)
Table B5 : Data type designator T_2 (when T_1 = E)
Table B6 : Data type designator T_2 (when T_1 = P, Q)
Table B7 : Data type designator T_2 (when T_1 = L)
Table C1 : Geographical designators A_1A_2 for use in abbreviated headings $T_1T_2A_1A_2$ii CCCC YYGGgg for bulletins containing meteorological information, excluding ships' weather reports and oceanographic data
Table C2 : Geographical designators A_1A_2 for use in abbreviated headings $T_1T_2A_1A_2$ii CCCC YYGGgg for bulletins containing ships' weather reports and oceanographic data including reports from automatic marine stations
Table C3 : Geographical area designator A_1 (when T_1 = D, G, H, O, P, Q, T, X or Y) and geographical area designator A_2 (when T_1 = I or J)
Table C4 : Reference time designator A_2 (when T_1 = D, G, H, J, O, P or T)
Table C5 : Reference time designator A_2 (when T_1 = Q, X or Y)
Table C6 : Data type designator A_1 (when T_1 = I or J)
Table C7 : Data type designator T_2 and A_1 (when T1 = K)
Table D1 : Level designator ii (when T_1 = O)
Table D2 : Level designator ii (when T_1 = D, G, H, J, P, Q, X or Y)
Table D3 : Level designator ii (when T_1T_2 = FA or UA)

Table A. Data type designator T_1 Matrix Table for $T_2A_1A_2$ii definitions

T_1	*Data type*	*T_2*	*A_1*	*A_2*	*ii*	*Priority*
A	Analyses	B1	C1	C1	**	3
B	Addressed message	***	***	***	***	1/2/4*
C	Climatic data	B1	C1	C1	**	4
D	Grid point information (GRID)	B2	C3	C4	D2	3
E	Satellite imagery	B5	C1	C1	**	3
F	Forecasts	B1	C1	C1	**	3
G	Grid point information (GRID)	B2	C3	C4	D2	3
H	Grid point information (GRIB)	B2	C3	C4	D2	3
I	Observational data (Binary coded) – BUFR	B3	C6	C3	**	2
J	Forecast information (Binary coded) – BUFR	B3	C6	C4	D2	3
K	CREX	B3	C7	C3	**	2
L	Aviation information in XML	B7	C1	C1	**	1/2/3
M	–					
N	Notices	B1	C1	C1	**	4
O	Oceanographic information (GRIB)	B4	C3	C4	D1	3
P	Pictorial information (Binary coded)	B6	C3	C4	D2	3
Q	Pictorial information regional (Binary coded)	B6	C3	C5	D2	3
R	–					
S	Surface data	B1	C1/C2	C1/C2	**	2/4*
T	Satellite data	B1	C3	C4	**	2
U	Upper-air data	B1	C1/C2	C1/C2	**	2
V	National data	(1)	C1	C1	**	(2)
W	Warnings	B1	C1	C1	**	1
X	Common Alert Protocol (CAP) messages					

Y	GRIB regional use	B2	C3	C5	D2	3
Z	–					

* Priority level: 1 is allocated to service messages.
2 is allocated to data and request messages.
3 is allocated to seismic waveform data (T_1T_2 = SY).
4 is allocated to administrative messages.

** See paragraph 2.3.2.2 for definition and use.

*** See paragraph 2.4.2 for definition and use.

(1) Table B2 or national table.

(2) To be determined.

Note: CLIMAT TEMP is not recommended for operations. See the *Abridged Final Report with Resolutions and Recommendations of the 2010 Extraordinary Session of the Commission for Basic Systems* (WMO-No. 1070).

Table B1. Data type designator T_2 (when T_1 = A, C, F, N, S, T, U or W)

Instructions for the proper application of the data type designators

1. The designators specified in this table should be used to the greatest extent possible to indicate the type of data contained within the body of the bulletin.

2. When the tables does not contain a suitable designator for the data type, an alphabetic designator which is not assigned in the table should be introduced and the WMO Secretariat notified.

3. This table includes only the FM number and code name for an individual code form. The Roman numeral identifying the latest version has been omitted to reduce clutter. In all cases the latest version of a code is implied. Refer to the *Manual on Codes* (WMO-No. 306) for the complete code name (including the version) of any numbered code. In those few instances where a numbered code does not exist, a reference and the common name is given: e.g. [ICAO] (AIREP). An explanatory note may be appended to an individual table if necessary.

4. In the event that no standard format has been established for a particular data type, and where there is a recommended format, that format is given in square brackets under the column labelled Code form (e.g. [TEXT]). This is a character code in free form – International Alphabet No. 2 (Attachment II-1) or International Alphabet No. 5 (Attachment II-2) will be used.

T_1 = A Analyses

T_2 Designator	*Data type*	*Code form (name)*
C	Cyclone	[TEXT]
G	Hydrological/marine	[TEXT]
H	Thickness	[TEXT]
I	Ice	FM 44 (ICEAN)
O	Ozone layer	[TEXT]
R	Radar	[TEXT]
S	Surface	FM 45 (IAC)/FM 46 (IAC FLEET)
U	Upper air	FM 45 (IAC)
W	Weather summary	[TEXT]
X	Miscellaneous	[TEXT]

T_1 = C Climatic data

T_2 Designator	Data type	Code form (name)
A	Climatic anomalies	[TEXT]
E	Monthly means (upper air)	FM 76 (SHIP)
H	Monthly means (surface)	FM 72 (CLIMAT SHIP)
O	Monthly means (ocean areas)	FM 73 (NACLI, CLINP, SPCLI, CLISA, INCLI)
S	Monthly means (surface)	FM 71 (CLIMAT)

T_1 = F Forecasts

T_2 Designator	Data type	Code form (name)
A	Aviation area/GAMET/advisories	FM 53 (ARFOR)/[TEXT]
B	Upper winds and temperatures	FM 50 (WINTEM)
C	Aerodrome (VT < 12 hours)	FM 51 (TAF)
D	Radiological trajectory dose	FM 57 (RADOF)
E	Extended	[TEXT]
F	Shipping	FM 46 (IAC FLEET)
G	Hydrological	FM 68 (HYFOR)
H	Upper-air thickness	[TEXT]
I	Iceberg	[TEXT]
J	Radio warning service (including IUWDS data)	[TEXT]
K	Tropical cyclone advisories	[TEXT]
L	Local/area	[TEXT]
M	Temperature extremes	[TEXT]
N	Space weather advisories	[TEXT]
O	Guidance	[TEXT]
P	Public	[TEXT]
Q	Other shipping	[TEXT]
R	Aviation route	FM 54 (ROFOR)
S	Surface	FM 45 (IAC)/FM 46 (IAC FLEET)
T	Aerodrome (VT ≥ 12 hours)	FM 51 (TAF)
U	Upper air	FM 45 (IAC)
V	Volcanic ash advisories	[TEXT]
W	Winter sports	[TEXT]
X	Miscellaneous	[TEXT]
Z	Shipping area	FM 61 (MAFOR)

T_1 = N Notices

T_2 Designator	Data type	Code form (name)
G	Hydrological	[TEXT]
H	Marine	[TEXT]
N	Nuclear emergency response	[TEXT]
O	METNO/WIFMA	[TEXT]
P	Product generation delay	[TEXT]
T	TEST MSG [System related]	[TEXT]
W	Warning related and/or cancellation	[TEXT]

T_1 = S Surface data

T_2 Designator	Data type	Code form (name)
A	Aviation routine reports	FM 15 (METAR)
B	Radar reports (Part A)	FM 20 (RADOB)
C	Radar reports (Part B)	FM 20 (RADOB)
D	Radar reports (Parts A & B)	FM 20 (RADOB)
E	Seismic data	* (SEISMIC)
F	Atmospherics reports	FM 81 (SFAZI)/FM 82 (SFLOC)/FM 83 (SFAZU)
G	Radiological data report	FM 22 (RADREP)
H	Reports from DCP stations	(any format)
I	Intermediate synoptic hour	FM 12 (SYNOP)/FM 13 (SHIP)
L	–	–
M	Main synoptic hour	FM 12 (SYNOP)/FM 13 (SHIP)
N	Non-standard synoptic hour	FM 12 (SYNOP)/FM 13 (SHIP)
O	Oceanographic data	FM 63 (BATHY)/FM 64 (TESAC)/ FM 62 (TRACKOB)
P	Special aviation weather reports	FM 16 (SPECI)
R	Hydrological (river) reports	FM 67 (HYDRA)
S	Drifting buoy reports	FM 18 (DRIFTER)
T	Sea ice	[TEXT]
U	Snow depth	[TEXT]
V	Lake ice	[TEXT]
W	Wave information	FM 65 (WAVEOB)
X	Miscellaneous	[TEXT]
Y	Seismic waveform data	(any format)
Z	Sea-level data and deep-ocean tsunami data	(any alphanumeric format)

* The international seismic code is documented in the *Manual on Codes* (WMO-No. 306), Volume I.1, Attachment III.

T_1 = T Satellite data

T_2 Designator	Data type	Code form (name)
B	Satellite orbit parameters	[TEXT]
C	Satellite cloud interpretations	FM 85 (SAREP)
H	Satellite remote upper-air soundings	FM 86 (SATEM)
R	Clear radiance observations	FM 87 (SARAD)
T	Sea surface temperatures	FM 88 (SATOB)
W	Winds and cloud temperatures	FM 88 (SATOB)
X	Miscellaneous	[TEXT]

T_1 = U Upper-air data

T_2 Designator	*Data type*	*Code form (name)*
A	Aircraft reports	FM 41 (CODAR), ICAO (AIREP)
D	Aircraft reports	FM 42 (AMDAR)
E	Upper-level pressure, temperature, humidity and wind (Part D)	FM 35 (TEMP)/FM 36 (TEMP SHIP)/ FM 38 (TEMP MOBIL)
F	Upper-level pressure, temperature, humidity and wind (Parts C and D) [National and bilateral option]	FM 35 (TEMP)/FM 36 (TEMP SHIP)/ FM 38 (TEMP MOBIL)
G	Upper wind (Part B)	FM 32 (PILOT)/FM 33 (PILOT SHIP)/ FM 34 (TEMP MOBIL)
H	Upper wind (Part C)	FM 32 (PILOT)/FM 33 (PILOT SHIP)/ FM 34 (TEMP MOBIL)
I	Upper wind (Parts A and B) [National and bilateral option]	FM 32 (PILOT)/FM 33 (PILOT SHIP)/ FM 34 (TEMP MOBIL)
K	Upper-level pressure, temperature, humidity and wind (Part B)	FM 35 (TEMP)/FM 36 (TEMP SHIP)/ FM 38 (TEMP MOBIL)
L	Upper-level pressure, temperature, humidity and wind (Part C)	FM 35 (TEMP)/FM 36 (TEMP SHIP)/ FM 38 (TEMP MOBIL)
M	Upper-level pressure, temperature, humidity and wind (Parts A and B) [National and bilateral option]	FM 35 (TEMP)/FM 36 (TEMP SHIP)/ FM 38 (TEMP MOBIL)
N	Rocketsonde reports	FM 39 (ROCOB)/FM 40 (ROCOB SHIP)
P	Upper wind (Part A)	FM 32 (PILOT)/FM 33 (PILOT SHIP)/ FM 34 (PILOT MOBIL)
Q	Upper wind (Part D)	FM 32 (PILOT)/FM 33 (PILOT SHIP)/ FM 34 (PILOT MOBIL)
R	Aircraft report	[NATIONAL*] (RECCO)
S	Upper-level pressure, temperature, humidity and wind (Part A)	FM 35 (TEMP)/FM 36 (PILOT SHIP)/ FM 38 (TEMP MOBIL)
T	Aircraft report	FM 41 (CODAR)
X	Miscellaneous	[TEXT]
Y	Upper wind (Parts C and D) [National and bilateral option]	FM 32 (PILOT)/FM 33 (PILOT SHIP)/ FM 34 (PILOT MOBIL)
Z	Upper-level pressure, temperature, humidity and wind from a sonde released by carrier balloon or aircraft (Parts A, B, C, D)	FM 37 (TEMP DROP)

_____

* For example, United States national code form for reports from a meteorological reconnaissance flight (RECCO), is documented in the *Manual on Codes* (WMO-No. 306), Volume II, Chapter IV, Part E.

T_1 = W Warnings

T_2 Designator	*Data type*	*Code form (name)*
A	AIRMET	[TEXT]
C	Tropical cyclone (SIGMET)	[TEXT]
E	Tsunami	[TEXT]
F	Tornado	[TEXT]
G	Hydrological/river flood	[TEXT]
H	Marine/coastal flood	[TEXT]
O	Other	[TEXT]
R	Humanitarian activities	(any format)
S	SIGMET	[TEXT]
T	Tropical cyclone (Typhoon/hurricane)	[TEXT]
U	Severe thunderstorm	[TEXT]
V	Volcanic ash clouds (SIGMET)	[TEXT]
W	Warnings and weather summary	[TEXT]

Table B2. Data type designator T_2 (when T_1 = D, G, H or Y)

Instructions for the proper application of the data type designators

1. The designator specified in this table should be used to the greatest extent possible to indicate the type of data contained within the text of the bulletin.

2. Where more than one type is contained in the text, the designator for one of the data types should be used.

3. When the table does not contain a suitable designator for the data type, an alphabetic designator which is not assigned in the table should be introduced and the WMO Secretariat notified.

Designator	*Data type*	*Designator*	*Data type*
A	Radar data	N	Radiation
B	Cloud	O	Vertical velocity
C	Vorticity	P	Pressure
D	Thickness (relative topography)	Q	Wet bulb potential temperature
E	Precipitation	R	Relative humidity
G	Divergence	T	Temperature
H	Height	U	Eastward wind component
J	Wave height + combinations	V	Northward wind component
K	Swell height + combinations	W	Wind
M	For national use	Z	Not assigned

Table B3. Data type designator T_2 (when T_1 = I or J)

Instructions for the proper application of the data type designators

1. The designators specified in this table should be used to the greatest extent possible to indicate the type of data contained within the body of the BUFR bulletin.

2. Where more than one data type is contained in the bulletin, the designators for only one of the data types should be used.

3. When the table does not contain a suitable designator for the data type, an alphabetic designator which is not assigned in the table should be introduced and the WMO secretariat notified.

Designator	*Data type*
N	Satellite data
O	Oceanographic/limnographic (water property)
P	Pictorial
S	Surface/sea level
T	Text (plain language information)
U	Upper-air data
X	Other data types

Table B4. Data type designator T_2 (when T_1 = O)

Instructions for the proper application of the data type designators

1. The designators specified in this table should be used to the greatest extent possible to indicate the type of data contained within the body of the GRIB bulletin for oceanographic products.

2. Where more than one data type is contained in the bulletin, the designators for only one of the data types should be used.

3. When the table does not contain a suitable designator for the data type, an alphabetic designator which is not assigned in the table should be introduced and the WMO secretariat notified.

Designator	*Data type*
D	Depth
E	Ice concentration
F	Ice thickness
G	Ice drift
H	Ice growth
I	Ice convergence/divergence
Q	Temperature anomaly
R	Depth anomaly
S	Salinity
T	Temperature
U	Current component
V	Current component
W	Temperature warming
X	Mixed data

Table B5. Data type designator T_2 (when T_1 = E)

Designator	*Data type*	*Designator*	*Data type*
C	Cloud top temperature	V	Visible
F	Fog	W	Water vapour
I	Infrared	Y	User specified
S	Surface temperature	Z	Unspecified

Table B6. Data type designator T_2 (when T_1 = P, Q)

Instructions for the proper application of the data type designators

1. The designator specified in this table should be used to the greatest extent possible to indicate the type of data contained within the text of the bulletin.

2. Where more than one type is contained in the text, the designator for one of the data types should be used.

3. When the table does not contain a suitable designator for the data type, an alphabetic designator which is not assigned in the table should be introduced and the WMO Secretariat notified.

Designator	*Data type*	*Designator*	*Data type*
A	Radar data	N	Radiation
B	Cloud	O	Vertical velocity
C	Clear air turbulence	P	Pressure
D	Thickness (relative topography)	Q	Wet bulb potential temperature
E	Precipitation	R	Relative humidity
F	Aerological diagrams (Ash cloud)	S	Snow cover
G	Significant weather	T	Temperature
H	Height	U	Eastward wind component
I	Ice flow	V	Northward wind component
J	Wave height + combinations	W	Wind
K	Swell height + combinations	X	Lifted index
L	Plain language	Y	Observational plotted chart
M	For national use	Z	Not assigned

Table B7. Data type designator T_2 (when T_1 = L)

Designator	*Data type*	*GTS priority*	*Code form name*
A	Aviation routine reports (“METAR”)	2	
C	Aerodrome Forecast (“TAF”) (VT < 12 hours)	3	
K	Tropical cyclone advisories	3	
N	Space weather advisories	3	
P	Special aviation weather reports (“SPECI”)	2	
S	Aviation general warning (“SIGMET”)	1	
T	Aerodrome forecast (“TAF”)) (VT ≥ 12 hours)	3	
U	Volcanic ash advisory	3	
V	Aviation volcanic ash warning (“SIGMET”)	1	
W	AIRMET	1	
Y	Aviation tropical cyclone warning (“SIGMET”)	1	

Note: Data that are expressed in extensible markup language (XML) and use data designators of T_1 = L and T_2 = A, C, K, P, S, T, U, V, W and Y are using IWXXM (FM-205).

Table C1. Geographical designators A_1A_2 for use in abbreviated headings $T_1T_2A_1A_2$ii CCCC YYGGgg for bulletins containing meteorological information, excluding ships' weather reports and oceanographic data

Instructions for the proper application of the geographical designators

1. This table is subdivided into two parts: Part I contains geographical designators related to countries or territories in each RTH zone of responsibility for the collection of observational reports (surface and upper-air); Part II contains those for vast areas such as continents, hemispheres, etc.

2. In the case of bulletins containing observational reports (surface and upper-air) from land stations, geographical designators contained in Part II of the table should be used only when no suitable designators are available in Part I of the table.

3. In the case of bulletins containing meteorological information related to aircraft reports, analyses, prognoses, warnings, climatological data, satellite data and also analogue facsimile information, all the geographical designators contained in this table can be used. However, as far as possible, the geographical designator XX should not be used.

4. For the geographical designator in the abbreviated heading of the METNO and WIFMA messages, XX should be used.

5. Geographical designators contained in this table should not be used in the abbreviated heading of bulletins containing ships' weather reports and oceanographic data.

Notes:

1. The designations employed and the presentation of the material in this table do not imply the expression of any opinion whatsoever on the part of the World Meteorological Organization concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.
2. For T_1T_2 = SZ, A_1A_2 area designator from Table C1 should be used.

Part I – Country or territory designators

A_1A_2	*Country*
AB	Albania
AG	Argentina
AH	Afghanistan
AI	Ascension Island
AJ	Azerbaijan
AK	Alaska
AL	Algeria
AN	Angola
AT	Antigua and Barbuda, Saint Kitts and Nevis, and other British islands in the vicinity
AU	Australia
AY	Armenia
AZ	Azores
BA	Bahamas
BC	Botswana
BD	Brunei Darussalam
BE	Bermuda
BH	Belize
BI	Burundi
BJ	Benin
BK	Banks Islands
BM	Myanmar
BN	Bahrain
BO	Bolivia (Plurinational State of)
BR	Barbados
BT	Bhutan
BU	Bulgaria
BV	Bouvet Island
BW	Bangladesh
BX	Belgium, Luxembourg
BY	Belarus
BZ	Brazil

A_1A_2	*Country*
CD	Chad
CE	Central African Republic
CG	Congo
CH	Chile
CI	China
CM	Cameroon
CN	Canada
CO	Colombia
CR	Canary Islands (Spain)
CS	Costa Rica
CT	Canton Island
CU	Cuba
CV	Cabo Verde
CY	Cyprus
CZ	Czechia
DC	Bonaire, St Eustatius and Saba
DJ	Djibouti
DL	Germany
DN	Denmark
DO	Dominica
DR	Dominican Republic
EG	Egypt
EI	Eritrea
EO	Estonia
EQ	Ecuador
ER	United Arab Emirates
ES	El Salvador
ET	Ethiopia
FA	Faroe Islands
FG	French Guiana
FI	Finland
FJ	Fiji
FK	Falkland Islands (Malvinas)
FM	Federated States of Micronesia
FP	Saint Pierre and Miquelon
FR	France
FW	Wallis and Futuna
GB	Gambia
GC	Cayman Islands
GD	Grenada
GE	Gough Island
GG	Georgia
GH	Ghana
GI	Gibraltar
GL	Greenland
GM	Guam
GN	Guinea
GO	Gabon

A_1A_2	*Country*
GQ	Equatorial Guinea
GR	Greece
GU	Guatemala
GW	Guinea-Bissau
GY	Guyana
HA	Haiti
HE	Saint Helena
HK	Hong Kong, China
HO	Honduras
HU	Hungary
HV	Burkina Faso
HW	Hawaiian Islands
IC	Comoros
ID	Indonesia
IE	Ireland
IL	Iceland
IN	India
IQ	Iraq
IR	Islamic Republic of Iran
IS	Israel
IV	Côte d'Ivoire
IY	Italy
JD	Jordan
JM	Jamaica
JP	Japan
KA	Caroline Islands
KB	Kiribati
KI	Christmas Island
KK	Cocos Islands
KN	Kenya
KO	Republic of Korea
KP	Cambodia
KR	Democratic People's Republic of Korea
KU	Cook Islands
KW	Kuwait
KY	Kyrgyzstan
KZ	Kazakhstan
LA	Lao People's Democratic Republic
LB	Lebanon
LC	Saint Lucia
LI	Liberia
LJ	Slovenia
LN	Southern Line Islands
LS	Lesotho
LT	Lithuania
LV	Latvia
LY	Libya

A_1A_2	*Country*
MA	Mauritius
MB	Marion Island
MC	Morocco
MD	Madeira
MF	Saint-Martin, Saint-Barthélemy, Guadeloupe and other French islands in the vicinity
MG	Madagascar
MH	Marshall Islands
MI	Mali
MJ	The former Yugoslav Republic of Macedonia
MK	Montenegro
ML	Malta
MN	St Maarten
MO	Mongolia
MR	Martinique
MS	Malaysia
MT	Mauritania
MU	Macao, China
MV	Maldives
MW	Malawi
MX	Mexico
MY	Mariana Islands
MZ	Mozambique
NC	New Caledonia
NE	Niue
NG	Papua New Guinea
NI	Nigeria
NK	Nicaragua
NL	Netherlands
NM	Namibia
NO	Norway
NP	Nepal
NR	Niger
NU	Curaçao and Aruba
NV	Vanuatu
NW	Nauru
NZ	New Zealand
OM	Oman
OO	Monaco
OR	South Orkney Islands
OS	Austria
PF	French Polynesia
PH	Philippines
PI	Phoenix Islands
PK	Pakistan
PL	Poland
PM	Panama
PO	Portugal
PP	Palau
PR	Peru
PT	Pitcairn
PU	Puerto Rico
PY	Paraguay
QB	Bosnia and Herzegovina
QT	Qatar
RA	Russian Federation (East)
RE	Réunion and associated islands
RH	Croatia
RM	Republic of Moldova
RO	Romania
RS	Russian Federation (West)
RW	Rwanda
SB	Sri Lanka
SC	Seychelles
SD	Saudi Arabia
SG	Senegal
SI	Somalia
SK	Sarawak
SL	Sierra Leone
SM	Suriname
SN	Sweden
SO	Solomon Islands
SP	Spain
SQ	Slovakia
SR	Singapore
SU	Sudan
SV	Swaziland
SW	Switzerland
SX	Santa Cruz Islands
SY	Syrian Arab Republic
SZ	Spitzbergen Islands
TA	Tajikistan
TC	Tristan da Cunha
TD	Trinidad and Tobago
TG	Togo
TH	Thailand
TI	Turks and Caicos Islands
TK	Tokelau
TM	Timor-Leste
TN	United Republic of Tanzania
TO	Tonga
TP	Sao Tome and Principe
TR	Turkmenistan
TS	Tunisia
TU	Türkiye
TV	Tuvalu

A_1A_2	*Country*
UG	Uganda
UK	United Kingdom of Great Britain and Northern Ireland
UR	Ukraine
US	United States of America
UY	Uruguay
UZ	Uzbekistan
VG	Saint Vincent and the Grenadines
VI	Virgin Islands
VN	Venezuela (Bolivarian Republic of)
VS	Viet Nam
YE	Yemen
YG	Serbia
ZA	South Africa
ZB	Zambia
ZM	Samoa
ZR	Democratic Republic of the Congo
ZS	South Sudan
ZW	Zimbabwe

Part II – Area designators

A_1A_2	*Geographical area*
AA	Antarctic
AC	Arctic
AE	South-East Asia
AF	Africa
AM	Central Africa
AO	West Africa
AP	Southern Africa
AS	Asia
AW	Near East
AX	Arabian Sea area
BQ	Baltic Sea area
CA	Caribbean and Central America
EA	East Africa
EC	East China Sea area
EE	Eastern Europe
EM	Middle Europe
EN	Northern Europe
EU	Europe
EW	Western Europe
FE	Far East
GA	Gulf of Alaska area
GX	Gulf of Mexico area
IO	Indian Ocean area
ME	Eastern Mediterranean area
MM	Mediterranean area
MP	Central Mediterranean area
MQ	Western Mediterranean area
NA	North America
NT	North Atlantic area
OC	Oceania
OH	Sea of Okhotsk
PA	Pacific area
PE	Persian Gulf area
PN	North Pacific area
PQ	Western North Pacific
PS	South Pacific area
PW	Western Pacific area
PZ	Eastern Pacific area
SA	South America
SE	Southern Ocean area
SJ	Sea of Japan area
SS	South China Sea area
ST	South Atlantic area
XE	Eastern hemisphere
XN	Northern hemisphere
XS	Southern hemisphere
XT	Tropical belt
XW	Western hemisphere
XX	For use when other designators are not appropriate

Table C2. Geographical designators A_1A_2 for use in abbreviated headings $T_1T_2A_1A_2$ii CCCC YYGGgg for bulletins containing ships' weather reports and oceanographic data including reports from automatic marine stations

Instructions for the proper application of the geographical designators

1. The first letter A_1 will denote the nature of the ship or automatic marine station:

For ocean weather stations:	W
For mobile ships and other marine stations:	V
For floats (T_1T_2 = SO):	F

2. The second letter A_2 will denote the area from which the reports contained in the bulletins originate.

3. Whenever practicable, separate bulletins should be prepared to avoid the use of the letter X.

Note: For T_1T_2 = SZ, A_1A_2 area designators from Table C1 should be used.

Designator	*Geographical area*
A	Area between 30°N–60°S, 35°W–70°E
B	Area between 90°N–05°N, 70°E–180°E
C	Area between 05°N–60°S, 120°W–35°W
D	Area between 90°N–05°N, 180°W–35°W
E	Area between 05°N–60°S, 70°E–120°W
F	Area between 90°N–30°N, 35°W–70°E
J	Area south of 60°S
X	More than one area

Table C3. Geographical area designator A_1 (when T_1 = D, G, H, O, P, Q, T, X or Y) and geographical area designator A_2 (when T_1 = I or J)

Instructions for the proper application of the geographical area designator

1. The designator specified in this table should be used to the greatest extent possible to indicate the geographical area of the data contained within the text of the bulletin.

2. Where the geographical area of the data does not correspond exactly with the designator, the designator for the area most approximating that of the data may be used.

3. When the table does not contain a suitable designator for the geographical area, an alphabetic designator which is not assigned in the table should be introduced and the WMO Secretariat notified.

Designator	*Geographical area*	
A	0° – 90°W	northern hemisphere
B	90°W –180°	northern hemisphere
C	180° – 90°E	northern hemisphere
D	90°E – 0°	northern hemisphere
E	0° – 90°W	tropical belt
F	90°W – 180°	tropical belt
G	180° – 90°E	tropical belt
H	90°E – 0°	tropical belt

Designator	*Geographical area*	
I	0° – 90°W	southern hemisphere
J	90°W – 180°	southern hemisphere
K	180° – 90°E	southern hemisphere
L	90°E – 0°	southern hemisphere
N	Northern hemisphere	
S	Southern hemisphere	
T	45°W – 180°	northern hemisphere
X	Global area (area not definable)	

Table C4. Reference time designator A_2 (when T_1 = D, G, H, J, O, P, or T)

Instructions for the proper application of the reference time designators

1. The designators specified in this table should be used to the greatest extent possible to indicate the reference time of data contained within the text of the bulletin.

2. Where the table does not contain a suitable designator for the reference time, an alphabetic designator which is not assigned in the table should be used.

Designator	*Reference time*	*Designator*	*Reference time*
A	Analysis (00 hour)	L	84 hours forecast
B	6 hours forecast	M	96 hours forecast
C	12 hours forecast	N	108 hours forecast
D	18 hours forecast	O	120 hours forecast (5 days)
E	24 hours forecast	P	132 hours forecast
F	30 hours forecast	Q	144 hours forecast
G	36 hours forecast	R	156 hours forecast (7 days)
H	42 hours forecast	S	168 hours forecast
I	48 hours forecast	T	10 days forecast
J	60 hours forecast	U	15 days forecast
K	72 hours forecast	V	30 days forecast
		W…Z	Not assigned

Table C5. Reference time designator A_2 (when T_1 = Q, X or Y)

Designator	*Reference time*	*Designator*	*Reference time*
A	Analysis (00 hour)	J	27 hours forecast
B	3 hours forecast	K	30 hours forecast
C	6 hours forecast	L	33 hours forecast
D	9 hours forecast	M	36 hours forecast
E	12 hours forecast	N	39 hours forecast
F	15 hours forecast	O	42 hours forecast
G	18 hours forecast	P	45 hours forecast
H	21 hours forecast	Q	48 hours forecast
I	24 hours forecast		

Table C6. Data type designator A_1 (when T_1 = I or J)

Instructions for the proper application of the data type designators

1. The designators specified in this table should be used to the greatest extent possible to indicate the type of data contained within the body of the BUFR bulletin.

2. Where more than one data type is contained in the bulletin, the designators for only one of the data types should be used.

3. When the table does not contain a suitable designator for the data types, an alphabetic designator which is not assigned in the table should be introduced and the WMO Secretariat notified.

T_1T_2	A_1	*ii*	*Data type*	*TAC correspondence*	*Data category subcategory (Common Table C13)*
IN	A		Satellite data (AMSUA)		003/003
IN	B		Satellite data (AMSUB)		003/004
IN	C		CrIS (selected channels)		003/030
IN	H		Satellite data (HIRS)		003/005
IN	I		IRAS		003/020
IN	J		HIRAS		003/030
IN	K		MWHS/MWHS-2		003/040
IN	M		Satellite data (MHS)		003/006
IN	Q		IASI (Principle component scores)		003/007
IN	S		ATMS		003/040
IN	T		MWTS/MWTS-2		003/040
IO	B		Buoy observations	BUOY	001/025
IO	I		Sea ice		
IO	P		Sub-surface profiling floats	TESAC	031/004
IO	R		Sea surface observations	TRACKOB	031/001
IO	S		Sea surface and below soundings	BATHY, TESAC	031/005
IO	T		Sea surface temperature		
IO	W		Sea surface waves	WAVEOB	031/002
IO	X		Other sea environmental		
IO	Z		Deep ocean tsunameter		031/007
IP	C		Radar composite imagery data		
IP	I		Satellite imagery data		
IP	R		Radar imagery data		
IP	X		Not defined		
IS	A	01–29	Routinely scheduled observations for distribution from automatic (fixed or mobile) land stations (e.g. 0000, 0100, … or 0220, 0240, 0300, …, or 0715, 0745, ... UTC)	n/a	000/006
IS	A	30–59	N-minute observations from automatic (fixed or mobile) land stations	n/a	000/007
IS	B		Radar reports (parts A and B)	RADOB	006/003
IS	C	01–45	Climatic observations from land stations	CLIMAT	000/020

T_1T_2	A_1	*ii*	*Data type*	*TAC correspondence*	*Data category subcategory (Common Table C13)*
IS	C	46–59	Climatic observations from marine stations	CLIMAT SHIP	001/020
IS	C	60	Climatic observations (monthly reports of daily climate data)	n/a	001/021
IS	D		Radiological observation	RADREP	010/001
IS	E		Measurement of surface ozone	n/a	008/000
IS	F		Source of atmospherics	SFAZI, SFLOC, SFAZU	000/030
IS	I	01–45	Intermediate synoptic observations from fixed land stations	SYNOP (SIxx)	000/001 000/051
IS	I	46–59	Intermediate synoptic observations from mobile land stations	SYNOP MOBIL	000/004
IS	M	01–45	Main synoptic observations from fixed land stations	SYNOP (SMxx)	000/002 000/052
IS	M	46–59	Main synoptic observations from mobile land stations	SYNOP MOBIL	000/005
IS	N	01–45	Synoptic observations from fixed land stations at non-standard time (i.e. 0100, 0200, 0400, 0500, ... UTC)	SYNOP (SNxx)	000/000 000/050
IS	N	46–59	Synoptic observations from mobile land stations at non-standard time (i.e. 0100, 0200, 0400, 0500, ... UTC)	SYNOP MOBIL	000/003
IS	R		Hydrologic reports	HYDRA	000/040
IS	S	01–19	Synoptic observations from marine stations	SHIP	001/000
IS	S	20–39	One-hour observations from automatic marine stations	n/a	001/006
IS	S	40–59	N-minute observations from automatic marine stations	n/a	001/007
IS	T	01–19	Tide gauge observations	n/a	001/030
IS	T	20–39	Observed water level time series	n/a	001/031
IS	V		Special aeronautical observations (SPECI)	SPECI	000/011
IS	W		Aviation routine weather observations (METAR)	METAR	000/010
IS	X		Other surface data	IAC, IAC FLEET	
IT	A		Administrative message		
IT	B		Service message		
IT	R		Request for data (inclusive of type)		
IT	X		Other text messages or information		
IU	A		Single level aircraft reports (automatic)	AMDAR	004/000
IU	A		Single level aircraft reports (manual)	AIREP/PIREP	004/001
IU	B		Single level balloon reports	n/a	
IU	C		(used for single level satellite-derived reports – see Note 3)	SAREP/SATOB	005/000
IU	D		Dropsonde/Dropwindsondes	TEMP DROP	002/007
IU	E		Ozone vertical sounding	n/a	008/001
IU	I		Dispersal and transport analysis	n/a	009/000
IU	J	01–19	Upper wind from fixed land stations (entire sounding)	PILOT (parts A, B, C, D)	002/001

T_1T_2	A_1	*ii*	*Data type*	*TAC correspondence*	*Data category subcategory (Common Table C13)*
IU	J	20–39	Upper wind from mobile land stations (entire sounding)	PILOT MOBIL (parts A, B, C, D)	002/003
IU	J	40–59	Upper wind from marine stations (entire sounding)	PILOT SHIP (parts A, B, C, D)	002/002
IU	K	01–19	Radio soundings from fixed land stations (up to 100 hPa)	TEMP (parts A, B)	002/004
IU	K	20–39	Radio soundings from mobile land stations (up to 100 hPa)	TEMP MOBIL (parts A, B)	002/006
IU	K	40–59	Radio soundings from marine stations (up to 100 hPa)	TEMP SHIP (parts A, B)	002/005
IU	L		Total ozone		008/002
IU	M		Model derived sondes		
IU	N		Rocketsondes		
IU	O		Profiles of aircraft observations in ascending/ descending	AMDAR	002/020
IU	P		Profilers	PILOT	002/010
IU	Q		RASS temperature profilers	TEMP	002/011
IU	R		(used for radiance data – see Note 3)		
IU	S	01–19	Radiosondes/pibal reports from fixed land stations (entire sounding)	TEMP (parts A, B, C, D)	002/004
IU	S	20–39	Radio soundings from mobile land stations (entire sounding)	TEMP MOBIL (parts A, B, C, D)	002/006
IU	S	40–59	Radio soundings from marine stations (entire sounding)	TEMP SHIP (parts A, B, C, D)	002/005
IU	T		(used for satellite-derived sondes – see Note 3)	SATEM, SARAD, SATOB	
IU	U	46–59	Monthly statistics of data from marine stations	SHIP	002/026
IU	W	01–19	Upper wind from fixed land stations (up to 100 hPa)	PILOT (parts A, B)	002/001
IU	W	20–39	Upper wind from mobile land stations (up to 100 hPa)	PILOT MOBIL (parts A, B)	002/003
IU	W	40–59	Upper wind from marine stations (up to 100 hPa)	PILOT SHIP (parts A, B)	002/002
IU	X		Other upper-air reports		
JO	I		Sea ice		
JO	S		Sea surface and below soundings		
JO	T		Sea surface temperature		
JO	W		Sea surface waves		
JO	X		Other sea environmental data		
JS	A		Surface area forecast (e.g. airways)		
JS	D		Radiological forecast	RADOF	
JS	M		Surface forecasts (e.g. MOS)		
JS	O		Maritime forecast	MAFOR	
JS	P		Forecast amendments (airways)		
JS	R		Hydrologic forecast	HYFOR	

T_1T_2	A_1	*ii*	*Data type*	*TAC correspondence*	*Data category subcategory (Common Table C13)*
JS	S		Forecast amendments (TAF)		
JS	T		Aerodrome forecast (TAF)		
JS	X		Other surface forecasts		
JT	E		Tsunami		
JT	H		Hurricane, typhoon, tropical storm warning		
JT	S		Severe weather, SIGMET		
JT	T		Tornado warning		
JT	X		Other warnings		
JU	A		Forecast at single levels		
JU	B		Binary coded SIGWX, Embedded Cumulonimbus		
JU	C		Binary coded SIGWX, Clear-air turbulence		
JU	F		Binary coded SIGWX, Fronts		
JU	N		Binary coded SIGWX, Other SIGWX parameters		
JU	O		Binary coded SIGWX, Turbulence		
JU	S		Forecast soundings		
JU	T		Binary coded SIGWX, Icing/Tropopause		
JU	V		Binary coded SIGWX, Tropical storms, sandstorms, volcanoes		
JU	W		Binary coded SIGWX, High-level winds		
JU	X		Other upper-air forecasts		

Notes:

1. Content of ISMx, ISIx, ISNx messages corresponds to the content of traditional SYNOP messages SMxx, SIxx, SNxx.
2. Category/Subcategory = 000/000 identifies SYNOP data from 0100, 0200, 0300, 0400, 0500, 0700, 0800, 1000, 1100, 1300, ... UTC). Thus SNxx in traditional SYNOP corresponds to ISNx in BUFR.
3. Designators A_1 for T_1T_2 already used for satellite data (e.g. IUC, IUR, IUT) are not allocated and reserved for future allocations, pending the allocation of A_1 for T_1T_2 = IN (satellite data).

Table C7. Data type designator T_2 and A_1 (when T_1 = K)

T_1T_2	A_1	*ii*	*Data type*	*TAC correspondence*	*Data category subcategory (Common Table C13)*
KF	A		Surface area forecast (e.g. airways)		
KF	D		Radiological forecast	RADOF	
KF	M		Surface forecasts (e.g. MOS)		
KF	O		Maritime forecast	MAFOR	
KF	P		Forecast amendments (airways)		
KF	R		Hydrologic forecast	HYFOR	
KF	S		Forecast amendments (TAF)		
KF	T		Aerodrome forecast (TAF)		
KF	X		Other surface forecasts		
KO	B		Buoy observations	BUOY	001/025

T_1T_2	A_1	*ii*	*Data type*	*TAC correspondence*	*Data category subcategory (Common Table C13)*
KO	I		Sea ice		
KO	P		Sub-surface profiling floats	TESAC	031/004
KO	R		Sea surface observations	TRACKOB	031/001
KO	S		Sea surface and below soundings	BATHY, TESAC	031/005
KO	T		Sea surface temperature		
KO	W		Sea surface waves	WAVEOB	031/002
KO	X		Other sea environmental	WAVEOB	031/002
KP	I		Sea ice		
KP	S		Sea surface and below soundings		
KP	T		Sea surface temperature		
KP	W		Sea surface waves		
KP	X		Other sea environmental		
KS	A	01–29	Routinely scheduled observations for distribution from automatic (fixed or mobile) land stations (e.g. 0000, 0100, … or 0220, 0240, 0300, …, or 0715, 0745, … UTC)	n/a	000/006
KS	A	30–59	N-minute observations from automatic (fixed or mobile) land stations	n/a	000/007
KS	B		Radar reports (parts A and B)	RADOB	006/003
KS	C	01–45	Climatic observations from land stations	CLIMAT	000/020
KS	C	46–59	Climatic observations from marine stations	CLIMAT SHIP	001/020
KS	D		Radiological observation	RADREP	010/001
KS	E		Measurement of surface ozone	n/a	008/000
KS	F		Source of atmospherics	SFAZI, SFLOC, SFAZU	000/030
KS	I	01–45	Intermediate synoptic observations from fixed land stations	SYNOP (SIxx)	000/001 000/051
KS	I	46–59	Intermediate synoptic observations from mobile fixed land stations	SYNOP MOBIL	000/004
KS	M	01–45	Main synoptic observations from fixed land stations	SYNOP (SMxx)	000/002 000/052
KS	M	46–59	Main synoptic observations from mobile land stations	SYNOP MOBIL	000/005
KS	N	01–45	Synoptic observations from fixed land stations at non-standard time (i.e. 0100, 0200, 0400, 0500,..., UTC)	SYNOP (SNxx)	000/000 000/050
KS	N	46–59	Synoptic observations from mobile land stations at non-standard time (i.e. 0100, 0200, 0400, 0500, 0700, 0800, 1000, 1100, 1300, ... UTC)	SYNOP MOBIL	000/003
KS	R		Hydrologic reports	HYDRA	000/040
KS	S	01–19	Synoptic observations from marine stations	SHIP	001/000
KS	S	20–39	One-hour observations from automatic marine stations	n/a	001/006
KS	S	40–59	N-minute observations from automatic marine stations	n/a	001/007
KS	V		Special aeronautical observations (SPECI)	SPECI	000/011
KS	W		Aviation routine weather observations (METAR)	METAR	000/010
KS	X		Other surface data	IAC, IAC FLEET	

T_1T_2	A_1	*ii*	*Data type*	*TAC correspondence*	*Data category subcategory (Common Table C13)*
KT	E		Tsunami		
KT	H		Hurricane, typhoon, tropical storm warning		
KT	S		Severe weather, SIGMET		
KT	T		Tornado warning		
KT	X		Other warnings		
KU	A		Single level aircraft reports (automatic)	AMDAR	004/000
KU	A		Single level aircraft reports (manual)	AIREP/PIREP	004/001
KU	B		Single level balloon reports	n/a	
KU	C		Single level satellite-derived reports	SAREP	005/000
KU	D		Dropsonde/dropwindsondes	TEMP DROP	002/007
KU	E		Ozone vertical sounding		008/001
KU	I		Dispersal and transport analysis	n/a	009/000
KU	J	01–19	Upper wind from fixed land stations	PILOT (parts A, B, C and D)	002/001
KU	J	20–39	Upper wind from mobile land stations	PILOT MOBIL (parts A, B, C and D)	002/003
KU	J	40–59	Upper wind from marine stations	PILOT SHIP (parts A, B, C and D)	002/002
KU	K	01–19	Radio soundings from fixed land stations	TEMP (parts A and B)	002/004
KU	K	20–39	Radio soundings from mobile land stations	TEMP MOBIL (parts A and B)	002/006
KU	K	40–59	Radio soundings from marine stations	TEMP SHIP (parts A and B)	002/005
KU	L		Total ozone	n/a	008/002
KU	M		Model derived sondes		
KU	N		Rocketsondes		
KU	O		Profiles of aircraft observations in ascending/descending	AMDAR	002/020
KU	P		Profilers	PILOT	002/010
KU	Q		RASS temperature profilers	TEMP	002/011
KU	S	01–19	Radiosondes/pibal reports from fixed land stations	TEMP (parts A, B, C and D)	002/004
KU	S	20–39	Radio soundings from mobile land stations	TEMP MOBIL (parts A, B, C and D)	002/006
KU	S	40–59	Radio soundings from marine stations	TEMP SHIP (parts A, B, C and D)	002/005
KU	T		Satellite derived sondes		
KU	U	46–59	Monthly statistics of data from marine stations	SHIP	002/026
KU	W	01–19	Upper wind from fixed land stations	PILOT (parts A and B)	002/001
KU	W	20–39	Upper wind from mobile land stations	PILOT MOBIL (parts A and B)	002/003
KU	W	40–59	Upper wind from marine stations	PILOT SHIP	002/002
KU	X		Other upper-air reports	(parts A and B)	

T_1T_2	A_1	*ii*	*Data type*	*TAC correspondence*	*Data category subcategory (Common Table C13)*
KV	A		Forecast at single levels		
KV	B		Coded SIGWX, Embedded Cumulonimbus		
KV	C		CREX coded SIGWX, Clear air turbulence		
KV	F		CREX coded SIGWX, Fronts		
KV	N		CREX coded SIGWX, Other SIGWX parameters		
KV	O		CREX coded SIGWX, Turbulence		
KV	S		Forecast soundings		
KV	T		CREX coded SIGWX, Icing/Tropopause		
KV	V		CREX coded SIGWX, Tropical storms, sandstorms, volcanoes		
KV	W		CREX coded SIGWX, High-level winds		
KV	X		Other upper-air forecasts		

Note: T_1T_2 = SZ is allocated to sea-level data and deep-ocean tsunami data in any alphanumerical form including CREX.

Table D1. Level designator ii (when T_1 = O)

Instructions for the proper application of level designators for ocean depths

The designators specified in this table should be used to the greatest extent possible to indicate the levels below the ocean surface in the body of the GRIB bulletin for oceanographic products.

Designator	*Depth (in metres)*	*Designator*	*Depth (in metres)*
98	Surface	62	500
96	2.5	60	600
94	5.0	58	700
92	7.5	56	800
90	12.5	54	900
88	17.5	52	1 000
86	25.0	50	1 100
84	32.5	48	1 200
82	40.0	46	1 300
80	50.0	44	1 400
78	62.5	42	1 500
76	75.0	40	1 750
74	100	38	2 000
72	125	36	2 500
70	150	34	3 000
68	200	32	4 000
66	300	30	5 000
64	400	01	Primary layer depth

Table D2. Level designator ii (when T_1 = D, G, H, J, P, Q, X or Y)

Instructions for the proper application of level designators

1. The designator specified in this table should be used to the greatest extent possible to indicate the level of the data contained within the text of the bulletin.

2. When data at more than one level are contained in the text, the designator for only one of the levels should be used.

3. When the table does not contain a suitable designator for the level, a designator which is not assigned in the table should be used.

Designator	*Level*
99	1000 hPa
98	Air properties for the Earth's surface
97	Level of the tropopause
96	Level of maximum wind
95	950 hPa
94	Level of 0°C isotherm
93	975 hPa
92	925 hPa
91	875 hPa
90	900 hPa
89	Any parameter reduced to sea level (e.g. MSLP)
88	Ground or water properties for the Earth's surface (i.e. snow cover, wave and swell)
87	1000–500 hPa thickness
86	Boundary level
85	850 hPa
84	840 hPa
83	830 hPa
82	825 hPa
81	810 hPa
80	800 hPa
79	790 hPa
78	780 hPa
77	775 hPa
76	760 hPa
75	750 hPa
74	740 hPa
73	730 hPa
72	725 hPa
71	710 hPa
70	700 hPa
69	690 hPa
68	680 hPa
67	675 hPa
66	660 hPa
65	650 hPa
64	640 hPa
63	630 hPa
62	625 hPa
61	610 hPa
60	600 hPa
59	590 hPa
58	580 hPa
57	570 hPa
56	560 hPa
55	550 hPa
54	540 hPa
53	530 hPa
52	520 hPa
51	510 hPa
50	500 hPa
49	490 hPa
48	480 hPa
47	470 hPa
46	460 hPa
45	450 hPa
44	440 hPa
43	430 hPa
42	420 hPa
41	410 hPa
40	400 hPa
39	390 hPa
38	380 hPa
37	370 hPa
36	360 hPa
35	350 hPa
34	340 hPa
33	330 hPa
32	320 hPa
31	310 hPa
30	300 hPa

Designator	*Level*
24	240 hPa
23	230 hPa
22	220 hPa
21	210 hPa
20	200 hPa
19	190 hPa
18	180 hPa
17	170 hPa
16	160 hPa
15	150 hPa
14	140 hPa
13	130 hPa
12	120 hPa

Designator	*Level*
11	110 hPa
10	100 hPa
09	090 hPa
08	080 hPa
07	070 hPa
06	060 hPa
05	050 hPa
04	040 hPa
03	030 hPa
02	020 hPa
01	010 hPa
00	Entire atmosphere (e.g. precipitable water)

Table D3. Level designator ii (when T_1T_2 = FA or UA)

T_1T_2	*Designator ii*	*Data type*	*Code form (name)*
FA	01–49	Aviation area/advisories	FM 53 (ARFOR) [text]
FA	50–59	GAMET	[TEXT]
FA	60–99	Not assigned	Not assigned
UA	01–59	Routine aircraft reports	ICAO AIREP
UA	60–69	Special aircraft reports, except for volcanic ash	ICAO AIREP
UA	70–79	Special aircraft reports, related to volcanic ash	ICAO AIREP
UA	80–99	Routine aircraft reports	ICAO AIREP

Note: Noting that there is no known use of the series 80–99, these series were allocated to routine aircraft reports up to 1 September 2008. After 1 September 2008, the series are reserved for future use.

ATTACHMENT II-6. FORMAT FOR THE TEXT OF ADDRESSED MESSAGES AND A GENERAL EXAMPLE OF EACH TYPE

General format form

(only International Telegraph Alphabet No. 5 is shown)

The abbreviated heading format for addressed messages consists of two lines of information.

The form of the abbreviated heading:

T_1T_2 A_1A_2 ii CaCaCaCa YYGGgg CCCC
where,

T_1T_2	=	BM designator for message in alphanumeric form BI designator for addressed message in binary form (use on binary links only)
A_1A_2	=	type of addressed message Options: AA – administrative message (to be passed to a person for information or action) BB – service message (to be passed to a person for action) RR – request for a GTS message by heading or sequence number RQ – request-to-database for data (request format TBD) intended for WIPPS (formerly GDPFS) action DA – the returned data response to the RR or RQ addressed message
ii	=	always 01 (no exceptions allowed)
$C_aC_aC_aC_a$	=	location indicator of the centre on the GTS to whom the message is addressed
YYGGgg	=	time of insertion on the GTS
CCCC	=	the international location indicator of the centre originating the message

TYPE 1

A_1A_2 = AA – Administrative message

The contents of this message type is a simple character free-flowing text, intended for human readability. This message type should be sent to a computer display or a printer. This type text message should be about general operational and/or administrative matters or discussions and GTS coordination topics. The T_1T_2 option to use is BM only, as the text is character data.

Example:
345
BMAA01 EDZW 261215
EGRR
ATTN OFFENBACH DATA MANAGER
THE BULLETINS YOU REQUESTED WILL BE RELAY TO YOUR CENTRE
BEGINNING THE FIRST OF THE MONTH
SMVG01 TVSV
SMTD01 TTPP
REGARDS, BMO DATA MANAGER SUPERVISOR=

Note: EDZW is the centre to which the message is addressed; EGRR is the originating centre of the message.

TYPE 2

A_1A_2 = BB – Service message

The contents of this message type is a simple character free-flowing text, intended for human readability. These message types should be sent to a display or printer. These are text messages about operational status and/or problem resolution matters. The T_1T_2 option to use is BM only, as the text is character data.

Example:
321
BMBB01 EGRR 281425
KWBC
ATTN EXETER COMMUNICATIONS SUPERVISOR
THE GTS LINK BETWEEN WASHINGTON AND BRASILIA IS DOWN FOR
6 HOURS DUE TO LINE RECONFIGURATION AT BRASILIA.
REGARDS, WASHINGTON COMMS SUPERVISOR=

Note: EGRR is the centre to which the message is addressed; KWBC is the originating centre of the message.

TYPE 3

A_1A_2 = RR – Request/reply message

The structure of the text for this message type has two specific classes using two different formats in the request text. This addressed message type is for use between nodes of the GTS. To use the CLASS 1 formatted request form, the nodes of the GTS must be adjacent nodes. To use the CLASS 2 formatted request form, the nodes of the GTS do not have to be adjacent to each other. The request/reply type message is for the acquisition of data at the bulletin level and the bulletin is assumed to exist already. If it is sent on a connection established for the exchange of alphanumeric data, then the T_1T_2 option of BM is recommended; and, if the connection was established for binary data exchange, then the T_1T_2 option of BI is recommended. If there is only one virtual channel between nodes for both alphanumeric and binary data exchange, it is recommended to use the T_1T_2 option of BI as a default. The use of the T_1T_2 option of BM would be used on all GTS links using character protocols (i.e. BAUDOT or ERROR CONTROL PROCEDURES), as all addressed messages and request/reply responses are alphanumeric.

CLASS 1. Request for repetition – to be sent between adjacent centres only. There can be three choices in the text of the request. The choices are:

1. For requesting only one message by its transmission sequence number;
2. For requesting a range of consecutive transmission sequence numbers; or
3. For requesting a group of specific messages by their transmission sequence numbers.

There will be only one request line per message.

The response to the request/reply CLASS 1 message will consist of two parts. The first part will be the construction and transmission of a status message using the TYPE 5 – data message format, indicating that action has been taken. This will be called a status of action message. The second part will be the transmission of the requested message(s). This will be a repeat of the originally sent message, including the original sequence number(s). The resulting transmission will most likely put the ongoing sequence numbers out of order. This should confirm, for the requesting centre, the receipt of the needed message(s).

Choice 1 – Requesting only one (previously received) message

1. Format for an alphanumeric connection.
   (SOH)(CR)(CR)(LF) nnn
   (CR)(CR)(LF) BMRR01 $C_aC_aC_aC_a$ YYGGgg
   (CR)(CR)(LF) CCCC
   (CR)(CR)(LF) SQN nnn = [one bulletin]
   (CR)(CR)(LF)(ETX)

2. Format for a binary connection.
   (SOH)(CR)(CR)(LF) nnn
   (CR)(CR)(LF) BIRR01 $C_aC_aC_aC_a$ YYGGgg
   (CR)(CR)(LF) CCCC
   (CR)(CR)(LF) SQN nnn = [one bulletin]

(CR)(CR)(LF)(ETX)

Choice 2 – Requesting a continuous series of (previously received) messages

1. Format for an alphanumeric connection.
(SOH)(CR)(CR)(LF) nnn
(CR)(CR)(LF) BMRR01 $C_aC_aC_aC_a$ YYGGgg
(CR)(CR)(LF) CCCC
(CR)(CR)(LF) SQN nnn-nnn = [a sequence of bulletins]
(CR)(CR)(LF)(ETX)

2. Format for a binary connection.
(SOH)(CR)(CR)(LF) nnn
(CR)(CR)(LF) BIRR01 $C_aC_aC_aC_a$ YYGGgg
(CR)(CR)(LF) CCCC
(CR)(CR)(LF) SQN nnn-nnn = [a sequence of bulletins]
(CR)(CR)(LF)(ETX)

Choice 3 – Requesting specific (previously received) messages

1. Format for an alphanumeric connection.
(SOH)(CR)(CR)(LF) nnn
(CR)(CR)(LF) BMRR01 $C_aC_aC_aC_a$ YYGGgg
(CR)(CR)(LF) CCCC
(CR)(CR)(LF) SQN nnn/nnn/nnn = [a selected number of bulletins]
(CR)(CR)(LF)(ETX)

2. Format for a binary connection.
(SOH)(CR)(CR)(LF) nnn
(CR)(CR)(LF) BIRR01 $C_aC_aC_aC_a$ YYGGgg
(CR)(CR)(LF) CCCC
(CR)(CR)(LF) SQN nnn/nnn/nnn = [a selected number of bulletins]
(CR)(CR)(LF)(ETX)

Note: Limit restriction: only one SQN line in a request.

Example – CLASS 1
788
BMRR01 LFPW 301215
DAMM
SQN 212-217=

Where LFPW is the centre to which the message is addressed and DAMM is the originating centre of the message.

CLASS 2. Request for a bulletin – can be sent to any centre on the GTS. There is only one choice for the form of the text of the request. The form is always alphanumeric, however, the T_1T_2 option of BM is to be used for all requests for alphanumeric messages, and the T_1T_2 option of BI is to be used for all requests for binary messages, as all returned responses will use the same T_1T_2 for the heading type to facilitate proper routing.

Format for the request:
Requests for messages (alphanumeric message request)
(SOH)(CR)(CR)(LF) nnn
(CR)(CR)(LF) BMRR01 $C_aC_aC_aC_a$ YYGGgg
(CR)(CR)(LF) CCCC
(CR)(CR)(LF) AHD $T_1T_2A_1A_2$ii CCCC YYGGgg =
(CR)(CR)(LF) AHD $T_1T_2A_1A_2$ii CCCC YYGGgg BBB =
(CR)(CR)(LF)(ETX)

Note 1: Limit restriction – no more than eight headings in a request beyond an adjacent centre.
Note 2: When the date-time group YYGGgg or the time group GGgg is not known, the following requests may be used:

AHD $T_1T_2A_1A_2$ii CCCCYY//// (BB/) (When BB=RR, CC or AA)
AHD $T_1T_2A_1A_2$ii CCCCYY//// (P//)
AHD $T_1T_2A_1A_2$ii CCCC //////

Where YY//// means for day YY, last occurrence in time.

Where ////// means last occurrence in day-time and the time is not older than 24 hours.

Examples – CLASS 2

- Used for a non-binary connection

051
BMRR01 AMMC 081220
KWBC
AHD SNAU55 AMMC 081100 RRA=
AHD SMID20 WIIX 081200=

Where AMMC is the centre to which the message is addressed and KWBC is the originating centre of the message.

- Used for a binary connection

110
BIRR01 KWBC 081220
AMMC
AHD HTAC30 KWBC 081200 =
AHD HHBC85 KWBC 081200 =

Where KWBC is the centre to which the message is addressed and AMMC is the originating centre of the message.

TYPE 4

A_1A_2 = RQ – Request-to-database message

The format for this message type will be in a specific format. The intent is for automatic computer processing. There is one type of request message to a database (for WIPPS (formerly GDPFS) use).

Format for the request:
(SOH)(CR)(CR)(LF) nnn
(CR)(CR)(LF) BIRQ01 $C_aC_aC_aC_a$ YYGGgg
(CR)(CR)(LF) CCCC
(CR)(CR)(LF) [TBD] [To be defined]
(CR)(CR)(LF)(ETX)

TYPE *5*

A_1A_2 = DA – Data message

This is the returned data message type. The purpose of this heading is to insure that if the requested data message is a bulletin containing a WMO abbreviated heading, the heading of the requested message heading is not used in the routing of the response back to the requesting centre. To insure proper routing the T_1T_2 for either BM or BI must reflect the code type in the returning data message. The data message has four different response forms. The response can be:

1. The requested message;
2. Message not found;
3. Message heading not recognized; or
4. Status message of action taken on RR CLASS 1 request.

There is only one bulletin or metadata file in a responding data message. In the examples below, assume the data message can either be BM or BI for CLASS 1 depending on the virtual channel used. If both the alphanumeric and binary messages are transmitted on only one virtual channel the use of BI will be the default.

Example of a requested message:
543
BMDA01 KWBC 081550
AMMC
SIID20 WIIX 081500
AAXX 08151
58424 42975 02203 10297 20251 40037 52008=

Where KWBC is the centre to which the message is addressed and AMMC is the originating centre of the message.

Example of the message not found (NIL response):
189
BMDA01 KWBC 081250
AMMC
NIL SNAU55 AMMC 081100 RRB=

Where KWBC is the centre to which the message is addressed and AMMC is the originating centre of the message.

Example of the message not recognized (ERR response):
154
BMDA01 KWBC 081250
AMMC
ERR SIID20 WIIX 081200=

Where KWBC is the centre to which the message is addressed and AMMC is the originating centre of the message.

Example of the reply message to the RR type CLASS 1 request (STATUS response):
264
BMDA01 RJTD 101255
KWBC
RETRANSMISSION ACTIVATED FOR 212-218=

Where RJTD is the centre to which the message is addressed and KWBC is the adjacent originating centre of the message.

Note: Connections with priority queues must guard against confusion when selecting and responding to sequence number requests for transmission.

Where: (CR) = Carriage return
(LF) = Line feed
(SOH) = Start of header control character
(ETX) = End of text control character

ATTACHMENT II-7. ROUTING CATALOGUES

1. FORMAT OF THE ROUTING CATALOGUE

1.1 The routing catalogue should be produced as an ASCII file, which could be imported into database applications. The information should therefore be presented in a database structure. The hereunder structure allows an easy display on a screen, e.g. using a "view" command.

1.2 The file containing the routing catalogue of a GTS centre should be named: CCCCROCA.TXT, where CCCC is the location indicator of the centre. The date of the preparation of the catalogue should be inserted in the first line of the line as YYYYMMDD (where YYYY is the year, MM the month and DD the day).

1.3 For each abbreviated heading, a record should comprise the following fields

Field number	*Content*	*Width*
1	Abbreviated heading TTAAii CCCC	11
2	GTS circuit from which the bulletin is received (see paragraph 1.4)	4
3	GTS circuit to which the bulletin is sent (see paragraph 1.4)	4
As many additional fields in the format of field No. 3 as additional circuits to which the bulletin is sent.		

1.4 The following combination of four characters should be used to designate the GTS circuits and entered into fields No. 2, 3 and subsequent fields:

(a) When the GTS circuit is a the unique point-to-point circuit connecting the GTS centre to an adjacent centre, the location indicator CCCC of the relevant adjacent GTS centre should be used;
(b) In other cases, e.g. when the circuit is a point-to-multipoint circuit (e.g. a satellite distribution system), a specific CCCC combination should be used, for example using a combination of letters and figures to differentiate them from the usual location indicators CCCC; the description of the relevant GTS circuits may be given in the file CCCCRMKS.TXT (see paragraph 2).

In the combination of characters CCCC, wild cards "*" should only be used when the GTS centre cannot provide complete information. The use of wild cards is not recommended, since it limits the information.

1.5 The fields should be surrounded by quotes and separated by commas.

Sample of structure:

"SMAA01 EGRR","RJTD","ANOU","DEMS","NFFN","NTAA","NZKL","PMBY"
"SMAA01 EGRR","KWBC","NZKL"
"SMAA10 KWBC","EGRR","DEMS","NFFN","NTAA","NZKL","WIIX"

2. ADDITIONAL INFORMATION

Any additional information, such as the creation dates of the directory, details of any extra CCCCs included in the routing catalogue, the means and procedures to access the routing catalogue (e.g. FTP server) and any other information which may help users should be included in a file named: CCCCRMKS.TXT, where CCCC is the location indicator of the centre.

3. ACCESS TO THE ROUTING CATALOGUES OF RTHs

3.1 Each RTH should make available its own routing catalogue on the FTP server, which it operates. The files from each centre should be found under GTS_routing/CCCC subdirectories on all servers. When an RTH does not have the capacity to make its routing catalogue available on a local server, it should transfer its routing catalogue CCCCROCA.TXT into the WMO FTP server under the subdirectory GTS_routing/CCCC, preferably by direct access to the WMO FTP server or by sending diskettes to the Secretariat.

3.2 RTHs should transfer their files CCCCRMKS.TXT into the WMO FTP server (ftp.wmo.int) under the subdirectory GTS_routing/CCCC, where CCCC is the location indicator of the RTH. Each subdirectory GTS_routing/CCCC is reserved for each RTH, which may transfer and update the data as required. Each RTH should transfer its CCCCRMKS.TXT into the WMO FTP server, preferably by direct access to the WMO FTP server or by sending diskettes to the Secretariat. By accessing the information included in the files CCCCRMKS.TXT available in the WMO FTP server, the GTS centres should find information on the means and procedures to access the routing directories of any RTHs.

3.3 RTH Offenbach operates on its own FTP server a mirror site of the part of the WMO FTP server related to the routing catalogues.

ATTACHMENT II-8. WMO FASCIMILE TEST CHART

1. The test chart is enclosed in a black frame 1.5 mm in width, the outer dimensions of which are:

length 449 mm; width 153 mm.

This frame is surrounded by a white margin 15 mm in width. The test chart is divided into sections marked on the transparency accompanying the test charts.

2. Section 1(1): Specimen of meteorological chart.

3. Section 2(2): Black and white lines for assessing the definition of the transmission according to different gradations.

2 mm	*1 mm*	*0.5 mm*	*0.33 mm*	*0.25 mm*	*0.20 mm*
0.5 line per mm	1 line per mm	2 line per mm	3 line per mm	4 line per mm	5 line per mm

4. Section 3(2): Abbreviation "WMO"

5. Section 4(1): Test chart identification number.

6. Section 5(4): Half-tone scales from black to white in eight density steps, according to a physiological scale.

7. Section 6(4): Black and white lines for assessing the definition of the transmission progressively from 2 mm to 0.20 mm (from 0.5 line per mm to 5 lines per mm).

8. Section 7(2): Tapering white line on a black background, opening out to 2 mm.

9. Section 8(2): white lines on a black background (thickness: 2 – 1 – 0.5 – 0.33 – 0.25 – 0.20 mm).

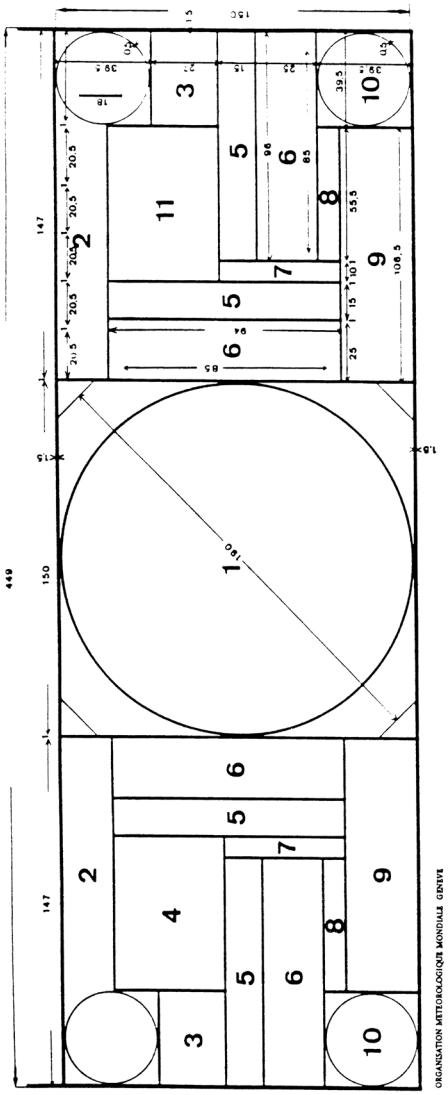
10. Section 9(2): Black lines of varying thickness (from 0.20 to 2 mm) on white background for assessing the reproduction quality of the separate lines.

11. Section 10(2): Black circle 0.5 mm thick with outer diameter of 39.5 mm and a square with diagonals inscribed in it.

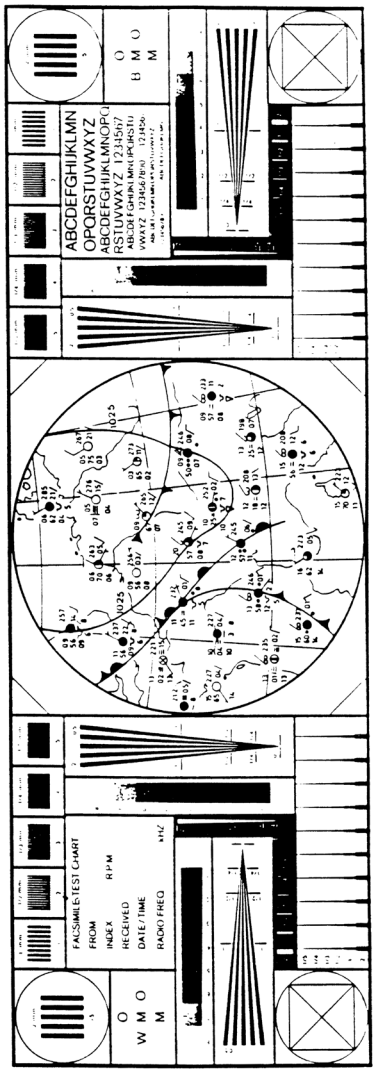
12. Section 11(1): 2 – 3 – 4 – 5 mm typographical signs.

Notes:

1. The accuracy is ± 0.015 mm (15/1000 of a millimetre) both as regards the thickness of the rectilinear or radial lines of the test chart, and as regards the length of the periodic element considered.
2. The position of the frames surrounding each element is to an accuracy of ± 0.15 mm (15/100 of a mm).
3. Taking into account the variations due to temperature changes (between 5 and 30°C) and humidity changes (from 25 to 85%) an accuracy of ± 0.2/1000 is achieved for lengths of 449 mm and 153 mm. All variations in length are regular and homogeneous whatever intermediate length is considered and remain within the limits of the above tolerance, all measurements being made on a flat surface.



Transparency



Test chart
(considerably reduced)

ATTACHMENT II-9. TRANSMISSION OF PICTORIAL INFORMATION BY CODED AND NON-CODED DIGITAL FACSIMILE

1. Coded or non-coded digital facsimile transmission procedures between centres on a network connection

1. The structure of the message, containing a bit-oriented product for transmission on GTS links should be as follows:

2. The starting line defined in Part II, paragraph 2.3.1.1 (b), should be the start of the transmission envelope; the end of message signal should consist of the characters [CR] [CR] [LF] [ETX] as defined in Part II, paragraph 2.3.4 (b).

[SOH] [CR] [CR] [LF] nnn (identification + data descriptor + product) [CR] [CR] [LF] [ETX]

(- - - - - - - - - - - start - - - - - - - - - - -)

(- WMO envelope -)

where nnn is the transmission sequence number of the message.

3. The structure of the abbreviated heading defined in Part II, paragraph 2.3.2.1 (b), should be used to identify the product,

i.e. [CR] [CR] [LF] $T_1T_2A_1A_2ii$ [SP] CCCC [SP] YYGGgg ([SP] BBB)

in which T_1 = P – Pictorial information in digital form.

4. Attachment II-5 should be used to describe the products transmitted by facsimile. Table B2 defines T_2, while Tables C3 and C4 completely define A_1 and A_2. Table D describes the ii level indicators.

5. The series of binary data representing the product in digital facsimile should be preceded by the data descriptor groups coded in International Alphabet No. 5,

[CR] [CR] [LF] DFAX $S_1S_2S_3S_4$

where DFAX indicates pictorial data which are coded or uncoded digital facsimile;
$S_1S_2S_3S_4$ are coded in accordance with Table A below to describe the characteristics of the product transmitted.

6. Example of identification and description of a product:

[CR] [CR] [LF] PEDA 98 [SP] KWBC [SP] 011200

[CR] [CR] [LF] DFAX 0122 - - - - - - - - - - binary data - - - - - - - - - -

where P indicates pictorial information in digital form;
E indicates precipitation;
D indicates northern hemisphere from 90°W to 0°;
A indicates an analysis (00 hour);
98 indicates surface of Earth or ocean;
KWBC indicates NMC Washington;
011200 indicates day one and time 1200 UTC;
DFAX indicates coded or uncoded digital facsimile;
0 indicates uncoded digital facsimile;
1 indicates control signals (for IOC, phasing, etc.) are included;
2 indicates scanning frequency of 120 rpm;
2 indicates 3.85 lines/mm IOC vertical resolution.

Therefore the product would be formed as follows:

[SOH] [CR] [CR] [LF] 001

[CR] [CR] [LF] PEDA 98 [SP] KWBC [SP] 011200

[CR] [CR] [LF] DFAX 0122 bbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbb

bbbbbbbbbbbbbbbbbbbbbbbb/ /bbbbbbbbbbbbbbbbbbbbbbbbbbbbb

bbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbbb [CR] [CR] [LF] [ETX]

where b represents binary data.

The length of the message is variable, depending on the product and data density.

Note: The envelope is used to recognize, store and retrieve data. The number of octets is only limited by the NMC transmitting of receiving the file (product). At present, the length of a chart transmitted by non-coded digital facsimile is less than 684 000 octets. NMCs should make sure that products of this length can in fact be transmitted by their systems. If products in digital facsimile were sent in coded form, the size of the file would be considerably reduced, enabling centres where the possibilities for processing are at present limited to implement more easily the new switching procedure for facsimile products.

Table A. Data descriptor $S_1S_2S_3S_4$ for identification of the characteristics of pictorial information in digital facsimile

S_1	S_2	S_3	S_4
Uncoded digital fax: 0 Digital fax coded according to ITU-T Recommendation T.4 – one-dimensional 1 Digital fax coded according to ITU-T Recommendation T.4 – two-dimensional: 2	No control signals included: 0 Control signals included: 1	Scanning frequency: 60 rpm: 0 90 rpm: 1 120 rpm: 2 240 rpm: 3 *or* Horizontal resolution: 1728 picture elements/ line: 6 3456 picture elements/ line: 7	Vertical resolution: 1.89 1/mm: 0 3.79 1/mm: 1 3.85 1/mm: 2 7.58 1/mm: 3 7.7 1/mm: 4

Note: Procedures for transmission of coded digital facsimile according to the ITU-T group 4 standards are for further study.

II. Procedure for digital facsimile transmission between centres when separate channels are used for the transmission of the alphanumeric identifier and digital facsimile information respectively

1. The coded or non-coded digital facsimile transmission procedure is intended for facsimile transmission on multiplexed channels by modems in conformity with ITU-T Recommendation V.29. The procedure can be used by automated centres (for facsimile transmission) as well as by non-automated centres. The procedure is based on the transmission of addressed messages for identification on the alphanumeric channel and facsimile products on the other channel.

2. DESCRIPTION OF PROCEDURE

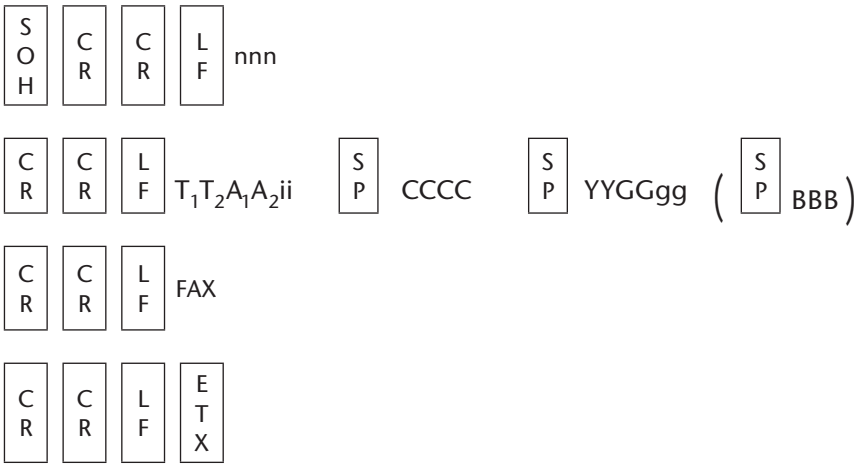
2.1 In the multiplexing mode, alphanumeric and facsimile products are transmitted separately over different channels of the multiplexer.

2.2 Channel B is used for the transmission of alphanumeric information while Channel A is used for the transmission of facsimile information.

2.3 For data transmission over Channel B, any WMO-recommended EDC procedure (WMO software, WMO hardware, X.25/LAPB) can be used.

Note: If WMO software or hardware procedures are used, the modem should have a backward channel.

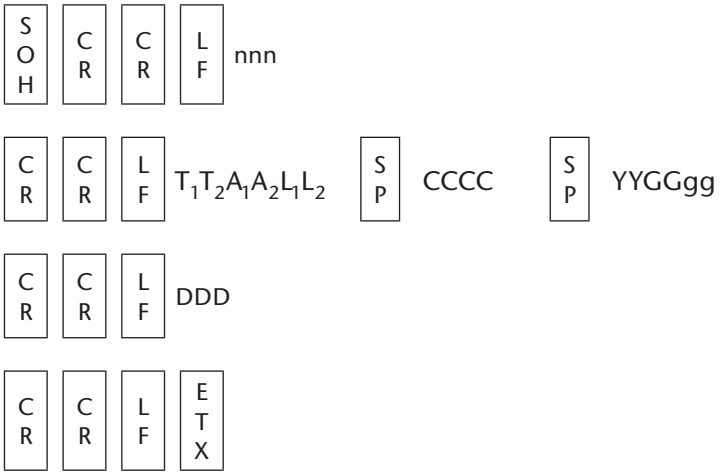
2.4 The transmitting centre, after a facsimile document has been prepared for facsimile transmission, should send a message identifying the document over Channel B. The format of the identifier message is as follows:



where

T_1	designates the data type	Attachment II-5, Tables A to D
T_2	designates the data type	
A_1	is the geographical area designator	
A_2	is the reference time designator	
ii	is the level designator	
CCCC	is the identifier of the originating station;	
YY	is the day of month;	
GGgg	is the standard time of observation;	
FAX	is the inclination of transmission of facsimile information.	

2.5 After receiving an identifier message, the receiving centre should send (over Channel B) a reply in the following form:



The reply message should be compiled in conformity with the rules for addressed messages (Part II, paragraph 2.4) with the following changes:

(a) Adoption of a new type of addressed message: a service message for facsimile exchange control (specific designator TT = BF);
(b) Service messages for facsimile exchange control should have first priority;
(c) Group DDD, which defines the control instruction (reply), is introduced into service messages for facsimile exchange control;
(d) Group DDD in a service message sent in reply to an identifier message may have one of the following meanings:

RDY	(ready)	–	Ready to receive document;
ABO	(abort)	–	Refusal to receive proposed document (this is sent if the receiving centre does not require this document);
RPT	(repeat)	–	Request to repeat identifier message (this is sent when an error is found in the identifier message by the receiving centre).

2.6 On receiving RDY, the transmitting centre starts sending the facsimile document over the multiplexed Channel A.

2.7 After reception of the document has been completed, or during the course of reception, the receiving centre sends a service message for facsimile exchange control. The format of the message is specified in paragraph 2.5 above. Group DDD may then have one of the following meanings:

ACK	(acknowledgement)	–	acknowledgement of reception of the facsimile document;
NAK	(negative acknowledgement)	–	Notification of the rejection of the facsimile document (or poor quality of reception).

3. ALGORITHM OF OPERATION OF THE TRANSMITTING CENTRE

3.1 Algorithm of operation of the transmitting centre is shown in Figure 1.

3.2 **Description of the algorithm**

Phase B–1 After a facsimile document has been prepared for transmission, the transmitting centre enters the "start" phase, then goes into Phase B–2.

Phase B–2 The transmitting centre sends an identifier message for the document, then waits for a reply (timer T01 is started).

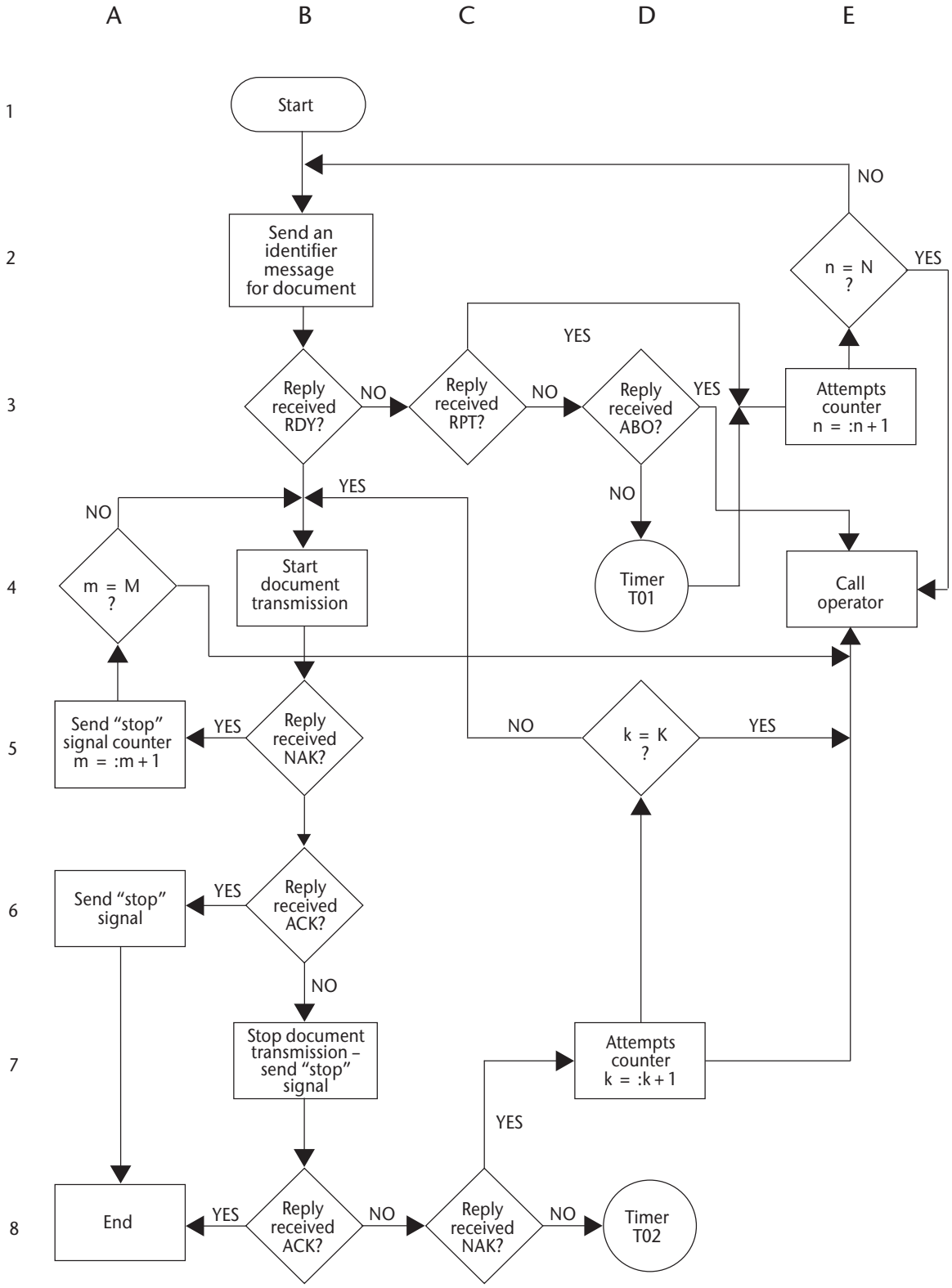


Figure 1. Algorithm of operation of the transmitting centre

Phases B–3, C–3, D–3, D–4	The transmitting centre is waiting for a reply to the identifier message. When timer T01 expires, the centre enters phase E–3. On receiving one of the possible replies (RDY, RPT, ABO), the centre enters the receptive phase (B–4, E–3, E–4)
Phase E–3	The number of attempts to send an identifier message is stored in counter n.

Phase E–2 When the number of attempts to send an identifier message becomes equal to N, the centre enters phase E–4.
If the number of attempts is less than N, the centre enters phase B–2.

Phase B–4 The transmitting centre starts sending the facsimile document over Channel A, then waits for a reply (phases B–5, B–6).

Phase B–5 After receiving NAK during the course of sending a document, the transmitting centre goes into phase A–5.

Phase A–5 Automatic control signals of termination of facsimile transmission are sent and the number of attempts to send the document is stored in counter m.

Phase A–4 When the number of attempts to send the facsimile document becomes equal to M, the centre goes into phase E–4.
The number of attempts to send a document is less than M, the centre enters phase A–5.

Phase B–6 After receiving ACK during the course of sending a document, the transmitting centre considers that the transmission may be completed and goes into phase A–6.

Phase A–6 Automatic control signals of termination of facsimile transmission are sent.

Phase B–7 When the transmission of the document is completed, the transmitting centre sends automatic control signals of termination of facsimile transmission, and waits for a replay (timer T02 is started).

Phase B–8, C–8, D–8 The transmitting centre is waiting for acknowledgement of reception of the document.
When timer T02 expires, the centre enters phase E–4.
On receiving one of the possible replies (ACK, NAK), the centre goes into the receptive phase (A–8, D–7).

Phase D–7 The number of attempts to retransmit the document is stored in counter k.

Phase D–5 When the number of attempts to retransmit the document becomes equal to K, the centre goes into phase E–4.
If the number of attempts is less than K, the centre enters phase B–4.

Phase E–4 The operator of the system is notified of any abnormal situation.

Phase A–8 Transmission procedures have been completed.

3.3 The following values for the algorithm parameters are suggested:

N = 3
M = 2
K = 2
} For channels operating in non-coded facsimile mode

M = 5
K = 5
} For channels operating in coded facsimile

T01 is equal to 40 seconds.
T02 is equal to 120 seconds.

ATTACHMENT II-10. REPORTS OF RECEPTION CONDITIONS OF METEOROLOGICAL RADIO TRANSMISSIONS

Code form:

RECEP $Q_cL_aL_aL_a$ $L_oL_oL_oL_o$ YYG_1G_1g $G_2G_2gm_km_k$ CCC(n)(n) SINPO .....
YYG_1G_1g $G_2G_2gm_km_k$ CCC(n)(n) SINPO .....

Meaning of symbolic words and letters:

RECEP – Code form for reports of reception conditions of radio transmission.

Q_c – Quadrant of the globe (according to the *Manual on Codes* (WMO-No. 306), Volume I.1.

$L_aL_aL_a$ – Latitude of the radio receiving station in tenths of a degree.

$L_oL_oL_oL_o$ – Longitude of the radio receiving station in tenths of a degree.

YY – Day of the month (UTC).

G_1G_1g – Time of observation in hours and tens of minutes (UTC) of the beginning of the period covered by the report.

G_2G_2g – Time of observation in hours and tens of minutes (UTC) of the ending of the period covered by the report.

m_km_k – Band in megahertz of the frequency to which the report refers, e.g.:
07 = 7 MHz or more, but under 8 MHz;
15 = 15 MHz or more, but under 16 MHz.

CCC(n)(n) – International call sign of the intercepted frequency (mostly three letters or three letters followed by one or two figures).

SINPO – Code indicator to be used and followed by a five-figure group referring to the SINPO code as defined by Recommendation No. 251-CCIR, published in Appendix 14 to ITU Radio Regulations, Geneva, 1968. The SINPO code is reproduced below.

SINPO signal reporting code

Rating scale	*S*	*I*	*N*	*P*	*O*
	Signal strength	*Degrading effect*			*Overall rating*
		Interference	*Noise*	*Propagation disturbance*	
5	Excellent	Nil	Nil	Nil	Excellent
4	Good	Slight	Slight	Slight	Good
3	Fair	Moderate	Moderate	Moderate	Fair
2	Poor	Severe	Severe	Severe	Poor
1	Barely audible	Extreme	Extreme	Extreme	Unusable

ATTACHMENT II-11. RE-ROUTING PROCEDURES FOR THE MAIN TELECOMMUNICATION NETWORK

1. DEFINITIONS

Breakdown of a circuit means that a technical failure has occurred.

Outage of a centre or a circuit means that a centre or a circuit, because of a breakdown, or for any other reason, will be non-operational for a time period exceeding 30 minutes.

Backup facilities means any equipment or circuits available for replacement of the equipment and/or circuits out of operation (the term "stand-by" should not be used in this connection).

Rerouting of traffic means transmission and/or reception of meteorological information via other circuits or by means other than normal.

2. PRE-OUTAGE ARRANGEMENTS

The following arrangements should be made on bilateral or multilateral agreements:

(a) Appropriate transmission programmes of meteorological information, as required by the different centres, should be prepared at an early date;
(b) At the same time, necessary routing tables should be prepared, taking into account the different routing possibilities, if several possibilities exist;
(c) Arrangements should be made to ensure proper coordination between the operators of the different centres;
(d) Each centre should prepare instructions to be used by the operators, indicating what measures should be taken under various conditions.

3. DURING-OUTAGE ARRANGEMENTS

3.1 In case of a circuit outage, operators from both centres shall make every effort to resume normal traffic as soon as possible.

3.2 If a failure in operation is observed by a centre, the centre shall immediately inform all the centres concerned, if possible indicating the type of failure.

3.3 The centre shall then check its own equipment and circuits.

3.4 After determining the reason for the faulty operation, the centre shall immediately send a second message to all centres concerned. In any case, a second message shall be sent, not later than one hour after the first message has been sent, even in the case where the reason for the failure has not been found. In order that all centres concerned may be kept informed as regards further developments, additional messages shall be sent as required.

3.5 After one hour at the latest, of interruption of traffic, centres concerned shall decide whether and at what time eventual re-routing procedures will commence. If centres concerned decide that re-routing procedures are to commence, these procedures shall be in accordance with the already agreed bilateral and/or multilateral arrangements in this respect.

3.6 In case of interruption of the normal operation of a centre, measures shall be taken to try to ensure the collection of basic data from the zone of responsibility of that centre for onward transmission for regional and global distribution.

4. POST-OUTAGE ARRANGEMENTS

4.1 As soon as a centre which has been out of normal service is able to resume normal operation, it shall immediately inform all centres accordingly.

4.2 At that stage, centres concerned will decide when (after what delay) normal traffic will be resumed. In doing so, the technical requirements for such action shall be taken into account.

5. SERVICE MESSAGES CONCERNING OUTAGES

5.1 Service messages may be transmitted on any available GTS circuits, taking into account the provisions, as defined in Part II, paragraph 2.4.

5.2 When no GTS circuit is available for the transmission of such service messages, they can be routed on the AFTN (in this case, service messages should conform to the format prescribed by ICAO), or on any other available telecommunication circuits.

ATTACHMENT II-12. INSTRUCTIONS FOR THE USE OF THE INDICATOR BBB

1. The BBB indicator shall be included in the abbreviated heading lines of additional, subsequent, corrected or amended bulletins by those centres which are responsible for preparing or compiling the bulletins concerned.

2. The BBB indicator shall be added when the abbreviated heading line defined by $T_1T_2A_1A_2$ii CCCC YYGGgg has already been used for the transmission of a corresponding initial bulletin. Once the initial bulletin has been transmitted, the centre responsible for preparing or compiling the bulletin uses the BBB indicator to transmit additional, subsequent corrected or amended messages for the same $T_1T_2A_1A_2$ii CCCC YYGGgg, but appended with the appropriate form of BBB indicator, following these guidelines:

(a) To transmit information or reports normally contained in an initial bulletin after the initial bulletin has been transmitted or for a subsequent or additional issuance of a bulletin whose $T_1T_2A_1A_2$ii CCCC YYGGgg would not be unique without a BBB field and CCx or AAx does not apply. The BBB indicator to be used is RRx, where x =:
A, for the first bulletin after the issuance of the initial bulletin;
B, if another bulletin needs to be issued;
and so on up to and including x = X;

(b) To transmit a bulletin containing corrected information or reports that have already been issued in a previous bulletin. The BBB indicator to be used is CCx, where x =:
A, for the first bulletin containing corrected reports or information;
B, if a second bulletin containing corrected reports or information is issued;
and so on up to including x = X;

(c) To transmit a bulletin containing amendments to the information included in a previously issued bulletin. The BBB indicator to be used is AAx, where x = :
A, for the first bulletin containing amendments to information;
B, for a second bulletin containing amendments to information;
and so on up to and including x = X;

(d) If more than 24 BBB indicators have to be used for the sequences detailed in (a), (b) and (c) above, then x = X should continue to be used;

(e) For (a), (b) and (c) above, the characters x = Y and x = Z are to be used for special purposes indicated below:
   (i) x = Y should be used for the encoding of BBB when a system failure causes loss of the record of the sequence of character values assigned to x;
   (ii) x = Z should be used for the encoding of BBB when bulletins are prepared or compiled more than 24 hours after the time of observation.

3. An RTH on the GTS should ensure the relay of the bulletins received in accordance with its routing directories even if the bulletins containing BBB indicators have not been received in the correct sequence.

ATTACHMENT II-13 (NOT USED)

ATTACHMENT II-14 (NOT USED)

ATTACHMENT II-15. RECOMMENDED PRACTICES AND PROCEDURES FOR THE IMPLEMENTATION, USE AND APPLICATION OF TCP/IP ON THE GTS

FOREWORD

Over the years, the GTS has evolved tremendously. Various protocols were used including X.25 in the 1980s and 1990s. Most GTS links have now been converted to the industry standard Transmission Control Protocol/Internet Protocol (TCP/IP), either using direct point-to-point links or more sophisticated networks. The use of TCP/IP protocols and associated procedures continues to deliver direct savings in financial and human resource costs to Members by:

(a) Reducing costs for communications equipment purchase and maintenance;
(b) Reducing software development work through use of industry standard software systems.

Considerable efforts have been applied in defining the framework for applying TCP/IP to the GTS. Furthermore, TCP/IP is now the basis for all new telecommunication functions implemented in support of the WMO Information System (WIS).

Procedures are defined to ensure that the primary function of the GTS in carrying real-time operational traffic with minimum delay is preserved. The issue of securing the GTS from interference from the Internet and other networks is also addressed in general terms. Reliance must, however, be placed on all Members with a TCP/IP-based connection to the GTS, who are also connected to the Internet and other networks, to implement and maintain thorough security practices.

This attachment and the information related to this topic, which is available on the WMO web pages, provide details of the technical implementation of many TCP/IP procedures for the GTS.

Members are strongly advised to take account of the adoption of the TCP/IP-based strategy for the future development of GTS in planning the future development of systems within their national Centres.

INTRODUCTION

Historical perspective

The GTS at present is predominantly used to support the message switching application using message exchange in WMO format. This exchange is done using TCP/IP protocols and is supplemented by broadcasts.

This implementation is adequate for the legacy application of message switching, but it requires continuous improvements to fully support the various WMO programmes and WIS. For example, the GTS should support:

(a) Distributed Databases (DDB);
(b) Data exchange between non-adjacent centres;
(c) Exchange of information that cannot readily be handled by message switching systems (MSSs).

Purpose of this attachment

This attachment is intended to assist Centres in implementing TCP/IP-based services on the GTS. Throughout this attachment, it is understood that the implementation of TCP/IP protocols includes all essential protocols that are normally part of the TCP/IP protocol suite, as described in

the Internet Engineering Task Force (IETF) reference documents RFC 1122 and RFC 1123. These documents are available from the IETF website at http://www.ietf.org/.

The aim of this attachment is to describe those aspects of the application of TCP/IP that apply specifically to the GTS to meet new requirements and also the long-established routine data exchange undertaken by MSSs. This attachment maintains the philosophy that Centres continue to be autonomous as far as possible. It is recognized that the timing for implementation of new systems is determined by individual Members in the light of their available resources and relative priorities, but it is also understood that new WIS functionality is expected to be achieved mostly via TCP/IP protocols.

This attachment does not cover fundamentals of TCP/IP but focuses on those aspects that are essential for successful application on the GTS. Such aspects include appropriate use of the GTS compared with the Internet, coexistence of the GTS and the Internet, IP and Autonomous System addressing, router management, TCP/IP application services (such as FTP) and fault management.

Information Technology Security (ITS) is an important consideration in the design and operation of networks today. A comprehensive discussion on security can be found in the *Guide to Information Technology Security* (WMO-No. 1115).

Relationship of the Internet and GTS

The Internet has grown rapidly in capacity, penetration and diversity of applications. Its bandwidth greatly exceeds that of the GTS and it could potentially take over some functions of the GTS. Although day-to-day performance of the Internet used to be a recognized weakness, recent experience shows that in many countries its reliability has reached acceptable levels. It should be noted, however, that the very nature of the Internet will always mean that no one can build a system using the Internet for which specific service levels can be guaranteed. The Internet is the result of the amalgamation of numerous telecommunication systems, for which no operator has complete responsibility.

It is therefore recognized that the Internet can be used:

(a) As an underlying technology for some components of the GTS in special conditions;
(b) As a backup to the GTS;
(c) As a complement to the GTS.

Table 1. Usage of GTS and the Internet

Communication component	*Underlying technologies*	*Function*
GTS	Dedicated links, high availability network clouds, VPN via Internet for backup or when no other technology is available	Delivery of time-critical communication for weather, water and climate operations
Internet	As provided by supplier	Communication for less critical requirements and possibly for large volumes of data

Coexistence with the Internet also brings some special security problems that must be addressed to ensure the GTS can fulfil its function. In particular, the networks must be engineered in such a way that the GTS is protected from general Internet traffic and is secured against inappropriate use and unauthorized access. For example, the use of IP and dynamic routing protocols such as BGP4 (Border Gateway Protocol) on the GTS will have to be managed in such a way as to allow communication between non-adjacent Centres only with the knowledge and concurrence of all intermediate Centres. Otherwise, there is a danger that large amounts of GTS capacity could be consumed by non-routine traffic, to the detriment of real-time operational data exchange.

Evolution of the GTS

TCP/IP is appropriate because:

(a) It is the dominant protocol suite in everyday use now being packaged with virtually all implementations of Unix and many PC operating systems;
(b) It offers a wide range of standard applications (file transfer, electronic mail, remote logon, World Wide Web, etc.) that will greatly reduce the need for the WMO community to develop special procedures and protocols as it has had to do in the past;
(c) It provides useful features such as automatic alternate routing (in a meshed network), which could improve the reliability of the GTS.

Other related issues

Many Centres now have experience with TCP/IP on the GTS. Experience has shown that the main technical issues, which need to be addressed to establish widespread use of TCP/IP on the GTS, are:

(a) Agreed methods for the message switching application to use TCP/IP either directly or via higher level applications, for example, FTP;
(b) An agreed file-naming convention and standard for metadata associated with files;
(c) A community-wide naming and addressing agreement.

The purpose of this attachment to make some progress with these issues, some of which lie in the domain of data management as much as telecommunications. It must also be recognized that, overall, the existing GTS is not a homogenous network in the true sense of the word but a collection of regional networks and discrete point-to-point links. Also, managed networks using Frame Relay and Multiprotocol Label Switching (MPLS) technology are now part of the GTS. These developments introduce new issues regarding multilateral cooperation in operating the GTS. While these issues are raised, they are beyond the scope of this attachment.

PRINCIPLES GOVERNING THE USE OF TCP/IP ON THE GTS

Basic concepts

The exchange of information using the standards proposed by WMO uses a layer model for telecommunication. These layers can be divided into two groups:

(a) The lowest layers are more or less the seven layers of the OSI Model (for example, http://en.wikipedia.org/wiki/OSI_model). These layers are the standard TCP/IP protocol stack;
(b) The top layers are the WMO MSS applications.

The introduction of TCP/IP does not remove the need for some meteorological MSS telecommunication components. They are still required to properly route the weather and environmental data based on standard $T_1T_2A_1A_2ii$ data designators (the WMO standard data designators are given in Attachment II-5) or based on standard file naming (described later in the present attachment).

The protocols in the rest of the TCP/IP protocol stack are used to actually deliver the messages to a given location in the world. When a message is transmitted, the MSS applications prepare the message and decide where the information should be sent. The information is then encapsulated in the TCP/IP protocol stack layers and it is the bottom layers that actually deliver the messages to their destination.

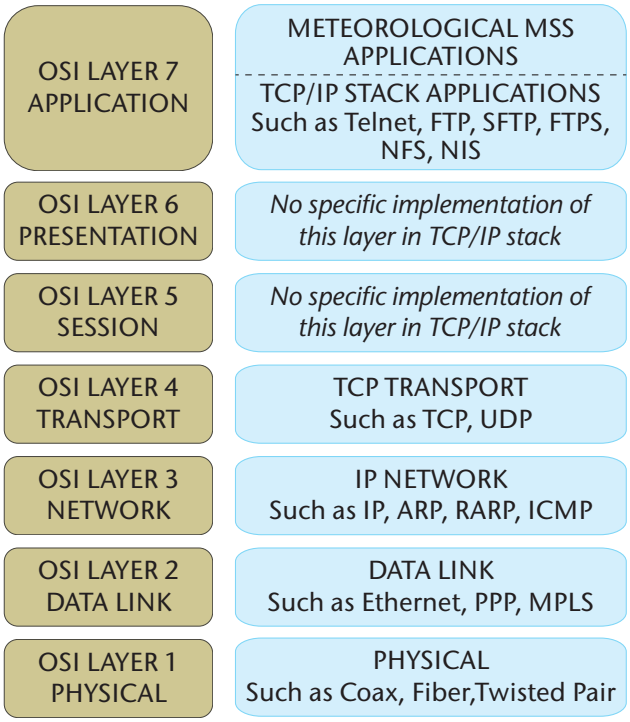


Figure 1. Layer model for telecommunications

The TCP/IP protocol suite is an enabler to:

(a) Simplify interconnectivity between computer systems by allowing several telecommunication technologies to be integrated into a coherent network which may include automatic redundant backup routes;
(b) Lower costs by providing standard telecommunication solutions;
(c) Build modern applications not just limited to strict, fixed store and forward traffic rules.

It should be noted that both the top layers (MSS applications) and bottom layers (TCP/IP protocol stack) use addresses and routing. These addresses are different from layer to layer. Also, the routing is different. The MSS layers use $T_1T_2A_1A_2$ii data designators and country codes for addresses. The routing is a manual configuration based on the particular data needs of each Centre.

Overall topology of interconnection

A general view of the possible interconnectivity between Centres is given in Figure 2.

Figure 2 shows that there are many ways to interconnect Centres. The functions carried out by a particular Centre will dictate which telecommunication systems and technologies that Centre will need to support.

The GTS, Internet and broadcast network are separate physical networks. Each provides different levels of security, service and redundancy. They should therefore be used for different purposes and different traffic types. They should also be kept as separate networks. This in particular is discussed further later on in this attachment.

It should be noted that the Internet as a network is also used in a second manner. Specifically, the former Commission for Basic Systems has expressed the view that the use of Internet for GTS links can be considered in circumstances where they are cost effective, offer an acceptable level of service and where adequate security measures are implemented. In general, the same principles for routing and security apply where Internet links are used instead of dedicated links. This

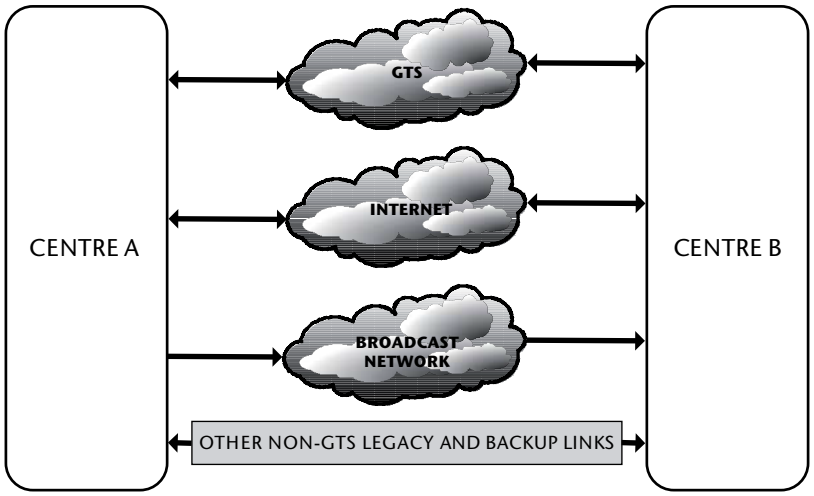


Figure 2. Possible interconnectivity between Centres

special configuration requires special devices and protocols and is a particular configuration of Virtual Private Networks (VPNs). Further details applying to the use of Internet-based links, especially related to small GTS Centres, are given in the *Guide to Information Technology Security* (WMO-No. 1115).

As most Centres and most telecommunication systems already use TCP/IP, the interconnection using the various networks becomes a fairly simple task. However, some care must be taken to address the counter effects of these benefits and, in particular, more flexibility in interconnection and in applications comes at the price of less control on where traffic can go. For example, a general-purpose link to a GTS cloud network might get flooded with less critical traffic requested by a site that does not normally request data through a given link. It may also mean that traffic has trouble reaching its destination, because there are several ill-defined routes (through both the GTS and the Internet) to get there.

This care can be achieved through traffic control and segregation, which would address three basic issues:

(a) Traffic management (ensuring timely delivery of critical data, controlling limited bandwidth availability in some areas);
(b) Security (protecting centres from unwanted threatening events);
(c) Routing coherence (ensuring that the overall resulting network can deliver traffic without difficulty to any given location).

In order to properly manage the interconnections of Centres and networks, the following elements are essential responsibilities of all Centres:

(a) Ensure that proper TCP/IP addressing is used and properly configured to maintain network integrity and to uniquely identify all components;
(b) Ensure that proper TCP/IP routing is used and properly configured to direct traffic on the correct network and to prevent traffic from going where it should not;
(c) Ensure that networks are separated from each other. Networks can also be divided in various security zones. Different networks and zones must not allow unfiltered routing and traffic to traverse their boundaries. Security gateways (such as firewall devices or routers using access lists) must be used to control the borders if networks must be interconnected;
(d) Ensure that only proper traffic is allowed on any given network to control the volume of data and prevent link flooding.

The following sections discuss these elements in detail.

TCP/IP addressing

Centres must use officially registered IP addresses issued by the Internet Assigned Numbers Authority (IANA) or the relevant Regional Internet Registry. Official IP addresses are required for all systems which communicate through any inter-organizational network, including the GTS (in particular the Main Telecommunication Network (MTN)) and the Internet.

Since it is recognized that official IP addresses are sometimes difficult to obtain in certain areas of the world, some compromise options have been developed to mitigate this problem.

Appendix 7 below describes IP addresses in further detail and the recommended options for the use of IP addresses over the GTS.

If Centres use private IP addresses or non-official addresses on their internal networks, then Network Address Translation (NAT) must be adopted for any hosts required to communicate over the GTS or the Internet.

A sufficient number of official addresses must be obtained to correspond to the number of hosts required to communicate externally, and the type of NAT supported by the Centre's access router. If static NAT is adopted, then a one-to-one correspondence of internal and official addresses is required. If dynamic NAT is used, then there can be more internal addresses than official addresses, with the router allocating the pool of official addresses dynamically as necessary.

Private addresses must not be visible on the GTS or Internet. Figure 3 shows simplified examples of allowable and non-allowable arrangements.

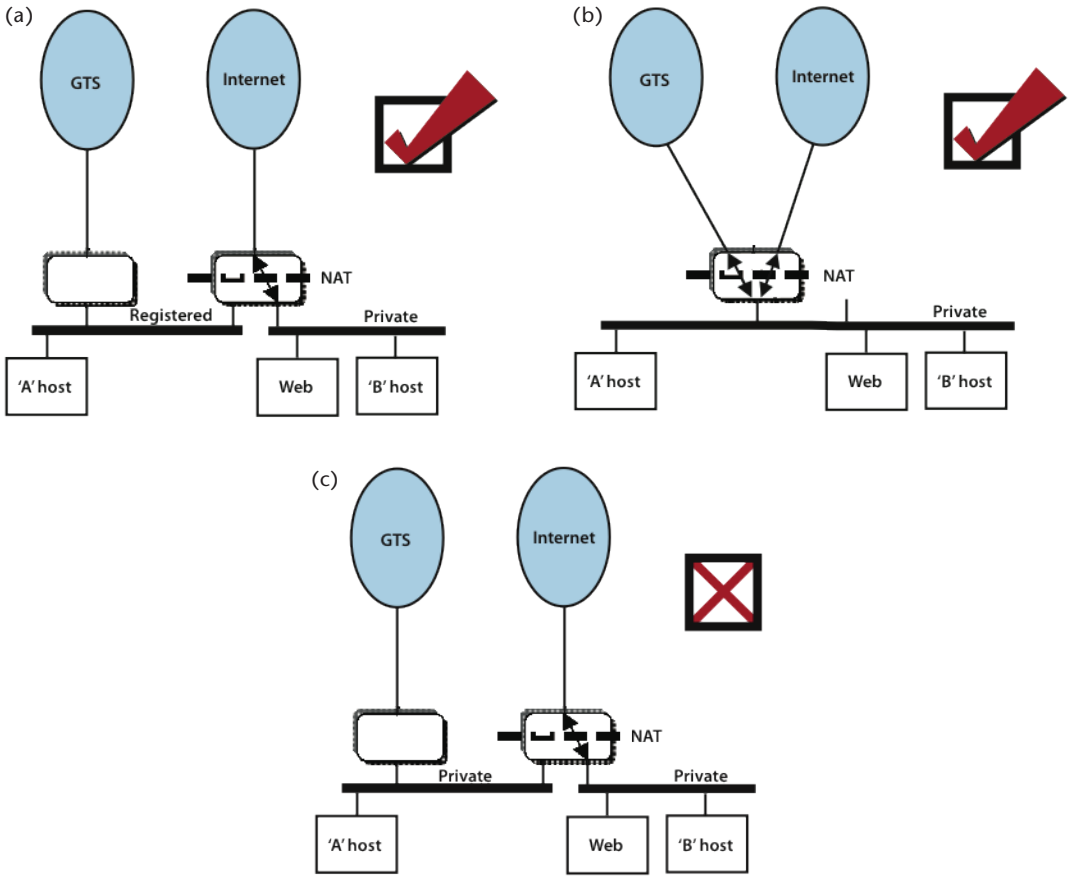


Figure 3. Examples of allowable (a and b) and non-allowable (c) addressing arrangements

Summary of tasks to ensure proper use of IP on the GTS

(a) Use only official IP addresses for external communication on the GTS;
(b) Establish an IP connection with one or more Centres. This connection will be pure IP using PPP as a level 2 protocol on the link, or a proprietary protocol such as Cisco High-level Data Link Control by bilateral agreement. Configure dynamic routing with BGP (unless a Centre has only one GTS connection and has agreed with a neighbouring Centre to use static routing);
(c) Check the barrier (security gateway) between the Internet and the GTS (prevent routing from the Internet to the GTS);
(d) Filter incoming and outgoing traffic in accordance with the requirements described above.

Routing and traffic management

Routing algorithms

In order to be able to send a packet, every host, router or equipment connected on an IP network must have a routing table. The table tells the system where to send the packet. This may be achieved by:

(a) Static routing; or
(b) Dynamic routing.

Static routing

With static routing, every required destination and next hop must be entered in the routing tables by the system administrator. Alternatively, a default route can be declared, although this option is mainly applicable to sites with only one connection to the outside world. If a default route is set up, filters must be established to ensure that only authorized hosts can access the GTS.

Whenever a new Centre is connected to the GTS with IP protocol, the site managers of all other IP-capable Centres must add the new address to their routing tables. This might become a major task as IP connectivity spreads over the GTS.

Dynamic routing

With dynamic routing, the routing information is automatically exchanged between routers. This enables the network to learn new addresses and to use alternative paths under fault conditions in a partially meshed network topology. The initial set-up of dynamic routing may be somewhat more complex, but the ongoing management task is greatly reduced.

Use of dynamic routing requires selection of an appropriate routing protocol to operate over the links of the GTS. The protocol must be an exterior gateway protocol (e.g. EGP, BGP) as opposed to an interior gateway protocol (such as IGRP, RIP, OSPF), because interior gateway protocols are intended for use within a single management domain. The GTS is an aggregation of many separate management domains. As such, it is necessary to select a gateway protocol that can be autonomously managed by each Centre to implement routing and hence traffic flow, consistent with its particular requirements.

Two exterior gateway protocols are defined by RFCs – EGP and BGP (now release 4 – RFC 1771). As the GTS is not a tree structure, setting up routing with EGP may be difficult. BGP4 does not suffer topological constraints. It is more powerful but a little more difficult to configure.

BGP can distribute subnetted routes. This feature might be very useful for the GTS. Instead of propagating host-based routes or full network routes, routing can be based on subnetted networks. Instead of declaring hosts eligible to use the GTS, a Centre could declare a full subnet

of eligible hosts, in which case the routing information would consist of just an IP address and a subnet mask. For example, if a Centre has a Class C address 193.168.1.0, by declaring that the subnet 193.168.1.16 with mask 255.255.255.248 is allowed to use the GTS, all hosts with IP addresses from 193.168.1.17 to 193.168.1.22 will be routable on the GTS.

Recommended routing method

Based on consideration of the above factors, the BGP4 routing protocol should be used between Centres on the GTS, unless an alternative is bilaterally agreed on individual links. Examples of BGP4 set-up for the Cisco router family are given in Appendix 2 below.

Network segregation and zoning

Any Centre that has a TCP/IP-based GTS connection and a connection to another TCP/IP network is a potential weak point where the GTS could be exposed to deliberate or inadvertent interference through unwanted traffic or unauthorized connection to GTS hosts.

Centres are strongly encouraged to implement protective barriers such as security gateways on the connection of their Centre with the Internet. It is important that every practical step is taken to prevent accidental or deliberate use of GTS links or unauthorized access to GTS Centres by Internet users.

When setting up IP on the GTS, it is vital to ensure that the GTS does NOT become part of the Internet or an unintended transmission path for Internet traffic. Each Centre must consider the GTS and other TCP/IP networks (such as the Internet) as separate networks and ensure that inappropriate flow of traffic from one to the other cannot occur. This will ensure that the GTS is used only for transferring bona fide meteorological data between authorized hosts.

To achieve traffic control and segregation, there are several important aspects to consider:

(a) IP addressing: using universally recognizable and coherent network addresses so that all systems only have one unique reference number, which is valid not only within the GTS but across the Internet and any other network that may eventually be interconnected to the GTS;
(b) IP network routing rules: using a common set of routing protocols and rules to ensure that any traffic can be consistently sent to its destination without delay or confusion;
(c) Zoning of each Centre's network elements: creating different network zones with different security levels to isolate a Centre's critical elements from publicly available areas and ensuring that data can still flow between zones of differing security levels.

Figure 2 illustrates in a general way how a Centre with TCP/IP connection to the GTS and an Internet connection might be set up. This set-up also infers that certain security functions must be implemented. Functions to be implemented include:

(a) Allowing only GTS designated hosts to communicate through the GTS router;
(b) Blocking access to GTS designated hosts through the security gateway and Internet router;
(c) Security gateway allowing only approved hosts on the Internet to access B hosts and then only for approved applications such as FTP;
(d) Preventing access to A hosts from Internet via B hosts.

In addition to network security measures, it is vital that good security practices are followed in the management of all hosts in a Centre. Computer security is a complex subject in itself and Centres are encouraged to study this in depth and apply appropriate practices. The *Guide to Information Technology Security* (WMO-No. 1115) provides information on basic essential security practices.

Traffic management

Traffic management is an area that unfortunately is not limited to networks but also involves data management and application configurations. Several groups are therefore involved in this matter.

In general, it can be said that some applications such as file transfer and the World Wide Web have potential to place heavy loads on the limited bandwidth circuits that comprise the GTS. Limits need to be applied to ensure that the GTS carries only important time-critical and operations-critical traffic, such as the real-time data and products currently exchanged on the GTS.

Less important traffic, such as ad hoc file exchange, e-mail and general World Wide Web, should be carried on the Internet. To protect the GTS, the full capabilities of TCP/IP connectivity and information exchange must be restricted. In practical terms, TCP/IP traffic carried on the GTS could be restricted on the basis of:

(a) Protocol type (for example, FTP, HTTP and SMTP);
(b) Originating and destination IP addresses;
(c) A combination of the above.

If the measures adopted are to be successful, it is necessary that they be:

(a) Not confined to a single router brand, as it cannot be assumed that all centres will have the same brand of router;
(b) Reasonably straightforward to configure, so that there is minimum risk that configuration errors or omissions will endanger the GTS.

IMPLEMENTATION GUIDELINES

IP addressing

Figure 4 illustrates how a pair of Centres has agreed to implement a direct IP connection using the first available pair of "host" numbers using the 193.105.178.0 network as an example.

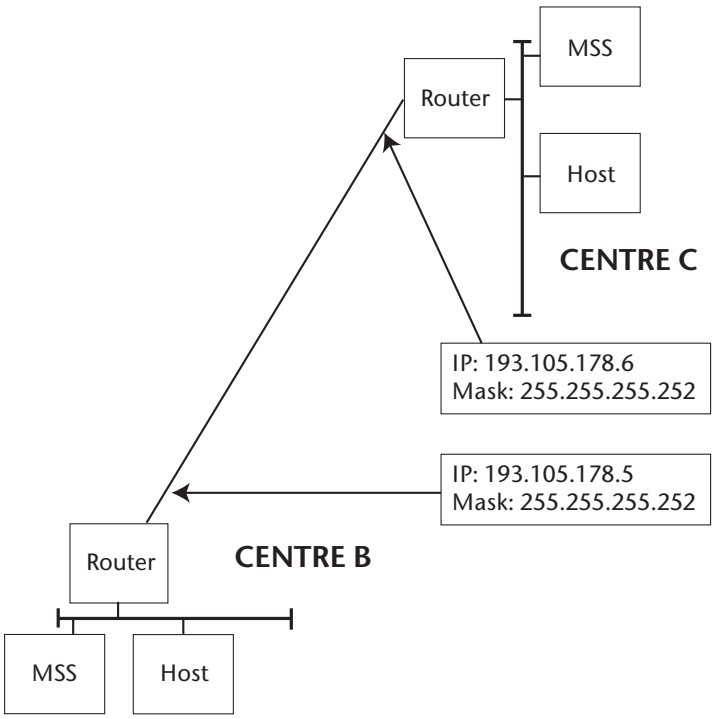


Figure 4. Direct IP link between centres B and C

Allocation of Class C addresses for direct IP links

Routers have to be connected by links having unique subnet numbers. To achieve this, a Class C address is used (for example 193.105.178.0) with a mask of 255.255.255.252. This provides 62 subnets each with two hosts. These two host numbers are allocated to the ends of the link connecting the routers between the two Centres. The lowest usable network number is 193.105.178.4, with host addresses of 193.105.178.5 and 6. The next network number is 193.105.178.8, with host addresses of 193.105.178.9 and 10, followed by:
193.105.178.12, with host addresses of 193.105.178.13 and 14, followed by
193.105.178.16, with host addresses of 193.105.178.17 and 18, followed by
193.105.178.20, with host addresses of 193.105.178.21 and 22, and so on, up to
193.105.178.248, with host addresses of 193.105.178.249 and 250.

TCP/IP routing

Autonomous System numbers

The use of BGP4 as the recommended dynamic routing protocol for the GTS (see section on Routing and traffic management above) requires allocation of Autonomous System (AS)[1] numbers to each GTS Centre.

The use of BGP requires the introduction of the concept of the AS. Each GTS Centre manages an AS number so as to enable it to adopt BGP with neighbouring centres. In addition to addressing, this section shows the allocation scheme of AS numbers.

The Internet Assigned Numbers Authority, through RFC 6696, has reserved the block of AS numbers 64512 through 65534 for private use (not to be advertised on the global Internet). This provides eight groups of 128 AS numbers to be assigned to GTS Centres, satisfying the current and foreseeable future needs of the GTS. The AS numbers will be assigned as follows:

MTN centres and reserve	64512 to 64639
Centres within RA I	64640 to 64767
Centres within RA II	64768 to 64895
Centres within RA III	64896 to 65023
Centres within RA IV	65024 to 65151
Centres within RA V	65152 to 65279
Centres within RA VI	65280 to 65407
Antarctic	65408 to 65471
Private use by GTS Centres	65472 to 65534*

* These AS numbers are for national use and are not to be advertised on the GTS.

Implementation details

In order to implement IP services, Centres need to know certain details regarding IP addressing at other Centres on the GTS. Figure 5 and associated Tables 2a to 2d explain in detail the information required at various Centres.

[1] An Autonomous System is defined in RFC 4271 as "a set of routers under a single technical administration, using an interior gateway protocol and common metrics to route packets within the AS, and using an exterior gateway protocol to route packets to other ASs."

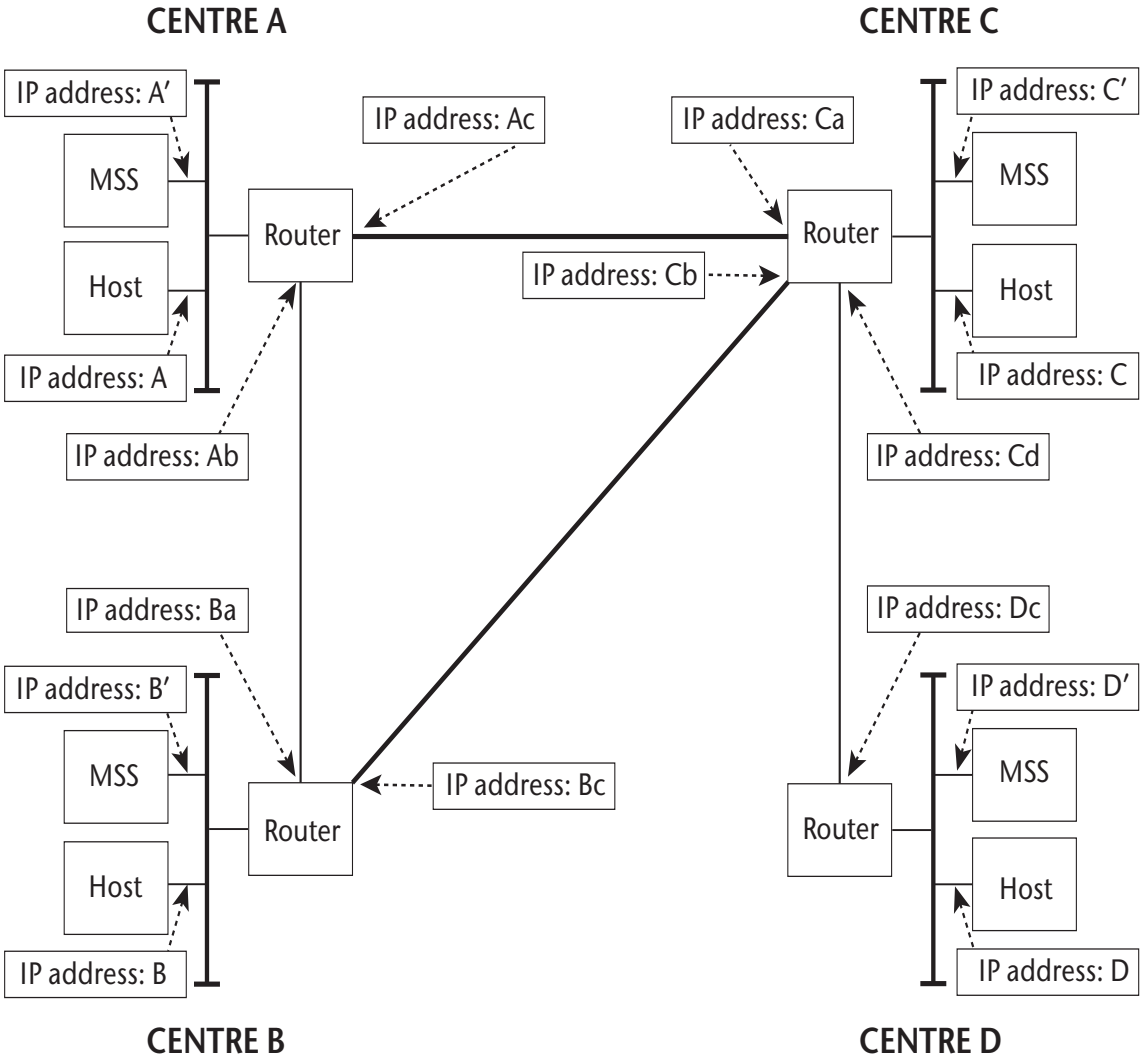


Figure 5. Direct IP network

Table 2a. IP address to be known at CENTRE A

Destination	*IP addresses to be known*		*Suitable route*
	for communication between ends	*for communication between routers*	
CENTRE B (Host to host)	IP address : B	IP address : Ba	CENTRE A – CENTRE B
CENTRE C (Host to host)	IP address : C	IP address : Ca	CENTRE A – CENTRE C
CENTRE D (Host to host)	IP address : D	IP address : Ca	CENTRE A – CENTRE C – CENTRE D (Host [A] – Router [A] – Router [C] – Router [D] – Host [D]) [x] : CENTRE x
CENTRE B (MSS to MSS)	IP address : B'	IP address : Ba	CENTRE A – CENTRE B
CENTRE C (MSS to MSS)	IP address : C'	IP address : Ca	CENTRE A – CENTRE C
CENTRE D (MSS to MSS)	IP address : D'	IP address : Ca	CENTRE A – CENTRE C – CENTRE D

Table 2b. IP address to be known at CENTRE B

Destination	*IP addresses to be known*		*Suitable route*
	for communication between ends	*for communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Ab	CENTRE B – CENTRE A
CENTRE C (Host to host)	IP address : C	IP address : Cb	CENTRE B – CENTRE C
CENTRE D (Host to host)	IP address : D	IP address : Cb	CENTRE B – CENTRE C – CENTRE D
CENTRE A (MSS to MSS)	IP address : A'	IP address : Ab	CENTRE B – CENTRE A
CENTRE C (MSS to MSS)	IP address : C'	IP address : Cb	CENTRE B – CENTRE C
CENTRE D (MSS to MSS)	IP address : D'	IP address : Cb	CENTRE B – CENTRE C – CENTRE D

Table 2c. IP address to be known at CENTRE C

Destination	*IP addresses to be known*		*Suitable route*
	for communication between ends	*for communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Ac	CENTRE C – CENTRE A
CENTRE B (Host to host)	IP address : B	IP address : Bc	CENTRE C – CENTRE B
CENTRE D (Host to host)	IP address : D	IP address : Dc	CENTRE C – CENTRE D
CENTRE A (MSS to MSS)	IP address : A'	IP address : Ac	CENTRE C – CENTRE A
CENTRE B (MSS to MSS)	IP address : B'	IP address : Bc	CENTRE C – CENTRE B
CENTRE D (MSS to MSS)	IP address : D'	IP address : Dc	CENTRE C – CENTRE D

Table 2d. IP address to be known at CENTRE D

Destination	*IP addresses to be known*		*Suitable route*
	for communication between ends	*for communication between routers*	
CENTRE A (Host to host)	IP address : A	IP address : Cd	CENTRE D – CENTRE D – CENTRE A
CENTRE B (Host to host)	IP address : B	IP address : Cd	CENTRE D – CENTRE C – CENTRE B
CENTRE C (Host to host)	IP address : C	IP address : Cd	CENTRE D – CENTRE C
CENTRE A (MSS to MSS)	IP address : A'	IP address : Cd	CENTRE D – CENTRE D – CENTRE A
CENTRE B (MSS to MSS)	IP address : B'	IP address : Cd	CENTRE D – CENTRE C – CENTRE B
CENTRE C (MSS to MSS)	IP address : C'	IP address : Cd	CENTRE D – CENTRE C

Management and allocation of addresses and AS numbers

IP addresses

IP addresses should be acquired or agreed on as per the instructions in Appendix 7 below.

GTS-nominated host/network addresses

Host and subnet IP addresses for use with GTS-nominated Centres should be notified to WMO as described above.

AS numbers

AS numbers for use on the GTS will be coordinated and issued by the WMO Secretariat as required. Centres should direct their requests for AS numbers to WMO as described above.

Publication of addresses and AS numbers

WMO will publish updated lists of addresses and AS numbers in the monthly WWW Newsletter and will also make these lists available in ASCII text form for access by FTP on the WMO web server and in World Wide Web format at https://community.wmo.int/en/activity-areas/operational-information-service/routeing-catalogues.

GTS DATA EXCHANGE METHODS

Introduction

FTP and SFTP are the two data exchange methods that can be used on the GTS.

Centres are encouraged to choose FTP or SFTP by bilateral agreement. The SFTP is to be preferred on the Internet.

SFTP/FTP procedures and file naming convention

Introduction

Secure Shell (SSH) File Transfer Protocol (SFTP) is a secure file transfer protocol based on SSH. There is no official standard RFC. Despite this, SSH (and therefore SFTP) is now widely available and used over the Internet.

File Transfer Protocol (FTP) is a convenient and reliable method for exchanging files, especially large files. The protocol is defined in RFC 959.

The main issues to be considered are:

1. Procedures for accumulating messages into files so as to minimize SFTP/FTP overheads with short messages (applies only to existing message types);
2. File naming conventions for existing message types (existing Abbreviated Heading Line (AHL));
3. General file naming conventions;
4. File renaming;
5 Use of directories;
6. Account names and passwords;
7. SFTP/FTP sessions;
8. Local SFTP/FTP requirements;
9. File compression.

Accumulating messages into files

Multiple messages in the standard GTS message envelope could be placed in the same file according to the rules set out below. This method of accumulating multiple messages applies only to messages for which AHLs have been assigned.

Centres have the option of including or deleting the Starting Line and End of Message strings and indicating which option they are using via the format identifier (points 2 and 4 below).

1. Each message should be preceded by an 8-octet message length field (8 ASCII characters). The length includes the Starting Line (if present), AHL, text and End of Message (if present).
2. Each message should start with the currently defined Starting Line and AHL as shown in Figure 6.

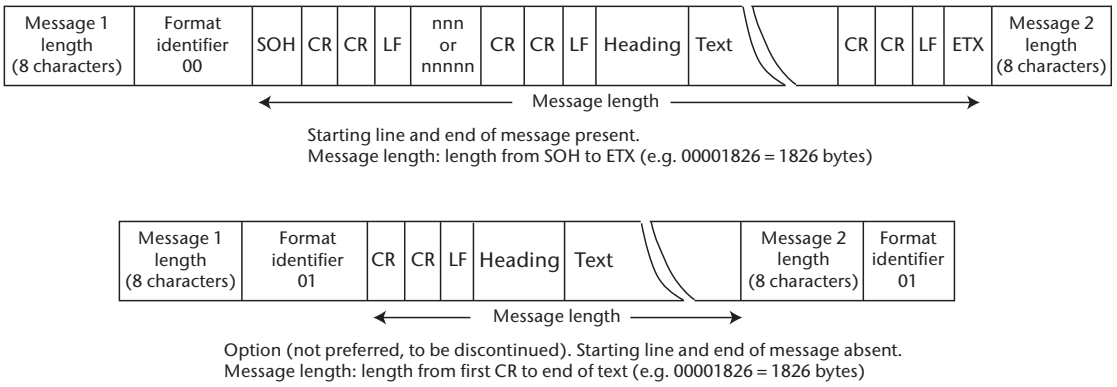


Figure 6. Structure of a typical message in a file

3. Messages should be accumulated in files thus:
   (a) Length indicator, message 1 (8 characters);
   (b) Format identifier (2 characters);
   (c) Message 1;
   (d) Length indicator, message 2 (8 characters);
   (e) Format identifier (2 characters);
   (f) Message 2;
   (g) And so on, until the last message;
   (h) If necessary, and subject to bilateral agreement, a "dummy" message of zero length may be inserted after the last real message, to assist with end of file detection in certain MSS systems. This requirement does not exist in most cases and need only be implemented where necessary, and agreed between centres.
4. Format identifier (2 ASCII characters) has the following values:
   (a) 00 if Starting Line and End of Message strings present;
   (b) 01 if Starting Line and End of Message strings absent (not preferred, to be discontinued).
5. The sending centre should combine messages in the file for no more than 60 seconds to minimize transmission delays; this limit should be set to a value depending upon the characteristics of the link. However, the file should be sent immediately when a GTS Priority 1 message (as defined in Part II, section 2.11.1 of the present Manual) is added to the file.
6. The sending centre should limit the number of messages in a file to a maximum of 100; this limit should be set to a value depending upon the characteristics of the link.
7. The format applies regardless of the number of messages, i.e., it applies even if there is only one message in the file.

File naming conventions for existing message types (existing AHL)

The file naming convention is:

CCCCNNNNNNNN.ext

where:
CCCC is the international four-letter location identifier of the sending Centre, as defined in *Weather Reporting* (WMO-No. 9), Volume C;
NNNNNNNN is a sequential number from 1 to 99999999 generated by the sending Centre for each data type determined by ext; 0 is used for (re-) initialization; through bilateral agreement, Centres may use NNNN instead of NNNNNNNN in case of limitation on filename length.
ext is
"ua" for urgent alphanumeric information
"ub" for urgent binary information
"a" for normal alphanumeric information
"b" for normal binary information
"f" for facsimile information

Note: Where, through bilateral agreement, Centres allow alphanumeric and binary data in the one file, the b or ub extent shall be used.

General file naming conventions

The procedure is based on transmission of file pairs, one file being the information file and the other being the associated metadata file. The concept of file pairs allows the communications function to be implemented independently of data management requirements for structure of metadata, yet provides for the carriage of whatever metadata is required. It is not compulsory to always have a .met file, such as when the information file itself is self-specifying or when a single .met file can describe several information files (for example, as in the case of same data type for different times). There is always, however, a clear relation between the Information File Name and the Metadata File Name, which should only differ from their Extension field and possible wildcards. File names for new message types (no existing AHL) shall follow the following format. It should be noted that file names for existing message types (existing AHL) can also follow the following format.

The File Name format is a predetermined combination of fields, delimited by the _ (underscore) character except for the last two fields, which are delimited by the . (period) character.

Each field can be of variable length, except for the Date/time stamp field which is predetermined.

The order of the fields is mandatory.

The File Name fields are as follows:

pflag_productidentifier_oflag_originator_yyyyMMddhhmmss[_freeformat].type[.compression]

where the mandatory fields are:

pflag is a character or combination of characters indicating how to decode the productidentifier field. At this time, the pflag field has only the following acceptable value:

Table 3. Accepted pflag values

pflag	*Meaning*
T	The productidentifier field will be decoded as a standard $T_1T_2A_1A_2$ii data designator. (The WMO standard data designators are given in Attachment II-5.)
A	The productidentifier field will be decoded as a standard Abbreviated Heading, including BBB as appropriate, space characters being discarded, e.g. $T_1T_2A_1A_2$iiCCCCYYGGgg[BBB].
W	WMO Product Identifier
Z	Originating centre's local product identifier
X	Multiple valid GTS files archive; will be extracted according to the type of the archive.[1,2]
TM	The productidentifier field will be decoded as a standard $T_1T_2A_1A_2$ii data designator (the WMO standard data designators are given in Attachment II-5). The file will contain the metadata corresponding to the related "T" file.
AM	The productidentifier field will be decoded as a standard Abbreviated Heading, including BBB as appropriate, space characters being discarded, e.g. $T_1T_2A_1A_2$iiCCCCYYGGgg[BBB]. The file will contain the metadata corresponding to the related "A" file.
WM	WMO Product Identifier. The file will contain the metadata corresponding to the related "W" file.
ZM	Originating centre's local product identifier. The file will contain the metadata corresponding to the related "Z" file.

Notes:

1. Use of file archives for FTP exchange is through bilateral agreement of Centres. Any new Global Information System Centre (GISC) should have this functionality from the start of 2018 and any existing GISC before the end of 2020.
2. For pflag X, only compressed archive file format extension is allowed (tar, tar.gz, tar.xz and .zip).

Example of file with **pflag** = X:

X_fr-meteofrance-Toulouse_C_LFPW_20060913030000.tar.xz

This could contain after extraction the following files:

- T_PGBE07_C_KWBC_20020610180000_D241_SIG_WEATHER_250-600_VT_06Z.tif
- W_fr-meteofrance-Toulouse,SYNOP,MAIN+HOURS,,RRA_C_LFPW_20060913030000.txt
- LFPW00000123.b
- LFPW00000124.f
- LFPW00000125.b

productidentifier is a variable length field containing information that describes the nature of the data in the file. The productidentifier field should be decoded according to the pflag.

The WMO Product Identifier to be used with **pflag** = W shall be decoded as follows:

<location indicator>,<data designator>,<free description>,<International date-timegroup>,<BBB modification header>

The WMO Product Identifier is composed of two parts:

(a) The "static part" for description of the product;
(b) The "optional part" to define the time stamp and status of the product (correction, amendment).

The WMO Product Identifier is not case sensitive. These two parts are defined as follows:

Static part: <location indicator>,<data designator>,<free description>

- <location indicator> defines the producer: Country, organization and the production centre; the country shall be represented by the official ISO 3166 standard 2-letter code. Example: <gb-metoffice-exeter>. Each field shall be separated by the symbol "-" . The ISO 3166 standard 2-letter code xx shall be used for international organizations and shall therefore be the two first characters of the location indicator of international organizations, for example, "xx-eumetsat-darmstadt", "xx-ecmwf-reading".

Note: Although ISO 3166 uses only upper case letters, WMO file names may use either upper or lower case letters for the ISO 2-letter country code and both cases are considered identical when comparing file names.

- <data designator> specifies the type of data with reference to the categories and subcategories defined in Common Table C-13 of the *Manual on Codes* (WMO-No 306), for example, <SYNOP>, <TAF>, <MODEL>, <RADAR>, <SATELLITE>. When the type of data is a composite type, use the sign "+" for concatenation.
- <free description> is determined by the production centre to characterize the product.

Optional part: [,<International date-time group>,<BBB modification header>]

- <International date-time group> is a YYYYMMDDHHMMSS time stamp of the product, full format without substitution characters (only decimal digits). This field is optional because it can be recovered from the file name field: yyyyMMddhhmmss.
- <BBB modification header> is a complementary group with a similar purpose as the current BBB group of AHL.

Note: In order to facilitate the identification of each field of the product identifier, the static part, as well as the optional part if used, shall comprise two symbols "," separating the fields. Each field shall not contain any symbol ",". If a field is empty, no character shall be inserted between the relevant field delimiters "_" or ",".

oflag is a character or combination of characters indicating how to decode the originator field. At this time, the oflag field has only the following acceptable value:

Table 4. Accepted oflag values

oflag	*Meaning*
C	The originator field will be decoded as a standard CCCC country code

originator is a variable length field containing information that states where the file originated. The originator field should be decoded according to the oflag.

yyyyMMddhhmmss is a fixed length date and time stamp field. The interpretation of this field should be in accordance with the standard rules set for specific data description and types. Therefore it may have various significance, such as date of creation of the file, or date of collection of data. If a particular date and time stamp field is not specified, it should be replaced by a "-" (minus) character. For example: ------311500-- represents a stamp that specifies only the day (31st), hours (15) and minutes (00). If there are no rules for a specific data type, this field should represent the date and time of creation of the file by the originator.

Type is a variable length field that describes the general format type of the file. Although this information could be considered somewhat redundant to the productidentifier field, it is kept as such for industry accepted standard compatibility. It should be noted that the delimiter before the type field is a "." (period). This is to help parse the file name for fields, since the freeformat field could make use of further "_" (underscore) to delimit subfields.

Table 5. Accepted type values

type	*Meaning*
met	The file is a metadata file pair which describes the content and format of the corresponding information file with the same name
tif	TIFF file
gif	GIF file
png	PNG file
ps	Postscript file
mpg	MPEG file
jpg	JPEG file
txt	text file
htm	HTML file
bin	a file containing data encoded in a WMO binary code form such as GRIB or BUFR
doc	a Microsoft Word file
wpd	a Corel WordPerfect file
hdf	HDF file
nc	NetCDF file
pdf	Portable Document Format file
xml	XML format files (data or metadata)

The non-mandatory fields are:

freeformat is a variable length field containing further descriptors as required by a given originator. This field can be further divided into subfields. Originating countries should strive to make their freeformat descriptions available to others.

compression is a field that specifies if the file uses industry standard compression techniques.

Table 6. Accepted compression values

compression	*Meaning*
Z	(DEPRECATED) The file has been compressed using the Unix COMPRESS technique.
zip	The file has been compressed using the PKWare zip technique.
gz	The file has been compressed using the Unix gzip technique.
bz2	The file has been compressed using the Unix bzip2 technique.
xz	The file has been compressed using the xz technique.

Maximum file name length: Although no maximum length is specified for the entire file name, the mandatory fields shall not exceed 128 characters (including all delimiters) to allow processing by all international systems.

Character set: The filenames shall be composed of any combination of the standard character set (ITU-T Rec. X.4) with the exceptions noted in Table 7. Case insensitivity shall be used as it is widely accepted and implemented in the industry (for example, e-mail addresses and URLs). However, it is recommended to use the "canonical form" of file names when files are being processed in a system. In this manner, it would be expected that:

(a) File names be saved in their original form as received (with any combination of upper–lower case characters or any character set);
(b) Files would be saved with lower-case characters only for internal processing, comparison, name searches, and so on;
(c) Files would be retransmitted with the original saved name to preserve character set and the upper–lower case differences.

This keeps the benefits of readability of upper–lower case throughout the systems, but provides case independence for processing and reference.

Table 7. Symbols for filenames

Symbol	*Allowed*	*Meaning*
_	yes	The underscore symbol is used as a delimiter symbol. To be used only as a delimiter of fields. The underscore is also accepted in the freeformat field, but not in other fields.
-	Yes	The minus symbol shall be used only as a field delimiter inside the "location indicator" and "free description" fields of the WMO Product Identifier in the productidentifier field. For example, in the case of location indicator: gb-metoffice-exeter. This symbol shall not appear in the "data designator" field.
+	Yes	The plus symbol shall be used to concatenate several words in a field of the WMO Product Identifier in the productidentifier field. For example, in the "data designator" field: TEMP+MOBIL or TEMP+SHIP.
.	yes	The period symbol is used as a delimiter symbol. To be used only before the type and compression fields.
/	no	Forward stroke often has special meaning for the full path specification of a filename in some operating systems.
\	no	Backward stroke often has special meaning for the full path specification of a filename in some operating systems.
>	no	Greater than symbol shall not be used, as it often represents special file manipulation in some operating systems.
<	no	Less than symbol shall not be used, as it often represents special file manipulation in some operating systems.
|	no	Vertical bar (pipe) symbol shall not be used since it often represents special file manipulation in some operating systems.
?	no	Question mark symbol shall not be used.
‘	no	Single quote shall not be used.

Symbol	*Allowed*	*Meaning*
"	no	Double quotes shall not be used.
*	no	The star symbol is often used for wildcard specification in procedures that process filenames.
Space	no	The space symbol shall not be used.
,	yes	The comma symbol shall be used as a field delimiter in the WMO Product Identifier of the productidentifier field, for example, in the static part: <location indicator>,<data designator>,<free description>. The comma symbol can be also used in the freeformat field.
A–Z a-z 0–9	yes	

The structure of the ".met" file, related to the WMO Metadata standard, is not defined in this attachment.

Examples:

- A possible imagery file (Sig Weather Chart) that would have originated from the United States:
  T_PGBE07_C_KWBC_20020610180000_D241_SIG_WEATHER_250-600_VT_06Z.tif
- A possible model output file from France:
  A_HPWZ89LFPW131200RRA_C_LFPW_20020913160300.bin
- A possible synoptic surface observations file from France:
  W_fr-meteofrance
  Toulouse,SYNOP,MAIN+HOURS,,RRA_C_LFPW_20060913030000.txt
- A possible model output file from France:
  W_fr-meteofrance-toulouse,GRIB,ARPEGE-75N10N-
  60W65E_C_LFPW_200610000000.bin
- A possible image from Australia:
  Z_IDN60000_C_AMMC_20020617000000.gif
  Note that this shows that the date and time stamp is to be interpreted to be 00 hours, 00 minutes and 00 seconds.
- A possible compressed TOVS satellite data file from the United Kingdom:
  Z_LWDA_C_EGRR_20020617000000_LWDA16_0000.BIN.Z
- A possible image (radar) from Canada:
  T_SDCN50_C_CWAO_200204201530--_WKR_ECHOTOP,2-0,100M,AGL,78,N.gif
- A possible single-record GRIB file from Canada:
  Z__C_CWAO_2002032812----_CMC_reg_TMP_ISBL_500_ps60km_2002032812_P036.bin
- A possible multiple record batch file from China:
  Z_SM_C_BABJ_20020520101502.TXT

File renaming

The method used by receiving centres to detect the presence of a new file may depend on the type of machine used. However, most centres will do this by scanning a directory for new files.

To avoid problems with the receiving centre processing a file before it has completely arrived, all sending centres must remotely rename the files they send.

The file shall be sent with the added extent ".tmp" and then renamed to the appropriate extent defined above when the transfer is completed, for example:

(a) put xxxxx RJTD00220401.a.tmp (xxxxx = local file name)
    rename RJTD00220401.a.tmp RJTD00220401.a
(b) put xxxxx AMMC09871234.ub.tmp
    rename AMMC09871234.ub.tmp AMMC09871234.ub

Use of directories

Some receiving centres may wish the files to be placed in specific subdirectories. This should be limited to require only that all files of the same type be delivered to the same directory. It is recommended that a separate directory be used for each host system that is initiating SFTP/FTP sessions to avoid the possibility of filename duplication.

Account names and passwords

Using SFTP/FTP, the sender "logs in" to a remote machine using a specific account name and password. The receiving centre defines the account name and the password. There are potential security implications for centres so care needs to be taken.

The following general rules, however, should apply:

(a) The receiving centre defines the user account and password for the sending centre;
(b) Anonymous FTP may be used or a specific account may be created. (If anonymous FTP is used, each sending Centre must have its own subdirectory on the FTP server.)

SFTP sessions can also be authenticated using asymmetric keys. National Meteorological and Hydrological Services can choose between user/password or asymmetric keys.

SFTP/FTP sessions

To limit the load on both the sending and receiving systems, no more than one SFTP/FTP session per file type should exist at the same time. If, for example, Centre A wishes to send two files to Centre B of the same type (for example, .ua), the second file must not be sent until the first is finished. Centres should limit the number of concurrent sessions with a particular Centre to five maximum.

The idle timer for closing the SFTP/FTP session should be set to a value between the cut-off time for accumulating messages (maximum 60 seconds) and a maximum of 3 minutes.

To minimize overheads the sending centre should keep the SFTP/FTP session connected for at least 10 minutes or until the idle timeout has been reached (subject to bilateral agreement).

Local SFTP/FTP requirements

All sending centres will need to allow for additional "static" FTP commands to be included in the FTP commands that they issue. For example, some Multiple Virtual Storage centres may require the inclusion of "SITE" commands to define record and block lengths. Centres should support FTP commands as specified in RFC 959 unless some are excluded by bilateral agreement. There may also need to be bilaterally agreed procedures and commands.

It is the responsibility of receiving Centres to delete files after they have been processed.

In order to meet the 2-minute maximum delivery requirement for warning messages, centres receiving files via SFTP/FTP should aim to pick up and process incoming files no later than 15 seconds after they are received.

Use of file compression

If large files are to be sent, it is often desirable to compress them first.

Centres should only use compression by bilateral agreement.

Backup with an IP-based GTS

A final consideration is that of MSS backup. The new GTS will use IP addresses, where an individual address is usually associated with only one system. Should a system fail and an alternative be used, there are implementation issues to be considered by transmitting centres. Ideally a transmitting centre should be unaffected by a receiving Centre's backup arrangements. This is a good principle to which all Centres should seek to adhere. However, it may not always be possible to achieve complete IP transparency. If this cannot be done, sending Centres must be prepared to try an alternate IP address. Once using such an alternate address a Centre must periodically try the primary address. It is suggested that such periodicity be established by bilateral agreement between centres because it will be heavily influenced by each centre's backup strategy.

TROUBLESHOOTING AND PROBLEM RESOLUTION

IP layer tools

In a large IP network, every router involved in the path between two hosts must know the next hop to be used to reach the destination address. As every router and/or link might be a point of failure, it is very important to determine rapidly where the problem is, and then how to solve it.

Suggested steps in resolving problems (not necessarily in the order given) are:

(a) Check the remote centre (if the security policy of the remote centre allows it);
(b) Check if the link to the "outside" network is reachable;
(c) Check the local network by trying to reach the next/default gateway;
(d) Check the local IP stack and configuration.

Some basic tools that can be used, such as Ping, Traceroute and Netstat, are described below. Ping and Traceroute provide information on paths between hosts. They both use ICMP (Traceroute also needs UDP), but it should be noted that many sites block ICMP packets as part of their security measures. To be able to locate problems in a network, it is necessary to have an exact documentation of the network.

Ping

Ping will check if the destination IP address can be reached. This tool is standard in almost every operating system with TCP/IP. On a Unix host the output looks like the following:

```
zinder# ping -s cadillac
PING cadillac : 56 data bytes
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=0. time=3. ms
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=1. time=2. ms
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=2. time=3. ms
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=3. time=3. ms
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=4. time=5. ms
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=5. time=3. ms
64 bytes from cadillac ( 193.168.1.17 ) : icmp_seq=6. time=3. ms
----cadillac PING statistics----
7 packets transmitted, 7 packets received, 0% packet loss
round-trip (ms) min/avg/max = 2/3/5
```

A useful test could be to ping the MSS of the neighbouring Centre. If this ping succeeds with an acceptable time delay, it would indicate that the network is operating correctly. If the ping fails, it could mean that the circuit is down or the ICMP ping packets are being blocked by the neighbouring Centre's router or security gateway. In this event, it could be useful to ping the serial

interface of the neighbouring Centre's router. If this succeeds, then the communications link to the neighbouring Centre is working. Any malfunction would then be within the neighbouring Centre.

Ping can be used to check whether the network performance is reasonable. The time is the delay between sending and receiving back the packet. It is not really possible to give an average value of the delay, but it is more important to notice any variation.

Finally, it might happen that packets are lost. In this case, there are missing numbers in the icmp_seq number. Either packet loss or variation in delays will badly degrade the performance.

Traceroute

This tool is used to show which routers are transitted on the network between A and B. As mentioned above, Traceroute needs UDP and ICMP packets to work. Firewalls or packet filter on a router may block such traffic as part of local security policy. It is not available on all systems, but is rather easy to compile. It is a free tool available on the Internet.

Traceroute output looks like the following:

```
cadillac 22: traceroute ftp.inria.fr
traceroute to ftp.inria.fr (192.93.2.54), 30 hops max, 40 byte packets
 1 antonio.meteo.fr (137.129.1.5) 3 ms 2 ms 2 ms
 2 clara.meteo.fr (137.129.14.249) 1 ms 2 ms 2 ms
 3 andrea.meteo.fr (193.105.190.253) 4 ms 3 ms 2 ms
 4 octares1.octares.ft.net (193.48.63.5) 30 ms 35 ms 10 ms
 5 192.70.80.97 (192.70.80.97) 9 ms 15 ms 27 ms
 6 stamand1.renater.ft.net (195.220.180.21) 40 ms 96 ms 29 ms
 7 stamand3.renater.ft.net (195.220.180.41) 56 ms 100 ms 108 ms
 8 stlambert.rerif.ft.net (195.220.180.10) 63 ms 56 ms 34 ms
 9 193.55.250.34 (193.55.250.34) 46 ms 28 ms 26 ms
10 rocq-gwr.inria.fr (192.93.122.2) 21 ms 147 ms 85 ms
11 ftp.inria.fr (192.93.2.54) 86 ms 58 ms 128 ms
```

When a router does not know where to send the packet, the result may be like the following:

```
cadillac 22: traceroute 193.105.178.5
traceroute to 193.105.178.5 (193.105.178.5), 30 hops max, 40 byte packets
 1 antonio.meteo.fr (137.129.1.5) 2 ms 1 ms 1 ms
 2 clara.meteo.fr (137.129.14.249) 1 ms 4 ms 1 ms
 3 andrea.meteo.fr (193.105.190.253) 4 ms 11 ms 4 ms
 4 octares1.octares.ft.net (193.48.63.5) 42 ms 39 ms 42 ms
 5 192.70.80.97 (192.70.80.97) 8 ms 7 ms 7 ms
 6 stamand1.renater.ft.net (195.220.180.5) 48 ms 86 ms 113 ms
 7 rbs1.renater.ft.net (195.220.180.50) 63 ms 107 ms 154 ms
 8 Paris-EBS2.Ebone.net (192.121.156.105) 146 ms 167 ms 140 ms
 9 stockholm-ebs-s5-2.ebone.net (192.121.154.21) 100 ms 80 ms 92 ms
10 Amsterdam-ebs.Ebone.NET (192.121.155.13) 249 ms 227 ms 205 ms
11 amsterdam1.NL.EU.net (193.0.15.131) 257 ms 249 ms 316 ms
12 * Amsterdam5.NL.EU.net (134.222.228.81) 300 ms 297 ms
13 Amsterdam6.NL.EU.net (134.222.186.6) 359 ms 218 ms 304 ms
14 Paris1.FR.EU.net (134.222.228.50) 308 ms 311 ms 388 ms
15 * Etoile0.FR.EU.net (134.222.30.2) 177 ms *
16 Etoile0.FR.EU.net (134.222.30.2) * * *
```

In the second case, cadillac would not be able to reach 193.105.178.5 because the router Etoile0.fr.eu.net failed to send the packet. With Traceroute, it is not possible to know if it is a router failure or a link failure.

Netstat

This is a command available on most computing platforms. It gives information about the set-up of the host's IP stack.

Netstat can be used to find out if the local IP address and subnet mask are configured correctly as well as if the routing information is still correct. There are many other options, but is it not the intention of this Manual to describe them all.

A sample output looks like the following:

$ netstat -rn
Routing tables

Internet:

Destination	Gateway	Netmask	Flags	Refs	Use	Interface
default	141.38.48.2		UG	12	4014211	ec0
127.0.0.1	127.0.0.1		UH	9	2321	lo0
141.38.48	141.38.48.12	0xffffff00	U	3	68981	ec0
141.38.48.12	127.0.0.1		UGH	10	253410	lo0
195.37.164.100	141.38.48.5		UGH	2	345	lo0
224	141.38.48.12	0xf0000000	U	1	19848	ec0

$

The output shows that this particular host has the IP address 141.38.48.12 with a subnet mask of 24 bit (0xffffff00 or 255.255.255.0). It also shows that the host 195.37.164.100 can be reached via the gateway 141.38.48.5, and the flags indicate that the route is up (U), that it is a route to a gateway (G) and that it is a host route (H). The first line indicates that all other destinations are reachable via the hosts default gateway 141.38.48.2.

In the next output:

$ netstat -rn
Routing tables

Internet:

Destination	Gateway	Netmask	Flags	Refs	Use	Interface
default	141.38.48.2		UG	12	4014211	ec0
127.0.0.1	127.0.0.1		UH	9	2321	lo0
141.38.48	141.38.48.12	0xffffff00	U	3	68981	ec0
141.38.48.12	127.0.0.1		UGH	10	253410	lo0
195.37.164.100	141.38.48.2		UGHM	2	345	lo0
224	141.38.48.12	0xf0000000	U	1	19848	ec0

$

The only difference to the first sample output is that the host route to 195.37.164.100 is now flagged with an M, which means that this route was modified by an ICMP redirect message from the old gateway 141.38.48.5. This usually means that the router with the IP address 141.38.48.5 has lost its route to 195.37.164.100 and may indicate a problem with the link to the remote network.

Other monitoring tools

Verifying correct IP connectivity is a necessary first step. Other tools can be used to provide more information on what is happening. There are many options. It is possible to use protocol analysers and SNMP-based software tools. For example, Sun Microsystems bundles with Solaris a tool called snoop that can replace in most cases a local area network analyser. Others tools such as TCPDUMP are available free on the Internet and can be installed on various systems. TCPDUMP is often bundled in various Linux distributions. These tools require a rather good knowledge of IP protocol; but, for example, TCPDUMP might be used to diagnose application-level problems.

The following is a simple example on the host "pontiac" of the capture of ICMP exchanges between zinder and cadillac.

```
pontiac# /usr/local/bin/tcpdump -i nf0 host cadillac and zinder and proto icmp
15:28:06.68 cadillac.meteo.fr > zinder.meteo.fr: icmp: echo request
15:28:06.68 zinder.meteo.fr > cadillac.meteo.fr: icmp: echo reply
15:28:19.45 cadillac.meteo.fr > zinder.meteo.fr: icmp: echo request
15:28:19.45 zinder.meteo.fr > cadillac.meteo.fr: icmp: echo reply
15:28:29.44 cadillac.meteo.fr > zinder.meteo.fr: icmp: echo request
15:28:29.45 zinder.meteo.fr > cadillac.meteo.fr: icmp: echo reply
```

SNMP

Simple Network Management Protocol (SNMP) was developed in the late 1980s in order to offer network managers a standard tool for controlling networks. In most cases, SNMP could be used to replace the cruder tools described above. Unfortunately, good SNMP software is not cheap. SNMP is a client-server protocol. In order to be able to gather information with SNMP, the equipment connected on the network must have a Management Information Base (MIB). These bases are catalogues of integer, counters, strings, etc. The manager asks the agents to send some values. These values might, for example, be an IP routing table. The following example is obtained by requesting with HP Open View (a commercial package) the routing table on the host monica.meteo.fr.

Title: : monica.meteo.fr
Name or IP Address: monica.meteo.fr

ipRouteDest	ipRouteMask	ipRouteNextHop	ipRouteProto	ipRouteMetric1
0.0.0.0	0.0.0.0	137.129.1.5	local	0
136.156.0.0	255.255.0.0	137.129.1.5	ciscoIgrp	8786
137.129.1.0	255.255.255.0	137.129.1.6	local	0
137.129.2.0	255.255.255.0	137.129.1.5	ciscoIgrp	1110
137.129.3.0	255.255.255.0	137.129.3.254	local	0
137.129.4.0	255.255.255.0	137.129.4.254	local	0
137.129.5.0	255.255.255.0	137.129.5.254	local	0
137.129.6.0	255.255.255.0	137.129.1.62	local	0
137.129.7.0	255.255.255.0	137.129.7.254	local	0
137.129.8.0	255.255.255.0	137.129.8.254	local	0
137.129.9.0	255.255.255.0	137.129.1.5	ciscoIgrp	1110

Information given above with TCPDUMP might be obtained with SNMP but, to do so, probes running the remote monitoring MIB must be connected on the network.

On a bilateral basis, it might be useful for Centres to allow SNMP access to their router from the other NMC. However, regular polling of other Centres' routers should be avoided to avoid overloading of circuits.

MRTG

Another public domain package, the Multi Router Traffic Grapher (MRTG), is a very helpful tool to gather information about the local network and about connected links. MRTG is a tool to monitor the traffic load on networks and links. It generates HTML pages containing images that provide a live visual representation of this traffic. It can also be implemented to indicate failures of network links. MRTG consists of a Perl script that uses SNMP to read the traffic counters of a router(s) and a fast C program that logs the traffic data and creates graphs representing the traffic on the monitored network connection(s). A sample output is shown in Figure 7. It shows traffic statistics for a dedicated link and gives information about the traffic pattern on the link. This is just one of many graphs that can be created with MRTG. More information about MRTG can be found at http://oss.oetiker.ch/mrtg/.

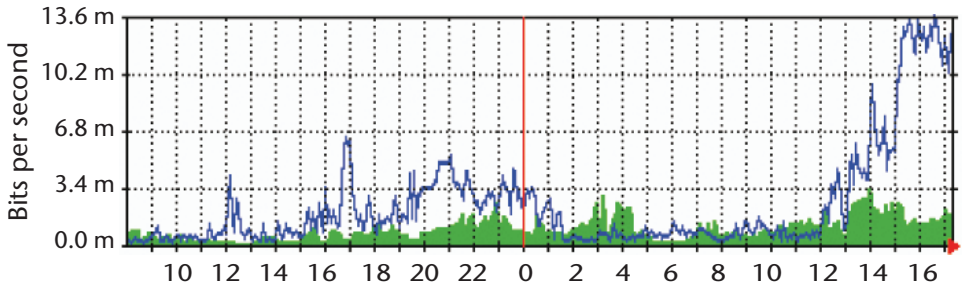


Figure 7. Sample MRTG graph

Syslog

Many of the possible problems can be located if one not only looks at the syslog files on the hosts, but uses a syslog server as well and lets the router(s) send their messages to it. This file can then be checked regularly, for example, for messages that indicate high CPU load, processes that use up much memory or CPU cycles, lines going up and down, and messages about events regarding the used routing protocol.

There are eight different levels of messages the router will log to the syslog server. They are:

Emergencies	0	System unusable
Alerts	1	Immediate action needed
Critical	2	Critical conditions
Errors	3	Error conditions
Warnings	4	Warning conditions
Notifications	5	Normal but significant condition
Informational	6	Informational messages only
Debugging	7	Debugging messages

The default logging facility on a Cisco router is set to local7. This is important to know when configuring a host to be a syslog server and will be explained in the section on configuring a syslog server.

The configuration commands on a Cisco router to activate logging are:

```
cisco-gts-1(config)#logging trap level-of-messages-to-log
cisco-gts-1(config)#logging 141.38.48.12
```

and can be checked with the command "show logging":

```
cisco-gts-1#sho logging
Syslog logging: enabled (0 messages dropped, 0 flushes, 0 overruns)
Console logging: level debugging, 117892 messages logged
Monitor logging: level debugging, 8317 messages logged
Trap logging: level debugging, 117150 message lines logged
Logging to 141.38.48.12, 117150 message lines logged
Buffer logging: disabled
cisco-gts-1#
```

In this example, logging is set to the level debugging ("logging trap debugging"), and all messages from level 7 up to level 0 will be sent to the syslog server with the IP address 141.38.48.12.

To activate the syslog server on, for instance, a SGI UNIX machine, the following entries should be included:

In the file /etc/services: syslog 514/udp

In the file /etc/syslog.conf: local7.debug /usr/people/cisco/logs/cisco.log

The local7.debug relates to the default facility of logging that is defined on a Cisco router as mentioned (local7). The file above will be the file to which the syslog daemon writes all incoming syslog messages for local7.

The last action on the host is to have the syslog daemon reread its config file (kill –1 pid-of-syslogd).

Bandwidth management

On an IP network, all packets will be routed over the links without any prioritization mechanism. Therefore, an FTP transfer can occupy all the bandwidth available starving all others applications. When traffic increases, it might therefore be necessary to introduce some bandwidth management in the network configuration.

APPENDIX 1. HIGH-LEVEL TCP/IP TOPOLOGY AND TCP/IP DATA FLOWS

The following figures show a high-level view of the topology of a simple Centre and the main data flows regarding GTS and Internet telecommunication.

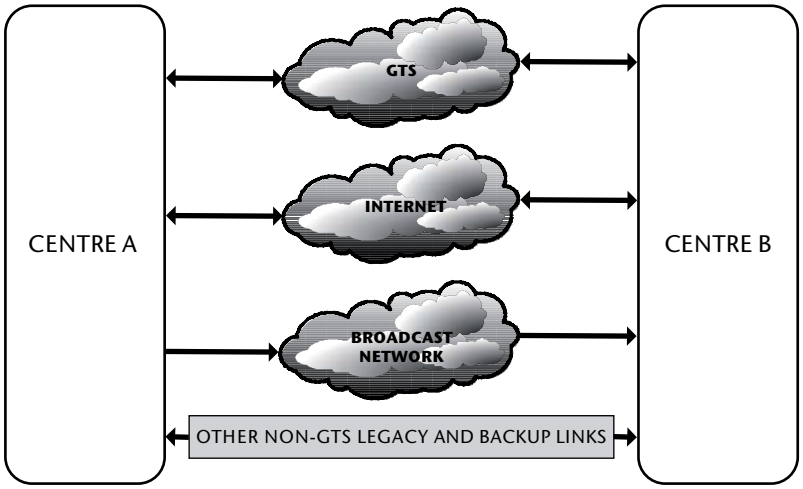


Figure 8. General interconnectivity between Centres

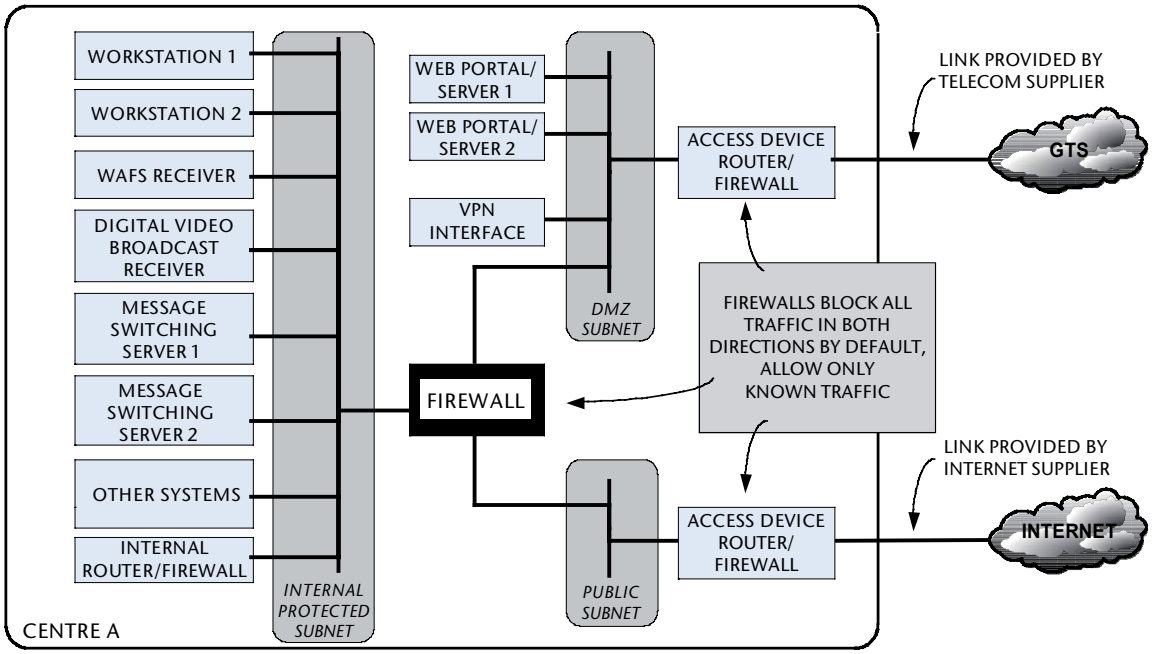


Figure 9. Topology of TCP/IP network in a simple Centre

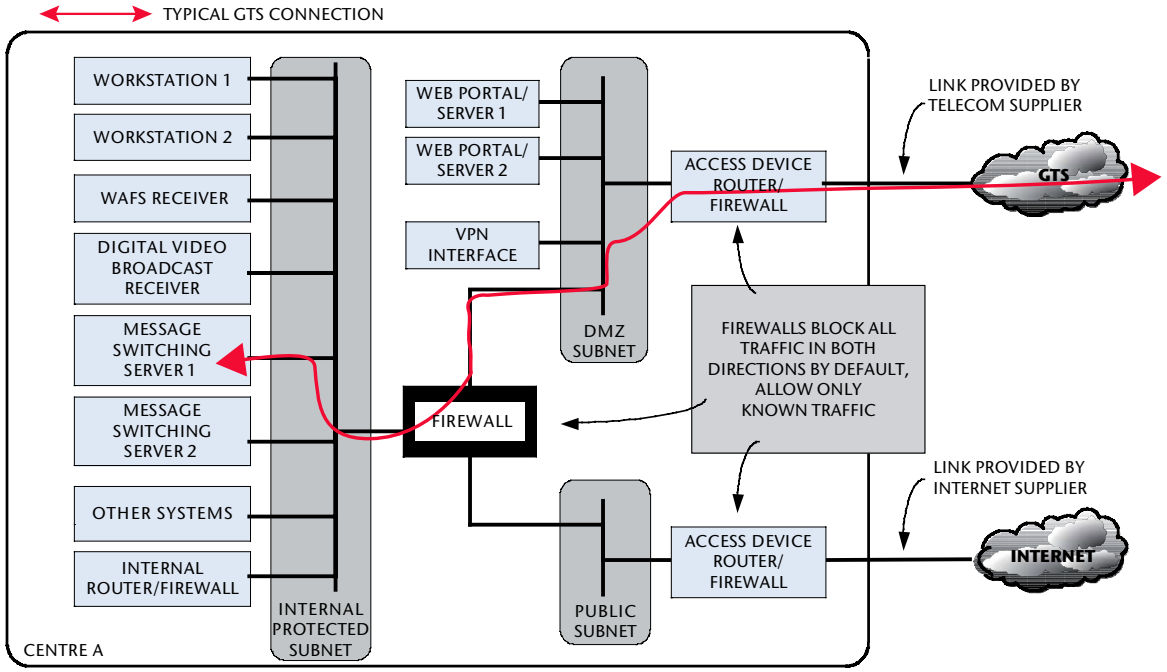


Figure 10. Data flow of traffic over the GTS – IP only

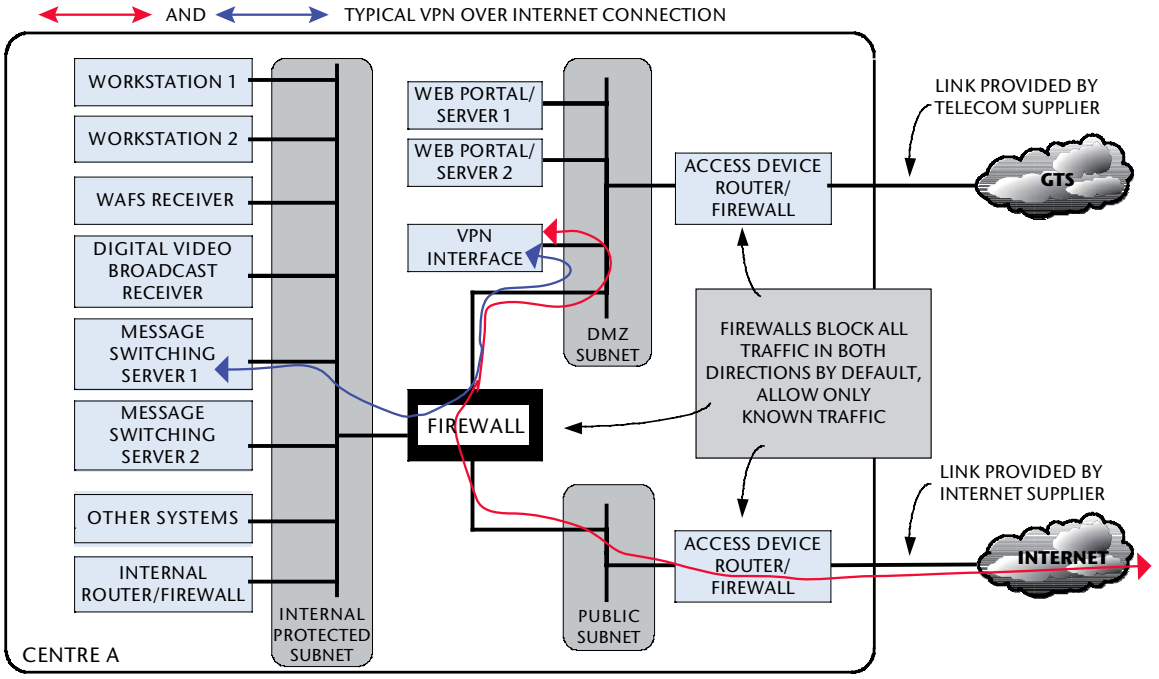


Figure 11. Data flow of traffic using VPN over the Internet

APPENDIX 2. CISCO ROUTER CONFIGURATIONS

The router configurations provided in this appendix are examples and should not be interpreted as a suggestion that Cisco is the only supplier capable of this functionality.

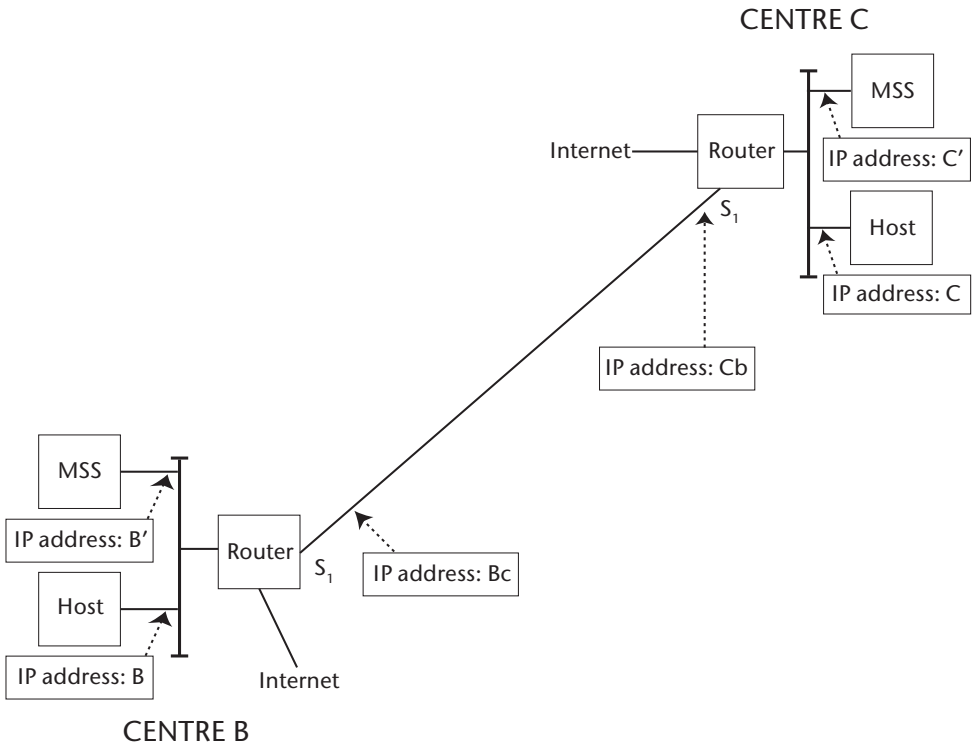
This appendix is not intended to be a complete description of all available commands for a Cisco router, nor a full course on this equipment, but it is useful to describe more precisely the configuration tasks in order to comply with the policy outlined in the section on routing and traffic management.

The configuration described below respects what is available in release 11.1 of Cisco IOS software. Some features were not available in previous releases, and some have been modified.

Different steps are described:

1. Establishing IP connection
   - IP over PPP
2. Routing configuration
   - Leaf node with dynamic routing (Centre C)
   - Configuration in a non-leaf node (in this case two different GTS connections, Centre B)
3. Security configuration
   - Filtering traffic based on declared IP addresses
   - Controlling routing exchanges between GTS and the Internet

In this example, Centre B is connected to C with IP over PPP.[1] B and C are also connected to the Internet. B and its Internet provider use static routes,[2] C and its Internet provider use RIP.[3]



[1] Note that using PPP encapsulation is not the preferred option, but as it is a non-default option, it shows the usage of the "encasulation" statement in this example.

[2] B cannot use EGP and BGP on the same router; one router cannot belong to more than one AS.

[3] RIP is NOT a good choice for this type of configuration but, as RIP is the most basic protocol, it is also used in this case.

The following will be used throughout this appendix:

	IP router address	IP hosts address for GTS	Autonomous-System
Centre B	193.105.177.2 193.105.178.5	137.129.9.0/255.255.255.0	65001
Centre C	193.105.178.6	195.1.1.0/255.255.255.0	65200

Centres B and C use serial interfaces 1 for the PPP link.

Step 1: Establishing connections

Centre B:

```
interface serial 1
 encapsulation PPP
 ip address 193.105.178.5 255.255.255.252
!
```

Centre C:

```
interface serial 1
 encapsulation PPP
 ip address 193.105.178.6 255.255.255.252
!
```

After this first step, IP configuration between the routers is complete.

MSSs at B and C can communicate with IP (once end-to-end routing is established).

Step 2: Routing

Centre B:

```
! BGP routing
router bgp 65001
 network 137.129.9.0 mask 255.255.255.0
 neighbour 193.105.178.6 remote-as 65200
```

Centre C:

```
! BGP routing
router bgp 65200
 network 195.1.1.0
 neighbour 193.105.178.5 remote-as 65001
! 196.1.1.0 is network address for non-GTS hosts in C
router rip
version 2
network 195.1.1.0
no auto-summary
```

Step 3: Security

Centre B:

```
! Declare which hosts can use GTS
access-list 1 permit 137.129.9.0 0.0.0.255
! Declare which hosts can come from GTS
access-list 2 permit 195.1.1.0 0.0.0.255
!
```

```
! Only accept BGP updates from AS neighbour
ip as-path access-list 3 permit ^$
ip as-path access-list 3 permit ^65200
!
interface serial 1
 ip access-group 1 out
 ip access-group 2 in
! Restrict BGP updates
router bgp 65001
 network 137.129.9.0 mask 255.255.255.0
 neighbour 193.105.178.6 remote-as 65200
 neighbour 193.105.178.6 filter-list 3 in
 neighbour 193.105.178.6 filter-list 3 out
```

Centre C:

```
! Declare which hosts can use GTS
access-list 1 permit 195.1.1.0 0.0.0.255
! Declare which hosts can come from GTS
access-list 2 permit 137.129.9.0 0.0.0.255
!
! Only accept BGP updates from AS neighbour
ip as-path access-list 3 permit ^$
ip as-path access-list 3 permit ^65001
!
interface serial 1
 ip access-group 1 out
 ip access-group 2 in
! Restrict BGP updates
router bgp 65200
network 195.1.1.0 mask 255.255.255.0
 neighbour 193.105.178.5 remote-as 65001
 neighbour 193.105.178.5 filter-list 3 in
 neighbour 193.105.178.5 filter-list 3 out
```

In these configurations, there are two important features used:

(a) BGP filtering

The access-list 3 in both B and C checks the autonomous system number sent by its neighbour. By filtering in and out in the BGP process this guarantees that all known routes must be issued from one of these ASs.

(b) IP filtering

The access-list 1 list allows IP addresses issued from within each Centre. This list should be quite stable. The access-list 2 checks the incoming IP addresses. As new Centres are added to the IP network, the corresponding addresses must be added to these access-lists.

It must also be noted that despite Internet connections in B and C no extra attention is required to control routing exchange. A static default route is not sent even if “redistribute static” is enabled. RIP and BGP ignore routing information known via the other protocol.

APPENDIX 3. SAMPLE SOCKET SEND AND RECEIVE ROUTINES

```
/*********************************************************************
* Sample TCP/IP Socket program that SENDS a single message
*********************************************************************/
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <signal.h>
#include <string.h>
#include <memory.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <netdb.h>

/* TCP/IP DESTINATION and SERVICE ARE DEFINED BY THE RECEIVING CENTRE */
#define DESTINATION      "localhost"
#define SERVICE 39000
#define GTS_LENFIELD 8
#define MAX_MSGSIZE     15000 /* value of the send buffer size, recommended: 4096 */

static void GetDestinationInfo();
static void SetupSocket();
static void SendData();
static void MakeConnection();

static struct sockaddr_in dest;
static int              pr_sock;

/*********************************************************************
*                              MAINLINE
* 1. Ignore SIGPIPE signals. These are generated if a connection
*  is lost. By default they cause a program to terminate.
* 2. Get information about the destination (GetDestinationInfo):
*          - IP number (and name)
*          - Service/Port number
* 3. Create a TCP/IP Socket (SetupSocket)
* 4. Connect to the destination centre (MakeConnection)
* 5. Send the message (SendData)
* 6. Close the socket (shutdown + close)
*********************************************************************/
main(int argc, char *argv[])
{

signal (SIGPIPE,SIG_IGN);

GetDestinationInfo();
SetupSocket();
MakeConnection();
SendData();
/* shutdown(pr_sock,1) */
close(pr_sock);

}

/*********************************************************************
*                              GET DESTINATION INFO
* Store the destination IP address and service number in a socket
* structure (dest).
* 1. Convert the destination name to an IP address (gethostbyname)
* 2. Store the IP address and service number in the "dest" structure.
*********************************************************************/
static void GetDestinationInfo()
{
struct hostent *hp;
hp = gethostbyname (DESTINATION);
```

```
if ( hp == NULL ) {
  printf("host error\n");
  exit(1);
  }

memset ((char *)&dest, 0, sizeof dest);
memcpy (&dest.sin_addr.s_addr, hp->h_addr, hp->h_length);
dest.sin_family = AF_INET;
dest.sin_port = SERVICE;
}

/*********************************************************************
*                              SETUP SOCKET
* Setup a TCP/IP Socket
* 1. Create the socket
* 2. Set the socket KEEPALIVE option.
*  This enables the automatic periodic transmission of "check"
*  messages to be sent on the connection. If the destination
*  does not respond then it is considered broken and this process
*  is notified (by SIGPIPE or end-of-file)
*3. Set the socket REUSEADDR option. Enable quicker restarting of
*  terminated processes.
*4. Reduce the size of the Socket send buffer to reduce the amount of data lost
*  if the connection fails.
*********************************************************************/
static void SetupSocket()
{
int        on = 1;
int        rc;
int        buffsize = MAX_MSGSIZE;

pr_sock = socket (AF_INET, SOCK_STREAM, 0);
if (pr_sock < 0) {
  printf("sock error\n");
  exit(1);
  }

 rc = setsockopt(pr_sock,SOL_SOCKET,SO_KEEPALIVE,(char *)&on,sizeof(on));
 if (rc != 0) {
  printf("keepalive error\n");
   }

 rc = setsockopt(pr_sock,SOL_SOCKET,SO_REUSEADDR,(char *)&on,sizeof(on));
 if (rc != 0) {
  printf("reuse error\n");
   }

rc = setsockopt(pr_sock,SOL_SOCKET,SO_SNDBUF,(char *)&buffsize,sizeof(buffsize));
 if (rc != 0) {
  printf("unable to set send buffer size\n");
   }

}

/*********************************************************************
*                              MAKE CONNECTION
* Attempt to make a TCP/IP Socket connection to the destination on
* the agreed service/port number.
*********************************************************************/
static void MakeConnection()
{
int        length;
```

```
length = sizeof (dest);
if ( connect (pr_sock,(struct sockaddr *)&dest,length) == -1 ) {
 printf("connection error\n");
 exit(1);
 }

printf("connected\n");
}

/*********************************************************************
*                              SEND DATA
* Send a message on the socket (5 times actually).
*
* NOTE: A real program would check the return code from the write
* and if the write failed it would close the socket, raise an operator
* alarm, and then try to re-send from the start of the message
*********************************************************************/
static void SendData()
{
char     msg[MAX_MSGSIZE+1], buffer[MAX_MSGSIZE+GTS_LENFIELD+3];
int      buflen, i, rc = 0;

strcpy(msg,"\001\r\r\n001\r\r\nTTAA01 AMMC 000000\r\r\n");
for (i=0;i<60;i++)
 strcat(msg,"THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789\r\r\n");
strcat(msg,"\r\r\n\003");

sprintf(buffer,"%0*dAN%s",GTS_LENFIELD,strlen(msg),msg);
buflen = strlen(buffer);

for (i=0; i<5; i++) {
 rc = write(pr_sock,buffer,buflen);
 printf("write. rc = %d\n",rc);
 }

}

/*********************************************************************
* TEST TCP/IP SOCKET RECEIVING PROGRAM.
* Program is designed to give some ideas as to how to receive GTS
* style messages on a TCP/IP Socket connection.
*********************************************************************/
#include <stdio.h>
#include <unistd.h>
#include <stdlib.h>
#include <signal.h>
#include <string.h>
#include <memory.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <netdb.h>

#define SERVICE             39000
#define MAX_MSGSIZE             15000
#define MAX_BUFLEN              MAX_MSGSIZE + 100
#define SOH             '\001'
#define ETX     '\003'
#define GTS_LENFIELD            8
#define GTS_SOCKET_HEADER       10

static void SetupService();
static void RecvData();
static void AcceptConnection();
static int ExtractMsg(char *buffer, int *buflen);
static int CheckMsgBoundaries (char *, int);
static int FindMessage (char *, int, int *);
```

```
static void ShiftBuffer (char *, int *, int);

static struct sockaddr_in dest;

static int          pr_sock, msgsock;
static char         buffer[MAX_BUFLEN+1];
static int          buflen = 0;

/*********************************************************************
*                              MAIN
* Listen for incoming IP calls and read any incoming messages on
* the first call established.
*
* 1. Ignore SIGPIPE signals. These are generated if a connection
*  is lost. By default they cause a program to terminate.
* 2. Set-up a listening socket for incoming msgs (SetupService)
* 3. Accept the first call received (AcceptConnection)
* 4. Read any messages on this connection (RecvData)
* 5. Close the call and close the listening socket.
*********************************************************************/
main(int argc, char *argv[])
{

signal (SIGPIPE,SIG_IGN);

SetupService();
AcceptConnection();
RecvData();

close(msgsock);
/* shutdown(pr_sock,1) */
close(pr_sock);
}

/*********************************************************************
*                              SETUP SERVICE
* Listen for calls on a given Service/Port.
* 1. Create a socket
* 2. Set the socket KEEPALIVE option.
*  This enables the automatic periodic transmission of "check"
*  messages to be sent on the connection. If the destination
*  does not respond then it is considered broken and this process
*  is notified (by SIGPIPE or end-of-file)
* 3. Set the socket REUSEADDR option. Enable quicker restarting of
*  terminated processes.
* 4. Bind the socket to the required Service/Port
* 5. Start listening for calls.
*********************************************************************/
static void SetupService()
{
int        on = 1;
int        rc;
/* adjust the TCP receive buffer size
int        buffsize = MAX_MSGSIZE; */

memset ((char *)&dest, 0, sizeof dest);
dest.sin_addr.s_addr = INADDR_ANY;
dest.sin_family = AF_INET;
dest.sin_port = SERVICE;

pr_sock = socket (AF_INET, SOCK_STREAM, 0);
if (pr_sock < 0) {
 printf("sock error\n");
 exit(1);
 }
```

```
 rc = setsockopt(pr_sock,SOL_SOCKET,SO_KEEPALIVE,(char *)&on,sizeof(on));
 if (rc != 0) {
  printf("keepalive error\n");
  exit(1);
  }
 rc = setsockopt(pr_sock,SOL_SOCKET,SO_REUSEADDR,(char *)&on,sizeof(on));
 if (rc != 0) {
  printf("reuse error\n");
  exit(1);
  }
/* adjust the TCP receive buffer size
rc = setsockopt(pr_sock,SOL_SOCKET,SO_RCVBUF,(char *)&buffsize,sizeof(buffsize));
 if (rc != 0) {
  printf("unable to set send receive size\n");
  }
*/
rc = bind(pr_sock,(struct sockaddr *)&dest,sizeof dest);
if ( rc < 0) {
  printf("bind error\n");
  exit(1);
  }

rc = listen(pr_sock,1);
if ( rc < 0) {
  printf("listen error\n");
  exit(1);
  }

printf("listening\n");
}

/*********************************************************************
*                              ACCEPT CONNECTION
* Wait for an incoming call (accept).
* Return the socket of the call established.
*********************************************************************/
static void AcceptConnection()
{
int        addrlen;

printf("waiting connection\n");

addrlen = sizeof(sockaddr_in);
msgsock = accept (pr_sock,&dest,&addrlen);
if ( msgsock < 0) {
  printf("accept error\n");
  exit(1);
  }
printf("connected\n");
}

/*********************************************************************
*                              RECV DATA
* Read data from the message/call socket.
* Extract GTS messages from this data.
* Keep reading until the sender drops the call or there is an error.
*********************************************************************/
static void RecvData()
{
int        numr = 1;
int        rc = 0;
```

```
while (numr > 0 && rc >= 0) {
 numr = read(msgsock,buffer+buflen, MAX_BUFLEN-buflen);
 if (numr > 0) {
  buflen += numr;
  buffer[buflen] = '\0';
  printf("buffer = %s\n",buffer);
  rc = ExtractMsg(buffer,&buflen);
  }
 }
}

/*********************************************************************
*                              EXTRACT MSG
*  DESCRIPTION
*  This function accepts a buffer of data on input, along with the
*  amount of data in the buffer, and extracts GTS messages from this
*  buffer.
*
*  Messages that are in the buffer are identified as follows…
*
*  – The first 8 bytes of the message buffer HAVE to be a message
*   length in character format.
*   If the length exceeds the GTS defined maximum message size, or
*   does not consist of numeric characters, then an error is returned
*   (lost synchronization).
*
*  – Immediately following the message length is a 2 character
*          Message Type: "AN" = Alphanumeric, "BI" = binary, "FX" = Fax
*
*  – The GTS message begins with a SOH character, and is terminated
*   with a ETX character, if this does not occur, then an error is
*   returned (lost synchronization).
*
*  – If a GTS message is identified, then it is extracted and the
*   message is shifted out of the buffer.
*
*  – As there may be more than 1 message in the buffer, this function
*   will loop (extracting messages) until either and
*   error or incomplete message is detected.
*
*
*  RETURNS   = 0 - Not a complete message in the buffer.
*                 < 0 - Fatal error in the format of the buffer.
*                 > 0 - Success, the message(s) have been extracted
*********************************************************************/
static int ExtractMsg(char *buffer, int *buflen)
{
int       rc, msglen;
char      msg[MAX_MSGSIZE+1];

/* FIND THE FIRST MESSAGE IN THE BUFFER */
rc = FindMessage (buffer, *buflen, &msglen);

/* WHILE A VALID MESSAGE LENGTH IS FOUND IN THE MESSAGE BUFFER… */
while ( rc > 0 ) {

 /* ENSURE THAT THE FIRST CHARACTER AFTER THE MESSAGE LENGTH IS
   A 'SOH' CHARACTER, AND THE LAST CHARACTER AS INDICATED BY
   THE MESSAGE LENGTH IS AN 'ETX' CHARACTER. */
 if ( (rc = CheckMsgBoundaries (buffer, msglen)) < 0 )
   continue;

 /* PRINT THE EXTRACTED MESSAGE */
 memcpy(msg,buffer+GTS_SOCKET_HEADER,msglen);
 msg[msglen] = '\0';
 printf("GTS MSG = \n%s\n",msg);
```

```
/* SHIFT THE JUST INJECTED MESSAGE OUT OF THE MESSAGE BUFFER,
  AND LOOP BACK TO LOOK FOR A NEW MESSAGE. */

 ShiftBuffer (buffer, buflen, msglen);

 /* FIND THE FIRST MESSAGE IN THE SHIFTED BUFFER */
 rc = FindMessage (buffer, *buflen, &msglen);

 }

return (rc);
}

/*********************************************************************
*                                FIND MESSAGE
* Check that the complete message is at the start of the buffer
* 1. Check the first 8 characters which are the message length
* 2. Check the next 2 characters - Message Type
* 3. Check that the complete message, as defined by the "message length"
*  field, is in the buffer
* Return codes:
*   0 = message incomplete
*   1 = message complete
*  -1 = error
*********************************************************************/
static int FindMessage (char *buffer, int buflen, int *mlen)
{
 char charlen[GTS_LENFIELD+1];
 int  intlen;

 *mlen = 0;

 /* IF THE LENGTH OF THE PASSED MESSAGE BUFFER IS NOT GREATER THAN
  10 CHARACTERS THEN RETURN 'INCOMPLETE'.  */
 if ( buflen < GTS_SOCKET_HEADER ) {
  return (0);
  }

 /* CHECK THAT THE MESSAGE TYPE IS VALID */
 if (strncmp(buffer+GTS_LENFIELD,"AN",2)   &&   strncmp(buffer+GTS_LENFIELD,"BI",2)   &&
  strncmp(buffer+GTS_LENFIELD,"FX",2)) {
  printf("ERROR: Message Type field invalid");
  return (-1);
  }

 /* EXTRACT THE MESSAGE LENGTH */
 strncpy (charlen, buffer, GTS_LENFIELD);
 charlen[GTS_LENFIELD] = '\0';

 /* CHECK THAT THE MESSAGE LENGTH CHARACTER STRING COMPRISES
ENTIRELY OF DIGITS. RETURN AN ERROR IF THIS IS NOT THE CASE. */
 if ( strspn (charlen, "0123456789") != strlen (charlen) ) {
  printf("ERROR: length not numeric");
  return (-1);
  }

 /* CONVERT THE MESSAGE LENGTH CHARACTER STRING TO AN INTEGER. */
 intlen = atoi (charlen);

 /* CHECK THAT THE LENGTH EXTRACTED FROM THE BUFFER IS NOT GREATER
  THAN THE GTS DEFINED MAXIMUM MESSAGE SIZE - RETURN AN ERROR IF
  THIS IS THE CASE. */
 if ( intlen > MAX_MSGSIZE ) {
  printf("ERROR: message overlength");
  return (-1);
  }
```

```
  /* CHECK IF THE ENTIRE MESSAGE HAS BEEN RECEIVED. RETURN IF NOT */
  if ( buflen < intlen + GTS_SOCKET_HEADER ) {
   return (0);
   }

  *mlen = intlen;
  return (1);
}

/*********************************************************************
*                              CHECK MSG BOUNDARIES
* Confirm the first character after the Socket Header is
* a SOH, and the last character in the message (given by the message
* length) is an ETX.
*********************************************************************/
static int CheckMsgBoundaries (char *buffer, int msglen)
{

  /* CHECK THAT THE FIRST CHARACTER (AFTER THE MESSAGE LENGTH
    FIELD) IS AN SOH CHARACTER - RETURN AN ERROR IF IT ISN'T. */
  if ( buffer[GTS_SOCKET_HEADER] != SOH ) {
   printf("ERROR: SOH not found\n");
   return (-1);
   }

  /* CHECK THAT THE LAST CHARACTER (ACCORDING TO THE MESSAGE LENGTH
    FIELD) IS AN ETX CHARACTER - RETURN AN ERROR IF IT ISN'T. */
  if ( buffer[msglen+GTS_SOCKET_HEADER-1] != ETX ) {
   printf("ERROR: ETX not found\n");
   return (-1);
   }

  return (1);
}

/*********************************************************************
*                              SHIFT BUFFER
* Shift the leading message in the buffer out of the buffer. This may
* either empty the buffer, or move all or part of a new message to the
* start of the buffer.
*********************************************************************/
static void ShiftBuffer (char *buffer, int *buflen, int msglen)
{
  int shiftlen;

  /* CALCULATE THE AMOUNT OF DATA TO BE SHIFTED OUT OF THE BUFFER. */
  shiftlen = msglen + GTS_SOCKET_HEADER;

  /* SHIFT THE 'PROCESSED' DATA OUT OF THE BUFFER BY MOVING THE
   UNPROCESSED DATA OVER THE TOP OF IT.
   CALCULATE THE NEW AMOUNT OF DATA IN THE BUFFER. */
  *buflen = *buflen - shiftlen;
  memcpy (buffer, buffer + shiftlen, *buflen);
}
```

APPENDIX 4. SOME SECURITY ARRANGEMENTS FOR SMALL GTS CENTRES

Appendix 4 has been removed from this attachment. All IT security material can now be found in the *Guide to Information Technology Security* (WMO-No. 1115).

APPENDIX 5. REFERENCE MATERIAL

General references on TCP/IP

1. *Internetworking TCP/IP* Vol. 1 (2/E) – Douglas Comer – Prentice Hall
2. *TCP/IP Illustrated Volume 1: The Protocols* – Stevens – Addison-Wesley
3. *TCP/IP Architecture, Protocols and Implementation* – Feit – McGraw Hill
4. *TCP/IP and Related Protocols* – Black – McGraw Hill
5. *TCP/IP Running a Successful Network* – Washburn and Evans – Addison-Wesley
6. *TCP/IP and ONC/NFS* (2/E) – Santifaller – Addison-Wesley
7. *Inside TCP/IP* – Arnett et al. – New Riders Publishing
8. *Teach Yourself TCP/IP in 14 Days* – Parker – SAMS
9. *An Introduction to TCP/IP* – Davidson – Springer

References on Security

1. *Firewalls and Internet Security* – Cheswick & Bellovin – Addison-Wesley
2. *Building Internet Firewalls* – Chapman – O'Reilly
3. *Practical Unix Security* – Garfinkel & Spafford – O'Reilly
4. Internet RFC 2196 (Site security Handbook: https://www.ietf.org/rfc/rfc2196.txt)

APPENDIX 6. SUGGESTED PASSWORD MANAGEMENT PRACTICES

Password management is a topic included in the IT security discussion. All IT security material can now be found in the *Guide to Information Technology Security* (WMO-No. 1115).

APPENDIX 7. IP ADDRESSES FOR USE ON THE GTS

INTRODUCTION

The current recommended practices and procedures for the implementation, use and application of the Transmission Control Protocol/Internet Protocol (TCP/IP) on the GTS, as given in the present Manual, Attachment II-15 (also known as the "Guide on the Use of TCP/IP on the GTS"), describe guidelines and a procedure for assigning IP addresses to GTS links that are no longer adequate. In particular, it states that a number of official Class C IP addresses were available through the WMO Secretariat to be assigned for GTS links. These sets of IP addresses are no longer officially available, as a consequence of a strict application of Internet standards (RFCs) by Internet Authorities and Services Providers. Thus, they unfortunately cannot be used on the GTS, as they may now be assigned to other organizations on the Internet. The WMO Secretariat has therefore been instructed to discontinue the assignment of such IP addresses.

The Expert Team on Telecommunication Infrastructure (ET-CTS) has been tasked to provide alternate solutions to solve this issue.

This appendix is a provisional description of the available options and related guidance to mitigate this problem and assist Members in their implementation. The included guidelines only concern IP addressing.

The ET-CTS will proceed with developing the proposed amendments to this attachment to reflect the new recommended practices for allocating IP addresses.

WHO CAN PROVIDE OFFICIAL IP ADDRESSES?

In order to build a network that interconnects many organizations from various countries in the world, it is essential to maintain a standard in the addressing scheme, and to maintain uniqueness in the allocation of addresses to the various organizations. The Internet community has identified this basic principle and created some official bodies to coordinate the distribution of official IP addresses. Today, this responsibility belongs to the Internet Assigned Numbers Authority (IANA), and its regional delegates, the relevant Regional Internet Registries:

AfriNIC (African Network Information Centre) – Africa region
APNIC (Asia Pacific Network Information Centre) – Asia-Pacific region
ARIN (American Registry for Internet Numbers) – Americas and Atlantic islands
LACNIC (Regional Latin American and Caribbean IP Address Registry) – Latin America and some Caribbean islands
RIPE NCC (Réseaux IP Européens Network Coordination Centre) – Europe and surrounding areas

These organizations further delegate the allocation of addresses to their regional Internet and telecommunications suppliers through national Internet registries.

In this scheme, it is not the responsibility of WMO to allocate IP addresses. As the GTS is not built as a unique network under the complete authority of a single organization, the allocation of addresses must therefore go through the respective national Internet registry or the appropriate Regional Internet Registry.

However, several countries now face the issue of the restriction of allocation of IP version 4 (IPv4) addresses and may have difficulty obtaining official addresses. This problem is not an easy one to solve in the short term and provisional measures may have to be taken to allow the further development of the GTS. The following guidelines explain how to interconnect networks with and without the use of official IP addresses.

CONNECTING NETWORKS WITH OFFICIAL IP ADDRESSES

Using official IP addresses assigned directly to an organization (e.g. the NMHS)

This remains the preferred option if it is feasible. It is basically the main procedure described in the existing "Guide on the Use of TCP/IP on the GTS". It follows all the Internet rules and allows an organization to build a coherent network with interconnections to the Internet, GTS and possibly other partner organizations. It is also the easiest configuration to maintain.

In interconnecting two countries to form a GTS link, the two National Meteorological and Hydrological Services (NMHSs) should decide which one actually provides the address to the interconnecting link. The decision remains one of practicality for the countries. There are no general rules that would favour one set of addresses over another.

Using official IP addresses provided by a telecommunications supplier

This option is very similar to the previous one. The addresses supplied would be official and all the rules would of course be followed.

It may require the use of a common telecommunications supplier between the two interconnecting organizations.

This option, however, has the drawback that a change in telecommunication suppliers may require a change in IP addressing should original incumbents reclaim "their" addresses. Each organization should plan for this possibility ahead of time and evaluate its impact on future operations. If these addresses are only used for link purposes and not for an organization's internal purposes, then this drawback may be of minimal impact.

Using IP version 6 (IPv6) addresses

The new IP version 6 (IPv6) protocol standard was designed in great part to address the shortage of IPv4 addresses. Although the IPv6 protocol is available and supported in many telecommunication equipment available today, its implementation requires much planning. In particular, IPv4 and IPv6 are not compatible without the use of gateways and there are several operational tools still missing to make IPv6 usable for the GTS at this time. Converting to IPv6 would be a major task that cannot be imposed on WMO Members until the industry is ready to take this step as a whole.

Therefore, this option is not available today. It is only mentioned herein for completeness and will be further studied over the next years.

CONNECTING NETWORKS WITHOUT OFFICIAL IP ADDRESSES

Using the "ip unnumbered" feature

Several network equipment suppliers (Cisco, 3Com, Juniper) have now introduced a feature in their configurations, which allows the implementation of links without the need for allocation of IP addresses. This feature is usually called the "ip unnumbered" feature. For example, Cisco provides a document on "Understanding and Configuring the ip unnumbered Command" (see http://www.cisco.com/en/US/tech/tk648/tk362/technologies_tech_note09186a0080094e8d.shtml for details).

This feature is not a standard IP protocol feature, so it requires compatible equipment at both ends of the link to work (the most frequent situation in any case).

Routing between the two networks can be accomplished by binding the unnumbered interface to another existing interface in the router (either a real LAN or virtual loopback interface). The use of this feature may introduce limitations in routing flexibility.

Using RFC 1918 – Addresses for private internets

The Internet Engineering Task Force (IETF) document RFC 1918 – Address allocation for private Internets, describes a set of addresses reserved for use by organizations for sole intra-enterprise communications, without any intention to ever directly connect to other enterprises or the Internet itself.

Therefore, the use of these addresses does not require official registration. The main purpose of this scheme is to allow a big organization to make use of a larger address space for its internal operations. As soon as the organization needs to exchange with others, a gateway must be traversed to enter an area of officially assigned addresses to maintain overall network coherence. This gateway must translate the internal RFC 1918 addresses into official external IP addresses, which must be obtained via the official bodies. The function (usually performed by a router or firewall) that does this translation is called Network Address Translation (NAT). This address translation will also have the effect of concentrating several RFC 1918 internal addresses into a very small number of official addresses, thus preserving official address space.

Although this scheme might seem attractive at first for the issue at hand, the GTS is not the network of a single enterprise. At this time, any number of the WMO Member NMHSs and related organizations may already make use of the RFC 1918 in their own networks, which may result in conflicting address allocations if the networks interconnect. A recommendation from WMO for the use of RFC1918 is almost an impossible task, as the NMHSs may already be under guidelines of their own government, which might conflict with a WMO directive. However, interconnecting countries may find adequate address space within RFC 1918 in a bilateral agreement.

Thus, this option is feasible as long as the following points are carefully considered, planned, maintained and monitored:

1. Great care should be taken in selecting a proper RFC 1918 set of addresses for links between organizations. It is important that the selected addresses are not already in use by any of the involved organizations.
2. Great care should be taken to ensure that routing configurations do not allow the leaking of RFC 1918 addresses into another organization's network or, worse, into the Internet.
3. Although this solution will work quite satisfactorily between a few countries, it cannot be expanded to many directly interconnected countries, as the choice of RFC 1918 addresses will become more and more complicated.
4. The IANA has reserved the following blocks in RFC 1918.
   10.0.0.0 – 10.255.255.255 (10/8 prefix)
   172.16.0.0 – 172.31.255.255 (172.16/12 prefix)
   192.168.0.0 – 192.168.255.255 (192.168/16 prefix)
   As many organizations already use the 10.0.0.0/8 block internally and as the 192.168.0.0/16 block is often used as default addresses by several equipment manufacturers, it is recommended that GTS links be used out of the 172.16.0.0/12 block only if possible.
5. Furthermore, it is also recommended that the 172.16.0.0/12 be subnetted in a way to maximize the usage of the address space. To that effect, GTS links can be subnetted to /30 bits. This allows four hosts per link (leaving the hosts addresses 1 and 2 available to designate the two ends of a given link).
6. NMHSs that consider using the RFC 1918 addresses should consult with all potential NMHSs with whom they might establish a link in order to coordinate and plan the use of these subnets ahead of time. In the case of address conflicts, other address schemes within RFC 1918 might be used by bilateral agreement. The ET-CTS would like to be informed of such issues if they arise to further develop this recommendation.

The use of RFC 1918 addresses should not introduce security problems as long as the above points are well managed.

RECOMMENDATION

All the options described above can be used in the GTS. The order of preference is as follows:

1. Using official IP addresses assigned directly to an organization, e.g. the NMHS (preferred).
2. Using official IP addresses provided by a telecommunications supplier.
3. Using the "ip unnumbered" feature.
4. Using RFC 1918 – Address allocation for private Internets.

The use of IPv6 on the GTS is not recommended at this time.

It should be understood that all options that do not require official IP addresses are workarounds to mitigate the shortage of addresses and must be used with care.

CONFIGURATION EXAMPLES

Option 1 – Using existing organization (NMHS) official IP addresses or Option 2 – Using Telecommunication Supplier official IP addresses

Below is the standard way to configure an interface between two networks.

Router A:
```
!
interface Ethernet0
ip address 131.238.17.11 255.255.255.0
!
interface Serial0
description 64Kbps leased line to router B
ip address 131.238.18.01 255.255.255.252
encapsulation ppp
bandwidth 64
!
ip route 142.47.43.0 255.255.255.0 131.238.18.2
!
```
Router B:
```
!
interface Ethernet0
ip address 142.47.43.201 255.255.255.0
!
interface Serial0
description 64Kbps leased line to router A
ip address 131.238.18.02 255.255.255.252
encapsulation ppp
bandwidth 64
!
ip route 131.238.17.0 255.255.255.0 131.238.18.1
```

ATTACHMENT II-16. PROCEDURES FOR TRANSMITTING AND COLLECTING METEOROLOGICAL BULLETINS USING E-MAIL AND WEB

A USE OF ELECTRONIC MAIL (E-MAIL)

Background

Electronic mail (e-mail) can be a very simple and cost-effective way to exchange meteorological bulletins, in particular for collecting meteorological data bulletins. It should be noted, however, that e-mail is not an end-to-end service and there is no guarantee of the timely delivery of messages. E-mail is also inherently insecure.

The following guidelines describe practices for sending both data collection bulletins and binary meteorological bulletins via e-mail while minimizing security risks.

Centres implementing this procedure should ensure that meteorological bulletins to be ingested in the GTS follow the standard GTS procedures and formats.

Guidelines for sending meteorological bulletins via electronic mail on the Internet

1. The main body of e-mail should use charset (character encoding) which is understandable by receiving centres. If e-mail client software can be configured, "US-ASCII" or "UTF-8" is suggested where there is no bilateral arrangement.

2. The sender should be reminded, however, that not all of transmittable characters are acceptable to the GTS. The main body of e-mail messages should use only characters defined in International Alphabet No. 5. Use of other characters, especially NO-BREAK SPACE, is discouraged for interoperability reasons. It is recommended that the meteorological bulletin should be contained in the main body of the e-mail message; as an option it may be contained in an attachment.

3. The "From:" header field should be previously agreed with the receiving centre.

4. The "Subject:" header field is recommended to be either:

   (a) The AHL if the e-mail message contains a single meteorological bulletin; or
   (b) A <security string> previously agreed with the receiving centre.

5. It is recommended that only a single bulletin should be sent in each e-mail message. However, receiving centres may agree to accept multiple meteorological bulletins per e-mail message to a maximum of five.

6. The meteorological bulletin(s) can be sent either as text in the main body of the e-mail message, or in the attachment(s) of the e-mail message, but not in both. Text data should be sent in the main body of the e-mail message. Binary data can only be sent in the attachment(s). Attachments should be encoded in Base64 (MIME standard).

7. When (a set of) meteorological bulletin(s) is sent in the main body of an e-mail message, the following format should be followed:

   <Meteorological Bulletin>
   NNNN
   where,
   <Meteorological Bulletin> is a standard meteorological bulletin starting with the abbreviated header line, such as
   TTAAii CCCC YYGGgg [BBB]
   message text
   A termination string NNNN is required after every meteorological bulletin.

No other information should be included in the main body of the e-mail message unless agreed by the receiving centre. For example, automatic forward and reply informational text should not be allowed in the body of the message.

Note: The receiving centre shall validate the AHL before processing the meteorological bulletin.

8. When (a set of) meteorological bulletin(s) is sent in attachments, the attachments must be in a format agreed with the receiving centre. One possible format is described in Attachment II-15 under "Accumulating messages into files". The main body should be blank.

9. The total size of all attachments should not exceed 2 Megabytes or as specified in a bilateral agreement. Attachments should be coded in Base64 (MIME standard).

Example

```
From: NMCAAAAA <NMCAAAAA@meteo.fr>                    } Information which
To: RTHcollector <RTHcollector@meteo.zz>              } is part of the e-mail
Subject: SMFW01 NWBB 270000                           } header

SMFW01 NWBB 270000                                    }
AAXX 27004                                            }
91753 32481 51008 10331 20259 40078 58017 83202       } Text in the main body
  333 20263 59018 83816 84078=                        } of the e-mail message
91754 01581 51812 10287 20245 40092 58017 60034 70182 85200 } or in the attachment
  333 20256 59016 60017 85820=                        }
NNNN                                                  }
```

Guidelines for e-mail-to-GTS gateways

1. To minimize security risks, the receiving centre should validate the e-mail message header "From:" field against a previously agreed list of source addresses before sending bulletins to GTS.

2. If receiving and sending centres agree to implement <security strings> > it should be placed in the message header "Subject:" field or the previously agreed field.

3. The receiving centre should validate the AHL found in the "Subject:" header field (if it is not <security string>) or extracted from meteorological bulletin(s) such as the main body.

4. No automatic acknowledgements or replies should be sent from the receiving centres.

5. It is recommended to use specific mail accounts for receiving GTS data transferred with bilaterally agreed names and not to receive GTS data in personal mailboxes.

6. A problem with some e-mail exchanger applications is that by default they operate as an "open-relay", which is exploited for sending unsolicited bulk e-mail. An open-relay occurs, for example, if site A.COM accepts mail from B.NET destined for C.ORG. This means that spammers can use A.COM's mail system to distribute their e-mails. Centres should ensure that they do not operate as an open-relay.

7. To minimize the risk of operational trouble, the receiving centre should understand and decode all MIME standard multipart structure and Content-Transfer-Encodings (namely Base64 and Quoted-Printable). When sending text bulletins intended for global distribution, the gateway should ensure the content is in ITU International Reference Alphabet. For example, a NO-BREAK SPACE (hexadecimal code A0 or C2 A0 in many charsets) can be replaced by an ordinary SPACE (20).

Security considerations

E-mail is inherently insecure. In order to minimize the risk of unauthorized message submission, it is recommended that e-mail-to-GTS gateways:

(1) Validate “From:” address;
(2) Validate <security-string> in “Subject:”

Hence, it is advised that the agreed e-mail address and/or <security-string> are treated as secret by both sending and receiving centres.

B USE OF WEB DATA INGEST

Background

This procedure is intended for use as a simple data collection mechanism by an NMC. It may also be used by an RTH or NMC to ingest meteorological bulletins in the event of failure of a primary access method. This method is expected to have better security, timeliness and reliability than e-mail ingest.

Preliminary requirements

The data provider that intends to send data to an RTH or NMC that offers the web-based ingest service shall first establish an account with that centre. An authentication mechanism (such as a USERID and PASSWORD combination) shall be established for security purposes. Validating the sending IP address is impractical in most cases due to the routine translating of addresses and the nature of the possible backup scenarios.

Input

The user shall input all mandatory fields in the abbreviated header and input the body of the message. For mandatory fields, drop-down-lists may be provided to reduce the possibility of errors. The body of the message shall conform to WMO standards.

Validation

The web bulletin input interface should provide a fill-in-the-blank area for a single GTS abbreviated heading line. It should confirm that:

(a) All mandatory fields have been filled with valid information;
(b) All optional fields either have valid information or are left blank;
(c) The CCCC field is valid for the authenticated user of the sending centre;
(d) There will be only one bulletin created per web page entry;
(e) The resulting abbreviated heading line follows all appropriate WMO standards, such as proper alphabet code and proper termination sequences.

Content verification

Before the completed message is ingested, the web bulletin input interface should display the entire message to the user and ask for confirmation that message is correct. The creator of the message should be given an opportunity to change the message before submission.

Security

For additional security, the use of HTTPS is recommended.

Example of implemented web bulletin input pages:

RTH Washington with URL: http://wis.wmo.int/WebBulletin.

PART III. TECHNICAL CHARACTERISTICS AND SPECIFICATIONS OF THE GLOBAL TELECOMMUNICATION SYSTEM

1. CIRCUIT CHARACTERISTICS OF THE MAIN TELECOMMUNICATION NETWORK

1.1 **The configuration of the Main Telecommunication Network shall be an integrated ensemble of circuits and centres/hubs forming a meshed network. It shall operate on a round-the-clock basis.**

1.2 **The World Meteorological Centres and the designated Regional Telecommunication Hubs shall be the centres/hubs of the Main Telecommunication Network.**

1.3 **The circuits of the Main Telecommunication Network shall be implemented by using efficient telecommunication services and facilities, including digital- or analogue-dedicated leased circuits, frame relay services and managed data-communication network services, based on relevant ITU-T Recommendations.**

1.4 **Analogue-dedicated leased circuits (i.e. telephone-type circuits) shall be operated with modems in conformity with relevant ITU-T Recommendations.** Modems in conformity with ITU-T Recommendation V.34 are recommended.

1.5 Additional low-speed channels, including a backward supervisory channel, may be established in both directions of a full duplex circuit by agreement between centres/hubs.

1.6 **Where a circuit of the Main Telecommunication Network is of necessity, an HF radio circuit, separate 3-kHz channels for data and facsimile transmissions shall be provided.**

1.7 **HF radio circuits shall be provided with at least two 3-kHz channels.** Where required and technically practicable, up to four 3-kHz channels may be used on HF radio circuits in accordance with ITU-R recommendations.

1.8 **The number of 3-kHz channels required in the radio circuit in order to transmit meteorological information in accordance with the required transit times and relevant times of transmission to meet agreed WMO requirements shall be as agreed bilaterally by the related centres.**

2. ENGINEERING OF WMCs AND RTHs ON THE MAIN TELECOMMUNICATION NETWORK

WMCs and RTHs on the Main Telecommunication Network shall be capable of operating as a node on the MTN and of providing the necessary gateway functions with the relevant regional meteorological telecommunication network.

3. REGIONAL NETWORKS

Regional networks developed by regional associations shall be compatible with the system characteristics (engineering, circuit, transmission) of the Main Telecommunication Network. Compatibility shall be essential, particularly to ensure an efficient flow of traffic over the GTS.

4. NATIONAL NETWORKS

National networks should be developed so as to ensure an efficient flow of traffic over the GTS within the specified time limits.

5. TECHNICAL CHARACTERISTICS OF EQUIPMENT FOR METEOROLOGICAL FACSIMILE (ANALOGUE) TRANSMISSIONS

5.1 Characteristics of the equipment

The technical characteristics given below shall be applied to meteorological facsimile (analogue) transmission facilities used in the international exchange of pictorial information.

5.1.1 *Scanning direction*

Viewing the document area in a vertical plane, the scanning line direction shall be from left to right, commencing in the left-hand corner at the top of the picture area and finishing in the lower right-hand corner. Each scan shall be adjacent to, and below, the previous scan.

5.1.2 *Index of cooperation (IOC)*

The index cooperation (M) shall be defined by the formula:

$$M = \frac{LF}{\pi}$$

where L is the length of the scanning line and F is the scanning density (or number of lines per unit length).

Note: The product LF is called factor of cooperation. It is essential to specify the index of cooperation in order to ensure compatibility between the transmitter and the recorder. These may have the scanning lines of different length but if the index is the same, the document will be received without distortion.

The standard index of cooperation shall be 576 or 288.

5.1.3 *Dimensions of the equipment*

The equipment should be able to accommodate at least documents of 420 x 594 mm, with reference base ISO Format A.2.

5.1.3.1 Equipment with flat-bed scanning

The total scanning line length (active sector plus dead sector) shall normally be 477.5 mm.

5.1.3.2 Equipment with drum scanning

The diameter of the drum shall be 152 mm. The usable length of the drum should be at least 660 mm.

5.1.3.3 Dead sector

The dead sector (that portion of the scanning line which cannot be used for picture signal transmission) shall be 4.5% ± 0.5% of the line scanning length.

The signal transmitted during the passage of the dead sector should, for the most part, correspond to white, but transmission of a black pulse within and not exceeding one half length of the dead sector is permissible.

5.1.4 *Scanning line density*

The scanning line density is found from the definition of index of cooperation and shall be nominally equal to:

3.8 lines/mm (index 576) and
1.9 lines/mm (index 288).

5.1.5 *Scanning frequency*

The scanning line frequency, or drum speed, shall be:

60 lines per minute (60 rpm);
90 line per minute (90 rpm);
120 lines per minute (120 rpm);
240 lines per minute (240 rpm).

The scanning line frequency, expressed in lines per minute or revolutions per minute, shall be maintained within ± 5.10^{-6} its nominal value.

Note: This tolerance allows a maximum oblique skew of approximately 1/55 when transmitter and receiver function with combined effect at opposite maximum deviation limits. A smaller tolerance is very desirable so as to reduce maximum oblique skew.

5.2 Remote control signals

5.2.1 *Starting device of receiving equipment*

Receiving equipment shall be designed to start upon receipt of either the IOC-selection signal (section 5.2.2 below) or the phasing signal (section 5.2.3 below). No other starting signal shall be transmitted.

5.2.2 *Selection of index of cooperation*

5.2.2.1 **The index of cooperation shall be selected by transmission of alternating black and white signals lasting 5–10 s, with frequency:**

300 Hz for IOC 576;
675 Hz for IOC 288 (or IOC 576 with alternate line scanning).

5.2.2.2 **The envelopes of the signals transmitted shall be approximately rectangular.**

5.2.3 ***Phasing and selection of line scanning frequency (or drum speed)***

5.2.3.1 **Phasing and selection of line scanning frequency shall be accomplished by a 30-second transmission of alternating white and black signals with the following frequencies:**

1.0 Hz for 60 lines per minute (60 rpm);
1.5 Hz for 90 lines per minute (90 rpm);
2.0 Hz for 120 lines per minute (120 rpm);
4.0 Hz for 240 lines per minute (240 rpm).

5.2.3.2 The wave-form should be either symmetrical, i.e. white and black, each lasting half the scanning line, or asymmetrical with the white lasting for 5% and black for 95% of the scanning line.

5.2.3.3 **Members publishing details of their facsimile transmissions shall include the description of the wave-form (symmetrical or asymmetrical) of the phasing signal transmitted.**

5.2.3.4 **Phasing shall be actuated by the leading edge of the white signal. This leading edge shall correspond in phase with the entry of the scanning beam into the dead sector of the net transmission.**

5.2.3.5 **The envelopes of the signals transmitted shall be approximately rectangular.**

5.2.4 ***Adjustment of recording levels***

Automatic adjustment of recording levels, when used, should be effected by reference to the phasing signal (section 5.2.3 above).

5.2.5 ***Stopping device of receiving equipment***

5.2.5.1 **The stop signal shall be a five-second transmission of alternating black and white signals at 450 Hz, followed by 10 seconds of signal corresponding to continuous black.**

5.2.5.2 **The envelopes of the 450 Hz signals shall be approximately rectangular.**

5.2.6 ***Frequency precision of remote control signals***

The tolerance for the remote control signals shall be ± 1% for frequencies.

5.3 Modulation characteristics

5.3.1 **The modulation characteristics for facsimile (analogue) transmissions shall be as follows:**

5.3.1.1 Amplitude modulation (AM)

The maximum amplitude of the carrier frequency shall correspond to the transmission of black.

Value of the carrier frequency:

About 1800 Hz for 60, 90 and 120 lines per minute (60, 90 and 120 rpm);
About 2600 Hz for 240 lines per minute (240 rpm).

For 240 lines per minute (240 rpm), transmissions shall be carried out with the vestigial side-band system, with the possible use of an asymmetric filter for transmission.

5.3.1.2 Frequency modulation (FM)

Mean frequency 1 900 Hz;
Frequency for black 1 500 Hz;
Frequency for white 2 300 Hz.

The frequencies for black and white shall vary by not more than 8 Hz over a period of 30 seconds and by not more than 16 Hz over a period of 15 minutes.

5.3.2 ***Power at the transmitter output***

For AM transmissions it shall be possible to adjust the power of the "black" signal at the output of the transmitter to between –7 dBm and 0 dBm.

For FM transmissions it shall be possible to adjust the output level of the transmitter to between –10 dBm and 0 dBm.

Whatever the transmission mode used (AM or FM), the contrast ratio for control signals and for black and white picture signals shall be the same and shall be between 12 and 25 dB.

5.3.3 ***Power at the receiver input***

For AM transmissions receiving equipment shall be designed to accept any level between 0 and –25 dBm, this being the level of the "black" signal.

For FM transmissions the input level shall be between 0 and –35 dBm.

5.4 Transmission of intermediate tones (analogue facsimile)

5.4.1 A linear distribution should be observed for the transmission of intermediate tones, on the basis of a number of tones equal to eight, including the "black" and "white" levels.

5.4.2 For amplitude modulation a dynamic range of 20 dB should be observed as follows:

0 dB; –1.2 dB; –2.6 dB; –4.2 dB; –6.3 dB; –9 dB; –13 dB; –20 dB.

5.4.3 For frequency modulation the following distribution should be observed:

1 500, 1 614, 1 729, 1 843, 1 957, 2 071, 2 186, 2 300 Hz.

5.5 Facsimile (analogue) transmission over radio circuits

5.5.1 **When frequency modulation of the sub-carrier is employed for the facsimile (analogue) transmission over radio circuits, the following specifications shall apply;**

Centre frequency 1 900 Hz;
Frequency corresponding to black 1 500 Hz;
Frequency corresponding to white 2 300 Hz.

5.5.2 **When direct frequency modulation (FSK) is employed for the facsimile (analogue) transmission of pictorial information over radio circuits, the following specifications shall apply:**

(a) HF (decametric) circuits (3 MHz–30 MHz)

Centre frequency (corresponding to the assigned frequency):	**f_o**
Frequency corresponding to black:	**f_o –400 Hz;**
Frequency corresponding to white:	**f_o +400 Hz.**

(b) LF (low-frequency) circuits (30 kHz–300 kHz)

Centre frequency (corresponding to the assigned frequency):	**f_o**
Frequency corresponding to black:	**f_o –150 Hz;**
Frequency corresponding to white:	**f_o +150 Hz.**

6. TECHNICAL CHARACTERISTICS OF EQUIPMENT FOR CODED DIGITAL FACSIMILE TRANSMISSIONS

6.1 **The technical characteristics given below shall be applied to meteorological coded transmission facilities used for international exchange of pictorial information.**

6.1.1 *Scanning track*

The message area shall be scanned in the same direction in the transmitter and receiver. Viewing the message area in a vertical plane, the picture elements should be processed as if the scanning direction were from left to right with subsequent scans adjacent to and below the previous scan.

6.1.2 *Preferred standard*

6.1.2.1 **The following provisions, based on ITU-T Recommendation T.4–Standardization of Group 3 facsimile apparatus for document transmission, applying to an ISO A4 document shall be used:**

(a) 1 728 picture elements along the scan line length of 215 mm ± 1%;
(b) A normal resolution and a higher resolution of 3.85 lines/mm ± 1% and 7.7 lines/mm ± 1%, respectively in a vertical direction;
(c) A coding scheme as defined in ITU-T Recommendation T.4, paragraph 4.1.

6.1.2.2 In addition to the basic A4 format specified in paragraph 6.1.2.1, the following characteristics may be used:

(a)	Useful line length:	456 mm;
(b)	Number of picture elements per line:	1 728, 3 456;
(c)	Horizontal resolution:	3.79, 7.58 lines/mm;
(d)	Vertical resolution:	(1) 3.79 lines/mm (IOC 576);
		(2) 1.89 lines/mm (IOC 288).

6.1.3 *Other standards*

The ITU-T Group 4 (G4) standards (Recommendation T.6) may be used as required.

6.1.4 ***Transmission rate***

The transmission rate over a point-to-point circuit shall be: 2 400, 4 800, 7 200, 9 600 bit/s.

7. TECHNICAL CHARACTERISTICS FOR THE EXCHANGE OF NON-CODED DIGITAL FACSIMILE

7.1 For the transmission of non-coded digital facsimile the terminal transmitting and receiving equipment should comply with WMO standards for analogue facsimile, using analogue-to-digital converters.

7.2 The remote control signals should conform to the WMO standard (section 5.2 above) and be transmitted through direct conversion into digital form.

7.3 At the ITU-T V.24 interface between analogue-to-digital converters and modems, black picture elements should be coded as bit set to 0 and white picture elements as bit set to 1, according to the following table:

Significant voltage levels in conformity with ITU-T V.28	$V_1 < -3$ volts	$V_1 > +3$ volts
Binary state	1	0
Condition	OFF/mark	ON/space
Picture element	White	Black

7.4 The scanning frequency, index of cooperation and data signalling rate on a discrete channel should be as follows:

Scanning frequency signalling (lines/min)	*Number of picture elements in a full line*	*IOC*	*Date rate (bit/s)*
60	2 400	288	2 400
120	1 200	288	2 400
240	1 200	288	4 800
60	2 400	576	2 400
120	2 400	576	4 800
240	1 800	576	7 200

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