International Telecommunication Union

Handbook on EMERGENCY Telecommunications

Edition 2005

International Telecommunication Union

HANBOOK ON EMERGENCY TELECOMMUNICATIONS

This Handbook on Emergency Telecommunications is written to serve as a close companion to those involved in the noble work of providing as well as using telecommunications for disaster mitigation and relief. It simplifies and demystifies the complex technical issues that characterize the fast evolving field of telecommunications especially in this era of convergence and emergence of next generation networks. While this handbook is meant to be simple, it is comprehensive, compact and contains useful factual information that is concise and organized for easy access especially by practitioners.

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Preface

It is with utmost pleasure that I present this edition of the Handbook on Emergency Telecommunications. This edition has its roots in the Handbook on Disaster Communications prepared under the auspices of ITU-D Study Group 2, for Developing Countries that was published in 2001. Owing to the fast evolving nature of both the technologies and the regulatory framework related to disaster mitigation and relief coupled with the high frequency with which disasters are occurring, we found it necessary to release this particular edition to address most of the topical issues related to this subject.

Whilst an attempt has been made to deal with all important aspects, this Handbook is by no means encyclopaedic. The arm has been to produce a user-friendly product that demystifies complex technical issues, is comprehensive, compact and contains useful factual information that is concise and organized for easy access by those seeking quick reference.

It is my fervent hope that this edition will add value to all those actively involved in humanitarian assistance and those interested in this subject because Telecommunications remain the bloodstream to disaster relief and mitigation.

The views expressed in this document are those of the authors and do not necessarily reflect the opinions of ITU or its Members.

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This publication was prepared by a team led by Cosmas Zavazava and comprising Hans Zimmermann, Mark Wood, Savitri Bisnath, and Legrand Walter. Jay Rushby, Peter Cassier, Hal Folts, Michel Milot, Robert Casca, Bob Barad, John Kluver, Norbert Huebner, Zahid Zaheer, and Nabil Kisrawi also contributed. There are many others to thank who made direct and indirect contributions.

Cosmas Zavazava was the principal editor.

Our thanks go to Rhode & Schwarz for their financial contribution towards the work related to this Handbook.

Table of Contents

APPENDICES

Figures

Page

Tables

PART I

CHAPTER 1

Telecommunications for Disaster Mitigation and Relief

1 Introduction

Highlighting the role of Telecommunications for humanitarian assistance, United Nations Secretary General, Kofi Annan said:

> *Humanitarian work is one of the most important, but also one of the most difficult tasks of the United Nations. Human suffering cannot be measured in figures, and its dimensions often surpass our imagination, even at a time when news about natural and other disasters reaches every corner of the globe in next to real time. An appropriate response depends upon the timely availability of accurate data from the often remote and inaccessible sites of crises. From the mobilization of assistance to the logistics chain, which will carry assistance to the intended beneficiaries, reliable telecommunication links are indispensable (ICET-98).*

Telecommunications is critical at all phases of disaster management. Drawing from various sources that include Telecommunications satellites, radar and telemetry, and meteorology, remote sensing for early warning is made possible. Before disasters strike, Telecommunications can be used as a conduit for disseminating information on the impending danger thus making it possible for people to take the necessary precautions to mitigate the impact of these disasters. Most recently this was demonstrated when Jamaica raised an alarm and broadcasted messages alerting citizens of Hurricane Ivan even days before the just below 155 mph mark giant waves and winds were due to hit the Island. This warning enabled Jamaica to prepare itself for this category 5 storm, the most powerful on the Saffir-Simpson scale. Even the international community was kept well informed by the world media prompting sympathetic governments to pledge assistance in the event of destruction even before the disaster struck. Other governments in the region such as Barbados, St. Lucia and St. Vincent, also used Telecommunications and broadcasting to coordinate pre-hurricane Ivan disaster activities.

When disaster eventually strikes, coordination of relief work by national entities, as well as the international community is made possible. Recently, this was evident in Grenada where Hurricane Ivan damaged 90 per cent of homes and left over 100’000 residents without electricity, water and telephone service. Finally, Telecommunications also play a critical role in facilitating the reconstruction process and coordinating the effort of getting returnees displaced by disasters back to their original homes.

It is clear therefore that Telecommunications play a pivotal role in disaster prevention, mitigation, and management. Other telecommunication applications ranging from remote sensing and global positioning system (GPS) to the Internet and Global Mobile Personal Communications via Satellite (GMPCS), have a critical role to play in tracking approaching hazards, alerting authorities, warning affected populations, coordinating relief operations, assessing damages and mobilizing support for reconstruction.

1.1 The need for a Handbook on Emergency Telecommunications

Well-crafted handbooks provide invaluable reference materials to students, the newly qualified practitioner, the seasoned operative, the policy-maker, and any other person or organization with an interest in the field covered by that particular handbook. This handbook is no exception as it is written to serve as a close companion to those involved in the noble work of providing as well as using Telecommunications for disaster mitigation and relief. It simplifies and demystifies the complex technical issues that characterize the fast evolving field of Telecommunications especially in this era of convergence and emergence of next generation networks. For this reason, while this handbook is meant to be simple, it is comprehensive, compact and contains useful factual information that is concise and organized for easy access especially by practitioners.

Part I of the Handbook consists of three chapters including this first introduction chapter. Chapter 2 looks at the organizational framework of emergency telecommunications. It discusses disaster prevention, response, and the available means of telecommunications.

Part II has seven chapters focusing on the operational aspects of emergency telecommunications. Chapter one discusses Telecommunications as tools for the providers of emergency response while Chaptertwo looks at public telecommunication networks and their role in disaster relief. Chapters 3, 4, 5, 6, and 7 look at the use of the Internet, private telecommunication services and networks, the amateur radio service, broadcasting, and emerging technologies respectively.

Part III discusses the technical elements of emergency telecommunications. This segment is critical especially for field practitioners who are often confronted by technical challenges while installing and using Telecommunications equipment in the field.

1.2 Who should read this Handbook

The Emergency Telecommunications Handbook is written to be read, studied and understood by every person who has responsibilities connected with the planning, usage, evaluation, or survey of emergency Telecommunications systems or their vulnerabilities. It can be read as a stand-alone text or be used in conjunction with formal training opportunities in the field. It is a project of the Telecommunication Development Sector of the International Telecommunication Union (ITU-D) and builds on the work already done by the Study Group 2 of ITU-D while drafting the first edition. This particular edition has a new look in terms of content, and contains up to-date information that takes into account the evolving regulatory environment as well as the rapid changes in the Telecommunications sector.

This edition is written by a group of experts drawn from key partner organizations involved in humanitarian assistance, to include those from administrations, international organizations, the technical community, and the service providers. It is an aide to the wider diffusion of knowledge on the subject of emergency Telecommunications and is an attempt to contribute to the already existing knowledge on emergency telecommunications.

CHAPTER 2

Organizational framework of Emergency Telecommunications

2 Introduction

The description of the organizational framework of emergency Telecommunications requires the definition of the two words, emergency and telecommunication. The first edition of this handbook appeared in 2001 as the handbook on disaster communication. Recent developments required the change to its present title.

By definition, an *emergency* is simply a situation requiring urgent response. Depending on the circumstances, initial response will be provided by whoever is present, using whatever means are available on site. Any other additional intervention deemed necessary can best be mobilized mainly through *telecommunications*.

An emergency situation might develop into a *disaster*, either due to its very nature, or as a consequence of insufficient response to the initial event. The magnitude of the event will require resource mobilization on a regional or even international scale; *communication* related to a disaster will however include activities well beyond an alert requesting emergency response, made through the normally available means of telecommunications.

Corresponding to the use of the four terms in recently developed documents and in the work of ITU Study Groups considering the subject matter, the present second edition of the handbook covers the use of Telecommunications as the logistics of information exchange in emergency and disaster situations. It does not cover communications in the sense of content, and its scope is not limited to Telecommunications in the strict sense of the word.

2.1 Prevention and Preparedness

Prevention, the avoidance of hazards, is a primarily local task. Telecommunications have a key role in the distribution of respective knowledge and the creation of awareness. They are the vital tools for early warning. *Preparedness* to respond to emergencies is a task of institutional responders, commonly known as emergency services. Due to the character of such services, their telecommunication equipment and networks can be expected to be in a permanent state of readiness. Response to disasters, including relief operations following such events, is likely to involve institutional responders, typically national and international humanitarian organizations. Different from usually local emergency services, these responders need to be prepared to operate in unpredictable locations and under widely different conditions. Telecommunications under these circumstances are a great challenge.

2.2 Response

Appropriate response depends first of all on rapid and accurate information exchange. An increasing complexity of administrative structures and the distribution of responsibilities in the response among authorities goes parallel to an increasing number of available communication links. Public networks, such as the fixed line and mobile telephone system are the mainstay of first level alert.

With the involvement of partners from outside the immediate vicinity of an event, the responsibilities and thus the communication requirements shift to larger dimensions. Decision-making in such unpredictable operation conditions becomes a process involving a multitude of institutions. In these circumstances, private networks, such as dedicated radio networks including satellite links are needed to bridge information gaps and facilitate information exchange.

2.3 Typical Scenarios

Among the oldest tools for an electronic "cry for help" were fire alarms. Pressing a button on a street corner would ring a bell at the fire brigade, providing information only about one fact: the emergence of an emergency in the vicinity of that alarm button.

This basic system developed into publicly accessible communication facilities allowing the exchange of information in two directions with increasing bandwidth and increasing information content. Over the years the tools available to the emergency services have improved both in terms of the services and applications they offer and in terms o diversity. It is for this last point that inter-operability becomes a key issue, and will be a main consideration in Part 2 of this handbook.

Today, international disaster response and relief operations following catastrophic events are no longer limited to natural disasters such as earthquakes, but extend to wars and post terrorist attack scenarios. Planning for reliable Telecommunications is critical irrespective of the nature of a disaster because existing publicly accessible Telecommunications networks might be disrupted by the event itself, or even get overloaded due to increased demand for service. Provision of timely and additional private networks might be hindered by regulatory restrictions if appropriate arrangements are not put in place well in advance to pave way for effective participation by the players involved in international response.

2.4 The Partners in Disaster Response

Initial response to any disaster is the responsibility of the local community. National, Regional, and International assistance are only mobilized when it is realized that the required assistance goes beyond the resources and capacities of the local response mechanisms. Involvement of entities outside a sovereign state's borders is conducted on a "request-offer-acceptance" basis. In all cases, coordination with national authorities is paramount.

Operating under volatile and difficult conditions, many organizations providing humanitarian assistance rely on dependable telecommunication networks and systems to coordinate their operations.

2.5 National Disaster Management Structures

The attribution of disaster-related functions differs from country to country. In most cases, it follows the country's administrative structures, with a disaster coordinator for each district, state, county or similar geographical division. The "horizontal" cooperation among specialized services at each level is as essential as the vertical "lines of command". For disaster Telecommunications this requires established links between disaster coordinators and Telecommunications authorities and service providers at each level.

This need for coordination throughout the national structures also applies to international humanitarian assistance. In the latter case, the national government is the primary counterpart of the foreign providers of assistance, but their operational activities must be fully integrated with those at various national levels. A "Disaster Management Team", normally convened by the United Nations Resident Representative and consisting of all international organizations present in the affected country is established in the capital. Its counterpart is the entity or official designated as national disaster manager. At the local level, an on-site operational coordination centre (OSOCC), usually established by a United Nations Disaster Assessment and Coordination (UNDAC) team, ensures the integration of international assistance with the national and local partners at the site of the event. Reliable communications are paramount to the effective functioning of each of these mechanisms and for their coordinated interaction.

2.6 International Disaster Management Structures

It is to some extent due to the availability of global real-time telecommunications, that response to emergencies and in particular to major disasters includes more and more international partners. Some of these are institutional bodies while others may be constituted ad-hoc in response to acute needs. All of them will however respond to what information is made available to them, and their response will be determined by the timeliness and reliability of this information.

2.6.1 United Nations Entities

The United Nations system includes specialized agencies for the various aspects of humanitarian work, including disaster response. Their cooperation is ensured through the United Nations Office for the Coordination of Humanitarian Affairs (OCHA), headed by the United Nations Emergency Relief Coordinator with offices in Geneva and New York, and with field offices in a number of countries. Using a permanent, 24 hours per day/365 days per year duty system, OCHA uses all available means of Telecommunications to monitor events, and to immediately alert the international community to mobilize appropriate resources in cases where international assistance is likely to be required.

In addition to maintaining its own telecommunication networks, OCHA carries out the functions of the Operational Coordinator as mandated by the Tampere Convention [see Chapter4]. The office regularly convenes the Working Group on Emergency Telecommunications (WGET), an open forum including all United Nations entities and numerous international and national, governmental and non-governmental organizations involved in disaster response as well as experts from the private sector and academia. In between the two annual plenary meetings, the WGET partners meet in *ad hoc* working groups on specific issues and maintain a continuous exchange of information through electronic means.

In the event of an emergency, OCHA dispatches United Nations Disaster Assessment and Coordination (UNDAC) teams to a country affected by a disaster. Such teams typically arrive at the site of the event within hours and support the national authorities in the coordination of international assistance.

In the affected countries, the various entities of the United Nations system work together in the Disaster Management Team (DMT). Such a team is convened by the Resident Coordinator, in most cases the Representative of the United Nations Development Programme (UNDP), which has offices in almost all member states of the United Nations. Depending on the nature of the emergency, the various agencies and institutions provide assistance in their specific field.

In addition to OCHA, the United Nations entities most commonly involved in disaster response include the World Food Programme (WFP) providing emergency food as well as logistics services for other relief goods, the Office of the United Nations High Commissioner for Refugees (UNHCR), providing shelter and related assistance for the affected population; the World Health Organization (WHO) and the United Nations Children’s Fund (UNICEF), providing health services in particular for the most vulnerable groups. Depending on the nature of assistance required, other agencies participate in their specific fields.

Throughout the monitoring, alert, mobilization and response process, Telecommunications are of vital importance. All United Nations entities maintain common and own networks, and have the capacity to extent such networks in cases where other means of communication are affected by a disaster. The interaction of all networks is ensured through the mechanism of the WGET, and in the affected country a Telecommunications Coordination Officer (TCO) is responsible for the optimum use of all available networks.

2.6.2 The International Telecommunication Union (ITU)

The International Telecommunication Union was established last century as an impartial, international organization within which governments and the private sector could work together to coordinate the operation of telecommunication networks and services and advance the development of communications technology. Whilst the organization remains relatively unknown to the general public, ITU's work over more than one hundred years has helped create a global communications network, which now integrates a huge range of technologies, yet remains one of the most reliable man-made systems ever developed. The work makes tremendous contribution to disaster prevention, preparedness, and response.

As the use of telecommunication technology and radiocommunication-based systems spreads to encompass an ever-wider range of activities, the vital work carried out by ITU is taking on growing importance in the day-to-day lives of people all around the world.

The Union's standardization activities, which have already helped foster the growth of new technologies such as mobile telephony and the Internet, are now being put to use in defining the building blocks of the emerging global information infrastructure, and designing advanced multimedia systems which deftly handle a mix of voice, data, audio and video signals.

Meanwhile, ITU's continuing role in managing the radio-frequency spectrum ensures that radio-based systems like cellular phones and pagers, aircraft and maritime navigation systems, scientific research stations, satellite communication systems and radio and television broadcasting all continue to function smoothly and provide reliable wireless services to the world's inhabitants.

ITU's increasingly important role as a catalyst for forging development partnerships between government and private industry is helping bring about rapid improvements in telecommunication infrastructure in the world's under-developed economies.

Whether in telecommunication development, standards-setting or spectrum sharing, ITU's consensus-building approach helps governments and the telecommunication industry confront and deal with a broad range of issues which would be difficult to resolve bilaterally. This is critical especially in the area of disaster mitigation and relief.

Article 1, Section 2 of the ITU Constitution provides that ITU shall "promote the adoption of measures for ensuring the safety of life through the cooperation of telecommunication services".

This mandate has been further enhanced through resolutions and recommendations adopted by past and recent World Telecommunication Development Conferences and World Radiocommunication Conferences, and ITU's Plenipotentiary Conferences, as well as its active role in activities related to the Tampere Convention. The ITU works in close cooperation with the United Nations Emergency Coordinator and head of the Office of the Coordinator of Humanitarian Affairs (OCHA), and is a member of the Working Group on Emergency Telecommunications (WGET). The role of the Union under the Tampere Convention and related instruments is more specifically dealt with in Chapter 3.

2.6.3 The International Committee of the Red Cross (ICRC)

The ICRC has a specific status in international law, which distinguishes this body from non-governmental organizations (NGOs). While in many cases the ICRC is a provider of operational humanitarian assistance, its primary function is the implementation of the Geneva Conventions, which govern humanitarian law in cases of conflict. The ICRC delegations in many countries worldwide are linked by their own Telecommunications network, which is reinforced as dictated by the magnitude of disasters.

2.6.4 International Non-Governmental Organizations

International non-governmental organizations play a key role in the provision of operational assistance. A well-known example of an international NGO is the International Federation of Red Cross and Red Crescent Societies (IFRC) with its national member societies worldwide. The IFRC and other NGOs maintain their own telecommunication networks and support their national counterparts when normal channels of Telecommunications are disrupted by a disaster. A new and important group among the NGOs, are commercial companies, such as Ericsson, who make available the expertise resources at their headquarters and their offices in many countries in support of disaster relief operations.

2.6.5 National Governmental Institutions providing International Assistance

Similar to international organizations, national institutions in many countries provide disaster relief abroad. Examples are the Swedish Rescue Services Agency (SRSA), the Swiss Disaster Relief Unit (SDR), and the German "Technisches Hilfswerk". They often provide services in specific fields, providing their assistance under bi-lateral arrangements with the receiving country or act as implementing partners in United Nations relief operations. National organizations for international assistance usually provide Telecommunications for their own needs, and often support other institutions, such as the United Nations, NGOs and national rescue services, with telecommunication support. National non-governmental organizations may in some cases assume similar roles to those of national governmental organizations.

2.7 Organizing Emergency Telecommunications

Real time information exchange is the backbone of all cooperation in emergency response, in preparedness and prevention, and in the assistance of those affected by disasters. The rapid technological developments and the numerous tools available, equipment and networks, have opened new possibilities. They can, however, not fulfil their task in the service of humanitarian work, if they are not fully integrated throughout the development and the implementation of operational concepts. Telecommunications are tools of an organizational structure, but they also need their own organisational support.

The availability and applicability of the most appropriate means of telecommunication in emergency situations is a result of close cooperation between those involved in humanitarian work, the manufacturers of equipment, and the service providers who run the various networks. This relationship will make objective assessments of what these technologies can and cannot do in various situations.

CHAPTER 3

The regulatory framework

3 Introduction

Maritime distress and safety communications have traditionally enjoyed privileges such as absolute priority and exemption from fees. The same rules apply for communications with and among aircraft. These privileges do not however apply to emergency Telecommunications on land. Recognition for their applicability in emergency and disaster situations has been recognised only recently, but much still remains to be done.

Telecommunications have a dual character. While their control and regulation is considered as an element of sovereignty of each State, by their nature, they do not respect national borders. For this reason, international regulation is indispensable, and national regulation is left to deal with issues related to national interest. In the area of emergency telecommunications, this means that an international framework has to be established and that international legal instruments have to be created to provide guidance. At the same time, national legislation to saveguard national interests has to conform to enacted the applicable international law.

3.1 The Creation of an International Regulatory Framework for Emergency Telecommunications

Effective and appropriate humanitarian assistance cannot be provided in the absence of functioning telecommunications. This is all the more important when there are many players on the ground be it before, during or after a disaster. Owing to this importance, various concerned parties involved in both disaster relief and mitigation as well as telecommunication development have over the years recognized the need for an international framework on the provision of telecommunication resources for disaster mitigation and relief operations. In 1991, an international Conference on Disaster Communications was convened in Tampere, Finland, and was attended by disaster and Telecommunications experts. The Conference adopted the Tampere Declaration on Disaster Communications, a declaration of experts without the status of a legal document, stressing the need to create an international legal instrument on telecommunication provision for disaster mitigation and relief. The Conference recognized that regular communication links were often disrupted during disasters, and that regulatory barriers often crippled the use of emergency Telecommunications equipment across national boundaries. The Declaration requested the United Nations Emergency Relief Coordinator to cooperate with the International Telecommunication Union (ITU) and other relevant organizations in solving this and other regulatory hurdles in support of the goals and objectives of the International Decade for Natural Disaster Reduction (IDNDR). It invited them to convene an intergovernmental conference for the adoption of a convention on disaster communications.

The Tampere Declaration was annexed to the unanimously adopted Resolution No. 7 (Disaster Communications) of the first World Telecommunication Development Conference (WTDC-94, Buenos Aires, 1994). This Resolution urged all administrations to remove national regulatory barriers in order to allow the unhindered use of Telecommunications in disaster mitigation and relief. It also requested the Secretary-General of the ITU to work closely with the United Nations and within the framework of IDNDR towards an international convention on disaster communications.

A few months later, the ITU Plenipotentiary Conference (PP-94, Kyoto, 1994) endorsed the WTDC resolution by its Resolution No. 36 (Disaster Communications). This resolution reiterates the need for an International Convention on Disaster Communications, and reinforces WTDC-94 Resolution No. 7 in urging administrations to reduce and/or remove regulatory barriers to facilitate rapid deployment and effective use of telecommunication resources for disaster relief operations.

These resolutions were further reinforced by Resolution No. 34 and Recommendation No. 12 of the Istambul World Telecommunication Development Conference of 2002 (WTDC-02) and Resolution No. 36 of the Marrakesh Plenipotentiary Conference of 2002 (PP-02).

Pursuant to these resolutions, and the mandate derived from the Inter Agency Standing Committee (IASC, the UN advisory body on humanitarian affairs), the Working Group on Emergency Telecommunications (WGET) was established. Since 1994 the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) and its predecessors, UNDRO and DHA, convene its meetings, which serve as an open forum for the discussion of all emergency telecommunication related issues. The WGET includes all partners in humanitarian assistance and emergency telecommunications. This includes United Nations entities as well as major international and national, governmental and non-governmental organizations, and is open to experts from the academia and the private sector. Among its basic tasks of coordination and standardization of information exchange in humanitarian assistance, the WGET developed and reviewed drafts of an International Convention on Emergency Telecommunications.

The ITU Secretary-General circulated a first official draft of the "Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations" to all ITU Member States in 1996. The World Radiocommunication Conference (WRC-97, Geneva, 1997) unanimously adopted Resolution No. 644, urging all administrations to give their full support to the adoption of the proposed convention and its national implementation.

In the same way, the second World Telecommunication Development Conference (WTDC-98, Valletta) adopted Resolution No. 19 that goes beyond the endorsement of all the aforementioned resolutions. It invites the UN Emergency Relief Coordinator and the WGET to collaborate closely with ITU in supporting administrations as well as international and regional telecommunication organizations in the implementation of the Convention. The ITU Telecommunication Development Sector was invited to ensure that proper consideration given to emergency Telecommunications as an element of telecommunication development, including the encouragement for the use of decentralized means of telecommunications. This handbook is an example of the response by the ITU.

3.2 International Regulatory Instruments on Emergency Telecommunications

International efforts in emergency Telecommunications came into fruition when from 16 to 18 June 1998, at the invitation of the Government of Finland, 76 countries and various intergovernmental and non-governmental organizations participated in the Intergovernmental Conference on Emergency Telecommunications (ICET-98) at Tampere, Finland. On 18 June 1998, thirty-three of the participating States signed the treaty, now called the Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations.

In 1998, the ITU Plenipotentiary held in Minneapolis unanimously urged national administrations to sign and ratify the Tampere Convention as soon as practicable. Its resolution 36 also calls for a speedy application of the Convention. Furthermore, the 54th session of the United Nations General Assembly, 1999, in its Resolution 54/233 also called for the ratification and implementation of the Tampere Convention.

3.3 The Tampere Convention

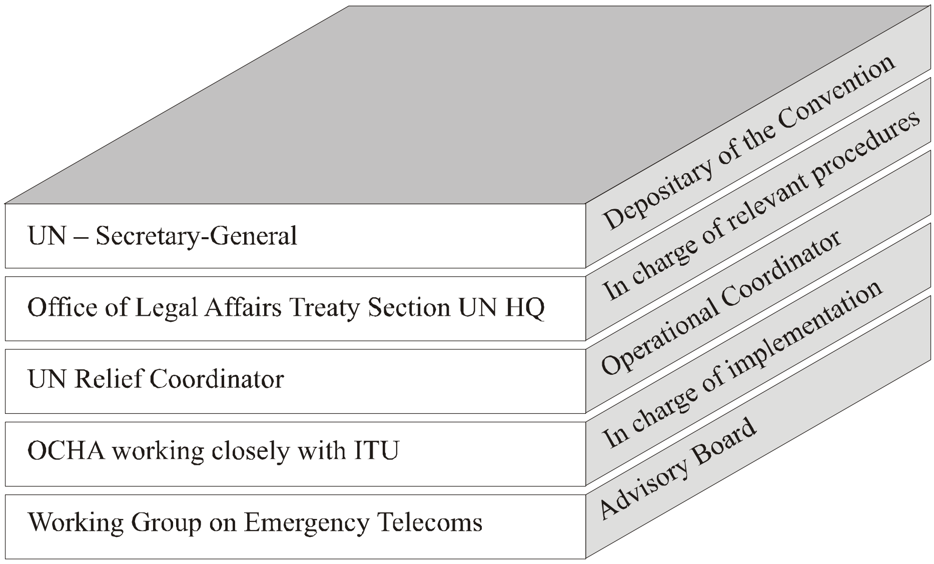
The structure of the Convention follows the format, which is characteristic of international treaties, and its text contains, in addition to the substantive paragraphs, the stipulations required in a treaty deposited with the United Nations Secretary-General:

- The Preamble of the Convention notes the essential role of Telecommunications in humanitarian assistance and the need for its facilitation, and recalls related major legal instruments, such as various Resolutions of the United Nations and those of the International Telecommunications Union, which led to the birth of the Tampere Convention.
- Article 1 defines the terms used in the Convention. Of particular significance are the definitions of non-governmental organizations and non-State entities, as the Tampere Convention is the first treaty of its kind, which attributes privileges and immunities to their personnel.
- Article 2 describes the operational coordination, to be carried out by the United Nations Emergency Relief Coordinator.
- Article 3 defines the overall framework for the cooperation among States Parties and all partners in international humanitarian assistance, including non-State entities.
- Article 4 describes the procedures for request and provision of Telecommunications assistance, specifically recognizing the right of a State Party to direct, control and coordinate assistance provided under this Convention within its territory.
- Article 5 defines the privileges, immunities and facilities to be provided by the Requesting State Party, again emphasizing that nothing in this Article shall prejudice rights and obligations pursuant to international agreements or international law.
- Articles 6, 7 and 8 define specific elements and aspects of the provision of Telecommunications assistance, such as Termination of Assistance, Payment or Reimbursement of Costs or Fees, and establishment of a Telecommunications Assistance Inventory.
- Article 9 can be considered as the core element of the Tampere Convention, as the Removal of Regulatory Barriers has been the primary aim of the work towards this treaty since 1990.
- The remaining Articles, 10 to 17, contain the standard provisions concerning the relationship between the Convention's and other international agreements, as well as dispute settlement, entry into force, amendments, reservations, and denunciation. They state that the Secretary-General of the United Nations is the depositary of the Convention and that the Arabic, Chinese, English, French, Russian and Spanish texts of the Convention are equally authentic. These texts are available for free download at: http://www.reliefweb.int/telecoms/tampere/index.html.

3.3.1 Guidelines for the Signature, Ratification, Acceptance, Approval or Accession

The "Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations" is an international treaty among States. It is binding for those States who have stated their accession to it, but all or part of its contents can at any time also be applied by reference in bi- or multi-lateral agreements governing international humanitarian assistance. The United Nations Secretary-General is the Depositary of the Convention (Art. 16). The Office of Legal Affairs, Treaty Section, United Nations Headquarters, New York, is in charge of the relevant procedures. The United Nations Emergency Relief Coordinator is the Operational Coordinator for the application of the Convention (Art.2). The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) is in charge of the implementation and execution of the respective functions and works closely with the International Telecommunication Union (ITU). The Working Group on Emergency Telecommunications (WGET) serves as an advisory board for this work. See Figure 1.

Figure 1 – Administrative Parties involved in Tampere Convention



A State may express its consent to be bound by the convention by:

- definitive signature;
- deposit of an instrument of ratification;
- during the intergovernmental conference (ICET-98) and for a limited period thereafter it was also possible signature subject to ratification, acceptance or approval followed by deposit of an instrument of ratification, acceptance or approval, such a provisional expression of consent is no longer possible.

The consent of a State to be bound may be expressed at any time; in view of the urgent need for the full application of the Convention it is, however, desirable, that the procedures for this purpose be completed with the depositary as soon as possible. Procedures relating to signature should follow the instructions in the attached note by the Legal Counsel of the United Nations. On all related matter it is advised that the assistance of the Treaty Section of the United Nations be sought. The Convention will enter into force thirty days after the deposit of such instruments by thirty States.

3.3.2 The main Implications for States Party to the Convention

Depending on applicable national legislation, the accession to an international treaty may require consultations with and/or approval by various legislative and executive bodies. The same applies to an adjustment of national laws, rules and regulations, which might be necessary to comply with the substantive articles of the treaty. In the course of these procedures the following aspects might deserve special consideration:

- The Convention has the purpose to expedite and facilitate the use of emergency Telecommunications within the framework of international humanitarian assistance. Such telecommunication assistance can be provided as a direct assistance, provided to national institutions and/or a location or region affected by a disaster, and/or as part or in support of other disaster mitigation and relief activities.
- The Convention defines the status of the personnel of the various partners in international humanitarian assistance, including that of government entities, international organizations, non-governmental organizations and other non-state entities, and defines their privileges and immunities.

- The Convention fully protects the interests of the States requesting and receiving assistance. The host government retains the right to supervise the assistance.
- The Convention foresees the establishment of bilateral agreements between the provider(s) of assistance and the State requesting/receiving such assistance. Standard frameworks for such agreements will be developed by the WGET. To avoid delay in the delivery of assistance, "best practices" will be codified into common implementing language. The use of such model agreements, which will be made available in hard copy and electronic format, will allow the immediate application of the Tampere Convention in any sudden impact disaster.

3.4 Other international Regulatory Instruments

The important role of emergency Telecommunications has been recognized in a number of other Documents resulting from international Conferences and from the work of specialized meetings such as those of ITU Study Groups. In addition to the documents mentioned above in section 3.1 on the quest to create an international regulatory framework for emergency telecommunications, the following are some of the most recent documents seeking to reinforce these efforts:

- *Recommendation 12 of the World Telecommunication Development Conference WTDC-02 (Istanbul, 2002),* on "Consideration of disaster Telecommunications needs in telecommunication development activities", that calls upon all Member States to give proper consideration to the specific requirements of emergency Telecommunications in all telecommunication development activities.
- *Resolution 34 of the World Telecommunication Development Conference WTDC-02 (Istanbul, 2002),* on "Telecommunication resources in the service of humanitarian assistance", that urges all administrations to work towards the entry into force of the Tampere Convention by the timely ratification of the Convention by the appropriate national authorities.
- *Resolution 36 of the ITU Plenipotentiary Conference (Marrakesh, 2002) on* "Telecommunication in the service of humanitarian assistance" that urges Member States to take all practical steps for the application of the Tampere Convention and calls upon the United Nations and the ITU to support such efforts.
- *Revision of Article 25 of the Radio Regulations (RR) by the World Radiocommunication Conference WRC-03 (Geneva 2003),* calling for the support and facilitation of Amateur Radio Service in Disaster Communications, and encouraging administrations to take the necessary steps to allow the necessary preparations by this service.

3.5 Emergency Telecommunications in the National Regulatory Framework

The implementation of international legal instruments may require changes to national laws and ordinances. In the case of the Tampere Convention, whilst the application of this convention concerns primarily telecommunication authorities, it also impacts a number of other government services such as those responsible for import, export and border control.

Advice and support on the creation of enabling telecommunication regulation and legislation in various countries for the successful implementation of the Tampere Convention can be obtained from the development arm of the ITU (ITU-D). This is in accordance with Article 12.2 of the Tampere Convention.

3.5.1 The Development of a National Disaster Communications Concept

As part of the implementation of the Tampere Convention, pilot projects will have to be carried out in several developing countries aimed at assessing the strengths, weaknesses, opportunities and threats of the existing disaster communications networks. These projects should attempt to study and evaluate background information on prevalent disasters in a country, the problems and constraints of disaster communications, the existing disaster-response operational structure and the equipment and personnel involved. Based on such information, recommendations – institutional, regulatory, technical and financial – will be presented for consideration by the appropriate national authorities as basis for improving or building a national disaster communications concept.

3.5.2 An overall Concept

The specific situation in each country will have to determine the structure of the study. The WGET secretariat can assist in the identification of experts with experience in the assessment of national disaster communications structures and the development of concepts.

3.5.3 Methods and Scope of a Study

Studies of this nature require the full involvement of disaster managers and Telecommunications entities if the studies are to achieve the set objectives. In these studies focus should be on all available communications networks i.e. public networks as well as private networks such as those run by public safety institutions, links to maritime and aeronautical networks, other specialized networks, and links to the Amateur Radio Service.

3.5.4 Confidentiality Considerations

Experience shows that gathering information on network vulnerability may not be possible without the approval of senior management and governmental officials since the vulnerability of National Telecommunications systems might be of great interest to would-be-saboteurs. For this reason, accurate information about the exact layout of networks may be hard to obtain as it might be considered classified as a strategic installation. In that case telecommunication staff may be reluctant to give information, when questions are asked for the purpose of disaster preparation and network operators may not give information unless they receive clearance from designated government officials.

Authority for a study of the vulnerability of systems will usually have to come from the highest levels of the authorities and entities concerned. A "Non Disclosure Agreement", "Non Disclosure Forum" or "Memorandum of Understanding" may be required before such clearance is given.

3.5.5 Need for Coordinated Approach

Emergency preparedness is most effective when the responsibilities, resources and objectives of government and industry are merged through joint planning. Such planning fosters a sense of common purpose amongst separate jurisdictional authorities and results in a spirit of cooperation that arises during the planning process as well as in actual emergency situations. Furthermore, such cooperative and coordinated approaches provide a forum in which problems can be openly discussed, mutually acceptable solutions sought, and agreements reached. A typical of this is the successful creation of the Canadian National Emergency Telecommunication Committee (NETC) and of 10 Regional Emergency Planning Committees (RETC).

3.5.6 Telecommunications Operators

In many countries de-regulation and privatization of Telecommunications has taken place, resulting in competing operators. Information about the capacity of an operator's network may be of commercial interest to a competitor. This can result in reluctance on the part of operators to respond to questions. An instruction to release such information would have to come from the most senior level of management.

Experience has shown that "Business Continuity Manager", often reporting directly to the Chief Executive Officer (CEO), are strategic persons to work with. Such an individual is best placed to know about the vulnerabilities of the existing system. Many companies have a "business continuity plan". Such a plan details the position of spares and the logistical plans for rapid restoration of services, and restoration of data.

3.5.7 Results

The results of the study, supplied by the network operator, may be difficult to interpret. It will likely refer to "Erlang" values and high-level PCM capacities but may avoid mention of transmission methods or back up power systems. Businessmen may tend to emphasize the strengths and play down the weaknesses of their networks, and an independent researcher will have to keep this in mind when performing the evaluation.

The study should consider three related but different issues:

- Capacity.
- Vulnerability.
- Rapid recovery.

3.5.8 Network Capacity

Very few telecom systems are designed to carry all the traffic that the users could possibly generate. That would be hopelessly uneconomical, so the designers make various assumptions about what the highest load on a busy working day is likely to be.

A typical residential area switch design assumes that about 5% of the users will be using it at any one time. In business districts, this figure may be closer to 10%. For example, a typical 10,000 line exchange in a residential area may be able to carry only 500 phone calls at any given time. The 501st person to make a call will get a "congestion tone", or no "dial tone".

Traffic on any network still functional after a disaster, is likely to increase dramatically. It is therefore important to study how systems behave during acute overload situations. In some systems, a public switch will respond to an overload situation by sending a signal to surrounding switches advising them that the incoming routes to the switch are closed. In this case it will not be possible to reach any subscriber on that switch from outside, but it will still be possible for users of that switch to make calls to the outside. Planners should reflect this when designing information flows within their organizations.

Priority can be offered to some users of the network, but the details of how this is done and how priority users can be identified are potentially sensitive issues. In the case of "wireline" systems, it may be on the basis of prioritizing individual lines. In mobile systems, this may take the form of a "classmark" for the phone, or a "Preemptive capability indication" feature on the account, which allows certain users to jump the queue. In data systems it may take the form of differentiating the "sub-net" grade of service. In all cases where competition between operators exists, mandatory application of the same determination criteria for all providers of public network services is indispensable.

An international emergency preference scheme for disaster relief is under consideration in the ITU Standardization Sector (ITU-T).

3.5.9 Additional Vulnerabilities

The impact of natural disasters can further reduce the capacity of a Telecommunications network by damaging elements on which it depends, such as power stations and the related distribution infrastructure, cable networks, switches and transmission stations. The resulting loss of power can be detrimental to a telecommunication system. Such damage will be discussed below.

3.5.10 Recovery

When equipment is damaged or destroyed, it must be replaced or repaired quickly. The operator will need rapid assistance from the supplier of the systems, who may be outside the country. The application of the Tampere Convention may help in this regard as it may facilitate the rapid passage of such equipment through customs authorities and may break whatever importation restrictions might have been imposed on a country by other State Parties.

3.5.11 The Implementation of the Plan

A plan, which is developed in close cooperation with all those national entities that are concerned with disaster management or with telecommunications, has the best prospects of being fully implemented. Experience shows that the awareness for the need for any disaster plan is always highest in the aftermath of a disaster and diminishes quickly when time goes by without the occurrence of a major emergency. It is therefore essential to establish, as part of the plan itself, a mechanism for the periodic review of all measures taken in the implementation of a disaster communications plan.

3.6 The need for a common approach

Improvements to the regulatory environment for the optimum use of Telecommunications in the service of response emergencies and disasters and of preparedness and prevention measures can only be achieved by joint efforts of all partners involved. It is the task of all national and international *providers of assistance*, to create the necessary awareness among the national regulators. It is the task of the *providers of telecommunication services and the suppliers of equipment*, to include provisions for the use of their goods and services in emergency telecommunications. It is the task of the *national taking part representatives* at Conferences run by international organizations to articulate the need for all entities to render support to all initiatives that favour the development, deployment and use of emergency Telecommunications ITU forums provide the best opportunities.

A common and coordinated approach by all stakeholders results in a win-win outcome. The private sector that manufactures and provides the right equipment, creates a market for themselves and participate through their corporate responsibility; assistance provides benefit from efficient and appropriate telecommunications; the national authorities fulfil their role of ensuring a quality life for the citizenry, and those affected by disaster end up, being the ultimate beneficiaries as humanitarian assistance delivery will be facilitated by efficient information flow.

CHAPTER 4

Emergency Telecommunications: Engendering Prevention and Response

When women and men confront routine or catastrophic disasters, their responses tend to mirror their status, role and position in society (DAW: 2001)

The importance of involving women in disaster preparedness and the promotion of gender sensitive responses invoke scepticism in the minds of many. This is partly because at the theoretical level the field offers little space for bringing in those issues that are directly related to women and men. Within this context, emergency Telecommunications have been mainly defined as the challenge of establishing and maintaining the proper infrastructure. However all disasters are experienced locally by the children, women and men who live and work in the affected communities. Given this human dimension, approaches focused on the use of communications to facilitate disaster preparedness and response must substantively engage women as actors and not only as victims.

In most communities women perform the roles of key communicators and care givers. However, in disaster reduction activities they are most often marginalized. In general, reducing disaster risk involves effective preparedness, mitigation, response and recovery and is partly dependent on access to, and the appropriate use of, emergency Telecommunications by vulnerable local communities and national and international institutions. A gender sensitive approach to effective and coherent disaster reduction accepts that those community members who are key communicators and care givers during normal weather conditions and peace time are also key actors before, during and after disasters. Given this reality, it is logical that they should be key participants in those training and capacity building activities that relate to reducing disaster risk.

Experience with both natural and man-made disasters highlight the simple truth that Telecommunications are useful only to the extent that they are accessible to, and useable by, women and men in communities at risk. During disaster events many vulnerable communities are often cut off from national response systems due to a lack of appropriate Telecommunications that should have been put in place before the disaster occurs. As disaster specialists note: while disaster Telecommunications are used during the response and initial recovery (transition) phase, ***effectiveness is partially reflective of preparedness***. In this regard, training plays a critical role especially in the area of emergency telecommunications. As aptly noted in ITU's Handbook on Disaster Communications, "…training should be geared not only to those who are developing and implementing appropriate technologies and applications, but also […] to the users, to allow them to make the best use of what can be made available".

Decisions regarding who is trained in the use of Telecommunications for disaster relief and recovery activities must however take into consideration the roles of both women and men. For example, an analysis of the 1991 cyclone in Bangladesh reveals that the largest number of casualties were women in part because their clothing prevented them from climbing to safer areas such as roof tops. In addition, because of the segregation between the sexes, many women did not receive the disaster warnings (South Pacific Disaster Reduction Program: 2002).

In identifying communities at risk it is also important to consider the make-up of households. In those low-income communities where there is a prevalence of female-headed households, women must be identified and targeted for training in disaster reduction activities, including in the use of emergency telecommunications equipment. Such training is critical because most often Telecommunications used in disasters are focussed on providing information from the disaster site to relief and rescue agencies and vice versa in order to save lives and reduce suffering. Thus such training in the use of Telecommunications also "serves the needs of the providers of assistance" (http://www/grameenphone.com).

Building on Local Solutions to Redress Gender Inequality

Telecommunication is important before, during and after disasters because it enables government and international institutions to give warning of the impending disaster, to coordinate relief efforts and get information to those affected after disaster strikes. It is often the case that traditional telecommunication infrastructure is rendered inoperable after natural and man-made disasters. Further, many rural poor areas in developing countries already lack basic telecommunication infrastructure and do not have access to Telecommunications to begin with.

Local programmes, such as the GrameenPhone in Bangladesh, can offer an effective, affordable and local solution to the telecommunication challenges experienced by relief organisations involved in disaster mitigation activities. The GrameenPhone program is implemented by Grameen Telecom (GTC) in cooperation with Grameen Bank, the micro-credit lender. This programme targets women from rural areas in Bangladesh. They are provided with the necessary financial resources to purchase a mobile phone which they in turn lease to other community members. This community mobile phone service enables female participants to both generate income and enhances their social status within their households and communities. GrameenPhone provides access to Telecommunications by over "60 million people [... in] more than 68,000 villages in 61 districts" in Bangladesh. (http://www.grameenphone.com).

Using appropriate technologies such as those based on satellite communications such local initiatives are particularly important when neither land lines nor terrestrial antennas are available to provide access to communication services, such as in disasters. Further, because women are the primary communicators in their households and communities and are often the ones to both heed warnings of disasters and plan for them, governments and disaster relief agencies stand to benefit from utilising such programmes in times of disaster and involve women who own and run them. Village phone systems such as the GrameenPhone can easily be transformed into an important element of the emergency Telecommunications system. In so doing, more lives will be saved and economic losses reduced. This will also, acknowledge and empower women to actively participate in disaster response.

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Data on women as participants during disaster response is emerging. From available anecdotal information and case studies it is clear that women, because of their multiple roles within their households and communities, serve important functions before and after disasters, including the purchase of radios and batteries. Because they tend to avoid risk, women are more apt to heed warnings and prepare for disasters. At the local level they are active providers of assistance such as food. The Yokohama World Conference on Natural Disaster Reduction (1994) recognised this contribution from, and potential of, women.

Like age, being a man or a woman shapes an individual's lived experience. This is in part because the ways in which women and men navigate their communities as "women" and as "men" and their relations with institutions and with each other partly inform their experiences. In the context of disasters, though gender is not always or necessarily the defining factor in an individual's experience of, or response to catastrophe, it is a relevant dimension for both women and men. (Enarson, Elaine et al.: 2003). For example, men are more at risk of death during armed conflicts, while women are more open to listening to early warnings before a natural disaster strikes because they tend to be risk averse.

Our experiences of disasters increasingly confirm the critical role of emergency Telecommunications before and after a disaster hits. Effective preparation for, and response to, disasters partially depend on the availability of communications as well as its use by those women and men of the community who are well placed to alert community members about emergency preparations, such as shelters, as well as inform them about available resources. Within this context the participation of women in emergency preparation and response is critical and their access to, and use of, emergency Telecommunications are essential components in reducing risk.

PART II

CHAPTER 1

Telecommunications as Tools for the Providers of Emergency Response

1 Introduction

Telecommunications are indispensable tools for the operational emergency management. The speed of response and, most of all, the appropriateness of such response, depend on the real-time exchange of information among a multitude of partners. Reliable Telecommunications are also a prerequisite for the safety and security of those who often risk their own life in their efforts to save lives and to alleviate the suffering caused by disasters. Last but not least, success in mobilizing of resources depends to a large degree on the quality of reporting from the site of an event.

To allow an effective and appropriate use of Telecommunications in the service of emergency response, the users of Telecommunications as well as the providers need to be aware of the particular operational aspects of emergency telecommunications. Disaster managers are often confronted with the task of defining requirements, and they can do so most realistically if they do not only know what is available, but are informed of what is feasible under given specific circumstances of an emergency situation.

Telecommunication service providers include enterprises providing services to the public or to specific users, mostly on a commercial basis, as well as those own telecommunication services established and run by emergency services and disaster response organizations. They also include the amateur radio service as a non-commercial resource provided by skilled volunteers. This segment of the handbook will look at two main elements. The first analyses the most common modes of telecommunications. The second looks at the networks and services using these various modes of telecommunications.

1.1 Interoperability and Interworking

A major difficulty experienced by players involved in disaster management is the incompatibility of their Telecommunications equipment and software. This problem has been experienced in almost all operations making the exchange of information difficult. This challenge is similar to that of military operations, that share with emergency operations a number of characteristics, such as a rapidly and often unpredictable changing physical and social environment, and the need for rapid and inter-dependent decision-making at all levels. Their Telecommunications requirements are comparable. The military terms of tactical and strategic communications best describe what has to be provided for a coordinated response to any emergency having more than local implications.

In order to deal with this challenge, standardization of Telecommunications networks is essential to achieve compatibility and make the exchange of information possible at least within the two groups i.e. technical and strategic networks. Sofar, gateways seem to be the only realistic solution although not an ideal one.

In tactical communications, this function is mostly carried out by a human interface – the operator or the disaster manager who uses more than one network at a time. For this, one needs solid knowledge of the structures and procedures of the networks involved. However, in strategic communications, automatic gateways that have been developed between different systems require the technical staff to be familiar with the technology and how it may be utilized.

1.2 Telecommunication Modes

Practically all modes of communications on public and private networks have their role in emergency telecommunications. The following sections give an overview of available modes, which will be described in more detail in the technical annex to this handbook:

a) Voice

This is the most common and most suitable mode of communication for the real-time transmission of short messages and it has minimal equipment requirements. Its applications in disaster communications range from point-to-point wired field telephone links, VHF and UHF hand-held or mobile transceivers to satellite phones. It also includes public address systems and broadcasts via radio. Voice has as its major pitfall the lack of permanent record making the transmission and reception of complex information difficult. It however, remains, the only mode that does not require user interface making it the most personal mode of communications. In a critical situation this remains the most preferred mode.

b) Data links

Data links were in fact the earliest forms of electronic communication. The telegraph was in use long before the telephone, and wireless telegraphy preceded radiotelephony. It was, the development of electronic interfaces and peripheral equipment – replacing the human operator translating between Morse code and written text – which made data communications for many applications superior to voice. The first such interface with practical applications in disaster communications was the teleprinter or teletype machine, commonly known in commercial usage as “Telex”. Initially used on wired networks, it was soon on radio links. While very reliable and with a very low error rate on wired circuits, efficient use over radio required strong signals and interference-free channels. The requirement of considerable technical resources for a reliable radio teletype (RTTY) link limited their usefulness in emergency situations. Where national and at least parts of the international wired telex network are still maintained, they remain a potentially valuable asset for emergency telecommunications. Completely independent from the public telephone network, they are immune against any overload of the latter, and their robust technology increases the resistance against the physical impact of disasters.

c) Advance Digital Technology

Advanced digital technology allowed the development of new data communication modes, which eliminate the shortcomings of RTTY. The key to error-free links is the splitting of the messages into “packets”, and the automatic transmission of an acknowledgement of correct reception or a request for re-transmission. The earliest general application of automatic error correction is the ARQ concept, standing for “automatic repeat request”, with communication protocols known as TOR (Second Generation Onion Protocol for asynchronous circuit), SITOR (Simplex Telex Over Radio designed to provide reliable RTTY communication under adverse conditions while maintaining an extremely low error-rate) and AMTOR (Amateur Teleprinting Over Radiowhich is a specialized form of RTTY). In ARQ (Automatic Repeat Query) mode, an automatic acknowledgement or request for re-transmission takes place after every third letter of the message. Different from RTTY, where the number of stations receiving a transmission is not limited, ARQ type signals can only be exchanged between two partners at any given time. To allow broadcasting, a somewhat less reliable version, “forward error correction (FEC) mode was introduced. In FEC, every “packet” of three letters is transmitted twice; the receiving station automatically compares the two transmissions and, if they differ, identifies the most likely correct content of the “packet”.

Further development led to even more efficient methods of data communications on both wired and radio links. The Internet as the most prominent tool for data communication has been dealt with in a more detailed way in a separate chapter. The Internet Protocol (IP) has also been adopted as the common standard of communications in dedicated radio networks of the major partners in international humanitarian assistance. The “Packet Radio” mode is most commonly used on VHF and UHF. Its derivative “Pactor” and various similar, often proprietary modes allow, through suitable gateways, the use of HF radio links for practically all functions of the Internet. Newer versions, such as “Pactor III” have further enhanced the speed and reliability of data communication.

d) Telefax

Telefax was the first mode allowing the transmission of images in graphic hard-copy format over wired and, to a limited extent, wireless networks. In its original form, fax images were carried as analogue signals over voice circuits such as the telephone network. The development in digital technology has led to new forms of image transfer, including the applications on the World Wide Web, and the use of fax mode has been greatly reduced.

e) Other advanced modes

Other advanced modes including those used for image transmission over broadband links, have provided new opportunities and have improved the provision of real-time information to many more publics beyond those in the fore-front of emergency responses such as the media. Their higher demand on bandwidth and on equipment tend to restrict their application in emergency situations.

CHAPTER 2

Public Communication Networks

2 Introduction

For the purpose of this Handbook on Emergency Telecommunications, a public network refers to that which ordinary citizens have access to. This is important to recognize because in the event of a disaster the public will tend to initiate calls to the country hit by a disaster and from that country to other countries where loved ones are located resulting in the overload of the Telecommunications network.

Typically a public network is designed to allow about 5-10% of the subscribers to call and receive calls at the same time. However, in emergencies more people make calls and tend to talk longer resulting in jamming, blocking or congestion of the network. There are a number of measures that can be taken to deal with this challenge.

2.1 The Public Switched Telephone Network (PSTN, POTS)

The Public Switched Telephone Network (PSTN) is sometimes called the Plain Old Telephone System (POTS). This name gives the misleading impression that it provides only public telephone service. The global cable and switch network was, built to serve telephones. But in reality it carries nearly all Telecommunications signals making the transmission of other applications and services possible e.g. Internet. Failure of the PSTN results in more losses than that of the telephone service. For this reason, those involved in emergency response must have a clear understanding of the operations of these networks and what can interfere with such networks functioning.

2.1.1 Local Wireline Distribution (Twisted Pair, Last Mile, Local Loop)

Unless one is using some kind of wireless system, voice and data transmission from a subscriber to the local exchange will be via a local cable.

In many places, telephone lines are open wires, or cables with numerous pairs of wires, suspended from poles. Such pole routes are themselves vulnerable to disasters involving high winds and earthquakes. Any disaster causing just one of the poles on the route to fall down, or the cable to be cut even at one point, will disrupt the circuit. Restoring service may take days especially if the roads are inaccessible. A move preferred approach is to have cables buried underground in ducts, thus reducing their vulnerability. Therefore, it is advisable to have all disaster management centres connected through underground cables as this significantly reduces the risk of loss of service.

The “local loop” used on the PSTN has the advantage that the telephone at the user’s premises is powered from a battery at the telephone exchange. If power at the user’s premises is lost, the phone will still work as long as the lines are not damaged. However, this does not apply to cordless phones, which will have a home base station powered by the domestic power. Every home and business should be urged to have at least one normal type phone i.e. one powered from its line.

In addition, many types of Private Branch Exchanges have a feature called “Fallback”. When the power fails or the system crashes, relays connect the incoming lines directly to certain fixed phones in the building. Management must know where these phones are and how they work then disseminate this information about how to use them after a power failure. It may however not be possible to have fallback if you have a digital link.

2.1.2 Wireless Local Loop (WLL)

Some operators offer access to their switches via “wireless local loop” (WLL) solutions. WLL relies on local Radio Base Stations (RBS). These provide a radio link to fixed radio units in the home, which in turn connect to telephones in the home or business. In some locations it provides lower cost and quicker installation than traditional wire line local loop.

One problem with WLL is that if the power in the user’s house is lost, the radio unit will be inoperable unless reliable alternative power is provided. The RBS stations do have backup power, but are connected to the switch via the local cable system. In other cases the base station is connected by dedicated microwave link. Nevertheless, wireless access may in some cases be less vulnerable to physical damage than pole routes, provided backup power is available.

“Private wires” used by enterprise systems are often routed through the local cable system of public networks. In such cases, damage to the latter is likely to affect any wire telecom system in the area i.e. public or private.

2.1.3 Switches (Telephone Exchange, Central Office)

Switches are the centre of a telephone system; they also present the most serious risk of failure during disasters because of their tendency to be overloaded. In a residential area, a switch is dimensioned to accommodate simultaneous calls by about 5% of the subscribers. In a business area this figure may be up to 10%. When the load is greater than what the switch is designed to handle, the switch gets “blocked”. It should be stated that the power system for the switch also supports the lines passing through for other purposes. Other things such as the Internet can fail if the switch fails because the multiplexers in the building and the repeaters down the lines are powered from the same exchange battery.

If the main power supply for the city has been cut off, the switches can be powered by diesel generators forming part or the switches. This diesel can last for few days. In recent Ice storms in North America, telephone service was lost due to shortage of Diesel fuel for the switches. A good Business Continuity Plan should be provided to prevent this, with emphasis the provision of adequate fuel and using the best the means to pump it.

It should be noted that switches can easily fail if the building housing them is destroyed.

Floods are also a cause for concern. Floods may cause the power system to fail at the switch due to short circuits. Where equipment has to be imported, restorations of services may take longer. Ideally switches should be sited in areas not prone to flooding or other damage.

Probable Solution

Prioritization, whereby some users are given priority access to the available capacity over others, is one solution to the blocking problem. The technology to do this exists but work needs to be done on the regulatory side, to define i.e. to develop criteria of who has priority access over who. There is also the matter of indemnifying the networks against lawsuits from those who did not get access in their time of need. There are three basic strategies for prioritization. First, all access is blocked to everyone except certain privileged users. The problem with this is that it denies citizens access in time of real need. Second, priority users can jump the queue and be assigned the next free circuit. Thirdly, some users are removed from system in order to give others priority. The choice of strategy is the prerogative of the network operator and the regulator.

2.1.4 The Trunk and Signalling System (Long Distance system)

Trunk lines are links between switches; they carry calls on the long distance routes between cities. Trunks often carry hundreds or thousands of calls on one link, by a process called multiplexing. The links may be implemented by microwave radio, copper cables, or optical fiber, depending on the expected capacity of the link. The trend is now to use optical fiber systems. To reduce vulnerability, cables are often buried.

In developing countries, the most economical and popular way to carry trunks is by microwave relay stations. These are repeater stations, usually mounted on hills or high buildings. Microwave relay stations are however, often located in exposed locations, and may sometimes be in remote areas that difficult to access. Given the importance of these remote stations, state assistance in getting rapid access to these stations is strongly recommended.

Many modern trunk systems feature automatic recovery systems, such as Sonnet rings and other automatic re-configuration methods so that a redundant link or route can take the load from a failed link. This of course depends on quite a lot of redundant capacity being designed into the system in the first place. There are also cost considerations and in the present de-regulated environment mainly small operators in developing countries who have limited resources consider this a luxury.

Even in well developed countries there have been spectacular flops, caused by the gradual erosion of redundant capacity as it is sold to paying customers in today's highly competitive business. When the network rings are broken, there may not be enough spare capacity in the ring to carry the entire resulting load. For this reason, government may have to ensure that margins of redundancy are kept, in the national interest.

A special case is the "Signalling system No. 7" also known as the "CCITT 7" system. This is a special network which is used for switches to talk to each other, to help get the call set-up. It is however, not carried on a special network, but is often added to the normal links. The loss of the trunk network may also disturb the function of the SS7 system, causing general signalling problems in the network.

2.1.5 Integrated Services Digital Network (ISDN)

Integrated Services Digital Network (ISDN) is a circuit switched, transparent data service at high speeds, which can be increased in 64 kbit/s steps. A typical use is in video phones and in scientific and technical applications. Generally, the same switch carrying phone calls is also switching the ISDN, using the same trunking system. ISDN cannot therefore be described as being less or more reliable when compared to phone calls. because it shares the same equipment.

It does however have one significant advantage over the Internet. The Internet is a "best-effort-but-no-promises" kind of network, which will disappoint users during disasters because of loading issues that it will face. ISDN on the other hand guarantees that a certain bandwidth will definitely be available to the user while paying to keep the circuit open. It is therefore more reliable for such things as streaming video, audio or data provided that a circuit is set up.

2.1.6 Telex

The importance of Telex is diminishing as text messages are increasingly handled by e-mail. Nevertheless, Telex remains an important tool especially in developing countries. The Telex system consists of teleprinters or specially programmed computer terminals, connected to each other by means of the International Telex network. Telex messages consist of only upper case letters of the Roman alphabet and some punctuation symbols, using the Baudot code ITU-ITA2.

Telex has two distinct advantages over other systems. The most important one is that Telex is switched through a different switch to that used for telephone calls. This is important in the case of a disaster, because of considerations that the telephone switch is often overloaded. Telex exchanges are designed to handle high levels of traffic, and will not usually be overloaded by private calls.

2.1.7 Facsimile (Fax)

A facsimile machine (FAX) consists of a scanner, a computer, a modem and a printer in one unit. This combination allows the transmission and reception of pictures on a piece of paper.

You can use this to transmit hand sketched diagrams, messages in hand written script and photographs. A general weakness of fax is that it is usually carried over normal telephone circuits. It is therefore subject to all the shortcomings of the PSTN. Furthermore most fax machines depend on external power. They are also quite big and heavy and require a steady supply of paper, sometimes of a special type.

2.2 Mobile Phones (cell phones, Handie phones)

Mobile phone service is provided by a large network of ground based Radio Base Stations (RBS). Typically each one provides for at least 3 "Cells". Software in the phone keeps the mobile station connected to the best cell for its current location.

When Mobile systems are designed, they optimize two tings; coverage and capacity. Both of those factors affect how they behave in disasters. These factors affect analogue, digital and third generation systems in exactly the same way.

Radio base Stations cost close to a quarter of a million USD each, and must have a payback period of up to 5 years. These are therefore often built in locations where there is enough traffic to justify them. The result is that, these are mostly built in urban areas and may be sparse in rural areas. As a result mobile communications for emergency response in remote and rural areas is often hampered.

In some countries differing operators won their license by different means. A "Beauty contest" means that the operator needs to impress the regulator with his good quality of service, which often means good coverage. As a result he has a lot of loss making RBS stations which he must cross subsidise with his urban ones. This operator ends up with higher prices but better coverage in rural areas.

An "Auction" means that the company prepared to pay the highest amount for the license will get the license. Such an operator may not have to build loss-making rural stations and as a result with cheap prices in urban areas but with almost no coverage in remote areas. When responding to a disaster and one has to choose an operator, it is important to consider the issue of coverage more than that of cost.

Capacity means deciding how many traffic channels to assign to each station. There is a maximum capacity that each station can support, so when more capacity is needed, cells are split into small cells to support the required traffic. It is however not easy to increase traffic capacity, so mobile systems do suffer from congestion just as fixed line systems do.

In fact the situation is far worse for mobile systems because, the only traffic channels available to a particular mobile, are the ones it can "see" from its present position. Spare capacity on the other side of town is useless. Local congestion problems are a very serious weakness of cellular systems in any emergency case and so cellular should on no account be considered a primary communications mode for any disaster management purposes.

The RBS stations are connected to mobile switches by means of fixed lines or microwave links. If these fail then the station cannot work as a stand alone. They are also vulnerable to as they are over dependent on the PSTN network. RBS stations are powered by the ground mains power system. When the mains power fails they will only remain operational for as long as the batteries hold out, about i.e. 8 hours or so.

"Cells on Wheels" (COWs) are mobile base stations that can be taken to the scene and deployed to provide extra coverage or capacity. Networks should be encouraged to invest in them and deploy them as soon as a capacity problem is anticipated.

Mobile switches have limits to their capacity just as fixed line switches. The major problem with this technology is the constant blocking of base stations.

"Pre-emptive capability" is a feature of most mobile switches. Provided that you have "pre-emptive capability" on your account, someone else will be kicked off the cell to allow your call to go through. Needless to say it is quite hard to get yourself on the list. It may take government intervention to do so.

SMS and GPRS are methods that GSM uses to transmit text messages or other multimedia data such as e-mail. These methods don't use voice traffic channels to pass the message. They also have limited capacity. Since they are store-and-forward methods, the best solution is to slow them down rather than block them completely.

Cell Broadcasting is a feature of many mobile systems. It transmits text in a downlink only stream, so that all mobiles in that cell can receive the text at the same time. Since it does not use a traffic channel, it is not prone to blocking, and is therefore very useful for mass messaging, for example for warning the public on a mass scale.

2.2.1 Pagers

Pagers can be characterized as a low speed narrow band, one way or two way radio communication system intended for the transmission of very short text messages. As a rule since the Engineers have to budget for downlink coverage only, they can raise transmitter power as high as is needed, even hundreds of watts. Pagers often have very good "in building" penetration while mobile networks may not because of the need to budget for mobile access link budget. Paging stations typically date from the pre-cellular era. They are often housed on mountain tops in remote locations. They do however nearly always have back up diesel power and back up radio feed links. As a result they can be very reliable in times of crisis.

These days, more and more users are switching over to SMS because of its convenience. This has the advantage that loads on paging systems, have become thus avoiding the very low overload problem. Eventually pagers might be phased out as more and more companies that traditionally supported these services are getting out of this business. While pagers have been a preferred means of communications, the lack of a roaming facility has always been a disadvantage.

2.2.2 Business Continuity Planning

The role of private telecommunication operators in times of disaster remains a topical and debatable issue. Whilst these companies are in the business of making money, they too have a social responsibility to ensure that their networks supports efforts aimed at disaster mitigation and relief. These organizations should be made accountable by governments that should stipulate in issued licenses that each telecommunication company must have a business continuity plan and must observe international norms and standards of good practice in this regard.

2.3 Satellite Terminals and Satellite Phones

Several systems, differing in their technological concept and their applications, are available for use in emergency operations. For the user, the difference is primarily in the size of the equipment and the coverage required.

2.3.1 Mobile terminals

The most widely used mobile satellite system at the time of writing is the Inmarsat system. Originally created under the auspices of the International Maritime Organization (IMO) in the early 1980's, to serve the international shipping community, Inmarsat is now a privatized enterprise offering service to maritime, aeronautical and land mobile customers.

The Inmarsat system consists of geostationary satellites. Mobile terminals communicating through Land Earth Stations (LES) handle traffic supported by PSTN and other public networks. Four satellites cover the surface of the earth with the exception of the Polar Regions. Part 3 of this handbook includes a map of the areas covered by the 4 satellites. LES are located in various countries, within the range of one or more satellites. The communication links consist of a connection between the user's terminal and one satellite, a link from the satellite to an LES, and the connections from there into a terrestrial public network.

All Inmarsat terminals need to be set up so that their antenna can "see" the satellite covering the operational area. Most terminals have provisions to remotely locate the antenna outdoors, separate from the actual user equipment. Like all equipment using directional antennas, Inmarsat terminals cannot be used in a vehicle while in motion unless equipped with special antennas used primarily in the maritime service, compensating for the movement of the vessel or vehicle.

For use in emergency telecommunications, various types or Inmarsat "standards" are available and suitable:

- *Standard M and mini-M* are the most popular for highly mobile applications. Mini-M terminals are about the size and weight of a laptop computer, while Standard M terminals are the size of a briefcase. They enable connections with any PSTN subscriber world-wide, including other mobile satellite terminals. Most M and mini-M terminals have a port to provide connection to a Fax machine, and they also have an RS-232 data port for the relatively slow rate of 2.4 kbit/s. Subscribers can use this type of terminal for email by means of a Post Office Protocol (POP) connection. While Standard M terminals can operate anywhere within the coverage of the Inmarsat satellites, the use of mini-M terminals is limited to the coverage provided by spot beams of these satellites. Such spot beams, which allow the use of terminals with lower power and smaller antennas, cover most landmasses but not the oceans and many of the smaller or more isolated islands. The number of simultaneous connections any one spot beam can provide is however limited, and the use of a large number of users in one location might result in saturation of the spot beam covering the area concerned. Only a temporary re-alignment of spot beams can in some cases prevent this problem.
- *Standard C* is a store-and-forward text system, initially developed for maritime traffic and today is an integrated part of the Global Maritime Distress and Safety System (GMDSS). It transmits and receives e-mails as well as Telex messages. It is however not suitable for carrying large files of data, such as attachments. Standard C terminals are typically briefcase sized, but require peripheral equipment such as a laptop computer and a printer. Some service providers can also forward messages from Standard C terminals to Fax machines (but not in the opposite direction). Especially the new Mini-C *TT-3026L/M* is ideally suited for fleet management purposes (vehicle tracking) as well as for remote status monitoring/controlling (SCADA) applications. There is no voice capability on this very robust and highly reliable system.

- *Standard B* service offers ISDN Data at 64 kbit/s. Standard B equipment is considerably larger and heavier than Standard M terminals and intended primarily for stationary use, where it can provide connectivity for multiple, simultaneous users or high-speed data applications.
- *Standard A* was the first generation of Inmarsat mobile satellite terminals, offering voice, data and Telex connections. They operate in analogue mode, and are now obsolete. This version will most likely be phased out in the very near future.
- *Inmarsat GAN, also called M4 (TT-3080 and NERA World Communicator).* Effectively a much lighter and cheaper follow-on to the Standard B working on spot-beams. It offers 64 kbit/s Data, Packet Data Service (IPDS) which is comparable to GPRS, but with a much higher throughput, high quality audio for broadcasters, Fax with up to 14.4 kbit/s speed and low cost Mini-M quality voice. Available in portable, stationary and mobile versions with a tracking antenna.
- *Inmarsat Regional BGAN* also called *Satellite IP Modem. It has been in operation* since 2003 on leased capacity via the Thuraya satellite, and is useable only in the limited coverage area (footprint) of the Thuraya satellite. The term BGAN stands for Broadband Global Area Network working on the switched packet principle over a 144 kbit/s shared channel. The effective throughput does thus depend on the number of users in a specific area. The R-BGAN terminals are very light (1.6 kg) and measure only 24 × 30 × 4.3 cm, thus ideally suited for quick deployment, fast file transfer purposes. The terminals come without handset as they are intended for data transfer only. Only the effectively sent/received Megabits are payable.
- *Inmarsat BGAN* is expected to become operational in 2005. This is a small light-weight satellite IP modem providing up to 432 kbit/s data throughput, to work via the new Inmarsat I4 satellites the first of which is scheduled to be launched in early 2005. According to Inmarsat the existing R-BGAN terminals will be upgradeable such that they can be used on the I4 satellites. The exact coverage area of this broadband switched packet system will be known only after the successful launch of the 3 planned I4 satellites.

2.3.2 Hand-held Satellite Telephones

Services of the Global Mobile Personal Communication Systems (GMPCS) allow the use of equipment very similar to terrestrial cellular telephones. They are particularly suitable for situations where a high degree of mobility is required, and while they still need a line-of-sight connection to the satellite or satellites, their mostly-omni directional antennas need not be aligned accurately. Different systems offer specific advantages but also have specific restrictions in respect to their applications in emergency telecommunications.

a) Thuraya

Thuraya is a system based on (presently) only one geostationary satellite having consequently a limited geographical coverage of about 100 countries. Its coverage spans Europe, North, Central Africa and parts of Southern Africa, the Middle East, Central and South Asia and the oceans in these regions. An extension of services, through the use of an additional geo-stationary satellite, is planned for 2005. The user equipment, similar to a cellular telephone, can be connected to auxiliary equipment such as a base station allowing the use of the handset indoors, while the antenna can be located outdoors. Where terrestrial GSM mobile phone coverage exists, the Thuraya phone can be set to automatically switch to this network. Thuraya phones report their position to the terrestrial gateway station; they do so using a built-in receiver for the Global Positioning System (GPS). They therefore require line-of-sight connection not only to the geostationary Thuraya satellite, but also to at least 3 of the orbiting satellites of the GPS system. The possibility of sending one's GPS position as an SMS is a very useful feature, especially for humanitarian relief workers operating in dangerous areas.

b) Iridium

Iridium uses a constellation of 66 satellites in Low Earth Orbit (LEO) at only 780 km above the earth. The satellite covering the location of the user does not normally have a direct link to the ground station providing the connection into the terrestrial public networks, but connects to such a station through other satellites of the system. The LEO concept is similar to that of a cellular telephone system, the difference being that the cells (i.e. the satellites) move in 6 polar orbits, while the user remains stationary. The complexity of the system and necessary frequent handovers can affect the operation of the system. Iridium is a truly global system, its coverage also including both Polar Regions, which are out of reach for geostationary satellites. Whilst it is satisfactory for voice, it is not suited for data as the very frequent hand-overs from one satellite to the next do limit the achievable net data throughput to less than 2400 bit/s.

c) Globalstar

Globalstar is a system that uses a constellation of 48 LEO satellites in 8 orbital planes with 6 satellites each, inclined at 52 degrees, flying at an altitude of 1400 km thus covering an area from 70° North to 70° South. The actual coverage of the system is limited by the need for simultaneous direct connection to the user and a ground station or gateway within the coverage of the same satellite. From locations where no such simultaneous coverage exists, communication is not possible. The lack of gateway stations on the African continent makes Globalstar virtually unusable in Africa. Globalstar phones can work on terrestrial GSM networks where such coverage exists. Voice quality is excellent and the throughput in data mode is 9.6 kbit/s.

Most systems operate with billing procedures through SIM cards, allowing control and attribution of communication cost and international roaming on the GSM networks with which the service providers have respective agreements. Due to the relatively high tariffs, in particular for connections between satellite terminals of different systems, the public satellite networks are attractive only for the initial response phase, but they should not be used as primary means in longer-term operations.

Other systems offer regional coverage for example in North America (Motient) and Asia (AceS). Several concepts for global coverage in data modes including Internet access are in various stages of development or deployment. Such systems may in the future offer appropriate solutions for specific regions or requirements, and should be considered whenever national emergency Telecommunications plans are being developed. They are however not suitable for international disaster response operations in unpredictable locations.

2.3.3 Direct Video (and Voice) Broadcasting

Another low cost and practical method of gaining satellite connection is to use the services of the Broadcast satellite. Typically in such schemes a circuit board is installed into a personal computer. Software then installs this as if it were an Internet service provider. The computer then gets fairly good speed Internet access over the satellite link, but at a much lower cost than with conventional VSAT. However the user is contending openly with other users at the same time, so there is no guarantee as to quality of service as there is with conventional VSAT.

Pros

- inexpensive.
- easy to ship.
- easy to set up, little ground work required for setting up.
- readily available from the shelf.
- quite OK and reliable for Internet browsing.

Cons

- Shared bandwidth.
- In complex emergencies when lots of other users deploy the same system even browsing becomes slow.

Problems with TCPIP e-mail exchange (like Notes replication). The priority on those systems is given to HTTP and during peak browsing hours (at the point where the beam lands) this almost wipes out the email replication. However during night time hours even the replication works quite well.

Pricing is significantly lower than with conventional VSAT, both in the capital costs of the equipment and in the monthly running costs.

Use has also been made of the downlink only data facility provided by world space radio's, Direct Voice Broadcasting. It has been used, for example to update intranet files that are small. Worldspace is DVoiceB. Typically it is used by FTPing daily update files of Intranet content to a Worldspace up-link site. WorldSpace then broadcast the file over its satellites to receivers in field offices. The receivers have a data adapter that feeds the bit steam to the USB port of a laptop running a client software. The laptop is effectively a single machine web server serving a mirror of the Intranet site.

There is no cost charged to the receiving partly, but there is a cost per megabyte charged for sending data.

The best configuration today is using a PCI card, to be installed in a Desktop PC, that has two receivers making it possible to receive both data and a voice simultaneously. This has very modest costs and could be compared to the costs associated with VHF radio.

CHAPTER 3

The Internet

3 Introduction

The Internet increasingly provides support for major operations and functions of organizations, including those with significant distances between headquarters and field offices. For governmental disaster workers, access to the Internet permits continuous updates of disaster information, accounts of human and material resources available for response, and state-of-the-art technical advice. As an important feature, messages can also be disseminated to groups of pre-selected recipients, thus allowing some form of targeted broadcasts.

The power of the Internet, specifically that of web-based information services, continues to grow and evolve. The integration of wireless (including satellite-based) technologies and of high-speed capability on wire connections will provide disaster managers with access to far more information resources than they are likely to use. In the context of disaster communications it is essential to always keep in mind that personnel at the site of an event has, first and foremost, the task to save lives. Specific information might greatly enhance the efficient and effective use of available resources, and disaster managers are managers, not reporters. On-site relief personnel cannot be expected to conduct information searches. They neither dispose of the time, nor, in most cases, of the peripheral equipment necessary to process such information in a format directly applicable to field operations. The same is valid for the provision of information from a disaster-affected location and the observations in respect to the use of facsimile and other graphic communication modes.

3.1 Applications

The use and application of the Internet to emergency Telecommunications is unquestionable. The following are some of the ways that this technology can contribute in disaster relief:

- Sending and receiving email and using web-based directories to communicate with colleagues, suppliers, governmental and non-governmental organizations who can provide assistance.
- Tracking news and weather information from a variety of government, academic and commercial providers.
- Finding up-to-date geopolitical information, geographical maps, travel warnings, bulletins and situation reports for areas of interest.
- Accessing medical databases to gather information on everything from parasitic infestations to serious injuries.
- Participating in worldwide discussion lists to exchange lessons learned and coordinate activities.
- Reading and commenting on content at various governmental, and non-governmental websites to maintain an awareness of the large picture and how others are portraying the disaster.
- Registering refugees and displaced persons to facilitate reunification with relatives and friends.
- Reporting other than disaster related news, such as sports results, as a morale builder.

There are also certain disadvantages to an Internet-based information resource strategy. Generally, the web is associated with high bandwidth and costly connectivity. A lot more need to be stated concerning the web, for instance the need to maintain older legacy systems (non-Windows, non-high bandwidth connectivity) as a redundancy option in the event of a systems failure should always be considered. The fact that equipment is not of the latest technology does not mean that it has no use, and in critical situations the opposite may hold true. The high vulnerability of solid-state circuitry to static electricity and electromagnetic pulses has been overcome in some cases by the re-introduction of vacuum tube technology in critical applications Other important issues pertaining to the Internet-based information exchange are reviewed in the following section.

3.2 Privacy

The openness and global reach of the Internet – the same characteristics that make it attractive for users in a disaster situation – threaten the security of data transferred via the Internet. Some institutions use secure data networks that bypass the Internet entirely except as a last resort. Given the sensitivity of information especially in a complex emergency, data tampering may be an issue. The unsuspecting and sometimes accidental wide dissemination of debilitating computer viruses and spam could seriously affect computer systems at crucial points just when they are needed most.

Focus should not only be on sending messages on the net but on ensuring that security is assured. It is therefore necessary to employ secure technologies that are now readily available of the shelf in order to authenticate the source of the message. This includes the use of digital or electronic signatures created and verified by cryptography, the branch of applied mathematics that concerns itself with transforming messages into seemingly unintelligible forms and back again. This form of signatures use what is known as “public key cryptography”, which employs an algorithm using two different but mathematically related “keys”, one for creating a digital signature or transforming data into a seemingly unintelligible form, and another key for verifying a digital signature or returning the message to its original form.

3.3 Availability

There are limits to the robustness and flexibility of the network. As more and more important traffic migrates to the Internet, it becomes an attractive target for disruption by extremist groups. In addition to deliberate and malicious actions, denial of service can be a result of excessive demand. There have already been examples in the USA, where servers providing storm information from the National Hurricane Centre and the National Oceanographic and Atmospheric Administration were overwhelmed by demand during the approach of a storm. During a crisis, the most valuable information source will often be found to be the most difficult to reach.

3.4 Accuracy

The quality of information to be found on the Internet is probably no better or no worse than of information available through more traditional channels. The Internet decreases the time lag between events and the posting of information about them. This free market of information gives equal play time to valuable information as well as to material that is out of date, slanted, misleading, or just plain wrong. Therefore the user of information provided by Internet resources must in each case verify the source of information before forwarding or applying it.

3.5 Maintainability

One of the key paradigm shifts realized by the Internet is user-initiated, demand-driven access to information. While this change can increase the effectiveness of an organization and lower the costs of information dissemination, information needs to be processed. Web planners need to carefully define the scope of information to be hosted, verify its reliability, structure it in a logical way that allows easy access, and ensure continuous and prompt updating. The availability of the human resources for these tasks is as important as the acquisition of information itself.

CHAPTER 4

Private Networks

4 Introduction

The term “private network” is used here to describe communications facilities available to specialized users like fire brigades, police, ambulances, utilities, emergency teams, civil protection, transport, government, ministries, and defence. These networks can also be used by business, corporate, and industry users. The network is usually owned by the private users themselves who can share it eventually in a multi – organizational environment. The users usually manage their private network, in some cases an operator can do it for his private customers.

These networks come in different forms. They can be wired or wireless, and they can share public networks resources, they can be fixed or offer mobility. These can be classified as:

- land mobile radio networks,
- maritime networks,
- aeronautical networks,
- enterprise networks,
- virtual private networks,
- location networks,
- satellite networks.

4.1 Land Mobile Radio (LMR) services

4.1.1 Land Mobile networks

The access to private Land Mobile Radio networks (LMR) is reserved to closed group of mobile users who make short exchanges of voice and data of an operational nature during day-to-day, emergency and disaster situations for Public Protection and Disaster Relief (PPDR).

The communications can be duplex but can also be half duplex where one user can talk at a time by pressing a Push To Talk (PTT) button. The LMR networks differ from public telecommunication networks as they offer specific services like immediate call set up, Group call, Emergency call, Priority call, end-to-end Security, ambiance listening.

LMR networks offer very short call set up times, simultaneous voice and data, mobility, high robustness and ease of use in harsh urban, wide areas, mountainous environments. They can cover different sizes of coverage from one cell of a few meters to large countrywide areas and they can also be set up quickly if needed.

LMR is a family of standards and technologies which can be combined to offer the required Voice and Data service. This is due to the fact that emergency users have specific varying needs according to their role as civil protection, police, and emergency teams. For example the security level needed is different between users, the data rate of information is varied, and the type of terrain of the critical missions is different as it could be urban, country, or a hot spot.

LMR systems are categorized as Narrow, Wide and Broad band according to the increasing width of their radio channel and to the data rate offered.

ITU-R report 8A/205 defines the radio communications objectives and requirements for Public Protection and Disaster Relief (PPDR). Three typical scenarios have been identified. These are day-to-day operations, (large) emergency, and public events, disasters. Typical applications (Data base access, messaging) are identified. Then, depending on the LMR system in use (narrow, wide and broad band) the possible applications are listed in order of importance depending on the Scenario.

4.1.2 The different modes of operation

LMR systems offer six possible main modes of working:

- **Direct mode** where the communications are done directly between the terminals without using an infrastructure. This is very practical. It is like a walkie-talkie mode where every one in the range can listen to the conversations if they are on the same radio channel.
- **Network mode** where the communications are under the control of the LMR network infrastructure composed of Radio Base Stations and Switches.
- **Dual watch** where the terminal is in both direct mode and in network mode.
- **Repeater mode** meant to extend the coverage around a vehicle, or in a building.
- **Gateway mode** meant to connect two different incompatible systems.
- **Ad hoc mode** where the terminals themselves have an information routing role as there is no infrastructure.

4.1.3 The different main services offered

LMR systems offer a wide range of **tele-services** such as the following:

- Group calls allowing communication between a calling party and one or several called parties belonging to the same group. This is also called talk group.
- Emergency calls with automatic call set-up and pre-emptive calls.
- Broadcast call allowing one caller to transmit to multiple parties.

LMR systems offer a wide range of services:

- Security services such as:

  Authentication of the user, end-to-end encryption of the voice and data, protection against intrusion, and key management.
- Mobility services such as:

Hand over, cell location registration, and presence check. The speed can be up to aircraft helicopter speed in order to allow air to ground communications.

- Voice Services such as:

  Access priority, discreet listening, preemptive priority, call authorized by dispatcher, presence check, call duration limitation, dynamic regrouping, and group merging.
- Data services such as :

  Access to a database, GPS support for location, short messaging, file transfer, and status transmission Video, and telemedicine can be supported if the data rate permits. Data rates offered by these systems vary between 2.4 kbit/s for short messages, images, and database query, to several Mbit/s for telemedicine, video, and file transfer.

LMR private networks serve emergency and disaster communications in two ways:

a) The regular users of the LMR network may be involved in disaster response activities. The different organizations may have different LMR systems and then they inter-work through Gateways or through the Emergency Control Centres.

b) The LMR network may be used temporarily as a back up to carry information from and to users who are not part of the mission critical user group.

The following sections look at the services that could be provided as part of emergency Telecommunications within the context of the two options discussed above.

4.1.4 Technologies

This section will not cover the technical details of each listed system as they are described in ITU documents ITU-R report M.2014 dealing with technical and operational characteristics spectrum efficient digital dispatch systems for international and regional use, and ITU-R 8A/109E which the Land Mobile handbook on digital dispatch systems. Radio propagation is a complex process, but some principles are useful to know in order to understand the classification of related technologies and their evolution. Before discussing the various systems, a few key points deserve mentioning:

- Analogue radio technology is being replaced by digital technology which allows secure services, better spectrum efficiency, larger coverage, better quality of service, data transmission, duplex, and hand over.
- The larger the radio channel the more data it can transmit when needed by specific applications. A classification is done according to the size of the band. These bands could be defined as, narrow (for example 25 kHz channel width), wide (for example 300 kHz channel width) and broadband (for example 2 MHz channel width). The wider the band the higher the data rate.
- The higher the data rate the smaller the radio coverage.
- The higher the frequency the higher the penetration.
- Mobility makes transmission more difficult due to fading and change of radio cells while moving, this can introduce discontinuity in communication if no hand-over is performed.
- Antenna technology can boost range of the same radio technology.
- Modulation techniques can boost data rates for the same radio channel width.
- Increasing power transmission can increase the coverage.

Technologies under this theme can be classified as analogue or digital systems. Digital systems can further be classified on the basis of whether they are Narrow band, Wide band or Broad band.

LMR systems initially use narrow band radio channels and may use trunking in order to share radio resources between multiple users in an optimized use of frequency. Wide band and broadband radio channels are generally used when higher data rates are needed for services such as file transfer, video, and telemedicine Analogue systems include the popular MPT1327. Below is a more detailed look at digital systems:

- ***Narrow band digital mobile systems***: TETRA, APCO 25, TETRAPOL and iDEN as listed and described in ITU-R document M.2014 and ITU-R 83/109E for LMR as well as DIMRS and IDRA. Other proprietary systems exist which are not standardized such as EDACS, FHMA. These systems are used in all types of terrain and coverage. They carry voice and data at rates up to 36 kbit/s.
- ***Wide band digital mobile systems*** are under development and are aimed at increasing the data rate. They are an evolution of the narrow band systems and are generally upward. Examples are: an evolution of the narrow band systems and are generally upward compatible. They are TAPS, TEDS in ETSI, APCO 34 and TETRAPOL in TIA. Some mobile public networks have developed a limited subset of LMR services like GSM/Pro and GSM R. Wide band is intended but not exclusively for urban areas where data traffic can be most critical. Data rates can go up to a few 100 kbit/s.

- ***Broad band digital mobile systems*** allowing very high data rates of a few megabits are under development for PPDR users and can be classified as follows: Body, Personal, Local, Metropolitan, and Wide Area Networks (BAN, PAN, LAN, MAN, WAN) depending on the coverage. Some technologies can already be used as WLAN – Wi-Fi but they still must be adapted to the users specific needs for example security concerns. It must be noted that these systems are mostly intended for hot spots emergency situations.

A subset of LMR services are offered on some public networks such as GSM, PSTN, and IP. The point to note here is that public networks are generally overloaded and end up being partially or completely destroyed in emergency and disaster situations. For this reason, these services are more appropriate for day-to-day operations and for some emergency situations.

These LMR technologies are robust against noise, and they offer the same coverage for voice and data irrespective of the type of terrain.

The equipment can be:

- Terminals such as portable handsets, mobiles, a data terminals.
- Radio Base stations.
- Switches.
- Gateways to other networks.
- Repeaters.
- Emergency control centres.

All these can be fully included in self powered containers which can be carried either by air or by road to the emergency site.

The range of PPDR reserved frequencies used by the different systems varies according to countries and systems which makes inter-operability difficult. Work is however ongoing in ITU to have the same frequencies designated worldwide or at least per region, as defined in the World Radio Conference WRC-03.

4.1.5 Interoperability/Inter working

Often different organizations have different telecommunication systems yet they are expected to coordinate operations and talk to each other at the emergency – disaster site. They also are expected to communicate with other local or remote users.

In order for critical users involved in disaster operations to obtain inter-operability the following measures should be taken:

- Use of the same technology in the same frequency band so as to make roaming from one network to another possible using the same terminal.
- Use of the same equipment in direct mode on the same frequency.
- Use of multi mode equipment handling different technologies in the same band. This is possible thanks to a new technology called Software Defined Radio (SDR).
- Use of multi band equipment in the same technology covering several radio frequency bands.

The mission critical users can inter work if:

- They can communicate through the emergency control centre of each mission critical users organization. Emergency operations are coordinated locally on the spot or remotely. This is done in the Emergency Control Centre which can be fixed or mobile, local or remote, in a vehicle, or in a shelter The emergency control centre user can monitor the on the spot users, he may have information on a computer screen where he may view the location of the users and vehicles on maps in real time He can also communicate with the on site users or the remote users.

- They can use gateways which are intermediate equipment to interconnect different technologies LMR, Satellite, GSM, public network.

It must be emphasized that in these situations of inter-operability and interworking, the services offered end-to-end can be a subset of those offered by the different networks separately. For example end-to-end security is no longer ensured if transcoding is needed at the gateway.

4.1.6 Wireless Private Area Networks

Private Area networks are just as can be noted from the name, private. These have a reserved licensed or un licensed frequency band for private use. These technologies have radio channels with a large frequency band of several MHz and belong to the broadband LMR family. There are different technologies offering different data rates, services, and distances of communication. The coverage depends on the type of antenna used, figures given for range, and frequency. Data rates are given only for indication.

Applications developed on top of the wireless private area networks standards allow the use of these private area networks for PPDR. They are classified according to their range as Local, Personal and Body Area Networks.

Wireless Local Area Networks (WLAN)

WLAN are radio links allowing very high data rates exchanges (between 10 Mbits /s and 100 Mbit/s) in direct mode between equipment such as portable computers, but with no or very little mobility. This equipment can also work in an ad hoc mode. This technology uses for instance the 2.5 GHz unlicensed frequency range or 5 GHz range. This requires one to be careful due to Potential interferences as several other systems are in this unlicensed frequency range.

Wireless LAN standard IEEE 802.11 (also called Wi-Fi) has many versions named a, b, c, and d. One has to check compatibility between equipments versions and the security level offered by each version used. The range is around 100 meters depending on the environment, such as the obstacles like walls It is very sensitive and easily affected by terrain features.

The data rates depend on the number of users and can decrease rapidly. With an increase in the number of users. Data rate cannot be guaranteed when other applications are running.ETSI HIPERLAN2 is another standard converging to IEEE 802.11 which includes a high level of Security and Quality of Service and hand over. However, mobility is very low.

Wireless Personal Area networks (PAN)

PAN are used between pieces of equipment in close proximity like a portable computer, a PDA and a printer for example. Infra-red and Blue tooth are examples of technology used. They allow short range data communications of a few meters, mainly for file access, file transfer, query. The frequency is in the range of 2.4 GHz and data rates are of a few 100 kbit/s. Mobility is not offered or very slow.

Wireless Body area networks (BAN)

BAN allow communications between different equipment that you wear on your clothes. Distances are very short and are around one meter, Technologies like Ultra Wide Band (UWB) are used. The frequency is in the range of 3.5 – 10 GHz and the data rates can go up to one Gbit/s.

UWB offers integrated 3D location service and suppers from slow mobility.

4.1.7 Coverage

These LMR technologies do not provide the same land size coverage. For example, a Wireless LAN network allows only a few hundred meters coverage while penetration for radio is variable, and Satellite radio is known to have a major drawback in not being able to provide coverage indoors. It must also be recalled that the higher the frequency band, the higher the possible data rate but the smaller the cell coverage.

Some systems can be configured from one cell to large national networks with many cells by adding a combination of Switches, and of Radio base stations. Repeaters are instrumental in extending the coverage area, while gateways make interconnection different telecommunication networks possible. It is also important to have some idea of the coverage size in order to avoid loss of communications.

As a general guideline, narrow band LMR technology offers coverage of one cell which is between 40 to 70 km in network mode, and a few kilometres in direct mode.

Wide band LMR technology can offer about the same coverage as narrow band using new antennas techniques such as MIMO. But generally speaking, coverage is smaller, and half the narrow band coverage. Broad band LMR offers smaller coverage, ranging from a few meters to a few kilometres.

In concluding this segment, it is fair to state that the figures given above are an estimate as coverage also depends on topographical factors.

4.2 Maritime Radio Service

The Maritime Radio Service uses frequencies on defined channels within the frequency bands allocated to this service. It is unlikely that a station of another service will need to communicate directly with a ship at sea, but the maritime radio service has, nevertheless, applications in disaster telecommunications. As its own emergency telecommunication system, the maritime service uses the Global Maritime Distress and Safety System (GMDSS). This service is only of use to ships and Marine Rescue centres for the purpose of safety of life at sea (SOLAS).

4.2.1 Maritime Networks

For short-range communications, typically within 20 km, the VHF band is used. The standard Distress Urgency and Safety frequency in the maritime VHF band is 156.8 MHz. By law, every ship is required to monitor this frequency 24 hours a day. In an emergency, it is recommended to first call the vessel on that frequency before moving to another channel to establish communication.

Ships may have an automatic selective call system called DSC (Digital selective calling), on VHF channel 70. To use this facility, the Maritime Mobile Service Indicator (MMSI) code of the ship is required. If this code is not known, the ship's name can be used in voice on VHF channel 16. In addition, coast stations must also have a MMSI. This code is assigned together with the station's call sign.

Another way to contact a ship if the MMSI code is not known is the use of an "all ships" code. This causes a text message to appear on the screens of communications terminals on board ships in range of the calling station. The originator will specify the desired ship, and both stations will switch to a voice channel.

While in port, a ship or boat may monitor a port operations channel. Once contact on a port frequency is established, the port radio station may assign a working channel.

A ship at sea may also be contacted through the shipping agent responsible for its cargo. This enterprise will be able to contact the shipping company operating the voyage, which will in turn have a reliable way of communication with the ship. The shipping line is likely to know the communications means available on board the specific vessel, and can assist with arrangements for direct contact.

4.2.2 Maritime Public Correspondence Stations

Ships at sea maintain contact with the shipping line by means of satellite telephone services such as Inmarsat, or through coastal radio stations. If the vessel is equipped with a satellite Telex terminal, then it may be possible to communicate directly with the ship by Telex. Ships also often have an e-mail address, usually through a storage and forward system including a mailbox on shore.

On HF Radio, many coast radio stations are set up for the purpose of public correspondence, offering phone patch service to PSTN phones. For long-range communications, HF radio frequencies are used.

Maritime Coast Stations traditionally accept disaster and emergency related traffic, even though the disaster relief station may be land rather than sea based. As with all radio systems, a license will be required from the country where the land station is operating. In an emergency situation, there has been flexibility on these issues, and a coast station might well accept to handle traffic from a station, which does not have an account with the respective service.

4.3 The Aeronautical Radio Service

The Aeronautical radio service has frequency bands allocated for communication with and among aircraft, and additional bands are allocated for Radio Navigation equipment such as used during instrument flight. A station intending to communicate with aircraft in flight needs “air band” radio equipment. Land Mobile Service equipment is technically incompatible with that used in the aeronautical band; this is not only due to the different frequency allocations, but because the aeronautical service on VHF uses amplitude modulation (AM), whereas FM is the standard on VHF in the Land Mobile Service.

4.3.1 Aeronautical Networks

Civil aircraft are usually fitted with VHF radios operating between 118-136 MHz, using the AM modulation system. This is the standard for air to ground and air to air communication. In addition, some long-range aircraft, (but not all), may be fitted with HF radio equipment using the Upper Side Band (USB) modulation system. By far most communication is performed using a single frequency in Simplex mode, without repeaters. The heights of aircraft mean that they are easy to communicate with, even at very great ranges.

The international standard emergency frequency is 121.5 MHz AM. Many high-flying aircraft monitor this frequency when they are en route. This frequency is also monitored by satellites, which can determine the position of a radio calling on this frequency. For this reason, 121.5 MHZ should only be used in the case of genuine life threatening emergencies. To contact an aircraft in flight without prior arrangement with the aircraft, calling on 121.5 MHz may get a reply, but this should be considered only as a last resort. Once contact has been made, both stations must immediately change to another working frequency.

Whenever possible, prior arrangements should be made when there is need to communicate with aircraft in flight. The local civil aviation authority should be asked for the allocation of a channel for such traffic, and respective information should be included in the agreement with the air carrier and in the briefings to the crew.

In disaster response operations, HF radio can play a key role in the airlift management. In such cases, the contract with the air carrier should specify that the aircraft is to be equipped for this type of communication. HF radios in the aeronautical service often feature a selective calling system (SELCAL). This works somewhat like a paging system and allows the crew to ignore calls not transmitted specifically to them. If a ground station does not have this capability, the flight crew needs to be instructed not to engage their SELCAL.

If no specific frequency for contact with disaster operations has been defined, 123.45 MHz is an option. Though not officially allocated to any purpose, it has come to be an unofficial “pilots’ chat frequency”. A pilot may not, however, be monitoring 121.5 MHz or 123.45 MHz, but rather a local or regional flight information frequency. Information about such channels can best be obtained from air traffic control centres in the region.

4.3.2 Aeronautical Public Correspondence Stations

The aeronautical service includes public correspondence stations, similar to those of the marine radio station previously described. All over the world, HF radio stations are established for the purpose of relaying flight operational information between pilots and their bases, and to provide reports to the respective control authorities. In addition, however, they also make phone patches to landline telephones for personal calls, such as home to family members. This service is charged against a credit card or an account.

For disaster communications, aeronautical public correspondence stations can be contacted for phone patch traffic in the same way as maritime correspondence stations. To facilitate this, relief organizations may wish to open an account with such stations in advance and they will then also receive information such as a frequency guide. In all cases frequencies in use for flight operations are to be avoided by other as these are reserved for aeronautical users.

4.3.3 NOTAM

When filing a flight plan, pilots are provided with Notices to Airmen (NOTAM), safety related messages, referring to the path of their intended flight. Such notices include updates on the navigation and other relevant information provided in charts and manuals. In the case of major disaster response activities with involvement of air operations, details about air drop sites, temporary airstrips and related communications arrangements may be published in a NOTAM.

4.3.4 Private Radio on Board Aircraft

Experience has shown that it is not a good solution to expect pilots to use a radio of the land mobile service. Land mobile FM radio equipment operates on other frequency bands other than aeronautical AM radio equipment, and additional equipment would have to be installed on board but this would be time consuming and would have implications with respect to air safety regulations.

A hand-held transceiver is hard to use in an aircraft, given the high noise levels in most light aircraft and even in some of the larger planes commonly used in airdrop operations. If such a link to the operations on the ground is inevitable, one crewmember should monitor this radio, independent of aeronautical radio traffic and use headphones. A skilled operator may then even succeed to get an extended range especially if the station is at a high making it possible to relay emergency traffic.

4.3.5 Special Considerations involving Communications with Aircraft

A station of the land mobile service must never, even accidentally, give the impression that the operator is a qualified air traffic controller, as this might be misleading. A ground station which is not providing official air traffic control needs to make this fact clear at all times. Pilots must know when they are in uncontrolled airspace, and apply the respective rules.

Communication with aircraft should preferably be conducted with the captain, who may also be called the pilot in command. Only the captain is authorized to make decisions such as whether an aircraft will take off or land, and the captain’s decision can in no case be overruled.

4.4 Location Services

Radio navigation systems have a complementary role in disaster communications. Hand-held equipment for personal use are available at low cost, and subscriptions or licenses are not required. The system most commonly used is the Global Positioning System (GPS), operated by the US Government. Available is also GLONASS, run by the Russian government, and an additional system, GALILEO, is being set up by Europe. GPS (and also the other mentioned systems) is using a set of satellites and ground stations. Some of the satellites must be in sight of the hand held in order to allow positioning. This is why this system works outdoor, and in open areas. There are however indoor systems such as UWB (Ultra Wide Band) that can be used.

The above-mentioned systems provide global coverage, and commercially available hand-held receivers have a position accuracy of about 50 meters. Their indication of altitude above mean sea level is somewhat less accurate. For special applications, equipment with higher accuracy is available at higher cost. In many emergency applications, affordability and simplicity may well be more important than seeking to obtain the highest accuracy. In disaster situations, position finding serves three main purposes which are outlined below. Speed and time can be computed.

Humanitarian personnel in the field are exposed to high safety and security risks. The provision of reliable communication links in combination with position information is therefore vital. Assistance to personnel in danger includes two separate elements: search, and rescue.

The search is the more time consuming and often more costly part of such response, and if the distressed person is able to report his or her position, this will enhance the speed and appropriateness of the response. Location services will help facilitate the searching process.

4.4.1 Automatic vehicle Location services

Periodic position reporting facilitates the provision of assistance and may at the same time provide essential information about potential hazards encountered by personnel at a disaster site. Positions can be read off from hand -held units in two ways, i.e. in coordinates, i.e. as Latitude and Longitude, or as a relative position. The use of coordinates requires that maps with respective grids be available, and that the operators be familiar with the use of the system. However, the exact locations on maps can be shown by using Global Information Systems (GIS).

Relative positions, the indication of direction and distance from or to pre-defined, fixed points, can be obtained from most hand-held GPS receivers. If an easily identifiable landmark is chosen as the reference point, this information can be more useful than coordinates, as it may be easier to interpret and even allows the use of a tourist or other less accurate map without coordinates.

Combinations of communications equipment and navigation systems, allow the automatic tracking of vehicles on a map displayed on a monitor screen in a dispatcher’s office. Similar equipment in hand-held form is available for the tracking of individual users.

Logistics Applications

Moving relief goods, supplies and equipment, is particularly difficult if drivers are not familiar with an area where road signs may not exist and language problems may furthermore hinder the acquisition of information. Knowing the coordinates of the destination, or its location in respect to a fixed reference point or landmark rather than just its name, can help to overcome these problems. Place names may be hard to write or pronounce, and are often duplicated within a close distance. Whenever possible, vehicles should be equipped with position locating equipment and drivers should receive training in its use.

Waypoints

Position finders may have a feature allowing the user to record his or her position. The unit will then allow the user to define this position as a waypoint. Storing such information along the route facilitates the return to any point passed previously. Others travelling the same route later can copy the waypoints to their equipment and follow the identified route. This will however require a systematic assignment of names to the waypoints.

4.4.2 Personal Locator Beacons (PLB)

A Personal Locator Beacon (PLB) is a body worn small radio transmitter designed to transmit positions, plus some information about the user, to a rescue centre. PLBs are intended primarily for the personal use by mountain climbers and yachtsmen. PLBs are more expensive than Emergency Location Transmitters (ELTs), but since ELTs are associated with aircraft and have limited accuracy, the PLB is recommended as personal equipment for field personnel.

When a specific button is pressed on the PLB, the position and the identity of the PLB is sent to the rescue centre via satellite. The voyage plan file is then associated with the PLB identity, and the contact details of the user's office can be recalled. The centre alerts the base of the PLB user or a rescue agency. It is the responsibility of the owner of the PLB to up-date the voyage plan regularly with the rescue centre. Such devices are valuable in cases of extreme isolation or when working in areas with high security risks.

4.5 The Enterprise private services

Enterprise systems are small-scale systems intended for use by businesses and organizations. Except for their small size, their structures are similar to those of the corresponding public systems to which they are inter connected through gateways. They can be wired or wireless.

Larger institutions often maintain their own enterprise systems over wide areas which can be transnational, between several sites.

In case of disaster, companies need to be able to be back to business quickly. Backing up their responsibility but they quickly must restore Telecommunications to be able to get back into business. They need to reconnect to the back up information systems, and need to be able to allow remote workers to run their business again.

4.5.1 The Private Branch Exchange (PBX)

This is one typical example of an enterprise system. It consists of a telephone switch on the owner's premises, usually connected to PSTN lines. Internal cabling connects the switch to extensions throughout the premises. Connections among the extensions of the PBX are therefore independent of any external network infrastructures.

Connection to the public networks and Internet is ensured by gateways.

Today, IPBX technology allows the use of IP and Voice over IP (VoIP) where the PABX is a software based technology running on Personal Computers acting as multimedia terminals and can be interconnected by wire or wireless. Voice and Data run on IP.

Mobility in the enterprise can be added with wireless technologies like WLAN Wi-Fi and /or the Digital Enhanced Cordless Telephones (DECT).

The CENTREX service is a PABX function offered by the public network itself, it then is vulnerable to disasters.

The Intranet is the own internal Internet of the company accessible by the internal wired or wireless multimedia personal computers. It may be connected to the outside through firewalls and can be accessed securely remotely by:

- **SOHO** which is the Small Office-Home Office using the Internet services through Virtual Private Networks (VPN).
- **ROBO** which is the Remote Office-Branch Office using the VPNs.

The Direct Dial-In (DDI) systems commonly used today reduce the need for switchboard operators by associating each extension with an external number. Thus, a caller from outside may be unaware that the called party is on an extension. At the same time, however, the functioning of the PBX even for internal connections may be affected by a disruption of the public network.

One significant advantage of PBX systems is that the owners keep control of the quality of service. Since they are paying for the capacity of the switch, they can decide to allow for the much greater traffic that a disaster can generate. Since their circuits will not be allocated for public use, they will not be contending for capacity.

A PBX will only work if it has power. Generally, switches have battery backup power for a few hours. If the regular power remains disrupted for a longer period, a back-up generator will be required. A PBX may take some time to reboot after power disruptions.

If a PBX becomes inoperable due to a power failure, a “fallback service” comes into play. With this system, certain pre-defined extensions are connected directly to incoming lines. In fallback mode, only these fallback phones will work, while all others will be inoperable. Permanent private links to other parts of the organization do not necessarily ensure immunity from failures by the public system. If any part of the public system is affected by a switch power failure, private lines may be disrupted as well. Connection by direct cable-connection, that does pass through elements of other networks, may overcome this problem.

A common solution to improve disaster resistance is to use microwave links and satellite links for longer distances. Microwave link systems should be considered if there is line-of-sight connection between premises.

4.6 Unlicensed Local and Wide Area Networks

Unlicensed networks are often used in case of emergency and disaster as they are private networks often separated from the public networks.

4.6.1 (Virtual) Private Networks

Many medium and large organizations operate their own network interconnecting computers for electronic mail service, data base accesses, and intranet. The servers of the company are connected to the office computers by means of a Local Area Network (LAN), which in some cases may cover various premises of an enterprise. Such an arrangement is known as a Wide Area Network (WAN).

The links can be wired or wireless locally or remotely.

Wired VPNs

LANs and WANs have switches called “routers”. Their function is to send traffic not intended for a local server over a long-range link to another router on different premises. A router can have more than one link to more than one off-site router. This adds redundancy, as alternative links may replace disrupted connections.

Business users may be located remotely at home or in Agencies which have to be connected securely to the company servers remotely.

VPNs are Virtual Private Networks set up on public networks offering a secured remote access. They allow private users to share public networks securely between them. Specific functions are needed on the public network to handle security and at the company premises to provide firewalls. Specific software is added at the remote end terminal in order to do a "secured tunnel" for communications end-to-end. In case of disaster they allow the user to work remotely and securely from home for example if offices are destroyed.

Wireless VPNs

Different solutions are operational which are replacing the wired solutions:

- DECT is a Digital Enhanced Cordless Telecommunication standard and wireless technology for corporate, business and commercial private communications. It replaces wired private telephones by cordless handsets and is unlicensed. Slow mobility is available. It is mainly used for voice but it can handle data. Security could be provided through encryption.
- Wi-Fi (IEEE 802.11) and Wi-MAX (IEEE 802.16) can respectively be used for short range and wide range broadband communications. ETSI HIPERMAN (these are <IIGHZ carriers, don't need line of sight, up to 15 miles range) and HIPER ACCESS (> IIGHZ carriers, needs line of sight connections, up to 5 miles range) can also be used.

4.7 Satellite Very Small Aperture Terminal (VSAT)

One way to improve the chances that an enterprise system will remain operational during a disaster, is to connect via satellite. This will make it free from both a failure by terrestrial infrastructure and congestion of the PSTN.

The acronym VSAT stands for "very small aperture terminals". The antennas determining the aperture typically range in size from less than one meter to 5 meters, depending on the frequency band used. They are mostly designed for fixed installation, but so-called "flyaway" systems are available for disaster recovery purposes. Further developments are expected to enhance their applications in disaster communications.

In general, subscribing to a VSAT service means the purchase of a group of channels for a fixed period. No other user will be sharing these channels, and the subscriber is guaranteed the use of these channels even when systems such as PSTN and mobile satellite are congested. This is a preferred alternative, but the cost is high and it may be economical only as part of a larger enterprise system. VSAT service is available from a number of commercial operators offering global or regional coverage. Services offered cover voice calls, fax, Internet access, and VPNs.

Alternatively, a demand assigned multiple access system (DAMA) can be used in case it should not be desirable to use a regular VSAT service as part of an enterprise system. DAMA permits access to bandwidth on a demand basis. The cost is likely to be lower, but there is a risk of not getting service when the demand on capacity is high.

If one is serious about reliable long-range communications, VSAT is a superior system. The terminal equipment must be protected from physical damage. The dish in particular should be placed where it is not exposed to flying debris during storms, while still maintaining its aim at the satellite. Following a storm or an earthquake an adjustment of the position of the antenna may be necessary, and special equipment in addition to the actual VSAT terminal is required for this.

VSAT systems connect the PBX directly at each end (location) by satellite link. This means immunity from failure by the ground services, as long as the earth station remains operational and has independent power. However, both the capital cost of the equipment and air-time charges requires serious consideration before a commitment is made. Another strategy is to use either satellite mobile phones, or fixed cellular terminals, as one of the outside lines. The terminal must have a standard 2-wire POTS interface in order to do this. When the terrestrial lines fail, the satphone can be used to initiate and receive calls.

Some institutions use private data networks for workstations. This is done to enable users to share file servers and printers. By far the most useful service provided is electronic mail (e-mail). A short-range system covering one building is called a Local Area Network (LAN). A network connecting different premises of the same institution is usually called a Wide Area Network (WAN).

4.8 Emerging technologies and trends

Technology is evolving very fast and emerging technologies are mainly in two main areas: the core network and the access network including inter-operability. Internet Protocol IP technology is being generalised in the core networks and data rates on the air are increasing to allow new applications like multimedia, video, and telemedicine.

The main ongoing developments are for services related to:

- Mobility
- Security
- Quality of Service (QoS)
- Inter-operability
- Data
- Voice, image and video coding

– ***Mobility*** is a major user requirement at high speed, allowing roaming from one network to another of different technologies. For example, if the user is under a LMR Narrow Band network with urban coverage and he moves out to a satellite wide area coverage and then to an in-building WLAN network, he wants continuity of service without any specific action by him. Hand over to maintain the communication is a necessity. These features are studied in large worldwide organisations such as the WWRF (World Wide Research Forum).

– ***Security*** is also an increasing user requirement in order to identify the user, to secure the information end-to-end. For example, IP develops a version called IP V6 which integrates security protocols. End-to-end security over heterogeneous networks is being developed under Secure Communication Interoperability Protocol (SCIP).

– ***Services*** offered to the user tend to become independent of the technology used, and will be seen by the user as similar whatever the standard is in use. The reason is that for private services, standards for access are many in both wireless and wired form and there is no convergence towards one unique access standard.

– ***Quality of Service*** is a difficult issue with priority schemes, and real time data. The core network tends to be IP based where Voice is transmitted over IP (VoIP) requiring specific Quality of service (QoS).

– ***Inter-operability*** is a key objective, allowing roaming, (service) portability, priority schemes, end-to-end security, guaranteed QoS. The Next Generation Network (NGN) developments in ITU will address this issue.

Software Defined Radio (SDR) developments intend to allow multi-mode terminals to be able to handle different radio standards seamlessly.

– ***Data*** rates will increase with new wireless standards:

  • ***Wide band*** is being developed for the four narrow band systems referred in ITU:

    a) TETRA develops two wide band ETSI standards called TAPS and TEDS. TAPS is an evolution of 3GPP/$3GPP_2$, Enhanced Data Rates for GSM Evolution (EDGE), GPRS (General Packet Radio Service) and is for data only. TEDS is an evolution of TETRA narrow band for voice and data while APCO25 and TETRAPOL develop new wide band solutions in TIA TR8.

  • ***Broad band*** is being developed in several projects:

    a) The partnership project ETSI, TIA, MESA (Mobility for Emergency and Safety Applications) develops a "system of systems" for hotspot where the network is ad hoc (all nodes are mobile) and several communication protocols are involved. It will review the broadband air interfaces in order to select and get the adaptations of the existing ones to the private users' needs. Eventually it will develop a specific one.

    b) The IEEE 802.16 (WiMAX) and IEEE 802.20 Mobile Broadband Wireless Access (MBWA) specify (mobile) broadband wireless access for large coverage.

    c) The Ultra Wide band UWB forum specifies the air interface evolutions including 3D position location.

Voice coding technologies evolve to transmit better quality voice in smaller data rates and compression video algorithms also evolve to require smaller data rates.

Public networks implement some of the Emergency Telecommunications which will then be available and can be used in emergency situations:

- EMTEL is the emergency Telecommunications project in ETSI which defines the emergency call with location (E112), and standardizes the interfaces between authorities and citizens, between authorities themselves, and between Public Safety Access Points (PSAPs).
- Public ProTection and Disaster Relief (PPDR) in ITU develops the International Emergency Preference Scheme (IEPS), as dealt with in ITU-T Recommendation E. 106.
- Internet Emergency Preparedness (IEPREP) in IETF develops the Internet Emergency preparedness to implement the priority scheme.
- 3GPP develops the Priority Access Service (PAS) in order to allow to implement priority, authentication features on the air. Fast call set up and Group call will also be implemented.
- GETS (Government Emergency Telecommunications Service) group develops the authentication and priority scheme for wired links.

It must be noted that:

a) **PABX** functions are implemented more and more in the public network called CENTREX (CENTRAL Exchange) and become full IP solutions for voice and data.

b) **Satellite** networks like IRRIDIUM and GLOBALSTAR implement mobile solutions with a whole range of satellites which can be used also for emergency telecommunications.

CHAPTER 5

The Amateur Radio Service

5 Introduction

Among the Radio Services defined in the Radio Regulations (RR), and regulated by this international treaty governing all aspects of radio communication, the Amateur Radio Service (RR S1.56, Geneva 1998) is the most flexible one. Using modes from Morse code and voice to television and to most advanced data modes, communicating in allocated frequency bands ranging from 136 kHz (longwave) throughout the HF (shortwave), VHF and UHF all the way into the GHz range, Amateur radio was throughout its history and still is today at the forefront of technology. Amateur radio operators form a global (long range) network, but they are equally at home when it comes to local (short range) or even satellite communications. Most of all, however, they acquire their skills because of their personal interest in the subject of radio communications, and they are the experts in achieving extraordinary results with whatever limited resources available.

These characteristics make the Amateur Radio Service a unique asset for communications under the often extreme conditions encountered in emergency and disaster response. Its technical information and training material covers the most critical aspects of emergency Telecommunications and much of part 3, the technical annex of this handbook, is based on the experience gained during more than 90 years of public service communications. The operational characteristics of many elements of emergency radio Telecommunications are best explained on the example of the amateur radio service. Most of the content of Chapter5 is thus applicable to all radio communication services utilized in response to emergencies and disasters.

The amateur radio service should not be confused with “citizens band” or “personal radio” operations, which are forms of public networks and described in Chapter 2 of part 2 of this handbook. Amateur radio operators have to pass an examination given by or on behalf of the respective national administration prior to the issuance of an individual, personal operator’s license.

The *International Amateur Radio Union (IARU)* is the federation of the national amateur radio associations existing in most countries. It represents the interests of the amateur radio service in the International Telecommunication Union (ITU) and in international Conferences. The IARU supports emergency telecommunication applications of its members and ensures the exchange of information and experience among them.

5.1 The Roles of the Amateur Radio Service in Emergency Telecommunications

Its wide scope of activities and of the skills of amateur radio operators make the amateur radio service a valuable asset in practically all sectors of emergency telecommunications. The following few points characterize this service:

- It has a large number of operational amateur radio stations in all regions and almost all countries of the world, providing a network which is independent from any other. It has in many cases provided the first and often for a long time only link with areas affected by disaster. Examples for this go back to the early days of radio, but are also found in most recent events, such as the role played when hurricanes hit on islands in the Caribbean in 2004.

- Their skills make amateur radio operators a prime human resource for emergency telecommunications. Many operators apply their skills and experience in the service of humanitarian assistance, be it temporarily as volunteers with governmental or non-governmental organizations, or as emergency telecommunication professionals with units of international organizations and other disaster response institutions.
- The training programmes and emergency simulation exercises developed by some of the national amateur radio societies are applicable to all sectors of emergency Telecommunications and can be adapted for training of all potential users of telecommunication in emergency situations.
- The technical documentation, literature and electronic resources, available for the amateur radio service, are unique resources for information on how to solve problems with often very limited and possibly improvised means.

The importance of the amateur radio service in emergency Telecommunications has been recognized in many documents and was reconfirmed by the World Radiocommunication Conference WRC-2003 (Geneva, 2003), which modified article 25 of the Radio Regulations, facilitating emergency operations of amateur radio stations and related training of operators, and encouraging all States, to reflect these changes in their national regulations.

5.2 Amateur Radio Networks and their Ranges

Three types of radio networks are typical for the amateur radio services, and all three are encountered in major disaster response operations.

5.2.1 Short-range networks

Typically provide operational or tactical communications at the site of a disaster and with the surrounding areas. They can include fixed, mobile and portable equipment and are mostly using frequencies in the VHF and UHF spectrum. The amateur radio service has frequency allocations as follows:

- 50-54 MHz (also known as the 6 meter band, but in some regions only 50-52 MHz is available due to restrictions). This band provides good ground wave propagation beyond line-of sight covering up to about 100 km. Depending on propagation conditions, this band can be subject to interferences from sky-wave signals.
- 144-148 MHz (2 meter band, restricted in some regions only to 144-146 MHz).This band is the best choice for local communication between hand-held transceivers within coverage of up to about 10 km or up to about 30 km with directional antennas. Radio amateurs are most likely to have fixed, mobile and hand-held transceivers for this band. Communication over a wider area is possible using a repeater installed in a favourable location with sufficient height over average terrain. Repeaters can furthermore be equipped with telephone interconnection devices (known as auto patch).
- 420-450 MHz (70 centimetre band, available in some regions only within 430-440 MHz). This band covers ranges shorter than those for the 2-meter band but otherwise has similar characteristics, including the possibility to use repeaters.
- Several bands in the range between 1 and 50 GHz. These bands have applications primarily for broadband, and point-to-point data links

5.2.2 Medium-range Networks

Typically provide communication from the site of an event to organisational and administrative centres outside an affected area, or to headquarters of response providers in neighbouring countries. They also ensure communication with vehicles, vessels and aircraft operating outside the coverage of available VHF or UHF networks. Communication at medium distances of 100-500 km may be accomplished by near-vertical-incidence sky wave (NVIS) propagation at the lower HF frequencies of up to about 7 MHz. The band characteristics are as follows:

- 1800-2000 kHz (160 meter band): This band is most useful at nightime and during low solar activity. Under field conditions, the dimensions of antennas may restrict the use of this band, which is also frequently affected by atmospheric noise, particularly in the tropical zone.
- 3500-4000 kHz (80 meter band, only available in some regions within 3500-3800 kHz): This is an excellent nightime band. Like all frequency ranges below about 5 MHz it can be subject to high atmospheric noise.
- 7000-7300 kHz (40 meter band, in some regions available within 7000-7100 kHz): This is an excellent daytime band for near-vertical-incidence sky wave paths. At the higher latitudes, especially during periods of low sunspot activity, lower frequencies may be preferable. In view of this band’s importance for amateur radio emergency communications, the World Radiocommunication Conference WRC-03 (Geneva, 2003) has initiated the process to increase the allocations in regions so far limiting the band to less than 300 kHz, and some national administrations have already implemented an increase from 100 to 200 kHz).
- In the 5 MHz range, several national administrations have allocated fixed frequencies (channels) for amateur radio emergency traffic and related training. The 5 MHz range allows the most reliable links in the medium range during 24 hours per day and under most propagation conditions.

5.2.3 Long-range networks

Ensure the links with headquarters of international emergency and disaster response providers. They also serve as backup connections between offices of such institutions in different countries or on different continents. Amateur stations routinely communicate over long distances, typically beyond 500 km, using oblique-incidence sky wave propagation in HF. The characteristics of the respective bands are as follows:

- 3500-4000 kHz (80 meter band, available in some regions within 3500-3800 kHz): This is an excellent nightime band, particularly during low sunspot activity. However, communications may be affected by high atmospheric noise, particularly at low latitudes.
- 7000-7300 kHz (40 meter band, which is available in some regions within 7000-7100 kHz): This band is a good choice for up to around 500km during daytime and for long distances, including intercontinental paths, at nightime.
- 10100-10150 kHz (30 meter band): The 30-m band has good day and night propagation and can be used for data communication. It is not currently used for voice because of its limited width.
- 14000-14350 kHz (20 meter band): The 20-m band is the common choice for the daytime communication over long distances.
- Propagation on the following bands is suitable for longer distances during daytime and high sunspot activity:
  - 18068-18168 kHz (17 meter band)
  - 21000-21450 kHz (15 meter band)
  - 24890-24990 kHz (12 meter band)
  - 28000-29700 kHz (10 meter band)

5.2.4 Amateur radio satellites

Can serve as an alternative to HF sky wave links for medium and long-range communication. The amateur radio service does not at this stage operate geostationary satellites or interlinked satellite constellations. Its satellites not therefore provide continuous global coverage, but in some cases the storage-and-forward capability allows the forwarding of messages between stations without simultaneous access. Further developments in the Amateur Radio Satellite service is be expected to increase its applications in emergency telecommunications. The amateur radio satellite service uses specific frequencies within the allocated bands, mostly in the VHF range and above. Communication over some satellites is possible with low power equipment and with low gain antennas.

5.3 Operating Frequencies

Different from most other services, the amateur radio service enjoys the privilege of band allocations, the use of which is left to the self regulation of the amateur radio associations. Flexible use of the rare commodity of frequency spectrum thus allows particular flexibility in operations.

The allocated frequency bands are described and their characteristics given in 5.2. above. The choice of the most suitable frequency band and of the most convenient channel within the selected band is, given in the band plans prepared by the IARU, and choice is prerogative of each individual operator. In emergency situations, any radio station can establish contact on any frequency that it can technically operate on. In such a situation, stations of the amateur radio service can be contacted, or can initiate contacts with, stations of other services such as the maritime or the land fixed or mobile service.

In some countries, specific frequencies (channels) have been defined as emergency frequencies. Due to the dynamic use of frequencies within the allocated amateur radio bands, a permanent reservation of such channels outside times of acute emergencies is however problematic and a restrictive policy in respect to the use of the available spectrum might prove counter-productive. In some cases, national administrations have assigned frequencies adjacent to the allocated amateur radio bands to disaster response organizations, thus facilitating communications with stations of this service and allowing the use of amateur radio equipment and antennas with ease.

5.4 Communication Modes

Stations of the amateur radio service are authorized to use a wide variety of transmission modes, provided the allocated frequency bands, IARU and national band plans, and national regulations provide the bandwidth needed for the particular mode chosen. The selection of the appropriate mode in any specific case depends on numerous factors, including volume and nature of the information to be transmitted, technical specifications of the equipment available and the quality of the communications link. The following communication modes are most commonly used in the amateur radio service as well as in other services such as the maritime and the fixed and land mobile services:

- ***Radio Telegraphy:*** Use of the international *Morse code* is still widespread throughout the amateur services and can play an important role in disaster communications, particularly when only elementary equipment or low transmitter power are available. The use of Morse code also helps to overcome language barriers in international telecommunications. Its effective use requires operators with skills greater than the minimum licensing requirements.
- ***Data communications:*** These have the advantage of accuracy and of creating records for later reference. Messages can be stored in computer memory or on paper. Digital data communication requires additional equipment such as a desktop or laptop computer communication interface, processor or modem. The communication processor performs encoding and decoding, breaks the data into transmission blocks for transmission and restores incoming data into a stream. It also compensates for transmission impairments, compresses and decompresses data, and handles analogue-to-digital and digital-to-analogue conversions.

- ***HF (shortwave) links:*** The Amateur Radio Service uses a variety of data communications *protocols*. PACTOR II and III is one of the common modes available for amateur disaster communications and is also used on emergency networks of the United Nations and other organizations. Depending on the specific requirements of a network, other data modes are available, among them PSK-31, a real-time data communications mode, replacing the radio teletype (RTTY) links used in the past.

- ***Packet radio:*** This is a powerful tool for traffic handling. Text messages can be prepared and edited off-line then transmitted in shortest time, thus reducing congestion on busy traffic channels. Packet radio can be used by fixed as well as mobile or portable stations. This is an error-correcting mode and uses the radio spectrum efficiently. It allows multiple communications on the same frequency at the same time by using time-shifting communication. By storing messages on packet bulletin boards (PBBS) or mailboxes, stations can communicate with other stations not on the air at the time. Packet radio operates over permanently established or temporary networks. The AX.25 packet radio protocol is a reliable and efficient method of data communications at rates of 1 200-9 600 bit/s, depending on the equipment used.

- ***Suppressed-Carrier Single-Sideband (SSB) radiotelephony:*** This is the most commonly used mode for HF (shortwave) voice radio links. Due to its high efficiency and narrow bandwidth, SSB has replaced the previously used amplitude modulation (AM) in all services using HF except the broadcast service. It can however only be received by equipment designed for this mode and not by ordinary broadcast receivers. Due to the narrow bandwidth, the voice signal might be somewhat difficult to understand for untrained ears. On frequency ranges, where more bandwidth is available, another voice mode is more common.

- ***Frequency modulation:*** This is used in local and regional fixed and mobile networks. It has the advantages of high audio quality and resistance against interference such as caused by vehicle engines and is therefore the communication mode of choice on local VHF and UHF networks.

- ***Image communications:*** The amateur radio Service supports two more modes that make the transmission of facsimile and television possible. In emergency situations, television images can provide valuable information from the site of an event. Analogue image communication modes are now generally replaced by the transmission of images as digital files using data modes.

5.5 Repeater Stations

Repeater Stations or Relays are used to extend the communication range of VHF and UHF stations. Positioned in elevated locations they allow communication between fixed or mobile stations separated by obstructions such as mountains or tall buildings when operating in an urban environment. A repeater station receives on one channel and transmits on a different frequency, usually within the same band. Filters, so called duplexers, prevent interference between its simultaneously operating transmitter and the receiver. Important considerations for the location of a repeater station are not only its geographical coverage, but also its power requirements. Rechargeable batteries, supplied from solar cells or wind generators are the most common solutions.

Special forms of repeaters are the analogue or digital transponders used in the amateur radio satellite service. Like terrestrial relays, they re-transmit a received signal on a different frequency; their geographical coverage or “footprint” is however much larger. Transponders on board of balloons or aircraft have successfully been used by radio amateurs and might in the future become available as an additional tool for emergency telecommunications. Digital transponders have the capability to store received messages, and to re-transmit them on demand, at the time when the receiving station is within their range.

5.6 The Organization of Amateur Radio Emergency Service

Amateur radio Service is a continuous activity. At any given time, at least some networks and operators of this service are available and can assume a role in emergency Telecommunications without delay. Additional resources can be mobilized on very short notice. For an efficient application of the service to emergency and disaster response, a higher degree of preparedness, including training, exercises and mobilization procedures, is desirable. Cooperation with the International Telecommunication Union has facilitated the training of some radio amateurs on the African continent in the past.

The structures of cooperation between the amateur radio service and the national authorities, emergency services and disaster response providers, depend on the situation in each country. The outline presented in the following sections is mostly based on the concepts used in the USA. The general principles should however be applicable in most parts of the world. In all cases, decisive factors include the number of amateur radio stations involved and the number of certified operators, as well as the structures of national response mechanisms.

5.6.1 The Amateur Radio Emergency Service (ARES) Groups

Amateur Radio Emergency Service Groups, in several countries known as ARES, consist of licensed amateurs who have voluntarily registered their qualifications and equipment for communications duty in the public interest. All licensed amateurs are eligible for membership in the ARES. Members of ARES groups either use their own personal emergency-powered equipment, or operate equipment that the group has acquired and maintains specifically for emergency telecommunications. The outline of standard ARES procedures given in the following section may also serve as a guideline for emergency Telecommunications support teams in general. The following important points must be noted:

- *Preparedness* requires, that team members are familiar with the functions they are expected to assume and prepared to do on shortest notice. Credentials should be provided for recognition by local authorities. If possible, an ARES activation should start with an operational and a technical briefing, based on information received from the requesting authority and supplemented by reports from amateur radio, media, and other sources. The briefing must include an overview of identified equipment and manpower requirements, hierarchical structures, ARES contacts, and conditions to be expected in the affected area.
- *Travel time* spent on the way to a disaster-affected location should be used for review of the situation with the team. The review should include task assignments, checklists, affected area profile, mission disaster relief plan, strengths and weaknesses of previous and current responses, maps, technical documents, contact lists, tactical operation procedures, and response team requirements.
- *Upon arrival*, team leaders should check with local ARES officials and obtain information on frequencies in use, current actions, available personnel, communication and computer equipment, and support facilities. The ARES plan in effect for the specific disaster should be obtained. Priority should be given to the establishment of an initial intra-team communication network and HF or VHF links to the home location. Team leaders should meet with served agencies, amateur radio clubs' communications staff, local communications authorities and others as needed to obtain information and coordinate the use of frequencies. Communication site selections should take into account team requirements and local constraints.

- *During operations* team leaders should continuously assess the operational status of regular communication facilities and of the networks of other response teams, to coordinate operations and avoid duplications. Proper safety and security procedures must be followed. Periodic reviews of communication effectiveness should be conducted with served units and communication personnel.
- *An exit strategy* for amateur communicators needs to be in place from the beginning of an operation. It needs to be negotiated with served agencies and host officials in time. To obtain volunteers' commitment to travel and participate, they must be assured that there will be an end to their commitment. Leaders must coordinate with served agencies in determining when equipment and personnel are no longer needed. A demobilization plan needs to contain clear definitions on the handover of responsibilities. A debriefing should be conducted at the earliest possible time and might include individual performance evaluations. Problems stemming from personality conflicts should however preferably be addressed and resolved outside of formal reports, as they provide distractions to the reports. Equipment should be accounted for. Lessons learned need to be documented and be made available for broader review, comments and use in future training and preparedness activities.
- *Standard Operational Procedures (SOP)* are a key element in all emergency operations. In emergency Telecommunications such SPO need to be in place in particular on message format and handling, the use of simplex channels, repeater operations, and on station identification. Following such standard principles of operations is preferable to the introduction of new and possibly not previously exercised ad hoc procedures.
- *Amateur radio operators do not need training on basic communication skills* or general technical matters. They do however need to become familiar with the operational environment and with the partners they serve with. Proper disaster training needs to prepare the participants for systematic and accurate work in even the most chaotic environment. The moto should be, "It's people, who communicate, not radios".
- *Training* should focus on the following subjects: emergency telecommunications, traffic handling, net or repeater operation, and technical knowledge. Practical on-the-air activities, such as a Field Day or a Simulated Emergency Test (SET) offer training opportunities on a nationwide basis for individuals and groups and reveal weak areas in which more training or improvements to equipment are needed. In addition, drills and tests can be designed specifically to check the readiness and the reliability of emergency equipment that is not permanently in use. A drill or test that includes interest and practical value makes a group motivated to participate because it is purpose or goal oriented. In order to present a realistic scenario, training should be centred on a simulated disaster situation and, if possible, in combination with training exercises of other partners in emergency assistance.
- *Exercises* should include the activation of emergency networks; including the assignment of mobile stations to served agencies, the originating and processing of messages and the use of emergency-powered equipment. As warranted by traffic loads, liaison stations may need to be assigned to receiving traffic on a local network and relay it to outside destinations. To a large degree, the value of any exercise depends on its careful evaluation and on the application of lessons learned.
- *Field Day (FD) events* are a traditional form of exercise with a competitive character. During a field day, radio amateurs operate under simulated emergency conditions. A premium is placed on operating skills and adapting equipment to meet the challenges of emergency conditions and related logistics. Amateurs are used to operate stations capable of short, medium and long-range communications at almost any place and under difficult conditions. Essential is the use of other sources of energy other than commercial power. Use of generators, batteries, wind, and solar power is an important element in this whole exercise.

- *Simulated Emergency Test (SET)* builds emergency-communications skills. SET help operators in gaining communication experience in using standard procedures under simulated emergency conditions, and to experiment with some new concepts. Issues to remember about SET are that it:
  - determines strong points, capabilities and limitations in providing emergency communications to improve the response to a real emergency,
  - provides a demonstration, to served agencies and the public through the news media, of the value of Amateur radio, particularly in time of need,
  - exercises VHF-to-HF interfaces at the local level,
  - encourages an increased use of digital modes for handling high-volume traffic and point-to-point welfare messages,
  - strengthens the cooperation between amateur radio operators, users and disaster response organizations, and
  - focuses energies on ARES communications at the local level, on the use and recognition of tactical communications, and on the procedures for formal message traffic.
- *Traffic handling* includes the forwarding of messages from and to others outside the circle of amateur radio operators. Where national regulations allow, amateurs radio stations can handle such third party traffic both in routine situations and in times of disaster. Such public-service communications make amateur radio a valuable public resource and provide the best training for emergency telecommunications. The traffic network structures differ in the various countries, but the outline given in the following section may serve as an example:
  - *The Tactical Net*work is the frontline net activated during an incident. Such a net is often used by a single government agency to coordinate with amateur radio operations within their jurisdiction. There may be several tactical nets in operation for a single incident depending on the volume of traffic and number of agencies involved. Communications typically include both traffic handling and resource mobilization.
  - A *Resource Network* may be needed to recruit operators and equipment in support of operations on the Tactical Networks in large scale operations. As an incident requires more operators or equipment, the Resource Network evolves as a check-in place for volunteers to register and to receive their assignments.
  - A *Command Network* may become necessary if the dimension of a disaster response operation increases and more partners become involved in the incident. This network allows incident managers to communicate with each other to resolve inter- or intra-agency problems, particularly between cities, or within larger operational areas. It is conceivable, that such a network becomes overloaded over passage of time due to high traffic volume. It may consequently be necessary to create multiple command nets to cover all requirements.
  - *Closed networks* operate with a network control station responsible for overseeing the flow of communications. When the amount of traffic is low or sporadic, such a network control function may not be required. In an open network, participating stations simply announce their presence and remain on standby. If they have traffic, they directly call another station after checking that the channel is not presently occupied. In a closed network, any station wishing to establish a contact, calls the network control station for authorization. The network

control station might either authorize direct communication on the calling channel or assign a working channel to the respective stations. Upon completion of their communication, the participating stations report to the network control station on the main frequency. For this type of operation, it is essential that the network control station keeps a record of the activities of all stations and of working channels assigned. This will ensure that all stations remain continuously available for urgent messages.

– *Network discipline* and message-handling procedures are fundamental concepts of amateur radio network operation. Training should involve as many different operators as possible in network control station and other functions. The basically informal character of amateur radio operations makes it necessary to pay particular attention to the procedures for handling messages within and among the different networks and between the amateur radio service and other networks. Permanently established traffic networks are ideal means to ensure efficient message handling during an emergency.

– *An Emergency Operations Centre (EOC) or Command Post (CP)* is usually established by the authorities in charge of a disaster response operation. The CP primarily controls the initial activities in emergency and disaster situations, and is typically a self-starting, spontaneously established entity. The initial functions of the CP are to assess the situation, to report to a dispatcher and to identify and request appropriate resources. The Emergency Operations Centre (EOC) responds to requests from a CP by dispatching equipment and personnel, anticipating needs to provide further support and assistance and pre-positioning additional resources in a staging area. If the situation at the site of the event changes, the CP provides the EOC with an update and maintains control until the arrival of additional or specialized resources. By being located outside the perimeter of potential danger, the EOC can use any appropriate type of communications, concentrate on gathering data from all partners involved, and mobilize and dispatch the requested means of response.

– *The format* chosen to handle traffic on a network depends on operational conditions and its selection requires knowledge of the possibilities and limitations of the Telecommunications resources available. Tactical traffic supports the initial response operations in an emergency situation, typically involving few operators within a limited area. Tactical traffic, even though unformatted and seldom written, is particularly important when different organizational entities are getting involved in the operations. The use of one VHF or UHF calling frequency, including possibly the use of repeaters and network frequencies, characterize most typical tactical communications. One way to make tactical network operation transparent is to use tactical call-signs, i.e. words that describe a function, location or agency, rather than call-signs of the Amateur Radio Service. When operators change shifts or locations, the set of tactical calls remains the same. Call-signs like “Event Headquarters”, “Network Control” or “Weather Centre” promote efficiency and coordination in public-service communication activities. Amateur radio stations must however identify their stations at regular intervals with the assigned call signs.

– *Formal message traffic* is handled in a standard message format and primarily on permanently or temporarily established HF and VHF networks. There may be links between local, regional and international networks. When accuracy is more important than speed, formatting a message before it is transmitted increases the accuracy of the information transmitted. Packet radio is a preferred mode for the handling of formal messages. It also allows the forwarding of traffic between various networks with a minimum of re-formatting, thus ensuring accuracy.

Health and Welfare Traffic is, for those affected by a disaster, of highest importance. The need to communicate may be less dramatic than the loss of one's home, but just in extreme situations a loss of such basic commodities as access to a telephone is felt very much. Secondary to the priority traffic of emergency response services, the handling of welfare traffic as a service to the public and often originating from places evacuees at shelters or at hospitals is a task of the amateur radio service. Incoming health-and-welfare traffic should always only be handled after all emergency and priority traffic is cleared. Answering welfare inquiries can take time and questions might have already been answered through restored circuits. Stations at shelters, acting as network control stations, may exchange information on the HF bands directly with destination areas as propagation permits. They may also handle formal traffic through outside operators.

5.6.2 Typical Situations for Amateur Radio Emergency Communications

Despite the wide spectrum of requirements in a disaster situation, amateur radio operators should neither seek nor accept any duties other than those foreseen in the agreements on their status in an emergency operation. Volunteer communicators are not the decision makers in relief operations, and they are not normally qualified or authorized to take on responsibilities beyond those of communicators. The amateur radio service provides communications in support of those who provide the actual emergency response. Operators with skills in other fields such as search and rescue or first aid and affiliation to respective organizations need to decide in advance, which role they wish to accept within an operation.

- *Initial Emergency Alerts* may originate from individual amateur radio operators using their equipment and networks to bring an incident to the attention of the competent institutional emergency services. Using their VHF hand-held and mobile radios, radio amateurs might activate a repeater autopatch code, connecting a repeater to a telephone line. By dialling an emergency number, the operator has direct access to the respective services.
- In *Search and Rescue* operations, operators of the amateur radio service can reinforce the professional teams by increasing their communication capabilities but also by making and reporting own observations.
- *Hospitals* and similar establishments might in the aftermath of a disaster be without communications. This affects in particular the coordination among various providers of health services. Inside a hospital, ARES operators might temporarily serve as replacement to a paging system and maintain critical interdepartmental communications. Local amateur radio emergency groups should prepare in advance for such hospital communications and ARES groups should be familiar with the communication structures they might be asked to replace.
- *Chemical Spills* and other incidents involving hazardous materials may require the evacuation of residents and the coordination between the disaster site and the evacuation sites or shelters. The term "hazardous materials" (HAZMAT) refers to substances or materials which, if released in an uncontrolled manner, are harmful to people, animals, crops, water systems, or other elements of the environment. The list includes explosives, flammable and combustible gases, liquids and solid material, oxidizing, poisonous and infectious substances, radioactive materials, and corrosives. The initial problem in an incident with such materials is the determination of the nature and quantity of the chemicals involved. Various institutions maintain registers of hazardous materials in order to provide rapid indications of the hazards associated with potentially dangerous substances, but this most essential information will not be available unless communications can be established immediately. ARES operators may be asked to establish communications with such institutions. Information on potential and real information sources, as well as the standard markings of hazardous goods and basic safety procedures should therefore be included in the briefing material of ARES groups.

5.7 Third Party Communications in the Amateur Radio Service

Under normal circumstances an, amateur radio communication connects two parties communicating with each other. In emergency situations, operators will be requested to pass a message on behalf of a third party, a person or organization that is not necessarily present at the radio station.

From the regulatory point of view, two cases need to be distinguished: If both sides of the radio link are within a single country, third party traffic is subject to national regulations. If the message originates from an amateur radio in one country but is destined for a third party in another country, the Radio Regulations (RR) of the ITU concerning international third party traffic need to be respected. They provide that, in the Amateur Radio Service such traffic is allowed only if a bilateral agreement exists between the national Administrations concerned, or in case of emergency operations and training for such. Some Administrations may tolerate third party traffic or enter into temporary agreements if this type of traffic is in public interest, such as when other communication channels have been disrupted.

Operators should be aware that it is a general rule for all radio communications that when safety of life and property is at stake, administrative regulations can be temporarily waived. Article 25 of the Radio Regulations, governing the amateur radio service, has been revised by the World Radiocommunication Conference (WRC-03, Geneva, 2003) to the effect, that third party traffic is authorized for emergency operations and related training.

5.8 Optimising the Use of the Amateur Radio Service as a Public Service

The amateur radio service is occasionally considered as a thing of the past. This mistaken impression may stem from its name, which distinguishes it from all other radio services. It is however just this distinction, which expresses the value of this service in times when other communication capabilities are lost. The amateur radio operator is able to communicate using the widest variety of tools, and the amateur radio service often makes the difference between “no communication” and a maybe less user-friendly, but functioning communications. The fact that personal mobile communications are becoming readily available to the majority of the people worldwide, does not make their users skilled communicators; they are consumers, and not active participants. In an emergency situation, communication such as that provided by radio amateurs continues to play a critical role. It is up to the national administrations and to the providers of emergency response, to keep making best use of this time proven, invaluable resource.

CHAPTER 6

Broadcasting

6.1 Broadcasting

Broadcast (Radio and TV) is a very powerful means to reach large sections of the public with information and advice. National regulations and customs differ from place to place as to how information is given to the public.

In some cases, the broadcaster allows only content created by their own staff, to be transmitted. Own presenters, principally news anchors, will make the announcements over the air. They will initiate a “News Flash” for this purpose, and interrupt normal programming. Journalists like to establish links with “Reliable Sources” in advance, so that they know who is the spokesperson for the government.

Governments need to understand that journalists are trained to gather and then spread information, so if government spokesmen are giving out old and inaccurate information, journalists tend to dig and search information by themselves. To the citizens, the government will look slow and incompetent if all the details only come from the independent journalist. Since this may backfire after the event, it is important to engage with the media very early providing as accurate and timely information as possible.

Today, there is also a tendency for news journalist to want to appear to be “on the spot”. They often quote commentators close to the scene of the event rather than those in the studio located in the capital. For this reason, there is need for government to move with this trend by setting up “media cities” close to the incident, but out of the “Hot Zone'. The media need locations for their cameras (preferably one where they can see the Hot Zone) and where their communications trucks can be safety sited. Creating a place where well informed spokespersons are located, and there is food, drink, power and broadband telecoms encourages the media to get its information from the right sources rather that from some uniformed and unreliable sources.

The Emergency Alert System (EAS), as is used in the USA is an example of another approach. By government mandate or voluntary participation, broadcasting stations are connected to an EAS data communications system. If there is an alert, a data burst is sent to the TV or radio stations in the countries concerned. In most cases, the running programme is interrupted by a data burst transmitted over the air. People can buy a decoder to read what the message says. Even radios playing pre-recorded music are interrupted with a special alert message. Today, most countries use this facility to warn drivers on road and traffic conditions. In the case of TV stations, a scrolling text bar can appear across the screen making clear text announcements.

Remote “opt out” is a system whereby a local radio station, (this may be automatic at night), can be controlled by another studio, say in the capital city. Local radio stations are often controlled by a clock, which switches to the big studio at news time, then back to local content at other times. By means of an opt out system, the main studio can cause the local station to stay connected to the news studio until the emergency announcements have been completed. The problem is that the local radio station may as a result fail to fulfil its obligation to transmit scheduled advertisements thus losing revenue. Some sort of agreement about this before it is done is required.

To ensure that this service is active all the time, planners should arrange for back up power and secure communications for broadcasting transmitters and their studios.

6.2 Mobile Emergency Broadcasting

Mobile Radio Stations can be quickly and cheaply moved into the affected area. However, locals should have powered radios or even wind up radios for them to be able to turn in. This is an efficient way of reaching out many people in the shortest time. However, there are a lot of political considerations to take into account.

Full consultation with relevant government authorities is imperative. Some governments are concerned about a free flow of information in times of national crisis. The concern is that certain broadcasts can cause panics if not well crafted.

CHAPTER 7

New Technologies and New Practices

7 Recent developments

This segment summarizes what have emerged as new ways of managing information in times disasters or impending disasters.

a) Cell Broadcasting was discussed in previous chapters on mobile networks Increasingly, there is use of SMS-CB to broadcast information. SMS-CB causes short text messages in selectable languages to appear on the screen of the mobile phone, and then set off the alert tone. Advantages of SMS-CB vs. normal SMS.

  – It transmits to everyone at the same time, taking about 20 seconds to deliver.

  – It does so over dedicated broadcast channels, and thus neither causes, nor is affected by overload of the network.

  – The sender of the message can select a single cell, or any number of cells to make the area of warning as big or as small as is required.

b) Cellular Emergency Alert Systems Association (CEASA) is one international organisation that is seeking to develop and deploy a network of government-to-citizen warning systems, which deliver messages to users via cell broadcast.

c) IP Telephony is growing in popularity. It should be noted that a normal Internet application such as email or the web browser is not very sensitive to delays. Voice on the other hand is very sensitive to delay and will cause unintelligible words breaking if there are delays on the route. Unlike conventional networks, IP packets can be stored in routers being queued for outgoing transmission. During an emergency, loading may make the output queues quite long and some packets may be discarded. IP telephony does not use TCP to request for a new packet resulting in the chopping of voices. The only way to avoid this is to use a well managed IP network to keep the loading and delays down to the barest minimum.

d) DVB

Digital video broadcast uses TV satellites to provide Internet access. It has the advantage of being significantly cheaper than conventional systems, but like any IP based system, suffers from contention at busy times. In other words it may be used with difficulty in times of emergencies.

e) ISTOS

ESA’s concept for an Integrated Space Technologies Operational System (ISTOS) Wide Area Network. It is designed to improve the utilisation of space technologies by end users working in the field of emergency management, by allowing the efficient interconnection of emergency application users to data and service providers, using integrated space technologies in telecommunications, earth observation and navigation.

f) STANAG is an emerging standard for HF data radio. This is a NATO standard for 9.6 kbit/s data over HF. Its deployment in emergency situations is yet to be tested.

g) Digital Trunked Radio Systems

We are witnessing the deployment on a wide-scale of Digital Trunked Radio Systems such TETRA (system offering advantages in terms of clarity, wide-area coverage, rich terminals and high security). In general the following are key elements associated with these systems:

- The old analogue systems were notoriously insecure and easy to listen into unless a secure encryption system was used. Digital systems normally feature very robust security such that even if a casual listener were to tune-in, data would appear as garbage.
- All terminals are uniquely identifiable. These will not be granted access to the system unless they are valid on that particular system and on the requested talk groups. In addition, each terminal can be remotely stunned or killed in case of it being lost. There is therefore no risk of an unauthorized person using a lost and found terminal.
- Digital systems are capable of transmitting both voice and data. They are also capable of point-to-point connection as well as mobile phone like through connection.
- Thanks to voice coding and compression, modern systems have up to 4 times more capacity than analogue services. As a result, there are more talk groups available thus remarkably reducing congestion.
- Whereas the traditional systems arranged talk groups on geographical basis, due to the need to use repeaters, trunked systems eliminates this problem making it possible to deploy talk groups on tactical basis which is much more convenient.
- Signals are cleaner and clearer thanks to speech coding and noise including squelch noise are eliminated thanks to speech coding.
- Many systems such as TETRA have a “simplex” mode otherwise known as “direct mode”.
- Trunked networks can take the form of simple stand-alone repeaters or form more complex national networks. In disaster operation, it is advisable for several agencies to club together to build a single wide-area-network. There remains an option for the agencies to maintain separate talk groups or to have inter-agencies common talk groups that make and facilitate coordination. This however, requires that terminals are available to all agencies. Interworking could be a solution as terminals could be made available at least in the control room of other agencies. This is however, a subject yet to be dealt with by senior management at agency level as it posses a lot of challenges.

PART III

Technical Annex

Some Technical Aspects of
Disaster Communications

1 Introduction

In Part 1 of this handbook, the reader was presented with definitions and overall policy considerations regarding disaster communications. Following this general discussion, the reader was invited to consider the more specific guidance required to operate an emergency Telecommunications network as presented in Part 2 designed for operational personnel.

In order to improve the flow of thought in Parts 1 and 2, technical details and formulas are consolidated in Part 3. This permitted the previous two parts to be written in a narrative style. Further, it made the text more readable for planners and policy-makers who require an overview of the problems, solutions and techniques related to emergency telecommunications.

Part 3 is organised into the following sections:

- The selection of the appropriate technology for emergency telecommunications
- Methods of radiocommunication
- Antennas as an essential part of any radio station
- Use of relay stations (repeaters) and trunking systems
- Power sources (including batteries)

In addition, there is a bibliography listing a number of references that will guide the reader to an extensive historical source listing. Also, it will provide information about useful sources of additional information from which it is possible to expand on the subjects raised in briefer form in this Handbook.

At the conclusion, there is an Appendix of a number of useful documents from a number of diverse original sources.

2 The selection of appropriate technologies for Emergency Telecommunications

2.1 Simplicity vs. new technologies

Generally, the simpler time-tested forms of radiocommunication work best in disaster situations. These include single-sideband (SSB) voice and Morse code (CW) telegraphy at HF and FM voice at VHF/UHF.

The equipment has been perfected over time, and its installation, maintenance and operation are widely understood. There are robust versions of equipment designed to meet the rigours of transportation and operation in the field.

Nevertheless, some newer technologies offer features that may facilitate emergency telecommunications. Those include cellular telephones, digital dispatch radios, facsimile, data communications, television and satellites. Each has their advantages and disadvantages, which should be weighed carefully in the planning process.

Emerging technologies such as 3rd generation cellular (IMT-2000), software-defined radio (SDR), broadband and multimedia systems should be evaluated in terms of their ability to function during emergency conditions.

Training of radiocommunication personnel is an important aspect of the selection of appropriate technologies. It is fruitless to plan on an HF Morse telegraphy capability without trained and experienced operators. Use of SSB voice to avoid training Morse operators is not necessarily a solution unless the operators are trained in installation, maintenance and operation of an SSB radio station. It is also inappropriate to introduce new technologies without a continuing supply of personnel adequately trained in system planning, installation, maintenance and operation.

The ideal emergency Telecommunications system is one in routine daily use that has the capability of functioning in disaster and other emergency conditions. Second best is a capability exercised periodically, such as weekly or monthly, under simulated emergency conditions.

2.2 Reliability of the infrastructure

HF communications, whether by SSB voice or Morse telegraphy, normally do not require any infrastructure for relaying or processing. Communication is usually a direct link between the originating station and the addressee. When long distances are involved, such as beyond 2 000 km, or when propagation conditions are poor, base stations or relay stations can be used to facilitate communication but may not necessary be required.

2.3 Transportation and mobility considerations

New technology includes such telecommunication systems as portable satellite earth stations, mobile and portable cellular telephone base stations, and telemedicine video base and remote stations. There are circumstances where it would be desirable to use these new technologies at a disaster area. However, transportation and mobility should be taken into account before using such systems. For example, a satellite earth station that is mounted on pallets requiring special handling equipment for loading and unloading because an aircraft may be available at the point of origin, but not at the point of debarkation.

Further, once the communications system is unloaded at the nearest available airport, ground transportation will be needed to transport it to the disaster area. Trucks and loading equipment are generally in full use at the disaster site and may not be available at an airport.

A third consideration is the condition of roads leading to the disaster area. In many cases, it may not be possible to move the communications equipment to a location where it is most desired because of obstructions.

2.4 Interoperability

The capability to communicate with the local public protection organisations such as police, fire and medical, the local military, international disaster relief organisations and neighbouring countries is an important consideration.

There may be circumstances where it should be possible for any station to be able to communicate with any other station in the disaster area. Such a feature can cut across the formal structure and get communications directly to the intended party without experiencing delays and possible misinterpretation by intermediaries. Unfortunately, there are other circumstances where separate channels are needed for different groups of stations and it would be difficult if not impractical for everyone to be on one channel.

2.5 Comparison of satellite systems for emergency telecommunications

2.5.1 Low Earth orbit satellites

Low Earth orbit (LEO) satellites may be used to relay radio signals far beyond line-of-sight. Depending on altitude, a single LEO satellite could be used to relay signals over paths up to about 5 000 km when the two earth stations are both visible to the satellite. Such visibility lasts only for a few minutes at such extreme distances. Stations closer together can have mutual visibility to the satellite for longer periods, perhaps up to 20 minutes on a favourable pass. Owing to their orbits, single LEO satellite have the disadvantage that they can provide real time communication only for a few times a day.

LEO constellations can be used for continuous real time relay. This requires a sufficient number of satellites to assure that at least one is visible to a point on Earth at all times. Also, there must be a means of networking the satellites, either through inter-satellite (satellite-to-satellite) links or via earth stations located throughout the world.

2.5.2.1 INMARSAT vs. VSAT and USAT

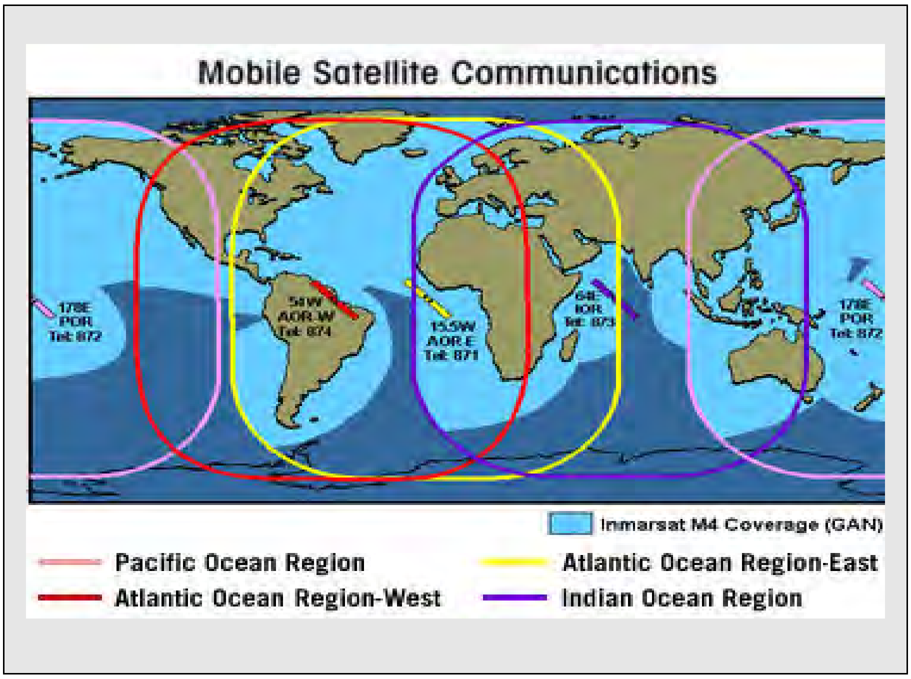
Common telephone and data services are available from land-based satellite terminal systems using the portable International Maritime Satellite (INMARSAT) or the semi-fixed Very Small Aperture Terminal (VSAT) satellite network. These services include voice, facsimile and electronic mail communications. Any device that works with a common telephone device may be used with these satellite systems. In addition to the above-mentioned services, some satellite terminals offer transfer of digital photographs or live video conferencing.

The choice of whether to use INMARSAT or VSAT is dependent upon the particular Telecommunications requirements for the system. Many variable factors will influence the choice of one over the other: cost, mobility, and the need for high volume use. Also, the ability of the system to support various modes of communication, such as: standard voice, computer data (networked or stand-alone e-mail connections), facsimile, text-only messages and videoconferencing.

Inmarsat provides a global mobile satellite communications capability with several advantages to support disaster preparedness and relief operations. Inmarsat terminals are self-sufficient and can be operational within 5-10 minutes of arriving at the disaster scene. They are independent from local Telecommunications infrastructures, and can be operated with batteries or generator power suppliers. Inmarsat systems can be configured to provide communications between two independent relief teams working in the same locality or to provide direct links to relief agencies and material suppliers worldwide. One important detail is that Inmarsat equipment is simple to operate, and can be set up and operated by untrained personnel using instructions provided with the units. The equipment is compact and lightweight. Some models can be hand carried.

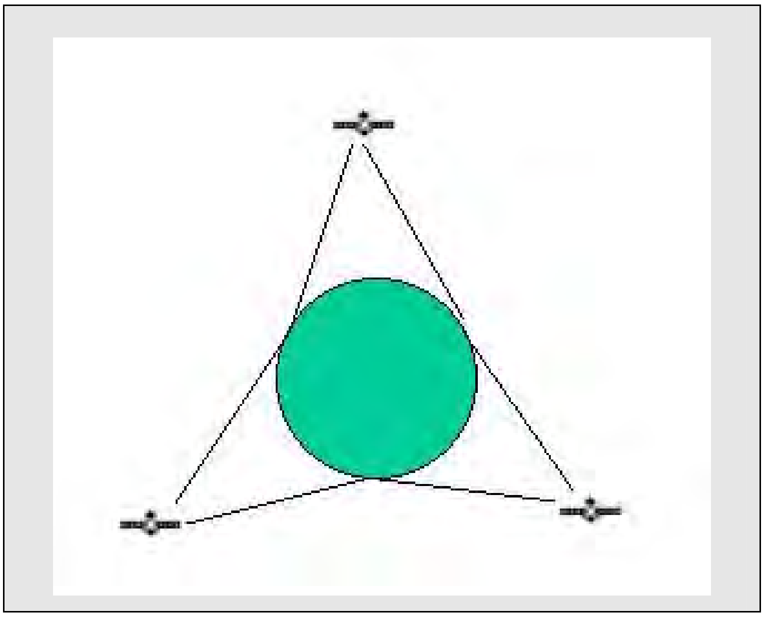
Inmarsat's primary satellite constellation consists of four Inmarsat I-3 satellites in geostationary orbit. A fifth spacecraft that can be brought in to provide additional capacity currently backs these up. Between them, the main "global" beams of the satellites provide overlapping coverage of the whole surface of the Earth apart from the poles. So, with Inmarsat coverage, it has become possible to extend the reach of terrestrial wired and cellular networks to almost anywhere on Earth.

Figure 2 – Mobile Satellite Communications



A geostationary satellite follows a circular orbit in the plane of the Equator at a height of 35,600 km, so that it appears to hover over a chosen point on the Earth's surface. Three such satellites are enough to cover most of the globe, and mobile users rarely have to switch from one satellite to another. Other mobile satellite systems use larger numbers of satellites in lower, non-geostationary orbits. From the user's point of view, they move across the sky at a comparatively high speed, often requiring a switch from one satellite to another in mid-communication and risking the possibility of an interrupted call.

Figure 3 – Three satellites in geostationary orbit can cover the entire Earth



The satellites are controlled from the Satellite Control Centre (SCC) at Inmarsat HQ in London. The control teams there are responsible for keeping the satellites in position above the Equator, and for ensuring that the onboard systems are fully functional at all times.

Data on the status of the nine Inmarsat satellites is supplied to the SCC by four tracking, telemetry and control (TT&C) stations located at Fucino, Italy; Beijing in China; Lake Cowichan, western Canada; and Pennant Point, eastern Canada. There is also a back-up station at Eik in Norway.

A call from an Inmarsat mobile terminal goes directly to the satellite overhead, which routes it back down to a gateway on the ground called a land earth station (LES). From there the call is passed into the public phone network.

The Inmarsat I-3 satellites are supported by four previous-generation Inmarsat-2s, also in geostationary orbit.

A key advantage of the Inmarsat I-3s over their predecessors is their ability to generate a number of spotbeams as well as single large global beams. Spotbeams concentrate extra power in areas of high demand, as well as making it possible to supply standard services to smaller, simpler terminals.

Inmarsat I-2 – Purpose-built quartet

Launched in the early 1990s, the four second-generation satellites were built to Inmarsat specification by an international group headed by British Aerospace (now BAE Systems).

The three-axis-stabilized Inmarsat I-2s were designed for a 10-year life. Inmarsat-2 F1 was launched in 1990 and is now located over the Pacific, providing lease capacity. F2, launched in 1991, is over the western Atlantic, providing leased capacity and backing up Inmarsat I-3 F4. Also orbited in 1991, F3 is stationed over the Pacific Ocean, providing lease capacity and backing up Inmarsat I-3 F3. The fourth Inmarsat-2 was launched in 1992 and is used to provide leased capacity over the Indian Ocean and backing up Inmarsat I-3 F1 and Inmarsat I-3 F3.

Inmarsat-3: A story of spotbeams

Launched in 1996-8, the Inmarsat I-3s were built by Lockheed Martin Astro Space (now Lockheed Martin Missiles & Space) of the USA, responsible for the basic spacecraft, and the European Matra Marconi Space (now Astrium), which developed the communications payload.

The Inmarsat I-3 communications payload can generate a global beam and a maximum of seven spotbeams. The spotbeams are directed as required to make extra communications capacity available in areas where demand from users is high.

Inmarsat I-3 F1 was launched in 1996 to cover the Indian Ocean Region. Over the next two years F2 entered service over Atlantic Ocean Region-East, followed by F3 (Pacific Ocean Region), F4 (Atlantic Ocean Region-West) and F5 (limited services on a single spot beam, back-up and leased capacity).

Inmarsat I-4: Gateway to Broadband

Responding to the growing demand from corporate mobile satellite users for high-speed Internet access and multimedia connectivity, Inmarsat has been building its fourth generation of satellites.

The company awarded European spacecraft manufacturer Astrium the contract to build the three Inmarsat I-4 satellites. Astrium is the European company that includes the former Matra Marconi Space, which built the Inmarsat I-2 satellites and the payload for the Inmarsat I-3s.

The job of the satellites will be to support the new Broadband Global Area Network (BGAN), currently scheduled to enter service in 2005 to deliver Internet and intranet content and solutions, video-on-demand, videoconferencing, fax, e-mail, phone and LAN access at speeds up to 432 kbit/s almost anywhere in the world. BGAN will also be compatible with third-generation (3G) cellular systems.

The satellites, the world's largest commercial communications satellites, will be 100 times more powerful than the present generation and BGAN will provide at least 10 times as much communications capacity as today's Inmarsat network.

The spacecraft will be built largely in the United Kingdom. The bus will be assembled at Astrium's factory in Stevenage and the payload in Portsmouth. The two sections will then be united in Toulouse, France, together with the US-built antenna and German-built solar arrays.

Inmarsat maritime communications and safety services contribute significantly to the safe and efficient management of ocean-going vessels whether merchant, fishing or leisure and luxury yachts.

Fleet Services

Fleet F77, F55 and F33 provide high-quality mobile voice and flexible data communications services, e-mail and secure Internet access for the maritime industry.

Fleet F77

Inmarsat Fleet F77 is a successor to the Inmarsat B service for deep-sea vessels. In addition to voice and fax, Fleet F77 provides both Mobile ISDN and the Mobile Packet Data Service (MPDS).

The 128 kbit/s ISDN channel enables large volumes of data to be transferred cost-effectively, and remote diagnostics to be carried out.

MPDS brings always-on connectivity to the bridge, with fully integrated Internet Protocol (IP) functionality. Operators are charged by the volume transferred, not for the time spent online, making it a cost-effective service for a range of applications. Officers and crew can access the Internet and browse the web, providing them with education, entertainment and information services.

Inmarsat Fleet F77 also meets the latest distress and safety requirements as specified by the International Maritime Organization (IMO) in resolution A.888 for voice pre-emption and prioritization within the Global Maritime Distress and Safety System (GMDSS).

> *Applications:* data transfer; Internet; LAN and private network access; e-mail; fax; instant messaging; SMS; voice; crew calling; encryption; video-conferencing; store-and-forward video; remote monitoring; chart and weather updates; telemedicine; GMDSS.

Fleet F55

Fleet F55 uses a medium-sized antenna for smaller vessels, and offers the 64 kbit/s Mobile ISDN and MPDS capabilities in the spotbeam areas, plus global voice. Smaller vessels, like trawlers and yachts, are not required to meet IMO regulations, so Fleet F55 and F33 do not include a GMDSS component.

> *Applications:* data transfer; Internet; LAN and private network access; e-mail; fax; instant messaging; SMS; voice; crew calling; encryption; videoconferencing; store-and-forward video; remote monitoring; chart and weather updates; telemedicine.

Fleet F33

F33 offers global telephone, as well as the Mobile Packet Data Service (MPDS) and enhanced 9.6 kbit/s data and fax services within the Inmarsat spotbeams, providing a wide range of applications to the small vessel market.

> *Applications:* data transfer; Internet; LAN and private network access; e-mail; fax; instant messaging; SMS; voice; crew calling; encryption; store-and-forward video; remote monitoring; chart and weather updates; telemedicine

Inmarsat mini-M

Inmarsat mini-M provides voice and 2.4 kbit/s data (or 9.6 kbit/s using compression) within the Inmarsat spotbeams. It makes the ideal Crew Calling solution when a payphone or crew extension is connected.

> *Applications:* data transfer; e-mail; fax; voice; crew calling; encryption; telemedicine.

Inmarsat C

A two-way, packet data service via lightweight, low-cost terminals small enough to be fitted to any vessel. Approved for use under the Global Maritime Distress and Safety System (GMDSS), it provides seven of the key GMDSS functions. Inmarsat C is ideal for distributing and collecting information from fleets of commercial vessels. It also meets the requirements for Ship Security Alert Systems (SSAS).

> *Applications:* data transfer; e-mail; SMS, crew calling; telex; remote monitoring; tracking; chart and weather updates; maritime safety information (MSI); maritime security; GMDSS; and SafetyNET and FleetNET services.

Inmarsat mini-C

Inmarsat mini-C offers the same primary functions as Inmarsat C through a lower-power, more cost-effective terminal. It is also GMDSS compatible and meets the requirements for Ship Security Alert Systems (SSAS).

> *Applications:* data transfer; e-mail; SMS, remote monitoring; and tracking; maritime security.

Inmarsat D+

A two-way data communications service from equipment the size of a personal CD player. With an integral GPS, Inmarsat D+ can be used for remote surveillance, asset tracking and short information broadcasts. It meets the requirements for Ship Security Alert Systems (SSAS).

Applications: data transfer; remote monitoring; tracking.

Inmarsat E/E+

The Inmarsat E emergency position indicating radio beacon (EPIRB) is a key element of GMDSS. Distress alerts are transmitted from the EPIRB when the unit floats free from a sinking vessel, or when activated manually, and are forwarded automatically to a Maritime Rescue Coordination Centre. Inmarsat E+ adds a key return channel to the EPIRB, which sends a confirmation to the seafarer that their alert has been received.

Applications: GMDSS.

Inmarsat A

The Inmarsat A system provides two-way direct-dial phone connection, including high-quality voice, fax, telex, e-mail and data communications to and from anywhere in the world with the exception of the poles. It also provides distress communication capabilities. It is based on analogue technology and supports data rates of between 9.6 kbit/s up to 64 kbit/s depending on different elements of the end-to-end connection.

Applications: voice; fax; telex; e-mail; data; GMDSS.

Inmarsat B

This remains a core service for the maritime industry. Voice, data at speeds from 9.6 kbit/s to 64 kbit/s, telex and fax are supported, in addition to voice, distress and safety.

Applications: data transfer; Internet; LAN and private network access; e-mail; fax; SMS; voice; crew calling; encryption; video-conferencing; store-and-forward video; remote monitoring; chart and weather updates; telemedicine; GMDSS.

Inmarsat M

Provides global voice and 2.4 kbit/s data on a medium-sized antenna.

Applications: data transfer; fax; voice.

Airtime services for Inmarsat satellites are available worldwide through a network of about 100 service providers. Some service providers also operate Inmarsat land earth stations. There are about 40 such stations in 31 countries. These stations receive and transmit communications through the Inmarsat satellites and provide the connection between the satellite system and the fixed communications networks.

2.5.2.2 VSAT

Very Small Aperture Terminal (VSAT) is a satellite communications technology using small earth antenna, usually 0.9 and 1.8 meters in diameter, for reliable voice, data, audio, video, multimedia, and wide-band service transmission. VSAT services constitute a network composed of a series of remote points connected to a main control centre, which in turn is connected through space with a data centre or central processor: the central station and a large number of geographically disbursed sites. One of the many applications of this technology is Internet via satellite.

VSAT communication networks are comprised of a space and a land segment. The space segment is comprised of a geostationary satellite, which amplifies and changes frequencies. The land component consists of a central station or *hub* and remote VSAT stations. VSAT networks can be configured in star-like or mesh shapes, based on the normal flow of communications through the hub or can be sent directly between the VSAT stations (with no need for double hopping).

Changes in technology have led to a reduction in antenna size and have decreased the cost and size of electronics, increased bandwidths and permitted better management capabilities.

When the communication requirement is to provide a long distance link between two or more nodes of a fixed network, a user may select VSAT for such full time, guaranteed bandwidth. For example, some Internet service providers in South America and Africa connect their router to the main Internet by a VSAT full time high-speed link.

VSAT can provide a single communications platform capable of providing service to an entire country or region. For semi-permanent or permanent applications with a large volume of traffic, VSAT may prove to be the best option for Telecommunications service.

For VSAT terminals, set-up time varies from 30 minutes to 3 hours, depending on system complexity.

2.5.2.3 USAT Networks

The diffusion of VSAT networks in fixed-satellite service (FSS) with small-antenna earth stations at distant locations – such as the terraces of office buildings, hotels, shopping centres and other useful locations – has stimulated the development of antennas that are even smaller than VSATs, generally with an effective aperture of less than 1 m. In general, they are known as ultra small aperture terminals (USATs). Antenna discrimination naturally deteriorates as its size decreases.

Satellite service provides wide-band and direct access to the backbone of the Internet for reception and/or reception-transmission of Internet information. Point-to-multipoint connections using high-speed frame relay technology are used. Standard Single Channel Per Carrier (SCPC) satellite connections can also be used. Or both systems can be used for the purposes of redundancy.

3 Methods of radiocommunication

3.1 Frequencies

Radio frequencies should be selected according to propagation requirements, allocation to the service for which they are used and in accordance with licensing regulations of the country in which the station is operating.

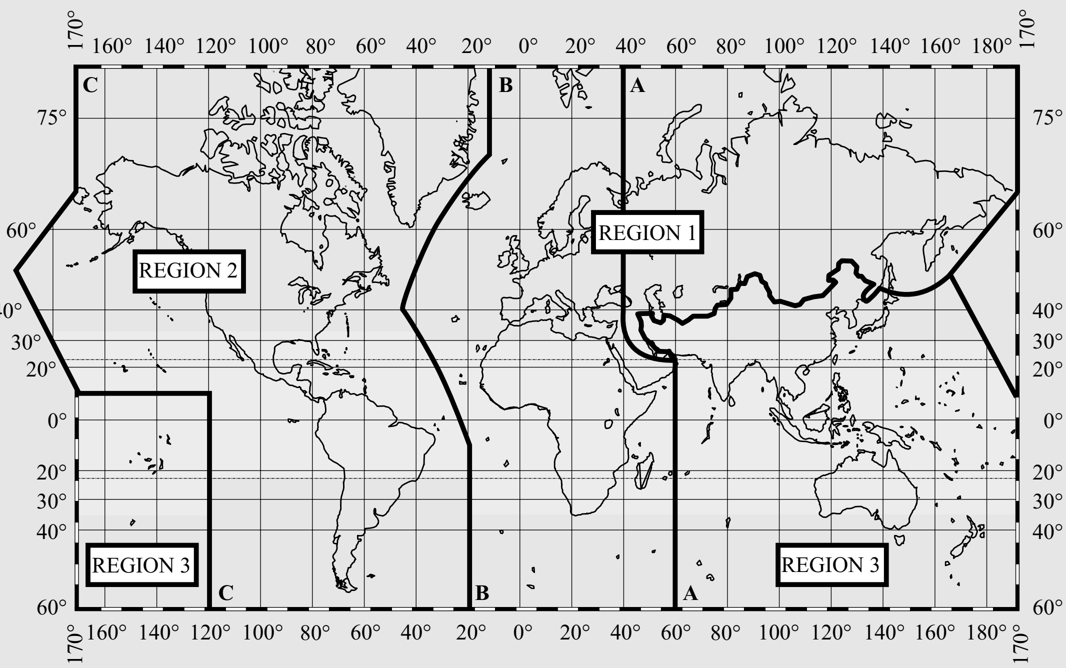
Example 1: An amateur station licensed to operate in the country may use a frequency of 7 050 kHz to communicate via sky wave with a station 300 km away, as this frequency is within the 7 MHz amateur allocation.

Example 2: A land mobile station licensed to operate in a country and assigned an operating frequency of 151.25 MHz may use this frequency to communicate up to about 60 km with other authorised stations.

3.1.1 International frequency allocations

The radio frequency spectrum is divided into bands of frequencies by means of international treaty conferences of the International Telecommunication Union (ITU). These bands are allocated to specific radio services and are listed in Article S5 of the international Radio Regulations. Some bands are allocated to the same service(s) worldwide, while others are allocated to different services on a regional basis. The three Regions are shown in the following map.

Figure 4 – ITU radio regions



The shaded part represents the Tropical Zones as defined in Nos. **S5.16** to **S5.20** and **S5.21.**

A simplified table of frequencies allocated to the amateur, fixed and mobile services is shown in Table 1.

Table 1 – Allocation to amateur, fixed and mobile services (simplified, footnotes omitted)

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>1 810-1 850 AMATEUR</td><td>1 800-1 850 AMATEUR</td><td rowspan="2">1 800-2 000 AMATEUR FIXED
MOBILE except aeronautical mobile</td></tr>
<tr><td>1 850-2 000 FIXED
MOBILE except aeronautical mobile</td><td>1 850-2 000 AMATEUR FIXED
MOBILE except aeronautical mobile</td></tr>
<tr><td>2 000-2 045 FIXED
MOBILE except aeronautical mobile (R)</td><td colspan="2" rowspan="2">2 000-2 065 FIXED MOBILE</td></tr>
<tr><td>2 045-2 160 FIXED MOBILE</td></tr>
<tr><td></td><td colspan="2">2 107-2 170 FIXED MOBILE</td></tr>
<tr><td>2 194-2 300 FIXED
MOBILE except aeronautical mobile (R)</td><td colspan="2">2 194-2 300 FIXED MOBILE</td></tr>
<tr><td>2 502-2 625 FIXED
MOBILE except aeronautical mobile (R)</td><td colspan="2" rowspan="2">2 505-2 850 FIXED MOBILE</td></tr>
<tr><td>2 650-2 850 FIXED
MOBILE except aeronautical mobile (R)</td></tr>
<tr><td>3 155-3 400</td><td colspan="2">FIXED MOBILE except aeronautical mobile (R)</td></tr>
<tr><td>3 500-3 800 AMATEUR FIXED
MOBILE except aeronautical mobile</td><td>3 500-3 750
AMATEUR</td><td rowspan="3">3 500-3 900
AMATEUR FIXED MOBILE</td></tr>
<tr><td rowspan="2">3 800-3 900 FIXED LAND MOBILE</td><td rowspan="3">3 750-4 000
AMATEUR FIXED
MOBILE except aeronautical mobile (R)</td></tr>
<tr></tr>
<tr><td>3 950-4 000 FIXED</td><td>3 950-4 000 FIXED</td></tr>
<tr><td>4 000-4 063</td><td colspan="2">FIXED</td></tr>
<tr><td colspan="2">4 438-4 650 FIXED MOBILE except aeronautical mobile (R)</td><td>4 438-4 650 FIXED
MOBILE except aeronautical mobile</td></tr>
<tr><td>4 750-4 850 FIXED LAND MOBILE</td><td>4 750-4 850 FIXED
MOBILE except aeronautical mobile (R)</td><td>4 750-4 850 FIXED Land mobile</td></tr>
<tr><td>4 850-4 995</td><td colspan="2">FIXED LAND MOBILE</td></tr>
<tr><td>5 005-5 060</td><td colspan="2">FIXED</td></tr>
<tr><td>5 060-5 450</td><td colspan="2">FIXED Mobile except aeronautical mobile</td></tr>
<tr><td>5 450-5 480 FIXED LAND MOBILE</td><td></td><td>5 450-5 480 FIXED LAND MOBILE</td></tr>
<tr><td>5 730-5 900 FIXED
MOBILE except aeronautical mobile (R)</td><td>5 730-5 900 FIXED
MOBILE except aeronautical mobile (R)</td><td>5 730-5 900 FIXED
Mobile except aeronautical mobile (R)</td></tr>
<tr><td>6 765-7 000</td><td colspan="2">FIXED Land mobile</td></tr>
<tr><td>7 000-7 100</td><td colspan="2">AMATEUR AMATEUR-SATELLITE</td></tr>
<tr><td></td><td>7 100-7 300 AMATEUR</td><td></td></tr>
<tr><td>7 350-8 100</td><td colspan="2">FIXED Land mobile</td></tr>
<tr><td>8 100-8 195</td><td colspan="2">FIXED</td></tr>
<tr><td>9 040-9 400</td><td colspan="2">FIXED</td></tr>
<tr><td>9 900-9 995</td><td colspan="2">FIXED</td></tr>
<tr><td>10 100-10 150</td><td colspan="2">FIXED Amateur</td></tr>
<tr><td>10 150-11 175</td><td colspan="2">FIXED Mobile except aeronautical mobile (R)</td></tr>
<tr><td>11 400-11 600</td><td colspan="2">FIXED</td></tr>
</table>

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Region 3</th></tr>
<tr><td>12 100-12 230</td><td colspan="2">FIXED</td></tr>
<tr><td>13 360-13 410</td><td colspan="2">FIXED</td></tr>
<tr><td>13 410-13 570</td><td colspan="2">FIXED Mobile except aeronautical mobile (R)</td></tr>
<tr><td>13 870-14 000</td><td colspan="2">FIXED Mobile except aeronautical mobile (R)</td></tr>
<tr><td>14 000-14 250</td><td colspan="2">AMATEUR AMATEUR-SATELLITE</td></tr>
<tr><td>14 250-14 350</td><td colspan="2">AMATEUR</td></tr>
<tr><td>14 350-14 990</td><td colspan="2">FIXED Mobile except aeronautical mobile (R)</td></tr>
<tr><td>15 800-16 360</td><td colspan="2">FIXED</td></tr>
<tr><td>17 410-17 480</td><td colspan="2">FIXED</td></tr>
<tr><td>18 030-18 068</td><td colspan="2">FIXED</td></tr>
<tr><td>18 068-18 168</td><td colspan="2">AMATEUR AMATEUR-SATELLITE</td></tr>
<tr><td>18 168-18 780</td><td colspan="2">FIXED Mobile except aeronautical mobile</td></tr>
<tr><td>19 020-19 680</td><td colspan="2">FIXED</td></tr>
<tr><td>19 800-19 990</td><td colspan="2">FIXED</td></tr>
<tr><td>20 010-21 000</td><td colspan="2">FIXED Mobile</td></tr>
<tr><td>21 000-21 450</td><td colspan="2">AMATEUR AMATEUR-SATELLITE</td></tr>
<tr><td>21 850-21 924</td><td colspan="2">FIXED</td></tr>
<tr><td>22 855-23 000</td><td colspan="2">FIXED</td></tr>
<tr><td>23 000-23 200</td><td colspan="2">FIXED Mobile except aeronautical mobile (R)</td></tr>
<tr><td>23 200-23 350</td><td colspan="2">FIXED</td></tr>
<tr><td>23 350-24 000</td><td colspan="2">FIXED MOBILE except aeronautical mobile</td></tr>
<tr><td>24 000-24 890</td><td colspan="2">FIXED LAND MOBILE</td></tr>
<tr><td>24 890-24 990</td><td colspan="2">AMATEUR AMATEUR-SATELLITE</td></tr>
<tr><td>25 010-25 070</td><td colspan="2">FIXED MOBILE except aeronautical mobile</td></tr>
<tr><td>25 210-25 550</td><td colspan="2">FIXED MOBILE except aeronautical mobile</td></tr>
<tr><td>26 175-27 500</td><td colspan="2">FIXED MOBILE except aeronautical mobile</td></tr>
<tr><td>27.5-28</td><td colspan="2">FIXED MOBILE</td></tr>
<tr><td>28-29.7</td><td colspan="2">AMATEUR AMATEUR-SATELLITE</td></tr>
<tr><td>29.7-47</td><td colspan="2">FIXED MOBILE</td></tr>
<tr><td rowspan="3"></td><td>47-50 FIXED MOBILE</td><td>47-50 FIXED MOBILE</td></tr>
<tr><td colspan="2">50-54 AMATEUR</td></tr>
<tr><td>54-68 Fixed Mobile</td><td>54-68 FIXED MOBILE</td></tr>
<tr><td rowspan="3">68-74.8 FIXED
MOBILE except aeronautical mobile</td><td>68-72 Fixed Mobile</td><td rowspan="3">68-74.8 FIXED MOBILE</td></tr>
<tr><td>72-73 FIXED MOBILE</td></tr>
<tr><td>74.6-74.8 FIXED MOBILE</td></tr>
<tr><td rowspan="4">75.2-87.5 FIXED
MOBILE except aeronautical mobile</td><td colspan="2">75.2-75.4 FIXED MOBILE</td></tr>
<tr><td>75.4-76 FIXED MOBILE</td><td rowspan="2">75.4-87 FIXED MOBILE</td></tr>
<tr><td rowspan="2">76-88 Fixed Mobile</td></tr>
<tr><td>87-100 FIXED MOB ILE</td></tr>
<tr><td>137-138</td><td colspan="2">Fixed Mobile except aeronautical mobile (R)</td></tr>
<tr><td></td><td>138-144 FIXED MOBILE</td><td>138-144 FIXED MOBILE</td></tr>
<tr><td>144-146</td><td colspan="2">AMATEUR AMATEUR-SATELLITE</td></tr>
<tr><td>146-148 FIXED
MOBILE except aeronautical mobile (R)</td><td>146-148 AMATEUR</td><td>146-148 AMATEUR
FIXED MOBILE</td></tr>
<tr><td>148-149.9 FIXED
MOBILE except aeronautical mobile (R)</td><td colspan="2">148-149.9 FIXED MOBILE</td></tr>
</table>

Region 1	Region 2	Region 3
150.05-174 FIXED MOBILE except aeronautical mobile	**150.05-174** FIXED MOBILE	
	174-216 Fixed Mobile	**174-223** FIXED MOBILE
	216-220 FIXED	
	220-225 AMATEUR	
223-230 Fixed Mobile	FIXED MOBILE	**223-230** FIXED MOBILE
401-406	Fixed Mobile except aeronautical mobile	
406.1-430	FIXED MOBILE except aeronautical mobile	
430-440 AMATEUR	**430-440** Amateur	
440-450	FIXED MOBILE except aeronautical mobile	
450-470	FIXED MOBILE	

3.1.2 National frequency allocations

The frequency allocation tables of most countries closely follow the international table of allocations. There are exceptions and it is necessary to be aware of, and adhere to, national radio regulations concerning frequencies and their use.

3.1.3 Frequency assignments

Assignment of specific radio frequencies to radio stations is made by national administrations. This is the case for the fixed and mobile services. Amateur stations do not normally have frequency assignments and are free to select a specific operating frequency dynamically within an allocated band.

In some cases, administrations may assign frequencies to services not allocated to those services in the international table of allocations on a non-interference basis. This is provided for in the Radio Regulations, as follows:

- **S4.4** Administrations of the Member States shall not assign to a station any frequency in derogation of either the Table of Frequency Allocations in this Chapter or the other provisions of these Regulations, except on the express condition that such a station, when using such a frequency assignment, shall not cause harmful interference to, and shall not claim protection from harmful interference caused by, a station operating in accordance with the provisions of the Constitution, the Convention and these Regulations.

In times of emergency, administrations may use the following provision of the Radio Regulations:

- **S4.9** No provision of these Regulations prevents the use by a station in distress, or by a station providing assistance to it, of any means of radiocommunication at its disposal to attract attention, make known the condition and location of the station in distress, and obtain or provide assistance.

Stations in the fixed and mobile services having emergency communications missions should have a family of frequencies from which to select according to propagation for specific paths.

3.2 Propagation

Radio signals are electromagnetic waves that travel through the Earth's atmosphere and into space. These waves propagate by means of difference mechanisms, such as surface wave, direct or space wave (line-of-sight), diffraction (knife-edge propagation), ionospheric refraction (sky wave), tropospheric refraction and tropospheric ducting. Ionospheric propagation varies according to time of day, season of the year, solar activity (sunspot number), path distance, and location of the transmitters and receivers. Tropospheric propagation is somewhat related to weather conditions.

Recommendation ITU-R P.1144, the guide to the propagation methods of Radiocommunication Study Group 3, may be used to determine which propagation methods should be used for different applications. Computer programmes are also available and are available from ITU-R.

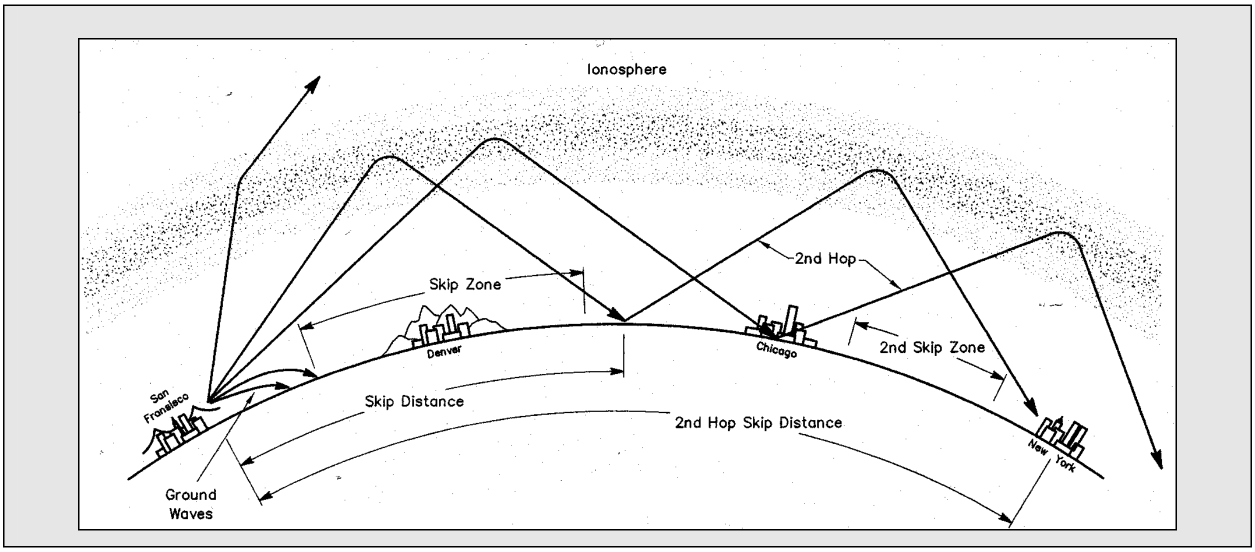
3.2.1 Ground wave

Ground waves are those confined to the Earth's lower atmosphere. Distances are dependent on transmitter power, antenna efficiency, ground conductivity and atmospheric noise levels. Ground-wave propagation curves for frequencies between 10 kHz and 30 MHz are given in Recommendation ITU-R P.368. For practical emergency communications, ground waves are useful only at lower high frequencies (near 3 MHz) and for relatively short distances of a few kilometres.

3.2.2 Sky wave propagation

Sky waves use the Earth's ionosphere to refract the signal. The ionosphere is formed by several layers, which are identified by letters of the alphabet. The *D layer* lies between about 60 and 92 km above the Earth. The *E layer* is about 100 to 115 km above the Earth. The D layer is used for medium frequency sky wave propagation. The D and E layers absorb signals at frequencies in the lower part of the HF band around 3 MHz. The *F layer* (about 160 to 500 km) may split into two layers, F_1 and F_2 and can support frequencies over the entire HF band at long distances. Frequencies and distances vary according to the specific path, time of day, season and solar activity. Sky wave propagation for the frequency range 2-30 MHz may be predicted using Recommendation ITU-R P.533.

Figure 5 – Illustration of how HF radio signals travel through the ionosphere. Frequencies above the maximum usable frequency (MUF) penetrate the ionosphere and go into space. Frequencies below the MUF are refracted back to the Earth. Ground waves, skip zones and multiple hop paths are shown



3.2.2.1 Near-vertical-incidence sky wave

Near-vertical-incidence sky wave (NVIS) is a term describing high angle ionospheric paths covering short distances. It is particularly useful for distances just beyond those practical for VHF or UHF. To be successful, it is necessary to select frequencies below the critical frequency, which means that frequencies will be in the 2-6 MHz range, the higher end during the daytime and the lower part of the range at night. Antenna take-off angle is essentially straight overhead so a practical antenna is horizontally polarised and just a few meters above ground.

3.2.3 VHF/UHF propagation

Radio signals travel somewhat beyond the optical line-of-sight, as though the Earth were 4/3 its size. The radio horizon for VHF/UHF signals can be approximated by:

$$D = 4.124\ h^{-2}$$

where:

D: distance in kilometers

h^{-2}: square root of the antenna height above ground in meters

Free-space propagation loss may be calculated using Recommendation ITU-R P.525.

Figure 6 – The ionosphere consists of several regions of ionised particles at different heights above Earth. At night, the D and E regions disappear. The F_1 and F_2 regions combine to form a single F region at night

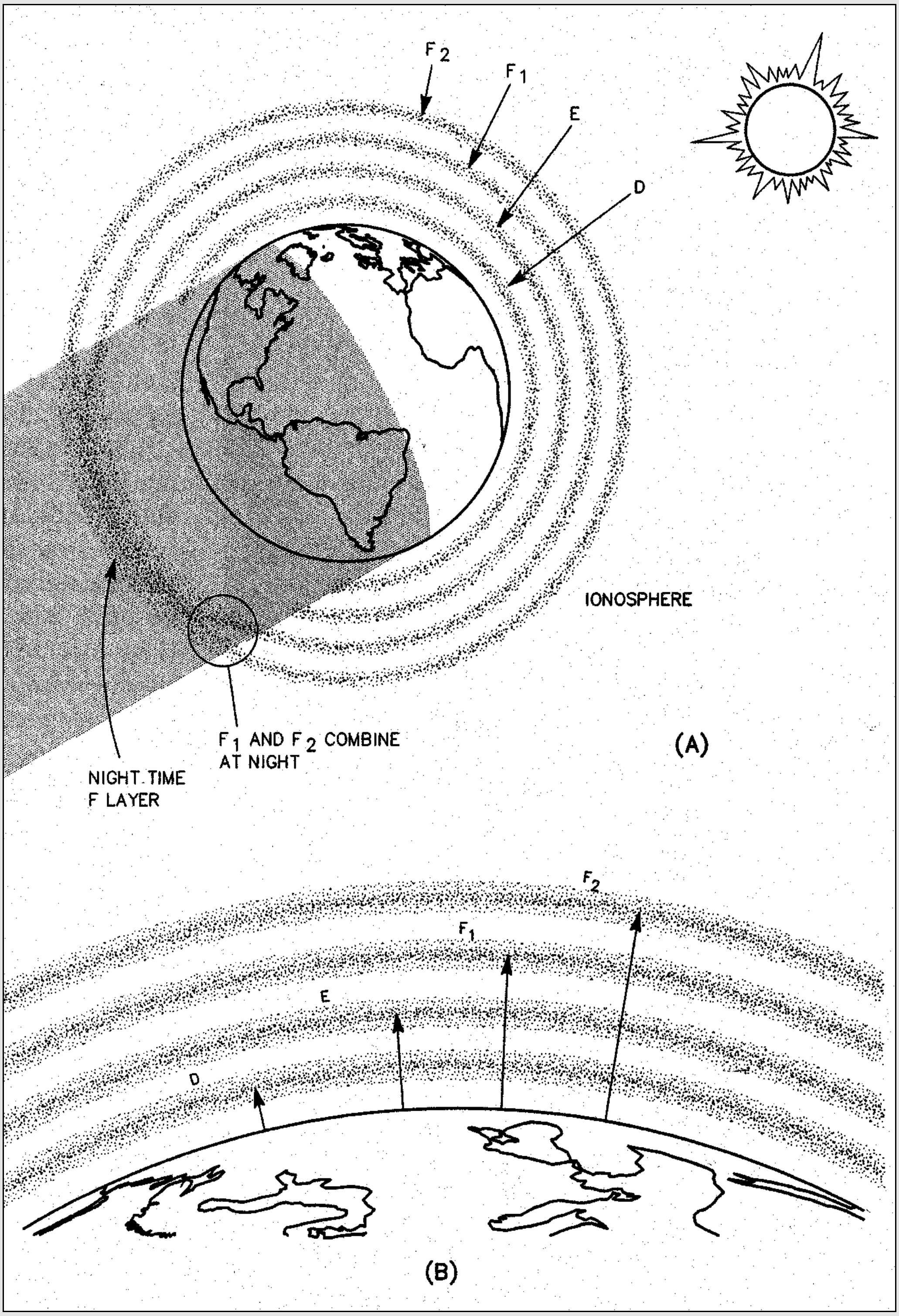
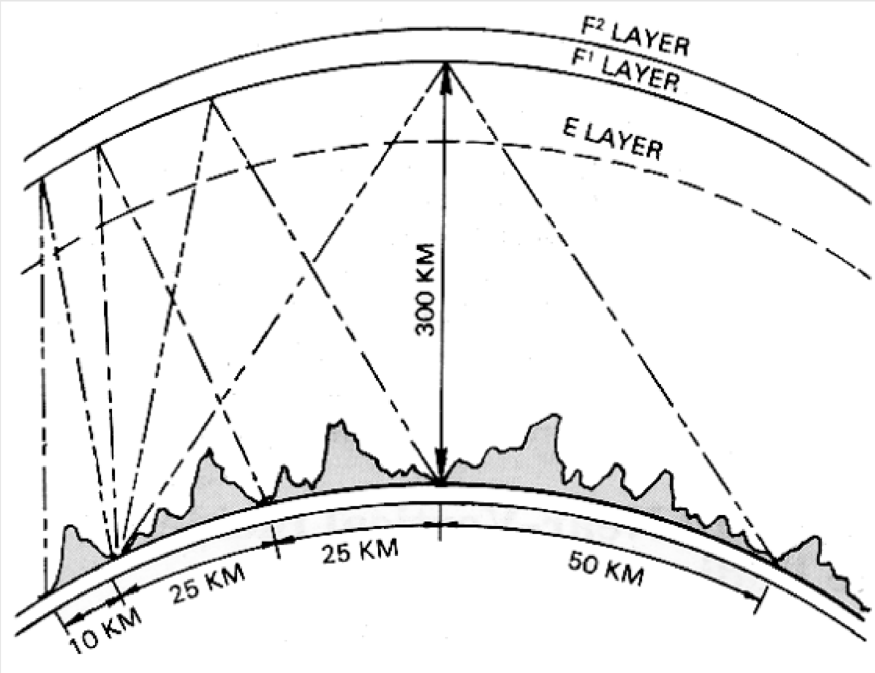


Figure 7 – Near-vertical incidence sky wave paths



3.2.3.1 Point-to-area links

If there is a transmitter serving several randomly distributed receivers (for example in the mobile service), the field is calculated at a point located at some appropriate distance from the transmitter by the expression:

$$e = \frac{\sqrt{30p}}{d}$$

where:

- e : r.m.s. field strength (V/m) (see Note 1),
- p : equivalent isotropically radiated power (e.i.r.p.) of the transmitter in the direction of the point in question (W),
- d : distance from the transmitter to the point in question (m).

Land mobile point-to-area propagation for the VHF (10-600 km) and UHF (1-100 km) may be predicted using Recommendation ITU-R P.529.

3.2.3.2 Point-to-point links

With a point-to-point link it is preferable to calculate the free-space attenuation between isotropic antennas, also known as the free-space basic transmission loss (symbols: L_{bf} or A_0), as follows:

$$L_{bf} = 20 \log \left(\frac{4\pi\, d}{\lambda} \right) \quad \text{dB}$$

where:

L_{bf} : free-space basic transmission loss (dB),

d : distance,

λ : wavelength, and

d and λ are expressed in the same unit.

The above equation can also be written using the frequency instead of the wavelength.

$$L_{bf} = 32.4 + 20 \log f + 20 \log d \quad \text{dB}$$

where:

f : frequency (MHz),

d : distance (km).

Point-to-area propagation for 150 MHz – 40 GHz for distances up to 200 km may be predicted using Recommendation ITU-R P.530

3.2.3.3 Conversion formulas

On the basis of free-space propagation, the following conversion formulas may be used.

Field strength for a given isotropically transmitted power:

$$E = P_t - 20 \log d + 74.8$$

Isotropically received power for a given field strength:

$$P_r = E - 20 \log f - 167.2$$

Free-space basic transmission loss for a given isotropically transmitted power and field strength:

$$L_{bf} = P_t - E + 20 \log f + 167.2$$

Power flux-density for a given field strength:

$$S = E - 145.8$$

where:

P_t : isotropically transmitted power (dB(W))

r : isotropically received power (dB(W))

E : electric field strength (dB(μV/m))

f : frequency (GHz)

d : radio path length (km)

L_{bf} : free-space basic transmission loss (dB)

S : power flux-density (dB(W/m^2)).

For further information on point-to-point line-of-sight propagation refer to Recommendation ITU-R P. 530.

4 Antennas as an essential part of any radio station

4.1 Choosing an antenna

Communicators quickly learn two antenna truths:

- Any antenna is better than no antenna.
- Time, effort and money invested in the antenna system generally will provide more improvement to communications than an equal investment to any other part of the station.

The antenna converts electrical energy to radio waves and radio waves to electrical energy, which makes two-way radio communication possible with just one antenna.

Success in communicating depends heavily on an antenna. A good antenna can make a fair receiver perform well. It can also make a few watts sound like much more. Since the same antenna is used to transmit and receive, any improvements to the antenna make the signal stronger at the desired reception points. Some antennas work better than others. It is useful to experiment with different antenna types.

4.2 Antenna system considerations

4.2.1 Safety

Safety should be the first consideration in installing an antenna system.

An antenna or transmission line should never be installed on top of electrical power lines. A vertical antenna should never be located where it could fall against the electrical power lines. Electrocution could result if power lines ever come into contact with the antenna.

Antennas should be high enough above the ground to ensure that no one can touch them. When the transmitter is active, the high voltages present at the ends of an antenna could kill or at least cause a serious RF burn.

A lightning arrester should be placed on the transmission line at the entrance point to the building housing the transmitting and receiving equipment. For safety, an Earth ground connection is necessary and the wire used for that purpose should be of conductor size equivalent to at least 2.75 mm diameter wire. The heavy aluminium wire used for TV-antenna Earth grounds is satisfactory. Copper braid 20 mm wide is also suitable. Ground connection may be made to a metal water pipe system, the grounded metal frame of a building, or to one or more 15 mm diameter ground rods driven to a depth of at least 2.5 meters.

Antenna work sometimes requires that someone climb up on a tower, into a tree, or onto the roof. It is not safe to work alone. Each move should be planned beforehand. The person on a ladder, tower, tree or rooftop should always wear a safety belt and keep it securely anchored. Before each use, the safety belt should be inspected carefully for damage such as cuts or worn areas. The belt will make it much easier to work on the antenna and will also prevent an accidental fall. A hard hat and safety glasses are also important safety equipment.

Tools should not be carried by hand when climbing. They should be placed on a tool belt. A long rope leading back to the ground should be secured to the belt and can be used to pull up other needed objects. It is helpful (and safe) to tie strings or lightweight ropes to all tools. This will save time in retrieving dropped tools and reduce the chances of injuring a helper on the ground.

Helpers on the ground should never stand directly under the work being done. All ground helpers should wear hard hats and safety glasses for protection. Even a small tool can cause an injury if it falls from 15 or 20 meters. A helper should always observe the tower work carefully. If possible, an observer with no other duties other than to watch for potential hazards should be positioned with a good view of the work area.

4.2.2 Antenna location

After assembling the antenna components, select a good place for it to be installed. Avoid running the antenna parallel close to power lines or telephone lines. Otherwise unwanted electrical coupling may occur, which could result in either power line noise in the station receiver or the transmitted signal appearing on the power or telephone lines. Avoid running the antenna close to metal objects, such as rain gutters, metal beams, metal siding, or even electrical wiring in the attic of a building. Metal objects may shield the antenna or modify its radiation pattern.

4.2.3 Antenna polarisation

Polarisation refers to the electrical-field characteristic of a radio wave. An antenna that is parallel to the earth's surface produces horizontally polarised radio waves. One that is perpendicular (at a 90° angle) to the Earth's surface produces vertically polarised waves.

Polarisation is most important when installing antennas for VHF or UHF. The polarisation of a terrestrial VHF or UHF signal tends not to change from transmitting antenna to receiving antenna. Both transmitting and receiving stations should use the same polarisation. Vertical polarisation is commonly used for VHF and UHF mobile operation including hand-held transceivers, in vehicles and base stations.

For HF sky-wave communications, radio signals tend to rotate through the ionosphere, thus horizontally or vertically polarised antennas can be used with almost equal results. Horizontally polarised antennas are preferred for receiving as they tend to reject local manmade noise, which is usually vertically polarised.

Vertical antennas provide low-angle radiation but have a null (radiate no energy) upward. This makes them suitable for longer sky-wave paths requiring a low take-off angle and they are not recommended for near-vertical-incidence sky-wave (NVIS) paths of about 0-500 km.

4.2.4 Tuning the antenna

The antenna length given by an equation is just an approximation. Nearby trees, buildings or large metal objects and height above ground all affect the resonant frequency of an antenna. An SWR meter can help to determine if the antenna should be shortened or lengthened. The correct length provides the best impedance match for the transmitter.

After cutting the wire to the length given by the equation, the tuning of the antenna should be adjusted for the best operation. With the antenna in its final location, the SWR should be observed at various frequencies within the desired band. If the SWR is much higher at the low-frequency end of the band the antenna is too short. If the antenna is too short, an extra length of wire can be attached to each end with an alligator clip. Then the extra length can be shortened a little at a time until the correct length is reached. If the SWR is much higher at the high-frequency end of the band, the antenna is too long. When the antenna is properly tuned, the lowest SWR values should be around the preferred operating frequency.

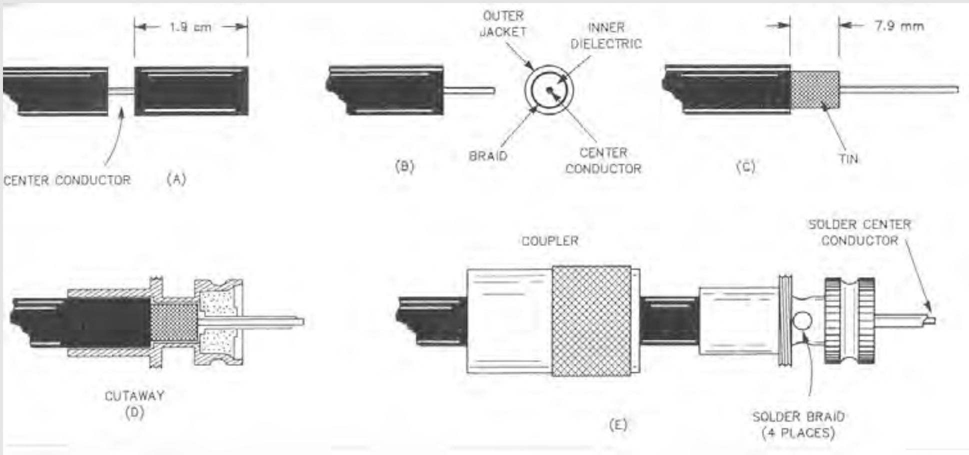
4.2.5 Transmission lines

The most commonly used type of antenna system transmission line is the coaxial cable ("coax"), where one conductor is inside the other. Coaxial cable has several advantages: It is readily available and resistant to weather. It can be buried in the ground if necessary, bent, coiled and run adjacent to metal with little effect.

Most common HF antennas are designed for use with transmission lines having characteristic impedances of about 50 ohms. RG-8, RG-58, RG-174 and RG-213 are commonly used coaxial cables. RG-8 and RG-213 are similar cables, and they have the least loss of the types listed here. The larger coax types (RG-8, RG-213, RG-11) have less signal loss than the smaller types. If the feed line is less than 30 meters long, the small additional signal loss on the HF bands is negligible. On VHF/UHF bands losses are more noticeable, especially when the feed line is long. On these bands, higher-quality RG-213 coax or even lower-loss rigid or semi-rigid coaxial cables minimise losses for transmission lines exceeding 30 meters.

Coaxial cable connectors are an important part of a coaxial feed line. It is prudent to check the coaxial connectors periodically to see that they are clean and tight to minimise any loses. If a bad solder connection is suspected, the joints should be cleaned and re-soldered. The choice of connectors normally depends on matching connectors on the radios. Many HF radios and many VHF radios use SO-239 connectors. The mating connector is a PL-259 (Figure 7). The PL-259 is sometimes called a UHF connector, although constant impedance connectors such as Type-N the best choice for the UHF bands. PL-259 connectors are designed for use with RG-8 or RG-213 cables. When using coax to connect the transmission line, an SO-239 connector should terminate the line at the centre insulator and a PL-259 should be used at the end connecting to the radio.

Figure 8 – PL-259 coaxial connector



4.2.6 Matching impedances within the antenna system

If an antenna system does not match the characteristic impedance of the transmitter, some of the power is reflected back from the antenna to the transmitter. When this happens, the RF voltage and current are not uniform along the line. The power travelling from the transmitter to the antenna is called forward power and is radiated from the antenna. The standing-wave ratio (SWR) is the ratio of the maximum voltage on the line to the minimum voltage. An SWR meter measures the relative impedance match between an antenna and its feed line. Lower SWR values mean a better impedance match exists between the transmitter and the antenna system. If a perfect match exists, the SWR is 1:1. The SWR defines the quality of an antenna as seen from the transmitter, but a low SWR does not guarantee that the antenna will radiate the RF energy supplied to it by the transmitter. An SWR measurement of 2:1 indicates a fairly good impedance match.

4.2.7 SWR meters

The most common SWR meter application is tuning an antenna to resonate on a given frequency. An SWR reading of 2:1 or less is quite acceptable. A reading of 4:1 or more is unacceptable. This means there is a serious impedance mismatch between the transmitter, the antenna or the feed line.

How the SWR is measured depends on the type of meter. Some SWR meters have a SENSITIVITY control and a FORWARD-REFLECTED switch. If so, the meter scale usually provides a direct SWR reading. To use the meter, first put the switch in the FORWARD position. Then adjust the SENSITIVITY control and the transmitter power output until the meter reads full scale. Some meters have a mark on the meter face labelled SET or CAL. The meter pointer should rest on this mark. Next, set the selector switch to the REFLECTED position. This should be done without readjusting the transmitter power or the meter SENSITIVITY control. Now the meter pointer displays the SWR value. Find the resonant frequency of an antenna by connecting the meter between the feed line and your antenna. This technique will measure the relative impedance match between the antenna and its feed line. The settings that provide the lowest SWR at the operating frequency are preferred.

4.2.8 Antenna impedance matching networks

Another useful accessory is an impedance matching network. It is also called an antenna matching network, antenna tuner, antenna tuning unit (ATU), or simply a tuner. The network compensates for any impedance mismatch between the transmitter, the transmission line and the antenna. A tuner makes it possible to use one antenna on several frequency bands. The tuner is connected between the antenna and SWR meter, if used. The SWR meter is used to indicate the minimum reflected power as the tuner is adjusted.

Just one more step and the antenna installation is complete. After routing the coaxial cable to your station, cut it to length and install the proper connector for the transmitter. Usually this connector will be a PL-259, sometimes called a UHF connector. Figure 7 shows how to attach one of these fittings to RG-8 or RG-11 cable. It is important to place the coupling ring on the cable *before* installing the connector body. If using RG-58 or RG-59 cable, use an adapter to fit the cable to the connector. The SO-239 female connector is standard on many transmitters and receivers.

If the SWR is very high, a problem may exist that cannot be cured by simple tuning. A very high SWR may mean that the feed line is open or shorted. If the SWR is very high the cause may be an improper connection or insufficient space between the antenna and surrounding objects.

4.3 Practical antennas

4.3.1 The half-wave dipole antenna

Probably the most common HF antenna is a wire cut to a half wavelength (½ λ) at the operating frequency. The transmission line attaches across an insulator at the centre of the wire. This is the half-wave dipole. This is often referred to as a dipole antenna. (*Di* means two, so a dipole has two equal parts. A dipole could be a length other than ½ λ.) The total length of a half-wavelength dipole is ½ λ. The feed line connects to the centre. This means that each side of this dipole is ¼ λ long.

Wavelength in space can be determined by dividing the constant 300 by the frequency in megahertz (MHz). For example, at 15 MHz, the wavelength is 300/15 = 20 meters.

Radio signals travel slower in wire than in air, thus the following equation may be used to find the total length of a ½ λ dipole for a specific frequency. Notice that the frequency is given in megahertz and the antenna length is in meters for this equation:

$$L \text{ (in meters)} = \frac{143}{f_{MHz}}$$

This equation also takes into account other factors, often called *antenna effects*. It gives the approximate length of wire for an HF dipole antenna. The equation will not be as accurate for VHF/UHF antennas. The element diameter is a larger percentage of the wavelength at VHF and higher frequencies. Other effects, such as *end effects* also make the equation less accurate at VHF and UHF.

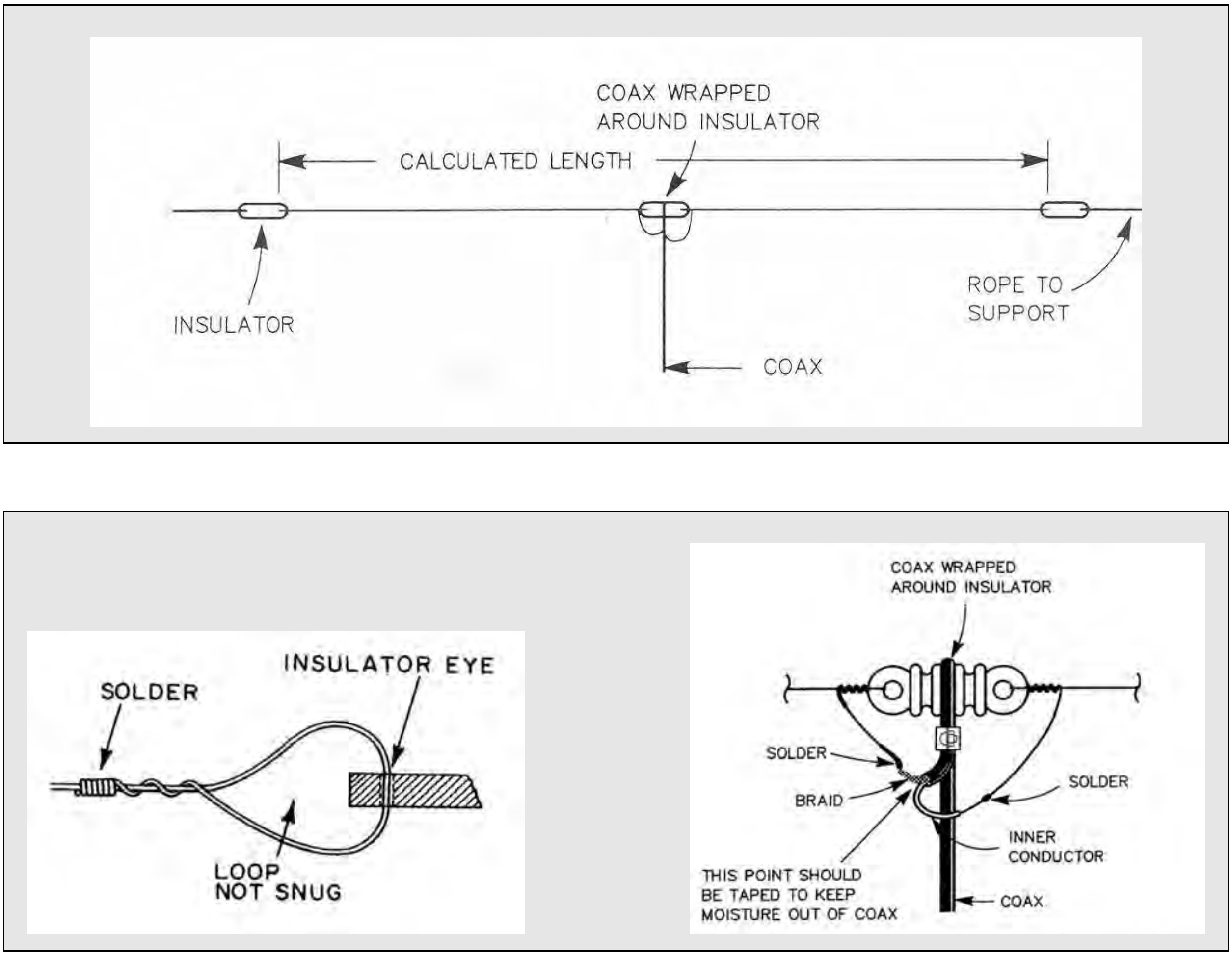
Table 2 – Approximate lengths for ½ λ dipoles suitable for fixed, mobile and amateur bands

Frequency (MHz)	Length (m)
3.3	43.3
3.5	40.8
3.8	37.6
4.5	31.8
4.9	29.2
5.2	27.5
5.8	24.6
6.8	21.0
7.1	20.1
7.7	18.6
9.2	15.5
9.9	14.4
10.1	14.1
10.6	13.5
11.5	12.4

Frequency (MHz)	Length (m)
12.2	11.7
13.4	10.7
13.9	10.3
14.2	10.0
14.6	9.8
16.0	8.8
17.4	8.2
18.1	7.9
20.0	7.1
21.2	6.7
21.8	6.5
23.8	6.0
24.9	5.7
25.3	5.6
29.0	4.9

Frequency (MHz)	Length (m)
30	4.8
35	4.1
40	3.6
50	2.86
145	99 cm
150	95
155	92
160	89
165	87
170	84
435	33
450	32
455	31.4
460	31
465	30.7

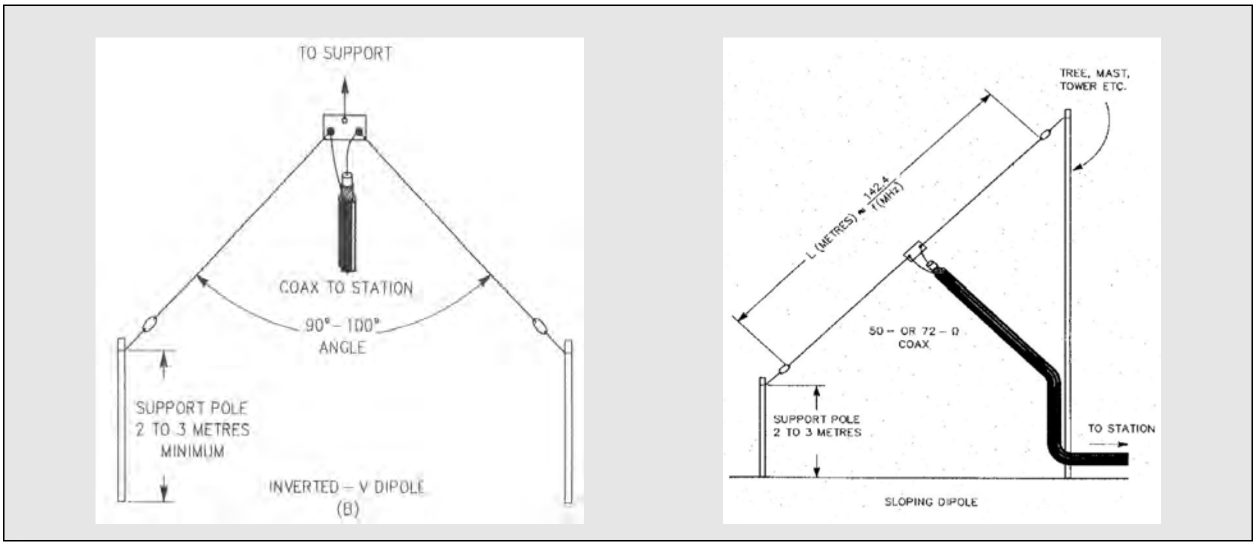
Figure 9 – Construction of a simple half-wave dipole antenna. At top is the basic dipole assembly. Bottom left shows how to connect wire ends to insulators. Bottom right illustrates connection of the transmission line to the centre of the dipole



Household electrical wire and stranded wire will stretch with time; a heavy gauge copper-clad steel wire does not stretch as much. The dipole should be cut according to the dimension found by the equation above (total length of a ½ λ dipole), but a little extra length should be provided to wrap the ends around the insulators. A coaxial or parallel transmission line is needed to connect the antenna to the transmitter. Three insulators are also needed. If supporting the antenna in the middle, both ends will droop toward the ground. This antenna, known as an inverted-V dipole, is almost omni-directional and works best when the angle between the wires is equal to or greater than 90°. A dipole can also be supported only at one end, in which case it is known as a sloping dipole.

Dipole antennas radiate best in a direction that is 90° to the antenna wire. For example, suppose a dipole antenna is installed so the ends of the wire run in an east/west direction. Assuming it was sufficiently above the ground (for example, ½ λ high), this antenna would send stronger signals in north and south directions. A dipole also sends radio energy straight up and straight down. Of course, the dipole also emits some energy in directions off the ends of the wire, but these signals will be attenuated. Though it is possible to contact stations to the east and west with this antenna, signals are stronger with stations to the north and south.

Figure 10 – Alternative ways of installing a dipole. The configuration on the left is an Inverted-V dipole. A sloping dipole is shown at right. A balun (not shown) may be used at the feed point, as this is a balanced antenna



4.3.2 Broadband folded dipole

A broadband version of the dipole, the folded dipole has an impedance of about 300 ohms and can be fed directly with any length of 300 ohm feed line. This variation of the dipole is termed *broadband* because it offers a better match to the feeder over a somewhat wider range of frequencies. When a folded dipole is installed as an inverted "V" it is essentially omni-directional. There are several broadband folded dipoles available commercially that provide acceptable HF performance, even when operating without a tuner.

4.3.3 Quarter-wavelength vertical antenna

The quarter-wavelength vertical antenna is effective and easy to build. It requires only one element and one support. On the HF bands it is often used for long distance communications. Vertical antennas are referred to as non-directional or omni-directional antennas because they send radio energy equally well in all compass directions. They also tend to concentrate the signals toward the horizon as they have a low-angle radiation pattern and do not generally radiate strong signals upward.

Figure 11 shows how to construct a simple vertical antenna. This vertical antenna has a radiator that is ¼ λ long. Use the following equation to find the approximate length for the radiator. The frequency is given in megahertz and the length is in meters in this equation.

$$L \text{ (in meters)} = \frac{71}{f_{\text{MHz}}}$$

Figure 11 – Simple quarter-wave vertical antenna

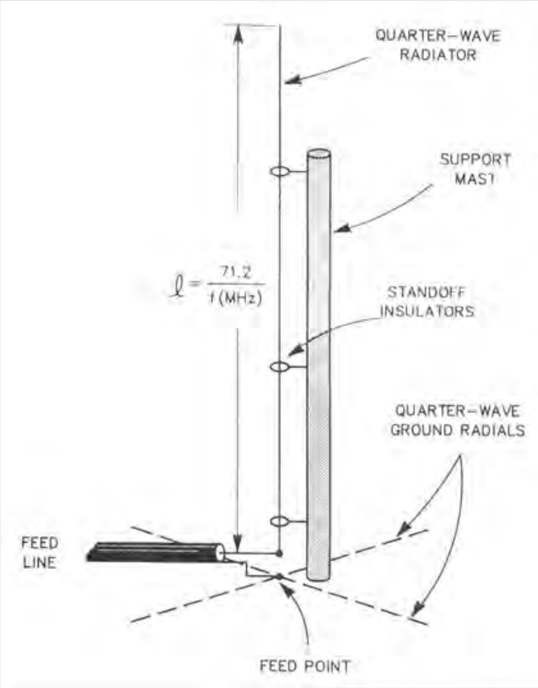


Table 3 – Approximate lengths for ¼ λ monopoles and ground radials suitable for fixed, mobile and amateur bands

Frequency (MHz)	Length (m)	Frequency (MHz)	Length (m)	Frequency (MHz)	Length (m)
3.3	21.6	12.2	5.9	30	2.4
3.5	20.4	13.4	5.3	35	2.1
3.8	18.8	13.9	5.1	40	1.8
4.5	15.9	14.2	5.0	50	1.43
4.9	14.6	14.6	4.9	145	50 cm
5.2	13.7	16.0	4.5	150	48
5.8	12.3	17.4	4.1	155	46
6.8	10.5	18.1	3.9	160	44
7.1	10.0	20.0	3.5	165	43
7.7	9.3	21.2	3.3	170	42
9.2	7.7	21.8	3.2	435	117
9.9	7.2	23.8	3.0	450	16
10.1	7.1	24.9	2.9	455	16
10.6	6.7	25.3	2.8	460	16
11.5	6.2	29.0	2.5	465	15

For successful results, the ¼ λ vertical should have a radial system to reduce Earth losses and to act as a ground plane. For operation on high frequencies, the vertical may be at ground level and the radials placed on the ground. At least 3 radials should be used and out like the spokes of a wheel, with the vertical at the centre. Radials should be at least ¼ λ long or more at the lowest operating frequency.

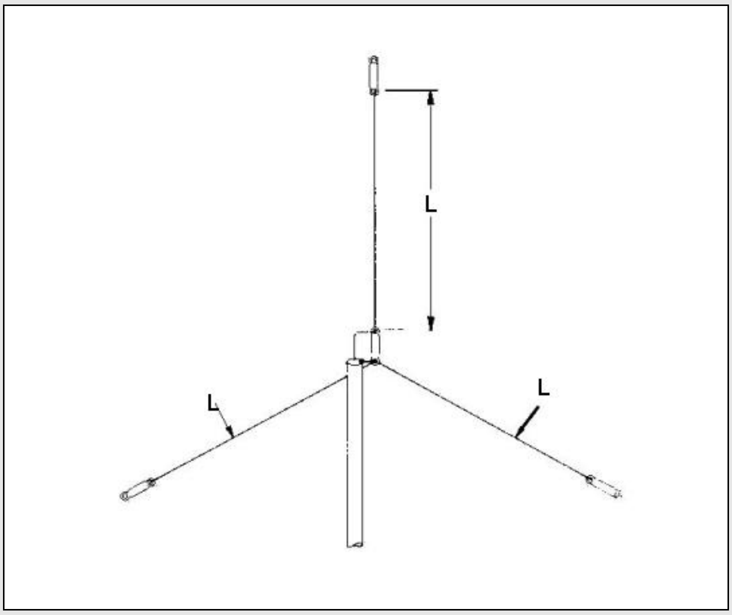
Most vertical antennas used at HF are ¼ λ long or shorter with appropriate loading networks. For VHF and UHF, antennas are physically short enough that longer verticals may be used. A popular mobile antenna is a 5/8 λ vertical, often called a "five-eighths whip". This antenna is popular because it concentrates more of the radio energy toward the horizon than a ¼ λ vertical.

Commercially available vertical antennas need a coax feed line, usually with a PL-259 connector. Just as with the dipole antenna, RG-8, RG-11 or RG-58 coax can be used.

Some manufacturers offer multi-band vertical antennas that use series-tuned circuits (traps) to make the antenna resonant at different frequencies.

To fabricate a tree-mounted HF ground plane antenna (Figure 12), a length of RG-58 cable is connected to the feed point of the antenna and is attached to an insulator. The radial wires are soldered to the coax-line braid at this point. The top of the radiator section is suspended from a tree limb or other convenient support, and in turn supports the rest of the antenna.

Figure 12 – Construction of tree-mounted ground plane antenna. L = 143/f_{MHz}



The dimensions for the antenna are the same as for a ¼ λ vertical antenna. All three wires of the antenna are ¼ λ long. This generally limits the usefulness of the antenna to 7 MHz and higher bands, as temporary supports higher than 10 or 15 meters may not be available.

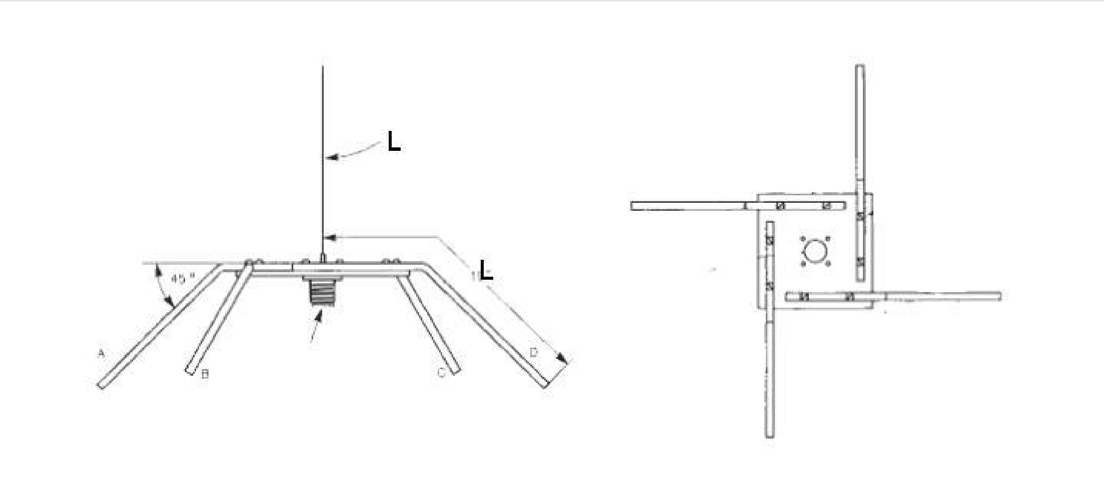
4.3.4 Antennas for hand-held transceivers

VHF and UHF hand-held transceivers normally use shortened flexible antennas that are inexpensive, small, lightweight and robust. On the other hand, they have some disadvantages: It is a compromise design that is inefficient and thus does not perform as well as larger antennas. Two better-performing antennas are the ¼ λ and the 5/8 λ telescoping types that are available as separate accessories.

4.3.5 Vertical antennas for VHF and UHF

For operation of stations at fixed locations, the ¼ λ vertical is an ideal choice. The 145 MHz model shown in Figure 13 uses a flat piece of sheet aluminium, to which radials are connected with machine screws. A 45° bend is made in each of the radials. This bend can be made with an ordinary bench vise. An SO-239 chassis connector is mounted at the centre of the aluminium plate with the threaded part of the connector facing down. The vertical portion of the antenna is made of 10 mm copper wire soldered directly to the centre pin of the SO-239 connector.

Figure 13 – A VHF or UHF ground plane antenna with 4 drooping radials. L = 143/f_{MHz}

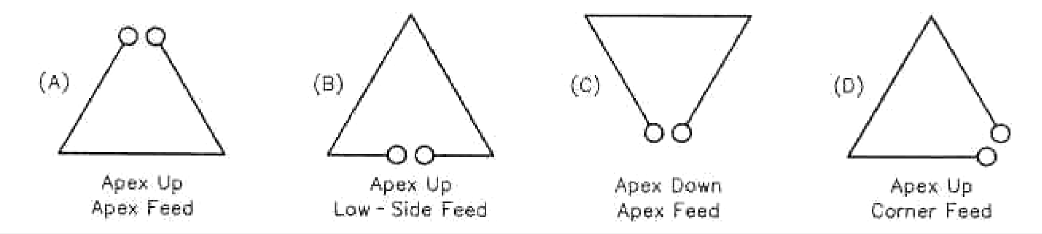


Construction is simple as it requires nothing more than an SO-239 connector and some common hardware. A small loop formed at the inside end of each radial is used to attach the radial directly to the mounting holes of the coaxial connector. After the radial is fastened to the SO-239 with hardware, a large soldering iron or propane torch is used to solder the radial and the mounting hardware to the coaxial connector. The radials are bent to a 45° angle and the vertical portion is soldered to the centre pin to complete the antenna. It is prudent to apply a small amount of sealant around the areas of the centre pin of the connector to prevent the entry of water into the connector and coax line.

4.3.6 Delta loop

The Delta loop is another field expedient wire antenna used by disaster relief organisations. There are three key advantages to a Delta loop antenna: 1) a ground plane is unnecessary; 2) a full-wave loop (depending on the shape) has some gain over a dipole; and 3) a closed loop is a “quieter” (improved signal-to-noise ratio) receiving antenna than are most vertical and some horizontal antennas. Feed point selection will permit the choice of vertical or horizontal polarisation. Various angles of radiation will result from assorted feed-point selections. The system is rather flexible and is capable of maximising close in or long distance communications (high angle versus low angle). Figure 14 illustrates various configurations that can be used. The bandwidth at resonance is similar to a dipole. An antenna-tuning unit (ATU) is recommended for matching the system to the transmitter in parts of the band where the SWR is high. There is no rule that dictates the shape of a full wave loop. It may be convenient to use a triangular shape with the apex is at the top in which case only one high support is needed. Circular, square or rectangular shapes have been used.

Figure 14 – Various configurations for a full-wavelength Delta loop antenna. Overall length of the antenna wire is approximately 286/f_{MHz}



Configuration	A	B	C	D
Polarisation	Horizontal	Horizontal	Horizontal	Vertical
Radiation angle	Moderately high	High	Moderately high	Low

4.3.7 Directional antennas

Directional antennas have two important advantages over simpler omni-directional antennas such as dipoles and vertical monopoles. As transmitting antennas, they concentrate most of the radiation in one direction. For receiving, directional antennas can be pointed toward the desired direction or away from a source of noise.

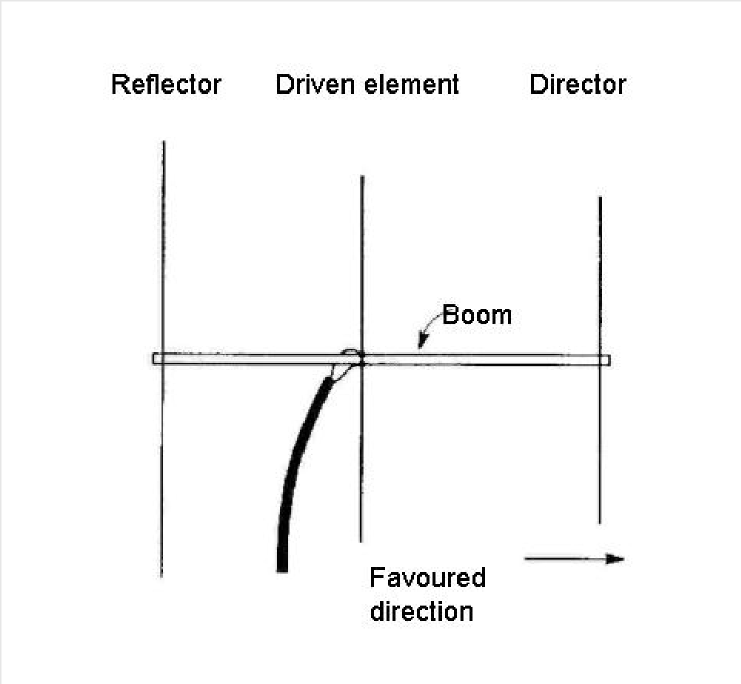
Although generally large and expensive below about 10 MHz, directional antennas often are used on the upper high frequency bands, such as from 10 MHz to 30 MHz. Directional antennas commonly used at VHF and UHF owing to their reasonably small size. The most common directional antenna is the *Yagi* antenna, but there are other types, as well.

A Yagi antenna has several elements attached to a central *boom*, as Figure 15 shows. The elements are parallel to each other and are placed in a straight line along the boom. Although several factors affect the amount of gain of a Yagi antenna, *boom length* has the largest effect: The longer the boom, the higher the gain.

The transmission line connects only to one element called the *driven element*. On a three-element Yagi like the one shown in Figure 15, the driven element is in the middle. The element at the front of the antenna (toward the favoured direction) is a director. Behind the driven element is the reflector element. The driven element is about ½ λ long at the antenna design frequency. The director is a bit shorter than ½ λ, and the reflector a bit longer. Yagi beams can have more than three elements, usually by adding more directors. Directors and reflectors are called parasitic elements, since they are not fed directly.

Communication in different directions may be achieved by turning the array using a rotator in the azimuthal (horizontal) plane, to point it in different directions.

Figure 15 – A three-element Yagi showing the reflector, driven element and director supported by a boom



4.3.7.1 Log-periodic arrays

Log-periodic antennas are an alternative directional antenna. They have wider bandwidth but lower directional gain than a Yagi.

A log-periodic antenna is a system of driven elements, designed for operation over a wide range of frequencies. Its advantage is that it exhibits essentially constant characteristics over the frequency range – the same radiation resistance (and therefore the same SWR), and the same pattern characteristics (approximately the same gain and the same front-to-back ratio).

5 Power sources and batteries

5.1 Power safety

As in antenna work, for safety purposes any electrical work should be done with a second person present. A switch should never be used in the neutral wire without also disconnect the equipment from an active or "hot" line.

All communications equipment should be reliably connected to an Earth ground by means of a separate heavy gauge wire. The power wiring neutral conductor should not be used for this safety ground. This places the chassis of the equipment at Earth ground potential for minimal RF energy on the chassis. It provides a measure of safety for the operator in the event of accidental short or leakage of one side of the power line to the classis.

No battery should be subjected to unnecessary heat, vibration or physical shock. The battery should be kept clean. Frequent inspection of leaks is recommended. Electrolyte that has leaked or sprayed from the battery should be cleaned from all surfaces. The electrolyte is chemically active and electrically conductive, and may ruin electrical equipment. Acid may be neutralized with sodium bicarbonate (baking soda), and alkalis may be neutralized with a weak acid such as vinegar. Both neutralizers will dissolve in water, and should be quickly washed off. The neutralizer should not be allowed to enter the battery. Gas escaping from storage batteries may be explosive. Keep flames or lighted tobacco products away.

When working with generators, keep safety foremost in your mind. Gasoline is a dangerous chemical and there is no scope for carelessness. Fuel should be stored only in the proper containers, well away from the generator and out of the sun. The generator should be turned off and cool before adding new fuel. Gasoline and oil-soaked rags should be disposed of properly. If they are tossed in a pile, they could catch fire by spontaneous combustion. A fire extinguisher should be kept near the generator. Smoking should not be allowed near the generator.

Internal combustion engines produce heat. The larger the engine, the higher the speed, the greater the heat produced. The combination of fuel fumes and engine heat in a small enclosure is dangerous. Generator exhaust fumes can be lethal. Whether gasoline, diesel, natural gas or propane is used, be sure that exhaust fumes are properly vented out of the operating area. Natural ventilation is usually not sufficient to maintain a safe atmosphere. A blower or ventilator fan should be used to bring fresh air from outside, with an exhaust fan installed to expel the heat.

5.2 Mains power

Mains power should be used when available to save any self-generated power systems for backup purposes. Even unreliable mains power can be used to charge batteries.

Electrical service enters buildings in the form of two or more wires to provide 100-130 V or 200-260 V alternating current at 50 or 60 Hz. The circuits may be divided into several branches and protected by circuit breakers or fuses.

A ground fault circuit interrupter (GFCI or GFI) is also desirable to safety reasons, and should be a part of the electrical power wiring if possible.

5.3 Power transformers

Numerous factors should be considered in selecting transformers, such as input and output volt-ampere (VA) ratings, ambient temperature, duty cycle and mechanical design.

In alternating-current equipment, the term "volt-ampere" is often used rather that the term "watt". This is because ac components must handle reactive power as well as real power. The number of volt-amperes delivered by a transformer depends not only upon the dc load requirements, but also upon the type of dc output filter used (capacitor or choke input), and the type of rectifier used (full-wave centre tap or full-wave bridge). With a capacitive-input filter, the heating effect in the secondary is higher because of the high peak-to-average current ration. The volt-amperes handled by the transformer may be several times the power delivered to the load. The primary winding volt-amperes will be somewhat higher because of transformer losses.

A transformer operates by producing a magnetic field in its core and windings. The intensity of this field varies directly with the instantaneous voltage applied to the transformer primary winding. These variations, coupled to the secondary windings, produce the desired output voltage. Since the transformer appears to the source as an inductance in parallel with the (equivalent) load, the primary will appear as a short circuit if dc is applied to it. The unloaded inductance of the primary must be high enough so as not to draw an excess amount of input current at the design line frequency (normally 50 or 60 Hz). This is achieved by providing sufficient turns on the primary and enough magnetic core materials so that the core does not saturate during each half-cycle.

To avoid possibly serious overheating, transformers and other electromagnetic equipment designed for 60 Hz systems must not be used on 50 Hz power systems unless specifically designed to handle the lower frequency.

5.4 Batteries and charging

The availability of solid-state equipment makes it practical to use battery power under portable or emergency conditions. Hand-held transceivers and instruments are obvious applications, but 100 W output transceivers may be practical users of battery power (for example, emergency power for HF transceivers).

Low-power equipment can be powered from two types of batteries. The *primary* battery is intended for one-time use and is then discarded; the *storage* (or *secondary*) battery may be recharged many times.

A battery is a group of chemical cells, usually connected in series to give some desired multiple of the cell voltage. Each assortment of chemicals used in the cell gives a particular nominal voltage. This must be taken into account to make up a particular battery voltage. For example, four 1.5 V carbon-zinc cells make a 6 V battery and six 2 V lead-acid cells make a 12 V battery.

5.4.1 Battery capacity

The common rating of battery capacity is ampere-hours (Ah), the product of discharge current and time. The symbol *C* is commonly used; C/10, for example, would be the current available for 10 hours continuously. The value of C changes with the discharge rate and might be 110 at 2 A but only 80 at 20 A. Capacity may vary from 35 mAh for some of the small hearing aid batteries to more than 100 Ah for a size 28 deep-cycle storage battery.

Sealed primary cells usually benefit from intermittent (rather than continuous) use. The resting period allows completion of chemical reactions needed to dispose of by-products of the discharge.

The output voltage of all batteries drops as they discharge. “Discharged” condition for a 12 V lead-acid battery, for instance, should not be less than 10.5 V. It is also good to keep a running record of hydrometer readings, but the conventional readings of 1.265 charged and 1.100 discharged apply only to a long, low-rate discharge. Heavy loads may discharge the battery with little reduction in the hydrometer reading.

Batteries that become cold have less of their charge available, and some attempt to keep a battery warm before use is worthwhile. A battery may lose 70% or more of its capacity at cold extremes, but it will recover with warmth. All batteries have some tendency to freeze, but those with full charges are less susceptible. A fully charged lead-acid battery is safe to –26 °C or colder. Storage batteries may be warmed somewhat by charging or discharging. Blow touches or other flame should never be used to heat any type of battery.

A practical discharge limit occurs when the load will no longer operate satisfactorily on the lower output voltage near the “discharged” point. Much gear intended for “mobile” use may be designed for an average of 13.6 V and a peak of perhaps 15 V, but will not operate well below 12 V. For full use of battery charge, the gear should operate well (if not at full power) on as little as 10.5 V with a nominal 12 to 13.6 V rating.

Somewhat the same condition may be seen in the replacement of carbon-zinc cells by NiCd storage cells. Eight carbon-zinc cells will give 12 V, while 10 for the same voltage. If a 10-cell battery holder is used, the equipment should be designed for 15 V in case the carbon-zinc units are plugged in.

5.4.2 Primary batteries

One of the most common primary-cell types is the alkaline cell, in which chemical oxidation occurs during discharges. When there is no current, the oxidation essentially stops until current is required. A slight amount of chemical action does continue, however, so stored batteries eventually will degrade to the point where the battery will no longer supply the desired current.

The alkaline battery has a nominal voltage of 1.5 V. Larger cells capable of production more milliampere hours and less voltage drop than smaller cells. Heavy duty and industrial batteries usually have longer shelf life.

Lithium primary batteries have a nominal voltage of about 3 V per cell and by far the best capacity, discharge, shelf life and temperature characteristics. Their disadvantages are high cost and that they cannot be readily replaced by other types in an emergency.

The lithium-thionyl-chloride battery is a primary cell and should not be recharged under any circumstances. The charging process vents hydrogen, and a catastrophic explosion can result. Even accidental charging caused by wiring errors or a short circuit should be avoided.

Silver oxide (1.5 V) and mercury (1.4 V) batteries are used where nearly constant voltage is desired at low currents for long periods. Their primary application is in small equipment.

Primary batteries should not be recharged for two reasons: It may be dangerous because of heat generated within sealed cells, and even in cases where there may be some success, both the charge and life are limited. One type of alkaline battery is rechargeable and is so marked.

5.4.3 Secondary batteries

The most common type of small rechargeable battery is the nickel-cadmium (NiCd), with a nominal voltage of 1.2 V per cell. Carefully used, these are capable of 500 or more charge/discharge cycles. For long life, the NiCd battery should not be fully discharged. Where there is more than one cell in the battery, the most-discharged cell may suffer polarity reversal, resulting in a short circuit or seal rupture. All storage batteries have discharge limits, and NiCd types should not be discharged to less than 1.0 V per cell. Nickel cadmium cells are not limited to "D" size and smaller cells. They also are available in large varieties ranging to mammoth 1 000 Ah units having carrying handles on the sides and top for adding water, similar to lead-acid types. They are used extensively for uninterruptible power supplies.

For high capacity, the most widely used rechargeable battery is the lead-acid type. In automotive service, the battery is usually expected to discharge partially at a very high rate and then to be recharged promptly while the alternator is also carrying the electrical load. The most appropriate battery for extended high-power electronic applications is the so-called "deep-cycle" battery. These batteries may furnish between 1 000 and 1 200 Wh per charge at room temperature. When properly cared for, they may be expected to last more than 200 cycles. They often have lifting handles and screw terminals, as well as the conventional truncated cone automotive terminals. They may also be fitted with accessories, such as plastic carrying cases, with or without built-in chargers. Lead-acid batteries are also available with gelled electrolyte. Commonly called "gel cells", these may be mounted in any position sensitive.

An automotive lead-acid battery was designed for one task: to deliver a lot of current for a brief period of time. Its output voltage does not remain constant during its discharge cycle, and it is not a good idea to discharge it completely. An automobile battery will not tolerate too many deep-discharge cycles before it's ruined.

A deep-discharge lead-acid battery is much better suited emergency power needs. It can be discharged repeatedly without damage, and will maintain full output voltage over much of its discharge cycle. This type of battery is available at automobile- and marine-parts supply outlets. They are not much more expensive than regular automobile batteries and are designed to deliver moderate current for long periods of time.

The nickel metal hydride (NiMH) battery is similar to the NiCd, but the cadmium electrode is replaced by one made from a porous metal alloy that traps hydrogen; therefore the name of metal hydride. Many of the basic characteristics of these cells are similar to NiCds. For example, the voltage is very nearly the same, they can be slow-charged from a constant current source and they can safety be deep cycled. These are also some important differences: They have higher capacity for the same cell size often nearly twice as much as the NiCd types. The typical size AA NiMH cell has a capacity between 1 000 and 1 300 mAh, compared to the 600 to 830 mAh for the same size NiCd. Another advantage of these cells is a complete freedom from memory effect. NiMH cells do not contain any dangerous substance, while both NiCd and lead-acid cells do contain quantities of toxic heavy metals.

The Lithium-ion (Li-ion) cells is another possible alternative to the NiCd cell. For the same energy storage, it has about one third the weight and one half the volume of NiCd. It also has a lower self-discharge rate. Typically, at room temperature, a NiCd cell will lose from 0.5 to 2% of its charge per day. The lithium-ion cell will lose less than 0.5% per day and even this loss rate decreased after about 10% of the charge has been lost. At higher temperature the difference is even greater. The results are that Lithium-ion cells are a better choice for standby operation where frequent recharge is not available. One major difference between NiCd and Li-ion cells is the cell voltage. The nominal voltage for NiCd cell is about 1.2 V. For the Li-ion cell it is 3.6 V with a maximum cell charging voltage of 4 V. Li-ion cells cannot be substituted directly for NiCd cells. Chargers intended for NiCd batteries must not be used with Li-ion batteries, and vice versa.

5.5 Inverters

One source of ac power for use in the field is a dc-to-ac converter, or more commonly, an inverter. The ac output of an inverter is a usually square wave. Therefore, some types of equipment cannot be operated from the inverter. Certain types of motor are among those devices that require a sine-wave output. Aside from having a square-wave output, inverters have some other traits that make them less than desirable for field use. Commonly available models do not provide a high power handling capability. Higher power models are available but are quite expensive.

5.6 Generators

For long-term emergency operation, a generator is a requirement. The generator will provide power as long as fuel is available. Proper care is necessary to keep the generator operating reliably, however.

For these periods when the generator is shut down, battery power can be used until the generator can be reactivated. The lubricating oil level should be checked periodically.

If the oil sump becomes empty, the engine can seize, putting the station out of operation and necessitating costly engine repairs.

Remember the engine will produce carbon monoxide gas while it is running. The generator should never run indoors and should be placed away from open windows and doors to keep exhaust fumes from coming inside.

Generators in the 3-5 kW range are easily handled by two people and can provide power for radios and other electrical equipment. Most generators provide 12 V dc output in addition to 120/240 V ac.

Some generators have a continuous power rating and an intermittent power rating. If the total station requirement exceeds the available generator power, transceivers draw full power only while transmitting and that they are not going to be transmitting 100% of the time. It is necessary to ensure that the total possible power consumption does not exceed the intermittent power rating of the generator.

Generators should be tested regularly. Fuel should be fresh. Operator level maintenance (tune-up or oil change) should be performed regularly. Spark plugs should be checked carefully and spare spark plugs should be maintained. The air cleaners should be checked and cleaned according to manufacturer’s instructions.

The generator should be checked for proper operation. If there are any fuel leaks, it should be turned off immediately and the problem corrected. The muffler should be inspected. All protective covers should be in place. The output voltage should be tested. If the generator does not have a built-in over-voltage protector, the voltage should be correct before applying power to radio equipment.

Finally, the generator should be checked for radio noise. Some generators are not fully suppressed for ignition noise. If there is a problem, it may be possible to use resistor-type spark plugs or spark-plug wires. A good Earth ground with a ground rod may help minimize noise.

5.6.1 Installation considerations

Any internal combustion engine is noisy and bothersome when communication equipment is being operated nearby. The placement of a power plant is important, regardless of its size. An engine running at 3 600 rotations per minute, even with an efficient muffler system produces noise and vibration. The engine vibrations are conducted thought the base upon which the engine is mounted to the ground or walls of the building housing the system. Brick or concrete-block construction will reduce the noise level, but if the generator shack is metal, there is less noise abatement. Metal panels may vibrate in sympathy with the sound source add to the din. Applying a hardening caulking compound to the vertical edges of the metal panels cab eliminate some of the noise, as can the use of sound-deadening material in lining the shack.

The distance between the alternator and the operating must be considered. Sound intensity varies inversely with the square of the distance from the source. The noise at a distance of 20 meters will be one-fourth that at a distance of 10 meters. At 30 meters, it will be one ninth.

Fuel consumption must be considered, both from an installation aspect and as a safety problem. Fuel will be used at the rate of 2 to 4 litres per hour is a 2.5-5 kW generator. There should be an ample reserve plan of at least 48 hours of operation. If the fuel is gasoline, safe storage can be a problem. Store gasoline in an area separate from the area housing the generator. Transfer only enough fuel at one time to fill the power unit's tank. If you in an area where propane or natural gas are available, it might be worthwhile to consider these options as a fuel source. Some alternators are supplied with multiple-fuel capabilities (gasoline or natural gas/propane). A special carburetion system is required for natural gas or propane.

5.6.2 Generator maintenance

Proper maintenance is necessary to obtain rated output and long service life from a gasoline generator. A number of simple measures will prolong the life of the equipment and help maintain reliability.

The manufacturer's manual should be the primary source of maintenance information and the final word on operating procedures and safety. The manual should be thoroughly covered by all persons who will operate and maintain the unit.

Fuel should be clean, fresh and of good quality. Many problems with gasoline generators are caused by fuel problems. Examples include dirt or water in the fuel land old, state fuel. Gasoline stored for any length of time changes as the more volatile components evaporate. This leaves excess amount of varnish-like substances that will clog carburetor passages. If the generator will be stored for a long period, it is good to run it until all of the fuel is burned. Faulty spark plugs are a common cause of ignition problems. Spare spark plugs should be kept with the unit, along with tools needed to charge them.

5.6.3 Generator earth ground

A proper ground for the generator is necessary for both safety reasons and to ensure proper operation of equipment powered from the unit. Most generators are supplied with a three-wire outlet. Some generators require that the frame be grounded also. An adequate pipe or rod should be driven into the ground near the generator and connected to the provided clamp or lug.

5.7 Solar power

A solar cell is a very simple semiconductor. Solar cells are, in fact, large-area semiconductor diodes. Simply explained, when the photons contained in light rays bombard the barrier of this semiconductor, hole electron pairs inside this P-N junction are freed, resulting in a forward bias of the junction, just as in phototransistors. This forward-biased junction can deliver current into a load. Because the exposed area of a solar cell can be quite large, the forward current proceed can be substantial. It follows that the output current of a photocell is directly proportional to the rate of photon bombardment, and thus to the exposed are of the photocell.

5.7.1 Types of solar cells

Originally, solar cells were made by cutting slides of grown silicon-crystal rod and subjecting them to doping and metallization process. These solar cells are called monocrystalline cells because each unit consists of only one crystal plate. The shape of these cells is the same as that of the silicon rod from which they are cut: round. A slice of this material with an area of 50 mm can be made into one photocell, but a slice of this size could also be used to produce upwards of a thousands transistors.

Most are polarity protected with a diode in series with the positive voltage line. When it gets dark, and the output voltage drops, the diode ensures that the panel won't start drawing current from the battery.

Solar panels typically deliver 15 to 18 V at 600 to 1 500 mA in full sunlight. This will not damage a high-capacity battery, such as a deep-cycle unit. All you need do is hook up the battery, put the solar panel in full sunlight, and charge away. The battery will regulate the maximum voltage from the panel.

If you're going to use a solar panel to recharge a smaller battery, such as a Nickel-Cadmium (NiCd) battery or gelled-electrolyte lead-acid battery, you'll need to pay a bit more attention to detail. These types of batteries can suffer damage if charged too quickly, so a regulated charge is necessary.

A dc-ac converter, or inverter converts 12 V to a square-wave ac output at approximately 60 Hz. Inverters are limited to about 100 to 400 watts, however, and some equipment (especially motors) cannot be powered by a square wave. An inverter will run a few light bulbs or a small soldering iron and can be a useful addition to a battery-operated station. Some newer ones use switching technology and are quite lightweight.

Polycrystalline cells are typically manufactures as rectangular blocks of seemingly randomly arranged silicon crystals from which the cell plates are cut. These cells are recognized by their shape, random pattern and colourful surface. Polycrystalline cells are less expensive to manufacture than monocrystalline cells. Reliable amorphous panels are available from many manufactures. These panels come in several forms: mounted on thin glass, framed, and even mounted on flexible substrates, such as steel.

5.7.2 Solar cell specifications

Depending on construction, each cell has an open-circuit, when exposed to the sun, of 0.6 to 0.8 V. This output voltage drops somewhat when current is drawn from a solar cell. This is called the cell’s *load curve*. Open-circuit voltage is approximately 0.7, and output voltage at optimum load is normally 0.45. Output current is maximum with shorted output terminals. This maximum current is called the short-circuit current, and is dependent on the cell type and size. Because a cell’s output current remains relatively constant under varying load conditions, it can be considered to be a constant-current sources.

As with batteries, solar cells may be operated in series to increase output voltage, and/or in parallel to increase output-current capability. Several manufactures supply arrays or panels with a number of cells in a series-parallel hook-up to be used, for example, for battery charging.

Techniques have been developed for the construction of amorphous cells whereby the cells are manufactured in series by cutting metal layers that have been vapour deposited on the amorphous silicon mass. This cutting is done with a laser. Cell width is such panels may be up to several feet, and the output-current capability of these relatively economical panels is excellent.

Solar-cell efficiency varies: Monocrystalline cell have efficiencies up to 15%; polycrystalline cells, 10 to 12%; amorphous cells, 6.5 to over 10%, depending on the manufactures process.

The output power of solar arrays or panels is specified in watts. Typically, the listed wattage is measured at full exposure to sunlight, at a nominal potential of 7 V for a 6-V system, 14 V for a 12-V system, and so on. You can calculate the maximum current that can be expected from a solar panel by dividing the specified output power by the panel voltage.

5.7.3 Storing solar energy

Because the sun does not shine 24 hours per day at many locations, some means of storing collected energy must be used. Batteries are commonly used for this purpose. Battery capacity is generally expressed in ampere-hours (Ah) or milliampere-hours (mAh). This rating is simply the product of discharge current and discharge time in hours. For example, a fully charge 500-mAh NiCd battery of good quality can deliver a discharge current of 100 mA for a period of 5 hours, or 200 mA for 2½ hours before recharging is required. Three types of rechargeable batteries are commonly used:

Nickel-cadmium (NiCd) batteries: NiCd are mostly used in relatively low energy applications such as hand-held transceivers, scanners, etc. The development of consumer electronics has contributed to the rapidly increasing availability (and somewhat-less-rapidly decreasing cost) of NiCd. Major advantage of NiCd: They are hermetically sealed, operate in any position and have a good service life (several hundred charge/discharge cycles), if they are properly maintained.

Gelled-electrolyte lead-acid batteries: These hermetically sealed batteries are available in capacities from below 1 Ah to more than 50 Ah. They are ideal for supplying energy to a radio station, but their cost (for capacities above 10 Ah) is rather high. For portable and low power stations, thought, this type of battery is difficult to beat. The cells can be operated in any position, but should be charged in an upright position. If properly maintained (no deep discharges-cell polarity reversal is possible under these conditions-and they stored in a fully charged state), gel cells last a long time (500 or so cycles).

Other lead-acid batteries: These are available in the standard automotive version, in the marine/recreational vehicle deep-discharge version and in the golf-cart variety. Differences: Automotive batteries usually fail (because of the thin plate and insulation material used in their construction), resulting in premature internal short circuits. Golf-cart and marine/recreational vehicle batteries have thicket plated with more rigid insulation between them, so these batteries can with stand deeper discharge without plate deformation and internal failure. Deep discharge batteries provide the best value in a ham station. Some of these batteries require attention (the electrolyte level must be maintained), and they last longest when kept charged. Because these batteries use a wet electrolyte (water), and most of them are not hermetically sealed, they must be kept upright.

5.7.4 A typical application

Here's a practical example of how to calculate power requirements for a solar-powered HF radio station. The first thing to do is define the power demand. Assume a 100-W transmitter. The assumption is that 100 W is the peak power consumption, and occurs only during CW operation and SSB voice peaks when a 13.6-V nominal supply (a fully charged battery) is provided.

The most reliable way to calculate realistic power requirements is to determine the power used over a longer period of time (say) a week or month. Because most of us have more or less recurring weekly habits, we'll take one week as the base period. (One can substitute numbers to adapt this calculation for the transmitter, under typical operating circumstances.) Assume that the transmitter is turned on five days. Of each two-hour period, 1½ hours is spent listening, and transmitting takes the remaining half hour. Assume that the current consumption of the transceiver during receive is 2 A; during the 100-W peaks on transmit, current drawn is 20 A. The owner's manual for transmitter should give the maximum dc current drain. The average current consumption during SSB transmitting is only about 4 A. Therefore, we need a battery that can supply a peak current of at least 20 A and an average current of 4 A. Now calculate the total energy consumed in ampere hours over a one-week period:

Receiving: 2 A × 2½ hours/day × 5 days = 25 Ah

Transmitting: 4 A × ½ hours/day × 5 days = 10 Ah

The total energy used per week is 25 + 10 = 35 Ah, or per day (average) is 35 ÷ 7 = 5 Ah. If we had a perfect system, all we would need to do is supply 35 Ah per week (5 Ah per day) to the battery. In practice, imperfections in battery construction cause some loss (self discharge), for which the charging system must compensate.

Next, calculate the minimum battery capacity required for this application. The system should be designed so that sufficient energy is available to run the equipment for two consecutive sunless days (this is rather arbitrary – some locations are worse than others in this regard). Because these sun less days could be days on which operation is necessary and because it is not good to discharge a battery to less than 50% of its capacity (for maximum battery life), this battery must have a capacity of lest 2 (days) × 5 Ah) ÷ 0.5 (for the 50% charge capacity left after 3 days without sunshine) = 20 Ah. If the location is likely to be without sunshine for as much as an entire week, the battery requirement would be 7 × 5 ÷ 0.5 = 70 Ah. Add about 10% to this number to compensate for self-discharge and other losses. (Typically, this means to procure the next-larger-size battery than the initial calculations indicated.)

To keep the battery sufficiently charged, firstly estimate the average number of hours of sunshine per year in the area. This information can be found in an almanac. As a guide, average annual sun exposure is approximately 3 200 hours per year in sunny regions, less elsewhere (down to about 1 920 hours per year in the far northern climates).

The solar panel should be mounted in a fixed position with an optimum angle relative to the Earth. In temperate zones, it could vary from about 30° in the summer up to about 60° in winter. Fixed-mounted solar panels cannot pick up maximum energy from the sun, for obvious reasons. In practice, they receive only 70% of the total sunlit time, which is anywhere between 1 340 and 2 240 hours per year (between 26 and 43 hours per week), depending on location.

The remaining system planning is easy. Earlier calculations showed that the solar cells must replenish 35 Ah per week, plus 10% to compensate for losses, or about 38.5 Ah or battery capacity. With solar energy available in the Sunbelt for 43 hours per week, the required charge current is 38.5 Ah ÷ 43 hours of sunshine = 0.9 A. In the northern part of the US, this is 38.5 Ah ÷ 25.8 hours = 1.5 A.

In the 12-V system described here, the solar panel operates, with a fully charged battery at about 13.6 V, plus the voltage drop of a series diode. With a fully loaded panel voltage of 14 V, a panel rated at 21 W (14 V × 1.5 A) is required in northern climes. In practice, this power can be obtain from good quality solar panel with a surface area as small as 65 cm^2. In sunny regions only 12.6 W (14 V × 0.9 A) of solar energy may be needed.

5.7.5 Some practical hints

Solar panels can be wired in series to provide increased output voltage. If the total output of the cell array exceeds 20 V, shunt diodes may be wired across each solar cells. Similarly, solar panels can be wired in parallel to yield increased output-current capability.

A series diode should be installed to prevent discharge of the battery into the panels. A Schottky diode can be used in applications where it is important to maintain the lowest voltage drop (and minimum loss of charge current).

Precaution should be taken to prevent battery overcharging and related gas discharge inside the battery. Several manufacturers supply simple charge regulators that serve this purpose by disconnecting the solar panel from the battery when the battery is fully charged. Some of these chargers allow charging to resume when the battery has reached a measurable level of discharge.

Note: These values are only valid for lead-acid batteries; and entirely different set of charge criteria exists for NiCds.

5.7.6 Installing solar panels

If you plan to permanently install solar panels, consider mounting them at ground level on a simple wooden or metal frame, or mounting the m on the roof. Roof mounting is more appropriate if you have a roof that slopes at the correct angle (30-60°), and in the right direction (anywhere between a kittle east of south and southwest is acceptable). The easiest way to mount panels permanently is with a silicone adhesive. First, series diodes should be mounted on the back of each panel.

If the solar panels are going to be located in an area where they might be subjected to lightning, it is especially important to ground the metal frames of the solar panels. A separate wire should be used for this Earth ground, that is, not combined with one of the power leads.

6 Repeaters and trunked networks

6.1 Communication beyond line-of-sight through relays

At VHF and UHF, some type of relay system or network is required for reliable communications beyond line-of-sight.

6.2 Terrestrial repeater

A single repeater station in a favourable location (on a hill or atop a building) may be used to retransmit signals between points not having line-of-sight.

6.3 Trunked land mobile radio systems with a central controller

Trunking is the automatic sharing of a common pool of possibly 10 or more frequencies in a multiple repeater system. Trunking may be performed at a single site or multiple sites for wide-area coverage.

Trunked systems are based on the premise that each user transmits only a small percentage of time, thus it is possible to provide more overall capacity with a band than if each station or group of users had its own frequency. Linked repeaters provide better geographical coverage than a single repeater. A trunked network includes some redundancy, which can be beneficial in disaster situations. If prearranged, trunked systems may include an emergency feature for speech or data calls to specified mobile units.

A trunked system has at least one control channel that continuously transmits the computer-generated digital data needed to control vehicular and hand-held radios within range. Channels are assigned to a group only when there is traffic, making the channels free for other users. This is accomplished in a way that users hear only the traffic intended for their group and in a way that is completely transparent to the users. There are two types of trunking control systems, known as dedicated control channel and distributed control channel. In the dedicated control system, the control channel operates on one frequency. The distributed type uses any idle channel for control transmissions.

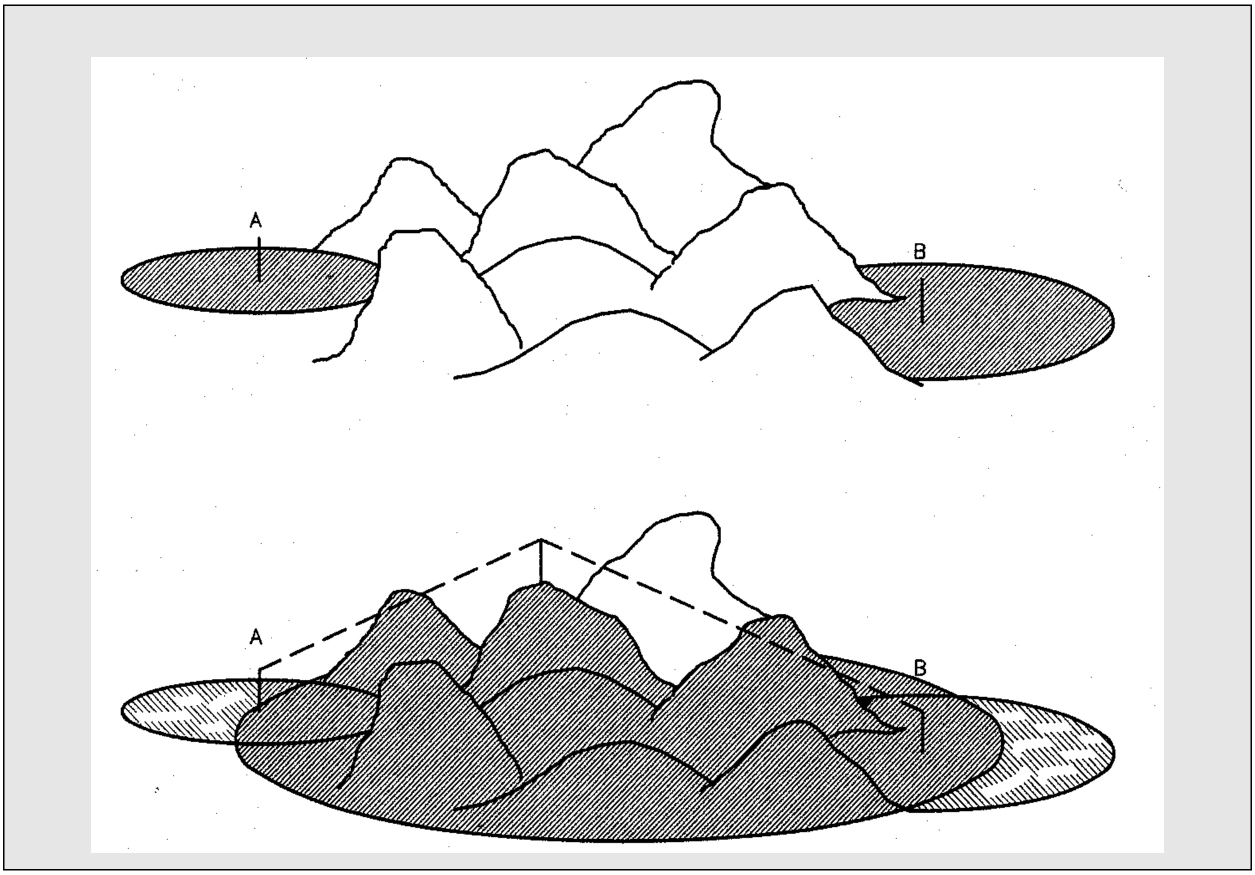
Mobile units are assigned identifiers and a home repeater. When a mobile unit is not transmitting, it always monitors the home repeater for data messages. When a mobile transmits, it identifies through a digital handshake protocol that takes only a fraction of a second.

Characteristics of digital land mobile systems are described in Report ITU-R M.2014. These systems include a trunked and non-trunked capability to permit direct mobile-to-mobile and group speech call facilities with user options to permit selective and secure calling.

6.4 Trunked land mobile radio systems without a central controller

There are also trunking systems using multi-channel access techniques and appropriate protocols that do not require a central controller for the detection of an idle radio channel, known as “Personal Radio System” and “Digital Short Range Radio”. Both systems work in the 900 MHz frequency band. They provide up to 80 channels and use a transmit power of up to 5 W. More detailed data of these systems are given in Recommendation ITU-R M.1032.

Figure 16 – In the top drawing, stations A and B are unable to interoperate because propagation is blocked by hills. In the bottom drawing, a repeater station is able to relay signals between stations A and B



All radios in these systems are normally in the standby state on a control channel, ready to receive a selective calling signal. A calling station looks for and finds an idle traffic channel and stores its number in its memory. Then the calling station transmits on a control channel, a selective calling signal including at least its own identity, the identity of the called station and the number of the identified idle channel. The standby stations detecting their identity code in the received signal, move to the indicated traffic channel and enter into communication. At the end of the communication all units return again to the standby mode.

List of commonly used abbreviations

A	Ampere
ac	Alternating current
A/D	Analogue-to-digital
Ah	Ampere-hour
AM	Amplitude modulation
AMTOR	AMateur Teleprinting Over Radio
ARES	Amateur Radio Emergency Service
ARQ	Automatic Repeat reQuest (error-control technique)
AX.25	Amateur Packet Radio Link Layer Protocol
CANTO	Caribbean Association of National Telecommunications Operators
CDERA	Caribbean Disaster Emergency Response Agency
CENTREX	Central Exchange
CEO	Chief Executive Officer
COW	Cell On Wheels
CP	Command Post
CQ	General call (to all radio stations)
CW	Carrier wave (Morse radiotelegraphy)
DAMA	Demand assigned multiple access
DECT	Digital Enhanced Cordless Telephone
DDI	Direct dial in
DHA	Department of Humanitarian Affairs (now OCHA)
DMT	Disaster Management Team (UN)
DSC	Digital Selective Calling
DSL	Digital Subscriber Line
DSP	Digital Signal Processing
EDGE	Enhanced Data Rates for GSM Evolution
ELT	Emergency Location Transmitter
EOC	Emergency Operations Centre
Fax	Facsimile
FD	Field Day (amateur)
FEC	Forward Error Control
FM	Frequency modulation
FSTV	Fast scan television
FTP	File Transfer Protocol

GAN	Global Area Network
GETS	Government Emergency Telecommunications
GLONASS	GLObal Navigation Satellite System
GMDSS	Global Maritime Distress and Safety System
GMPCS	Global Mobile Personal Communications by Satellite
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GSO	Geostationary orbit (satellite)
GTC	Grameen Telecom
HAZMAT	Hazardous materials
HF	High frequencies (3-30 MHz)
HTML	Hypertext Markup Language
IAPSO	The Inter-Agency Procurement Services Office (UNDP)
IARU	International Amateur Radio Union (NGO)
IASC	Inter Agency Standing Committee (UN advisory body)
ICAO	International Civil Aeronautical Organisation
ICET	Intergovernmental Conference on Emergency Telecommunications
ICRC	International Committee of the Red Cross
IDNDR	International Decade for Natural Disaster Reduction
IEPREP	Internet Emergency Preparedness
IF	Intermediate frequency
IFRC	International Federation of Red Cross and Red Crescent Societies
IMO	International Maritime Organization
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ITA	International Telegraph Alphabet
ITU	International Telecommunication Union
ITU-D	Telecommunication Development Sector (ITU)
ITU-R	Radiocommunication Sector (ITU)
ITU-T	Telecommunication Standardization Sector (ITU)
kW	Kilowatt
LAN	Local area network
LEO	Low Earth orbit (satellite)
LES	Land earth station
MESA	Mobility for Emergency and Safety Applications
MMSI	Maritime Mobile Service Indicator

NCS	Net Control Station
NGN	Next Generation Networks
NGO	Non-governmental organisation
NiCd	Nickel cadmium (cell)
NiMH	Nickel metal hydride (cell)
NOTAM	Notice to Airmen
NVIS	Near-vertical-incidence-sky wave (propagation)
OCHA	Office for the Coordination of Humanitarian Affairs (UN)
OSOCC	On-side operations coordination centre
PACSAT	Packet (radio) satellite
PACTOR	PAcket Transmission Over Radio
PBBS	Packet bulletin board system
PBX	Private Branch Exchange
PCS	Personal Communications Systems
PLB	Personal locator beacon
PLMN	Public Land Mobile Network
POP	Post Office Protocol
POTS	Plain Old Telephone System
PSAP	Public Access Point
PSTN	Public Switched Telephone Network
RBGAN	Regional Broadband Global Area Network
RBS	Radio base station
RF	Radio frequency
ROBO	Remote Office – Branch Office
RTTY	Radioteletype (narrow-band direct-printing radiotelegraph)
SCIP	Secure Communication Interoperability Protocol
SDR	Swiss Disaster Relief Unit, Software Defined Radio
SELCAL	Selective Calling
SET	Simulated Emergency Test
SITOR	Simplex Teletype Over Radio (narrow-band direct-printing radiotelegraphy system used in the maritime mobile service)
SOHO	Small Office – Home Office
SOLAS	Safety of Life at Sea
SRSA	Swedish Rescue Services Agency
SSB	Single sideband
SSTV	Slow scan television

SWR	Standing wave ratio
TCP/IP	Transmission Control Protocol/Internet Protocol
TCO	Telecommunications Coordination Officer
TNC	Terminal Node Controller (packet radio)
UNHCR	United Nations High Commissioner for Refugees
UNDAC	United Nations Disaster Assessment and Coordination
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNOG	United Nations Organisation, Geneva
UNB	Ultra Wide Band
UHF	Ultra high frequencies (30-3 000 MHz)
USAT	Ultra small aperture terminal
USB	Upper Side Band
USD	United States Dollar
V	Volt
VHF	Very high frequencies (30-300 MHz)
VPN	Virtual Private Network
VITA	Volunteers in Technical Assistance
VSAT	Very Small Aperture Terminal
W	Watt
WAN	Wide area network
WAP	Wireless Access Protocol
WFP	World Food Programme
WHO	World Health Organization (UN)
WI-FI	Wireless Fidelity
WLL	Wireless local loop (generally replaced by fixed wireless access (FWA)
WTDC	World Telecommunication Development Conference
WGET	Working Group on Emergency Telecommunications
WRC	World Radiocommunication Conference
WWRF	World Wide Research Forum
WWW	World Wide Web

Morse code signals[1]

1.1 The following are the written characters that may be used and the corresponding Morse code signals:

1.1.1 *Letters*

a .-	i ..	r .-.
b -…	j .---	s …
c -.-.	k -.-	t -
d -..	l .-..	u ..-
e .	m --	v …-
accented e ..-..	n -.	w .--
f ..-.	o ---	x -..-
g --.	p .--.	y -.--
h ….	q --.-	z --..

1.1.2 *Figures*

1 .----	6 -….
2 ..---	7 --…
3 …--	8 ---..
4 …-	9 ----.
5 …..	0 -----

1.1.3 *Punctuation marks and miscellaneous signs*

Full stop (period)…………………………………………	[.]	.-.-.-
Comma……………………………………………………	[,]	--..--
Colon or division sign…………………………………….	[:]	---…
Question mark (note of interrogation or request for repetition of a transmission not understood)……………………….	[?]	..--..
Apostrophe……………………………………………….	[‘]	.----.
Hyphen or dash or subtraction sign………………………	[-]	-….-
Fraction bar or division sign……………………………...	[/]	-..-.
Left-hand bracket (parenthesis)…………………………..	[(]	-.--.
Right-hand bracket (parenthesis)…………………………	[)]	-.--.-

[1] From Recommendation ITU-T F.1 Division B.

Inverted commas (quotation marks)(before and after the words)………………………………………………	[“”]	.-..-.
Double hyphen……………………………………………	[=]	-…-
Understood……………………………………………….		…-.
Error (eight dots)…………………………………………		……..
Email (at) Sign	[@]	---.--.
Cross or addition sign……………………………………	[+]	.-.-.
Invitation to transmit…………………………………….		-.-
Wait ……………………………………………………...		.-…
End of work………………………………………………		…-.-
Starting signal (to precede every transmission)………….		-.-.--
Multiplication sign……………………………………….	[x]	-..-

Phonetic alphabet code[2]

Letter to be transmitted	Code word to be used	Spoken as
A	Alfa	AL FAH
B	Bravo	BRAH VOH
C	Charlie	CHAR LEE or SHAR LEE
D	Delta	DELL TAH
E	Echo	ECK OH
F	Foxtrot	FOKS TROT
G	Golf	GOLF
H	Hotel	HOH TELL
I	India	IN DEE AH
J	Juliett	JEW LEE ETT
K	Kilo	KEY LOH
L	Lima	LEE MAH
M	Mike	MIKE
N	November	NO VEM BER
O	Oscar	OSS CAH
P	Papa	PAH PAH
Q	Quebec	KEH BECK
R	Romeo	ROW ME OH
S	Sierra	SEE AIR RAH
T	Tango	TANG GO
U	Uniform	YOU NEE FORM or OO NEE FORM
V	Victor	VIK TAH
W	Whiskey	WISS KEY
X	X-ray	ECKS RAY
Y	Yankee	YANG KEY
Z	Zulu	ZOO LOO

2 From Radio Regulations Appendix S14.

Figure code

Figure or mark to be transmitted	Spoken as[3] (ICAO)	Code word (Appendix S14)	Spoken as (Appendix S14)
0	ZE-RO	Nadazero	NAH-DAH-ZAY-ROH
1	WUN	Unaone	OO-NAH-WUN
2	TOO	Bissotwo	BEES-SOH-TOO
3	TREE	Terrathree	TAY-RAH-TREE
4	FOW er	Kartefour	KAR-TAY-FOWER
5	FIFE	Pantafive	PAN-TAH-FIVE
6	SIX	Soxisix	SOK-SEE-SIX
7	SEV en	Setteseven	SAY-TAY-SEVEN
8	AIT	Oktoeight	OK-TOH-AIT
9	NIN er	Novenine	NO-VAY-NINER
Decimal point	DAY SEE MAL	Decimal	DAY-SEE-MAL
Hundred	HUN dred		
Thousand	TOU SAND		

3 From ICAO Radiotelephony Procedures.

Q Code[4]

Certain Q code abbreviations may be given an affirmative or negative sense by sending, immediately following the abbreviation, the letter C or the letters NO (in radiotelephony spoken as: CHARLIE or NO).

The meanings assigned to Q code abbreviations may be amplified or completed by the addition of other appropriate groups, call signs, place names, figures, numbers, etc. It is optional to fill in the blanks shown in parentheses. Any data which are filled in where blanks appear shall be sent in the same order as shown in the text of the following tables.

Q code abbreviations are given the form of a question when followed by a question mark in radiotelegraphy and RQ (ROMEO QUEBEC) in radiotelephony. When an abbreviation is used as a question and is followed by additional or complementary information, the question mark (or RQ) should follow this information.

All times shall be given in Coordinated Universal Time (UTC) unless otherwise indicated in the question or reply.

Abbreviation	Question	Answer or Advice
QRA	What is the name of your vessel (*or* station)?	The name of my vessel (*or* station) is …
QRB	How far approximately are you from my station?	The approximate distance between our stations is … nautical miles (*or* kilometres).
QRG	Will you tell me my exact frequency (*or* that of …)?	Your exact frequency (*or* that of …) is ... kHz (*or* MHz).
QRH	Does my frequency vary?	Your frequency varies.
QRI	How is the tone of my transmission?	The tone of your transmission is … 1. good 2. variable 3. bad.
QRK	What is the intelligibility of my signals (*or* those of … *(name and/or call sign)*)?	The intelligibility of your signals (*or* those of … *(name and/or call sign)*) is … 1. bad 2. poor 3. fair 4. good 5. excellent.

4 From Recommendation ITU-R M.1172, *Miscellaneous abbreviations and signals to be used for radiocommunications in the maritime mobile service*, Radio Regulations (1998).

Abbreviation	Question	Answer or Advice
QRL	Are you busy?	I am busy (*or* I am busy with … *(name and/or call sign)*). Please do not interfere.
QRM	Is my transmission being interfered with?	Your transmission is being interfered with … 1. nil 2. slightly 3. moderately 4. severely 5. extremely.
QRZ	Who is calling me?	You are being called by … (on … kHz(*or* MHz)).
QSA	What is the strength of my signals (*or* those of … *(name and/or call sign)*)?	The strength of your signals (*or* those of … *(name and/or call sign)*) is … 1. scarcely perceptible 2. weak 3. fairly good 4. good 5. very good.
QSB	Are my signals fading?	Your signals are fading.
QSO	Can you communicate with … *(name and/or call sign)* direct (*or* by relay)?	I can communicate with … *(name and/or call sign)* direct (*or* by relay through …).
QSP	Will you relay to … *(name and/or call sign)* free of charge?	I will relay to … *(name of and/or call sign)* free of charge.
QSV	Shall I send a series of Vs (*or* signs) for adjustment on this frequency (*or* on … kHz (or MHz))?	Send a series of Vs (*or* signs) for adjustment on this frequency (*or* on … kHz (or MHz)).
QSW	Will you send on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …)?	I am going to send on this frequency (*or* on … kHz (*or* MHz)) (with emissions of class …).
QSX	Will you listen to … *(name and/or call sign(s))* on … kHz (*or* MHz), or in the bands …/channels …?	I am listening to … *(name and/or call sign(s))* on … kHz (*or* MHz), or in the bands …/channels …
QSY	Shall I change to transmission on another frequency?	Change to transmission on another frequency (*or* on … kHz (*or* MHz)).
QSZ	Shall I send each word or group more than once?	Send each word or group twice (*or* … times).

Abbreviation	**Question**	**Answer or Advice**
QTA	Shall I cancel telegram (*or* message) number …?	Cancel telegram (*or* message) number …
QTC	How many telegrams have you to send?	I have … telegrams for you (*or* for … (*name and/or call signs*)).
QTH	What is your position in latitude and longitude *(or according to any other indication)*?	My position is … latitude, … longitude *(or according to any other indication).*
QTR	What is the correct time?	The correct time is … hours.

Miscellaneous Abbreviations and Signals[5]

Abbreviation or signal	Definition
AA	All after … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition).*
AB	All before … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition).*
ADS	Address *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition).*
AR,	End of transmission.
AS,	Waiting period.
BK	Signal used to interrupt a transmission in progress.
BN	All between … and … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition).*
BQ	A reply to an RQ.
BT,	Signal to mark the separation between different parts of the same transmission.
C	Yes *or* “The significance of the previous group should be read in the affirmative”.
CFM	Confirm (*or* I confirm).
CL	I am closing my station.
COL	Collate (*or* I collate).
CORRECTION	Cancel my last word *or* group. The correct word *or* group follows *(used in radiotelephony, spoken as KOR-REK-SHUN).*
CQ	General call to all stations.
CS	Call sign *(used to request a call sign).*
DE	“From …” *(used to precede the name or other identification of the calling station).*
K	Invitation to transmit.
KA,	Starting signal.
MIN	Minute (*or* Minutes).
NIL	I have nothing to send to you.
NO	No *(negative).*
NW	Now.
OK	We agree (*or* It is correct).

5 From Recommendation ITU-R M.1172 Miscellaneous abbreviations and signals to be used for radiocommunications in the maritime mobile service, Radio Regulations (1998).

Abbreviation or signal	Definition
PBL	Preamble *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition).*
PSE	Please.
R	Received.
REF	Reference to … (*or* Refer to …).
RPT	Repeat (*or* I repeat) (*or* Repeat …).
RQ	Indication of a request.
SIG	Signature *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition).*
SVC	Prefix indicating a service telegram.
SYS	Refer to your service telegram.
TFC	Traffic.
TU	Thank you.
TXT	Text *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition).*
VA, $\overline{}$	End of work.
WA	Word after … *(used after a question mark in radiotelegraphy or after RQ in radiotelephony (in case of language difficulties) or after RPT, to request a repetition).*
WD	Word(s) *or* Group(s).
WX	Weather report (*or* Weather report follows).

Note: When used in radiotelegraphy, a bar over the letters composing a signal denotes that the letters are to be sent as one signal.

Procedure words[6]

Signal strength and readability

Signal strength	
Spoken	**Meaning**
LOUD	Your signal is strong.
GOOD	Your signal is good.
WEAK	I can hear you but with difficulty.
VERY WEAK	I can hear you but with great difficulty
NOTHING HEARD	I cannot hear you at all.

Readability	
Spoken	**Meaning**
CLEAR	Excellent quality.
READABLE	Good quality, no difficulty in reading you.
DISTORTED	I have problems reading you.
WITH INTERFERENCE	I have problems reading you due to interference.
NOT READABLE	I can hear that you are transmitting but cannot read you at all.

Procedure word	Meaning
ACKNOWLEDGE	Confirm that you have received my message and will comply (WILCO)
AFFIRMATIVE	Yes/Correct
ALL AFTER	Everything that you transmitted after …
ALL BEFORE	Everything that you transmitted before …
BREAK	Indicates separation of text from rest of message.
BREAK BREAK	I wish to interrupt an ongoing exchange of transmissions in order to pass an urgent message.
CALL SIGN	The group that follows is a call sign.
CANCEL	Annul the previously transmitted message.
CORRECT	You are correct or what you have transmitted is correct.
CORRECTION	An error has been made in this transmission (or message indicated). The correct version is …
DISREGARD	Consider that transmission as not sent.

6 Adapted from UNHCR Procedure for Radio Communication and supplemental sources.

Procedure word	Meaning
DO NOT ANSWER – OUT	Station(s) called are not to answer this call, acknowledge this message, or to transmit in connection with this transmission
FIGURES	Numerals or numbers will follow.
HOW DO YOU READ?	What is the readability of my signal?
I SAY AGAIN	I repeat for clarity or emphasis.
MESSAGE FOLLOWS	I have a formal message which should be recorded (e.g.) written down
MONITOR	Listen out on … (frequency).
NEGATIVE	No/Incorrect
OVER	This is the end of this transmission and a response is necessary.
OUT	This is the end of my transmission. No answer is required or expected. (OVER and OUT are never used together.)
READ BACK	Repeat this entire transmission back to me exactly as received.
RELAY (TO)	Transmit the following message to all addressees or to the address immediately following …
REPORT	Pass me the following information …
ROGER	I have received your last transmission. (Not an answer to a question.)
SAY AGAIN	Repeat your last transmission or repeat the portion indicated by "ALL AFTER".
SILENCE	Cease all transmission immediately. Maintain until lifted.
SILENCE LIFTED	Transmissions may resume after SILENCE has been previously ordered.
SPEAK SLOWER	Your transmissions are too fast. Reduce speed.
UNKNOWN STATION	The identity of the station heard is unknown.
VERIFY	Verify the entire message (or portion indicated) with the originator and send corrected version. To be used only when the addressee has serious questions about the validity of the message.
WAIT	Wait for a few seconds.
WAIT OUT	Wait for a longer period. I will re-establish contact when I return on the air.
WILCO	I have received your message and will comply. (ROGER is implied but not stated.)
WORD AFTER	The word of the message to which I refer is that which follows …
WORD BEFORE	The word of the message to which I refer is that which precedes …
WORDS TWICE	Communication is difficult. Transmit each word or phrase twice.
WRONG	The last transmission was incorrect. The correct version is …

RECOMMENDATION ITU-R P.1144-1

GUIDE TO THE APPLICATION OF THE PROPAGATION METHODS OF RADIOCOMMUNICATION STUDY GROUP 3

(1995-1999)

The ITU Radiocommunication Assembly,

considering

a) that there is a need to assist users of the ITU-R Recommendations P Series (developed by Radiocommunication Study Group 3),

recommends

1 that the information contained in Table 1 be used for guidance on the application of the various propagation methods contained in the ITU-R Recommendations P Series (developed by Radiocommunication Study Group 3).

NOTE 1 – For each of the ITU-R Recommendations in Table 1, there are associated information columns to indicate:

Application: the service(s) or application for which the Recommendation is intended.

Type: the situation to which the Recommendation applies, such as point-to-point, point-to-area, line-of-sight, etc.

Output: the output parameter value produced by the method of the Recommendation, such as path loss.

Frequency: the applicable frequency range of the Recommendation.

Distance: the applicable distance range of the Recommendation.

% *time:* the applicable time percentage values or range of values of the Recommendation; % time is the percentage of time that the predicted signal is exceeded during an average year.

% *location:* the applicable per cent location range of the Recommendation; % location is the percentage of locations within, say, a square with 100 to 200 m sides that the predicted signal is exceeded.

Terminal height: the applicable terminal antenna height range of the Recommendation.

Input data: a list of parameters used by the method of the Recommendation; the list is ordered by the importance of the parameter and, in some instances, default values may be used.

The information, as shown in Table 1, is already provided in the Recommendations themselves; however, the table allows users to quickly scan the capabilities (and limitations) of the Recommendations without the requirement to search through the text.

Table 1 – ITU-R radiowave propagation prediction methods

Method	Application	Type	Output	Frequency	Distance	% time	% location	Terminal height	Input data
Rec. ITU-R P.368	All services	Point-to-point	Field strength	10 kHz to 30 MHz	1 to 10 000 km	Not applicable	Not applicable	Ground-based	Frequency Ground conductivity
Rec. ITU-R P.370	Broadcasting	Point-to-area	Field strength	30 MHz to 1 000 MHz	10 to 1 000 km	1, 5, 10, 50	1 to 99	Tx: effective height from less than 0 m to greater than 1 200 m Rx: 1.5 to 40 m	Distance Tx antenna height Frequency Percentage time Rx antenna height Terrain clearance angle Terrain irregularity Percentage locations
Rec. ITU-R P.1147	Broadcasting	Point-to-area	Sky-wave field strength	0.15 to 1.7 MHz	50 to 12 000 km	10, 50	Not applicable	Not applicable	Latitude and longitude of Tx Latitude and longitude of Rx Distance Sunspot number Tx power Frequency
Rec. ITU-R P.452	Services employing stations on the surface of the Earth; interference	Point-to-point	Path loss	700 MHz to 30 GHz	Not specified but up to and beyond the radio horizon	0.001 to 50 Average year and worst month	Not applicable	No limits specified	Path profile data Frequency Percentage time Tx antenna height Rx antenna height Latitude and longitude of Tx Latitude and longitude of Rx Meteorological data
Rec. ITU-R P.528	Aeronautical mobile	Point-to-area	Path loss	125 MHz to 15 GHz	0 to 1 800 km (for aeronautical applications 0 km horizontal distance does not mean 0 km path length)	5, 50, 95	Not applicable	H1: 15 m to 20 km H2: 1 to 20 km	Distance Tx height Frequency Rx height Percentage time
Rec. ITU-R P.1146	Land mobile Broadcasting	Point-to-area	Field strength	1 to 3 GHz	1 to 500 km	1 to 99	1 to 99	Tx ≥ 1 m Rx: 1 to 30 m	Distance Frequency Tx antenna height Rx antenna height Percentage time Percentage location Terrain information

Table 1 – ITU-R radiowave propagation prediction methods *(continued)*

Method	Application	Type	Output	Frequency	Distance	% time	% location	Terminal height	Input data
Rec. ITU-R P.529	Land mobile	Point-to-area	Field strength	30 MHz to 3 GHz (limited application above 1.5 GHz)	VHF: 10 to 600 km UHF: 1 to 100 km	VHF: 1, 10, 50 UHF: 50	Unspecified	Base: 20 m to 1 km Mobile: 1 to 10 m	Distance Base antenna height Frequency Mobile antenna height Percentage time Ground cover
Rec. ITU-R P.530	Line-of-sight Fixed links	Point-to-point Line-of-sight	Path loss Diversity improvement (clear air conditions) XPD Outage Error performance	Approximately 150 MHz to 40 GHz	Up to 200 km if line-of-sight	All percentages of time in clear-air conditions; 1 to 0.001 in precipitation conditions (1)	Not applicable	High enough to ensure specified path clearance	Distance Tx height Frequency Rx height Percentage time Path obstruction data Climate data
Rec. ITU-R P.533	Broadcasting Fixed Mobile	Point-to-point	Basic MUF Sky-wave field strength Available receiver power Signal-to-noise ratio LUF Circuit reliability	2 to 30 MHz	0 to 40 000 km	All percentages	Not applicable	Not applicable	Latitude and longitude of Tx Latitude and longitude of Rx Sunspot number Month Time(s) of day Frequencies Tx power Tx antenna type Rx antenna type
Rec. ITU-R P.534	Fixed Mobile Broadcasting	Point-to-point via sporadic E	Field strength	30 to 100 MHz	0 to 4 000 km	0 to 50	Not applicable	Not applicable	Distance Frequency
Rec. ITU-R P.616	Maritime mobile	As for Recommendation ITU-R P.370							
Rec. ITU-R P.617	Trans-horizon fixed links	Point-to-point	Path loss	> 30 MHz	100 to 1 000 km	20, 50, 90, 99, and 99.9	Not applicable	No limits specified	Frequency Tx antenna gain Rx antenna gain Path geometry
Rec. ITU-R P.618	Fixed satellite	Point-to-point	Path loss. Diversity gain and (for precipitation condition) XPD	1 to 55 GHz	Any practical orbit height	0.001-5 for attenuation; 0.001-1 for XPD	Not applicable	No limit	Meteorological data Frequency Elevation angle Height of earth station Separation and angle between earth station sites (for diversity gain) Antenna diameter and efficiency (for scintillation) Polarization angle (for XPD)

Table 1 – ITU-R radiowave propagation prediction methods *(end)*

Method	Application	Type	Output	Frequency	Distance	% time	% location	Terminal height	Input data
Rec. ITU-R P.620	Earth station frequency coordination	Coordination distance	Distance of which the required propagation loss is achieved	100 MHz to 105 GHz	up to 1 200 km	0.001 to 50	Not applicable	No limits specified	Minimum basic transmission loss Frequency Percentage of time Earth-station elevation angle
Rec. ITU-R P.680	Maritime mobile satellite	Point-to-point	Sea-surface fading Fade duration Interference (adjacent satellite)	0.8-8 GHz	Any practical orbit height	To 0.001% via Rice-Nakagami distribution Limit of 0.01% for interference(1)	Not applicable	No limit	Frequency Elevation angle Maximum antenna boresight gain
Rec. ITU-R P.681	Land mobile satellite	Point-to-point	Path fading Fade duration Non-fade duration	0.8 to 20 GHz	Any practical orbit height	Not applicable Percentage of distance travelled 1 to 80%(1)	Not applicable	No limit	Frequency Elevation angle Percentage of distance travelled Approximate level of optical shadowing
Rec. ITU-R P.682	Aeronautical mobile satellite	Point-to-point	Sea-surface fading	1 to 2 GHz	Any practical orbit height	To 0.001% via Rice-Nakagami distribution(1)	Not applicable	No limit	Frequency Elevation angle Polarization Maximum antenna boresight gain Antenna height
Rec. ITU-R P.684	Fixed	Point-to-point	Sky-wave field strength	30 to 500 kHz	0 to 40 000 km	50	Not applicable	Not applicable	Latitude and longitude of Tx Latitude and longitude of Rx Distance Tx power Frequency
Rec. ITU-R P.843	Fixed Mobile Broadcasting	Point-to-point via meteor-burst	Received power Burst rate	30 to 100 MHz	100 to 1 000 km	0 to 5	Not applicable	Not applicable	Frequency Distance Tx power Antenna gains

(1) Time percentage of outage; for service availability, subtract value from 100.

Appendices

Editor's Note: Texts for information, as adopted by the Intergovernmental Conference on Emergency Telcommunications (ICET-98). The official publication of the Tampere Convention in the United Nations Treaty Series is expected, in all six official languages, for 1999.

TAMPERE CONVENTION ON THE PROVISION OF TELECOMMUNICATION RESOURCES FOR DISASTER MITIGATION AND RELIEF OPERATIONS

THE STATES PARTIES TO THIS CONVENTION,

Recognizing

that the magnitude**,** complexity, frequency and impact of disasters are increasing at a dramatic rate, with particularly severe consequences in developing countries,

recalling

that humanitarian relief and assistance agencies require reliable, flexible telecommunication resources to perform their vital tasks,

further recalling

the essential role of telecommunication resources in facilitating the safety of humanitarian relief and assistance personnel,

further recalling

the vital role of broadcasting in disseminating accurate disaster information to at-risk populations,

convinced

that the effective, timely deployment of telecommunication resources and that rapid, efficient, accurate and truthful information flows are essential to reducing loss of life, human suffering and damage to property and the environment caused by disasters,

concerned

about the impact of disasters on communication facilities and information flows,

aware

of the special needs of the disaster-prone least developed countries for technical assistance to develop telecommunication resources for disaster mitigation and relief operations,

reaffirming

the absolute priority accorded emergency life-saving communications in more than fifty international regulatory instruments, including the Constitution of the International Telecommunication Union,

noting

the history of international cooperation and coordination in disaster mitigation and relief, including the demonstrated life-saving role played by the timely deployment and use of telecommunication resources,

further noting

the Proceedings of the International Conference on Disaster Communications (Geneva, 1990), addressing the power of telecommunication systems in disaster recovery and response, *further noting*

the urgent call found in the Tampere Declaration on Disaster Communications (Tampere, 1991) for reliable telecommunication systems for disaster mitigation and disaster relief operations, and for an international Convention on Disaster Communications to facilitate such systems,

further noting

United Nations General Assembly Resolution 44/236, designating 1990-2000 the International Decade for Natural Disaster Reduction, and Resolution 46/182, calling for strengthened international coordination of humanitarian emergency assistance,

further noting

the prominent role given to communication resources in the Yokohama Strategy and Plan of Action for a Safer World, adopted by the World Conference on Natural Disaster Reduction (Yokohama, 1994),

further noting

Resolution 7 of the World Telecommunication Development Conference (Buenos Aires, 1994), endorsed by Resolution 36 of the Plenipotentiary Conference of the International Telecommunication Union (Kyoto, 1994), urging governments to take all practical steps for facilitating the rapid deployment and the effective use of telecommunication equipment for disaster mitigation and relief operations by reducing and, where possible, removing regulatory barriers and strengthening cooperation among States,

further noting

Resolution 644 of the World Radiocommunication Conference (Geneva, 1997), urging governments to give their full support to the adoption of this Convention and to its national implementation,

further noting

Resolution 19 of the World Telecommunication Development Conference (Valletta, 1998), urging governments to continue their examination of this Convention with a view to considering giving their full support to its adoption,

further noting

United Nations General Assembly Resolution 51/194, encouraging the development of a transparent and timely procedure for implementing effective disaster relief coordination arrangements, and of ReliefWeb as the global information system for the dissemination of reliable and timely information on emergencies and natural disasters,

with reference

to the conclusions of the Working Group on Emergency Telecommunications regarding the critical role of Telecommunications in disaster mitigation and relief,

supported

by the work of many States, United Nations entities, governmental, intergovernmental, and non-governmental organizations, humanitarian agencies, telecommunication equipment and service providers, media, universities and communication- and disaster-related organizations to improve and facilitate disaster-related communications, *desiring*

to ensure the reliable, rapid availability of telecommunication resources for disaster mitigation and relief operations, and

further desiring

to facilitate international cooperation to mitigate the impact of disasters,

have agreed as follows:

ARTICLE 1

Definitions

Unless otherwise indicated by the context in which they are used, the terms set out below shall have the following meanings for the purposes of this Convention:

1 “State Party” means a State which has agreed to be bound by this Convention.

2 “Assisting State Party” means a State Party to this Convention providing telecommunication assistance pursuant hereto.

3 “Requesting State Party” means a State Party to this Convention requesting telecommunication assistance pursuant hereto.

4 “This Convention” means the Tampere Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations.

5 “The depositary” means the depositary for this Convention, as set forth in Article 16.

6 “Disaster” means a serious disruption of the functioning of society, posing a significant, widespread threat to human life, health, property or the environment, whether caused by accident, nature or human activity, and whether developing suddenly or as the result of complex, long-term processes.

7 “Disaster mitigation” means measures designed to prevent, predict, prepare for, respond to, monitor and/or mitigate the impact of, disasters.

8 “Health hazard” means a sudden outbreak of infectious disease, such as an epidemic or pandemic, or other event posing a significant threat to human life or health, which has the potential for triggering a disaster.

9 “Natural hazard” means an event or process, such as an earthquake, fire, flood, wind, landslide, avalanche, cyclone, tsunami, insect infestation, drought or volcanic eruption, which has the potential for triggering a disaster.

10 “Non-governmental organization” means any organization, including private and corporate entities, other than a State or governmental or intergovernmental organization, concerned with disaster mitigation and relief and/or the provision of telecommunication resources for disaster mitigation and relief.

11 “Non-State entity” means any entity, other than a State, including non-governmental organizations and the Red Cross and Red Crescent Movement, concerned with disaster mitigation and relief and/or the provision of telecommunication resources for disaster mitigation and relief.

12 “Relief operations” means those activities designed to reduce loss of life, human suffering and damage to property and/or the environment caused by a disaster.

13 “Telecommunication assistance” means the provision of telecommunication resources or other resources or support intended to facilitate the use of telecommunication resources.

14 “Telecommunication resources” means personnel, equipment, materials, information, training, radio-frequency spectrum, network or transmission capacity or other resources necessary to telecommunications.

15 “Telecommunications” means any transmission, emission, or reception of signs, signals, writing, images, sounds or intelligence of any nature, by wire, radio, optical fibre or other electromagnetic system.

ARTICLE 2

Coordination

1 The United Nations Emergency Relief Coordinator shall be the operational coordinator for this Convention and shall execute the responsibilities of the operational coordinator identified in Articles 3, 4, 6, 7, 8, and 9.

2 The operational coordinator shall seek the cooperation of other appropriate United Nations agencies, particularly the International Telecommunication Union, to assist it in fulfilling the objectives of this Convention, and, in particular, those responsibilities identified in Articles 8 and 9, and to provide necessary technical support, consistent with the purposes of those agencies.

3 The responsibilities of the operational coordinator under this Convention shall be limited to coordination activities of an international nature.

ARTICLE 3

General Provisions

1 The States Parties shall cooperate among themselves and with non-State entities and intergovernmental organizations, in accordance with the provisions of this Convention, to facilitate the use of telecommunication resources for disaster mitigation and relief.

2 Such use may include, but is not limited to:

a) the deployment of terrestrial and satellite telecommunication equipment to predict, monitor and provide information concerning natural hazards, health hazards and disasters;

b) the sharing of information about natural hazards, health hazards and disasters among the States Parties and with other States, non-State entities and intergovernmental organizations, and the dissemination of such information to the public, particularly to at-risk communities;

c) the provision of prompt telecommunication assistance to mitigate the impact of a disaster; and

d) the installation and operation of reliable, flexible telecommunication resources to be used by humanitarian relief and assistance organizations.

3 To facilitate such use, the States Parties may conclude additional multinational or bilateral agreements or arrangements.

4 The States Parties request the operational coordinator, in consultation with the International Telecommunication Union, the depositary, and other relevant United Nations entities and intergovernmental and non-governmental organizations, to use its best efforts, in accordance with the provisions of this Convention, to:

a) develop, in consultation with the States Parties, model agreements that may be used to provide a foundation for multinational or bilateral agreements facilitating the provision of telecommunication resources for disaster mitigation and relief;

b) make available model agreements, best practices and other relevant information to States Parties, other States, non-State entities and intergovernmental organizations concerning the provision of telecommunication resources for disaster mitigation and relief, by electronic means and other appropriate mechanisms;

c) develop, operate, and maintain information collection and dissemination procedures and systems necessary for the implementation of the Convention; and

d) inform States of the terms of this Convention, and to facilitate and support the cooperation among States Parties provided for herein.

5 The States Parties shall cooperate among themselves to improve the ability of governmental organizations, non-State entities and intergovernmental organizations to establish mechanisms for training in the handling and operation of equipment, and instruction courses in the development, design and construction of emergency telecommunication facilities for disaster prevention, monitoring and mitigation.

ARTICLE 4

Provision of Telecommunication Assistance

1 A State Party requiring telecommunication assistance for disaster mitigation and relief may request such assistance from any other State Party, either directly or through the operational coordinator. If the request is made through the operational coordinator, the operational coordinator shall immediately disseminate this information to all other appropriate States Parties. If the request is made directly to another State Party, the requesting State Party shall inform the operational coordinator as soon as possible.

2 A State Party requesting telecommunication assistance shall specify the scope and type of assistance required and those measures taken pursuant to Articles 5 and 9 of this Convention, and, when practicable, provide the State Party to which the request is directed and/or the operational coordinator with any other information necessary to determine the extent to which such State Party is able to meet the request.

3 Each State Party to which a request for telecommunication assistance is directed, either directly or through the operational coordinator, shall promptly determine and notify the requesting State Party whether it will render the assistance requested, directly or otherwise, and the scope of, and terms, conditions, restrictions and cost, if any, applicable to such assistance.

4 Each State Party determining to provide telecommunication assistance shall so inform the operational coordinator as soon as possible.

5 No telecommunication assistance shall be provided pursuant to this Convention without the consent of the requesting State Party. The requesting State Party shall retain the authority to reject all or part of any telecommunication assistance offered pursuant to this Convention in accordance with the requesting State Party's existing national law and policy.

6 The States Parties recognize the right of requesting States Parties to request telecommunication assistance directly from non-State entities and intergovernmental organizations, and the right of non-State entities and intergovernmental organizations, pursuant to the laws to which they are subject, to provide telecommunication assistance to requesting States Parties pursuant to this Article.

7 A non-State entity or intergovernmental organization may not be a "requesting State Party" and may not request telecommunication assistance under this Convention.

8 Nothing in this Convention shall interfere with the right of a State Party, under its national law, to direct, control, coordinate and supervise telecommunication assistance provided under this Convention within its territory.

ARTICLE 5

Privileges, Immunities, and Facilities

1 The requesting State Party shall, to the extent permitted by its national law, afford to persons, other than its nationals, and to organizations, other than those headquartered or domiciled within its territory, who act pursuant to this Convention to provide telecommunication assistance and who have been notified to, and accepted by, the requesting State Party, the necessary privileges, immunities, and facilities for the performance of their proper functions, including, but not limited to:

a) immunity from arrest, detention and legal process, including criminal, civil and administrative jurisdiction of the requesting State Party, in respect of acts or omissions specifically and directly related to the provision of telecommunication assistance;

b) exemption from taxation, duties or other charges, except for those which are normally incorporated in the price of goods or services, in respect of the performance of their assistance functions or on the equipment, materials and other property brought into or purchased in the territory of the requesting State Party for the purpose of providing telecommunication assistance under this Convention; and

c) immunity from seizure, attachment or requisition of such equipment, materials and property.

2 The requesting State Party shall provide, to the extent of its capabilities, local facilities and services for the proper and effective administration of the telecommunication assistance, including ensuring that telecommunication equipment brought into its territory pursuant to this Convention shall be expeditiously licensed or shall be exempt from licensing in accordance with its domestic laws and regulations.

3 The requesting State Party shall ensure the protection of personnel, equipment and materials brought into its territory pursuant to this Convention.

4 Ownership of equipment and materials provided pursuant to this Convention shall be unaffected by their use under the terms of this Convention. The requesting State Party shall ensure the prompt return of such equipment, material and property to the proper assisting State Party.

5 The requesting State Party shall not direct the deployment or use of any telecommunication resources provided pursuant to this Convention for purposes not directly related to predicting, preparing for, responding to, monitoring, mitigating the impact of or providing relief during and following disasters.

6 Nothing in this Article shall require any requesting State Party to provide its nationals or permanent residents, or organizations headquartered or domiciled within its territory, with privileges and immunities.

7 Without prejudice to their privileges and immunities in accordance with this Article, all persons entering the territory of a State Party for the purpose of providing telecommunication assistance or otherwise facilitating the use of telecommunication resources pursuant to this Convention, and all organizations providing telecommunication assistance or otherwise facilitating the use of telecommunication resources pursuant to this Convention, have a duty to respect the laws and regulations of that State Party. Such persons and organizations also shall have a duty not to interfere in the domestic affairs of the State Party into whose territory they have entered.

8 Nothing in this Article shall prejudice the rights and obligations with respect to privileges and immunities afforded to persons and organizations participating directly or indirectly in telecommunication assistance, pursuant to other international agreements (including the Convention on the Privileges and Immunities of the United Nations, adopted by the General Assembly on 13 February 1946, and the Convention on the Privileges and Immunities of the Specialized Agencies, adopted by the General Assembly on 21 November 1947) or international law.

ARTICLE 6

Termination of Assistance

1 The requesting State Party or the assisting State Party may, at any time, terminate telecommunication assistance received or provided under Article 4 by providing notification in writing. Upon such notification, the States Parties involved shall consult with each other to provide for the proper and expeditious conclusion of the assistance, bearing in mind the impact of such termination on the risk to human life and ongoing disaster relief operations.

2 States Parties engaged in providing or receiving telecommunication assistance pursuant to this Convention shall remain subject to the terms of this Convention following the termination of such assistance.

3 Any State Party requesting termination of telecommunication assistance shall notify the operational coordinator of such request. The operational coordinator shall provide such assistance as is requested and necessary to facilitate the conclusion of the telecommunication assistance.

ARTICLE 7

Payment or Reimbursement of Costs or Fees

1 The States Parties may condition the provision of telecommunication assistance for disaster mitigation relief upon agreement to pay or reimburse specified costs or fees, always bearing in mind the contents of paragraph 8 of this Article.

2 When such condition exists, the States Parties shall set forth in writing, prior to the provision of telecommunication assistance:

a) the requirement for payment or reimbursement;

b) the amount of such payment or reimbursement or terms under which it shall be calculated; and

c) any other terms, conditions or restrictions applicable to such payment or reimbursement, including, but not limited to, the currency in which such payment or reimbursement shall be made.

3 The requirements of paragraphs 2 b) and 2 c) of this Article may be satisfied by reference to published tariffs, rates or prices.

4 In order that the negotiation of payment and reimbursement agreements does not unduly delay the provision of telecommunication assistance, the operational coordinator shall develop, in consultation with the States Parties, a model payment and reimbursement agreement that may provide a foundation for the negotiation of payment and reimbursement obligations under this Article.

5 No State Party shall be obligated to make payment or reimbursement of costs or fees under this Convention without having first expressed its consent to the terms provided by an assisting State Party pursuant to paragraph 2 of this Article.

6 When the provision of telecommunication assistance is properly conditioned upon payment or reimbursement of costs or fees under this Article, such payment or reimbursement shall be provided promptly after the assisting State Party has presented its request for payment or reimbursement.

7 Funds paid or reimbursed by a requesting State Party in association with the provision of telecommunication assistance shall be freely transferable out of the jurisdiction of the requesting State Party and shall not be delayed or withheld.

8 In determining whether to condition the provision of telecommunication assistance upon an agreement to pay or reimburse specified costs or fees, the amount of such costs or fees, and the terms, conditions and restrictions associated with their payment or reimbursement, the States Parties shall take into account, among other relevant factors:

a) United Nations principles concerning humanitarian assistance;

b) the nature of the disaster, natural hazard or health hazard;

c) the impact, or potential impact, of the disaster;

d) the place of origin of the disaster;

e) the area affected, or potentially affected, by the disaster;

f) the occurrence of previous disasters and the likelihood of future disasters in the affected area;

g) the capacity of each State affected by the disaster, natural hazard or health hazard to prepare for, or respond to, such event; and

h) the needs of developing countries.

9 This Article shall also apply to those situations in which telecommunication assistance is provided by a non-State entity or intergovernmental organization, provided that:

a) the requesting State Party has consented to, and has not terminated, such provision of telecommunication assistance for disaster mitigation and relief;

b) the non-State entity or intergovernmental organization providing such telecommunication assistance has notified to the requesting State Party its adherence to this Article and Articles 4 and 5; and

c) the application of this Article is not inconsistent with any other agreement concerning the relations between the requesting State Party and the non-State entity or intergovernmental organization providing such telecommunication assistance.

ARTICLE 8

Telecommunication Assistance Information Inventory

1 Each State Party shall notify the operational coordinator of its authority(ies):

a) responsible for matters arising under the terms of this Convention and authorized to request, offer, accept and terminate telecommunication assistance; and

b) competent to identify the governmental, intergovernmental and/or non-governmental resources which could be made available to facilitate the use of telecommunication resources for disaster mitigation and relief, including the provision of telecommunication assistance.

2 Each State Party shall endeavour to inform the operational coordinator promptly of any changes in the information provided pursuant to this Article.

3 The operational coordinator may accept notification from a non-State entity or intergovernmental organization of its procedures for authorization to offer and terminate telecommunication assistance as provided in this Article.

4 A State Party, non-State entity or intergovernmental organization may, at its discretion, include in the material it deposits with the operational coordinator information about specific telecommunication resources and about plans for the use those resources to respond to a request for telecommunication assistance from a requesting State Party.

5 The operational coordinator shall maintain copies of all lists of authorities, and shall expeditiously disseminate such material to the States Parties, to other States, and to appropriate non-State entities and intergovernmental organizations, unless a State Party, non-State entity or intergovernmental organization has previously specified, in writing, that distribution of its material be restricted.

6 The operational coordinator shall treat material deposited by non-State entities and intergovernmental organizations in a similar manner to material deposited by States Parties.

ARTICLE 9

Regulatory Barriers

1 The States Parties shall, when possible, and in conformity with their national law, reduce or remove regulatory barriers to the use of telecommunication resources for disaster mitigation and relief, including to the provision of telecommunication assistance.

2 Regulatory barriers may include, but are not limited to:

a) regulations restricting the import or export of telecommunication equipment;

b) regulations restricting the use of telecommunication equipment or of radio-frequency spectrum;

c) regulations restricting the movement of personnel who operate telecommunication equipment or who are essential to its effective use;

d) regulations restricting the transit of telecommunication resources into, out of and through the territory of a State Party; and

e) delays in the administration of such regulations.

3 Reduction of regulatory barriers may take the form of, but shall not be limited to:

a) revising regulations;

b) exempting specified telecommunication resources from the application of those regulations during the use of such resources for disaster mitigation and relief;

c) pre-clearance of telecommunication resources for use in disaster mitigation and relief, in compliance with those regulations;

d) recognition of foreign type-approval of telecommunication equipment and/or operating licenses;

e) expedited review of telecommunication resources for use in disaster mitigation and relief, in compliance with those regulations; and

f) temporary waiver of those regulations for the use of telecommunication resources for disaster mitigation and relief.

4 Each State Party shall, at the request of any other State Party, and to the extent permitted by its national law, facilitate the transit into, out of and through its territory of personnel, equipment, materials and information involved in the use of telecommunication resources for disaster mitigation and relief.

5 Each State Party shall notify the operational coordinator and the other States Parties, directly or through the operational coordinator, of:

a) measures taken, pursuant to this Convention, for reducing or removing such regulatory barriers;

b) procedures available, pursuant to this Convention, to States Parties, other States, non-State entities and/or intergovernmental organizations for the exemption of specified telecommunication resources used for disaster mitigation and relief from the application of such regulations, pre-clearance or expedited review of such resources in compliance with applicable regulations, acceptance of foreign type-approval of such resources, or temporary waiver of regulations otherwise applicable to such resources; and

c) the terms, conditions and restrictions, if any, associated with the use of such procedures.

6 The operational coordinator shall regularly and expeditiously make available to the States Parties, to other States, to non-State entities and to intergovernmental organizations an up-to-date listing of such measures, their scope, and the terms, conditions and restrictions, if any, associated with their use.

7 Nothing in this Article shall permit the violation or abrogation of obligations and responsibilities imposed by national law, international law, or multilateral or bilateral agreements, including obligations and responsibilities concerning customs and export controls.

ARTICLE 10

Relationship to Other International Agreements

1 This Convention shall not affect the rights and obligations of States Parties deriving from other international agreements or international law.

ARTICLE 11

Dispute Settlement

1 In the event of a dispute between States Parties concerning the interpretation or application of this Convention, the States Parties to the dispute shall consult each other for the purpose of settling the dispute. Such consultation shall begin promptly upon the written declaration, delivered by one State Party to another State Party, of the existence of a dispute under this Convention. The State Party making such a written declaration of the existence of a dispute shall promptly deliver a copy of such declaration to the depositary.

2 If a dispute between States Parties cannot be settled within six (6) months of the date of delivery of the written declaration to a State Party to the dispute, the States Parties to the dispute may request any other State Party, State, non-State entity or intergovernmental organization to use its good offices to facilitate settlement of the dispute.

3 If neither State Party seeks the good offices of another State Party, State, non-State entity or intergovernmental organization, or if the exercise of good offices fails to facilitate a settlement of the dispute within six (6) months of the request for such good offices being made, then either State Party to the dispute may:

a) request that the dispute be submitted to binding arbitration; or

b) submit the dispute to the International Court of Justice for decision, provided that both States Parties to the dispute have, at the time of signing, ratifying or acceding to this Convention, or at any time thereafter, accepted the jurisdiction of the International Court of Justice in respect of such disputes.

4 In the event that the respective States Parties to the dispute request that the dispute be submitted to binding arbitration and submit the dispute to the International Court of Justice for decision, the submission to the International Court of Justice shall have priority.

5 In the case of a dispute between a State Party requesting telecommunication assistance and a non-State entity or intergovernmental organization headquartered or domiciled outside of the territory of that State Party concerning the provision of telecommunication assistance under Article 4, the claim of the non-State entity or intergovernmental organization may be espoused directly by the State Party in which the

non-State entity or intergovernmental organization is headquartered or domiciled as a State-to-State claim under this Article, provided that such espousal is not inconsistent with any other agreement between the State Party and the non-State entity or intergovernmental organization involved in the dispute.

6 When signing, ratifying, accepting, approving or acceding to this Convention, a State may declare that it does not consider itself bound by either or both of the dispute settlement procedures provided for in paragraph 3 above. The other States Parties shall not be bound by a dispute settlement procedure provided for in paragraph 3 with respect to a State Party for which such a declaration is in force.

ARTICLE 12

Entry into Force

1 This Convention shall be open for signature by all States which are members of the United Nations or of the International Telecommunication Union at the Intergovernmental Conference on Emergency Telecommunications in Tampere on 18 June 1998, and thereafter at the headquarters of the United Nations, New York, from 22 June 1998 to 21 June 2003.

2 A State may express its consent to be bound by this Convention:

a) by signature (definitive signature);

b) by signature subject to ratification, acceptance or approval followed by deposit of an instrument of ratification, acceptance or approval; or

c) by deposit of an instrument of accession.

3 The Convention shall enter into force thirty (30) days after the deposit of instruments of ratification, acceptance, approval or accession or definitive signature of thirty (30) States.

4 For each State which signs definitively or deposits an instrument of ratification, acceptance, approval or accession, after the requirement set out in paragraph 3 of this Article has been fulfilled, this Convention shall enter into force thirty (30) days after the date of the definitive signature or consent to be bound.

ARTICLE 13

Amendments

1 A State Party may propose amendments to this Convention by submitting such amendments to the depositary, which shall circulate them to the other States Parties for approval.

2 The States Parties shall notify the depositary of their approval or disapproval of such proposed amendments within one hundred and eighty (180) days of their receipt.

3 Any amendment approved by two-thirds of all States Parties shall be laid down in a Protocol which is open for signature at the depositary by all States Parties.

4 The Protocol shall enter into force in the same manner as this Convention. For each State which signs the Protocol definitively or deposits an instrument of ratification, acceptance, approval or accession, after the requirements for the entry into force of the Protocol have been fulfilled, the Protocol shall enter into force for such State thirty (30) days after the date of the definitive signature or consent to be bound.

ARTICLE 14

Reservations

1 When definitively signing, ratifying or acceding to this Convention or any amendment hereto, a State Party may make reservations.

2 A State Party may at any time withdraw its prior reservation by written notification to the depositary. Such withdrawal of a reservation becomes effective immediately upon notification to the depositary.

ARTICLE 15

Denunciation

1 A State Party may denounce this Convention by written notification to the depositary.

2 Denunciation shall take effect ninety (90) days following the date of deposit of the written notification.

3 At the request of the denouncing State Party, all copies of the lists of authorities and of measures adopted and procedures available for reducing regulatory measures provided by any State Party denouncing this Convention shall be removed from use by the effective date of such denunciation.

ARTICLE 16

Depositary

1 The Secretary-General of the United Nations shall be the depositary of this Convention.

ARTICLE 17

Authentic Texts

1 The original of this Convention, of which the Arabic, Chinese, English, French, Russian and Spanish texts are equally authentic, shall be deposited with the depositary. Only the English, French and Spanish authentic texts will be made available for signature at Tampere on 18 June 1998. The depositary shall prepare the authentic texts in Arabic, Chinese and Russian as soon as possible thereafter.

RECOMMENDATION 12 (Istanbul, 2002)

Consideration of disaster telecommunication needs in telecommunication development activities

The World Telecommunication Development Conference (Istanbul, 2002),

considering

a) the increasing number of disasters causing human suffering;

b) the particular needs of developing countries and the special requirements of the inhabitants of remote areas;

c) the potential of modern telecommunication technologies as an essential tool for disaster mitigation and relief operations,

considering further

the provisions of Nos. 17 and 191 of the ITU Constitution which state, respectively, that the Union shall promote the adoption of measures for ensuring the safety of life through the cooperation of telecommunication services, and that international telecommunication services must give absolute priority to all telecommunication concerning the safety of life,

noting

that the resilience of all telecommunication infrastructure depends on proper continuity planning at every stage of development and implementation of a network,

noting further

the necessity of an appropriate regulatory environment to ensure the full utilization of telecommunication networks in the above sense,

recommends

1 that administrations ensure proper consideration of disaster Telecommunications by the telecommunication service providers;

2 that the regulators ensure the inclusion of provision of Telecommunications as part of disaster mitigation and relief operations through appropriate national regulations;

3 that ITU-D study, as a matter of urgency, those aspects of Telecommunications that are relevant to disaster resilience and continuity,

instructs the Director of the Telecommunication Development Bureau (BDT)

to support administrators and regulators in the recommended activities by including appropriate measures into the work plan,

invites the Secretary-General

to bring this matter to the attention of the Plenipotentiary Conference for consideration.

RESOLUTION 34 (Istanbul, 2002)

Telecommunication resources in the service of humanitarian assistance

The World Telecommunication Development Conference (Istanbul, 2002),

considering

a) that the Intergovernmental Conference on Emergency Telecommunications (Tampere, 1998) (ICET-98) adopted the Convention on the Provision of Telecommunication Resources for Disaster Mitigation and Relief Operations (Tampere Convention);

b) that the Plenipotentiary Conference (Minneapolis, 1998), convinced that the Tampere Convention provides the necessary framework for the unhindered use of telecommunication resources for disaster mitigation and disaster relief operations, in its Resolution 36 (Rev.Minneapolis, 1998), urged Member States to work towards the earliest possible ratification of the Tampere Convention;

c) that the Valletta Declaration adopted at the World Telecommunication Development Conference (Valletta, 1998) included among a number of pressing issues, the importance of emergency Telecommunications and the need for an international convention on this subject;

d) that the World Radiocommunication Conference (Istanbul, 2000), in its Resolution 644, urged administrations to give their full support to the adoption and national implementation of the Tampere Convention;

e) that the second Tampere Conference on Disaster Communications (Tampere, 2001) (CDC-01) invited ITU to study the use of public mobile networks for early warning and the dissemination of emergency information and the operational aspects of emergency Telecommunications such as call prioritization,

noting

that activities are being undertaken at the international, regional and national levels within ITU and other relevant organizations to establish internationally agreed means to operate systems for public protection and disaster relief on a harmonized and coordinated basis,

further noting

the publication of the ITU-D Handbook on Disaster Communications and the adoption of Recommendation ITU-D 13 on Effective Utilization of the Amateur Services in Disaster Mitigation and Relief Operations,

recognizing

that the recent tragic events in the world clearly demonstrate the need for high-quality communications services to assist public safety and disaster relief agencies in minimizing risk to human life and to cover the necessary general public information and communication needs in such situations, *resolves*

to invite ITU-D to continue to ensure that proper consideration be given to emergency Telecommunications as an element of telecommunication development, including, in close coordination and collaboration with ITU-R and ITU-T and other relevant international organizations, by facilitating and encouraging the use of decentralized means of communications that are appropriate and generally available, including those provided by the amateur radio service and satellite and terrestrial network services,

instructs the Director of the Telecommunication Development Bureau (BDT)

1 to support administrations in their work towards the implementation of this resolution and of the Tampere Convention;

2 to report to the next world telecommunication development conference on the status of implementation of the Convention,

requests the Secretary-General

to work closely with the office of the United Nations Emergency Relief Coordinator and other relevant external organizations with a view to further increasing the Union's involvement in, and support to, emergency communications, and to report on the outcome of related international conferences and meetings so that the Plenipotentiary Conference or the ITU Council may take any action that they deem necessary,

invites

the United Nations Emergency Relief Coordinator and the Working Group on Emergency Telecommunications and the other relevant external organizations or bodies to collaborate closely with ITU in work towards implementing this resolution and the Tampere Convention, and supporting administrations and international and regional telecommunication organizations in the implementation of the Convention,

urges administrations

to work towards the entry into force of the Tampere Convention by the timely ratification of the Convention by the appropriate national authorities*.

* NOTE – A minimum of 30 ratifications of the Tampere Convention is needed by the deadline of 21 June 2003.

RESOLUTION 36 (Rev. Marrakesh, 2002)

Telecommunications in the service of humanitarian assistance

The Plenipotentiary Conference of the International Telecommunication Union (Marrakesh, 2002),

endorsing

a) Resolution 644 (Rev. WRC-2000) of the World Radiocommunication Conference (Istanbul, 2000) on telecommunication resources for disaster mitigation and relief operations;

b) Resolution 34 (Istanbul, 2002) of the World Telecommunication Development Conference on telecommunication resources in the service of humanitarian assistance,

considering

a) that the Intergovernmental Conference on Emergency Telecommunications (Tampere, 1998) adopted the Tampere Convention on the provision of telecommunication resources for disaster mitigation and relief operations;

b) that the second Tampere Conference on Disaster Communications (Tampere, 2001) invited ITU to study the use of public mobile networks for early warning and the dissemination of emergency information, and the operational aspects of emergency Telecommunications such as call prioritization,

noting

that activities are being undertaken at the international, regional and national levels within ITU and other relevant organizations to establish internationally agreed means for the operation of systems for public protection and disaster relief on a harmonized and coordinated basis,

recognizing

a) the seriousness and magnitude of potential disasters that may cause dramatic human suffering;

b) that the recent tragic events in the world clearly demonstrate the need for high-quality communications services to assist public safety and disaster relief agencies in minimizing risk to human life and to cover the necessary general public information and communication needs in such situations,

convinced

that the unhindered use of telecommunication equipment and services is indispensable for the provision of effective and appropriate humanitarian assistance,

further convinced

that the Tampere Convention provides the necessary framework for such use of telecommunication resources,

resolves to instruct the Secretary-General

1 to work closely with the United Nations Emergency Relief Coordinator to support Member States which so request in their work towards their national adherence to the Tampere Convention,

2 upon entry into force of the Tampere Convention, and in close collaboration with the United Nations Emergency Relief Coordinator, to assist Member States which so request with the development of their practical arrangements for its implementation,

urges Member States

to work towards signature of the Tampere Convention prior to the deadline of 21 June 2003 and, as a matter of priority, ratification, acceptance, approval or accession to the Convention,

further urges Member States Parties to the Tampere Convention

to take all practical steps for the application of the Tampere Convention and to work closely with the operational coordinator as provided for therein.

INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

E.106

(10/2003)

SERIES E: OVERALL NETWORK OPERATION, TELEPHONE SERVICE, SERVICE OPERATION AND HUMAN FACTORS

International operation – General provisions concerning Administrations

International Emergency Preference Scheme (IEPS) for disaster relief operations

ITU-T Recommendation E.106

ITU-T E-SERIES RECOMMENDATIONS

OVERALL NETWORK OPERATION, TELEPHONE SERVICE, SERVICE OPERATION AND HUMAN FACTORS

INTERNATIONAL OPERATION	
Definitions	E.100–E.103
General provisions concerning Administrations	**E.104–E.119**
General provisions concerning users	E.120–E.139
Operation of international telephone services	E.140–E.159
Numbering plan of the international telephone service	E.160–E.169
International routing plan	E.170–E.179
Tones in national signalling systems	E.180–E.189
Numbering plan of the international telephone service	E.190–E.199
Maritime mobile service and public land mobile service	E.200–E.229
OPERATIONAL PROVISIONS RELATING TO CHARGING AND ACCOUNTING IN THE INTERNATIONAL TELEPHONE SERVICE	
Charging in the international telephone service	E.230–E.249
Measuring and recording call durations for accounting purposes	E.260–E.269
UTILIZATION OF THE INTERNATIONAL TELEPHONE NETWORK FOR NON-TELEPHONY APPLICATIONS	
General	E.300–E.319
Phototelegraphy	E.320–E.329
ISDN PROVISIONS CONCERNING USERS	E.330–E.349
INTERNATIONAL ROUTING PLAN	E.350–E.399
NETWORK MANAGEMENT	
International service statistics	E.400–E.409
International network management	E.410–E.419
Checking the quality of the international telephone service	E.420–E.489
TRAFFIC ENGINEERING	
Measurement and recording of traffic	E.490–E.505
Forecasting of traffic	E.506–E.509
Determination of the number of circuits in manual operation	E.510–E.519
Determination of the number of circuits in automatic and semi-automatic operation	E.520–E.539
Grade of service	E.540–E.599
Definitions	E.600–E.649
Traffic engineering for IP-networks	E.650–E.699
ISDN traffic engineering	E.700–E.749
Mobile network traffic engineering	E.750–E.799
QUALITY OF TELECOMMUNICATION SERVICES: CONCEPTS, MODELS, OBJECTIVES AND DEPENDABILITY PLANNING	
Terms and definitions related to the quality of telecommunication services	E.800–E.809
Models for telecommunication services	E.810–E.844
Objectives for quality of service and related concepts of telecommunication services	E.845–E.859
Use of quality of service objectives for planning of telecommunication networks	E.860–E.879
Field data collection and evaluation on the performance of equipment, networks and services	E.880–E.899

For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation E.106

International Emergency Preference Scheme (IEPS) for disaster relief operations

Summary

This Recommendation describes an international preference scheme for the use of public Telecommunications by national authorities for emergency and disaster relief operations. The International Emergency Preference Scheme for Disaster Relief Operations (IEPS) is needed when there is a crisis situation causing an increased demand for Telecommunications when use of the International Telephone Service may be restricted due to damage, reduced capacity, congestion or faults. In crisis situations there is a requirement for IEPS users of public Telecommunications to have preferential treatment.

Source

ITU-T Recommendation E.106 was approved by ITU-T Study Group 2 (2001-2004) under the WTSA Resolution 1 on 31 October 2003.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing Telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

Introduction

In a crisis situation, there is a need for Telecommunications among IEPS users of public Telecommunications networks, such as the PSTN, ISDN or PLMN. These communications, which are regarded as essential, will be needed at the same time as the public will be attempting an increased number of calls during the period when the Telecommunications networks may be restricted due to damage, congestion or faults.

Many countries have, or are developing, national preference schemes to allow preferential treatment for such national traffic. However, during a crisis, it is important for an international support scheme to allow communications between the IEPS users in one country and their correspondents in another. The International Emergency Preference Scheme for Disaster Relief Operations (IEPS) addresses this international support scheme.

This preference scheme is only intended for use by IEPS users to be able to place calls with preference. Public emergency services, on the other hand, are intended for use by members of the general public to request services such as fire, police, and medical. They are often invoked by a short access code.

ITU-T Recommendation E.106

International Emergency Preference Scheme (IEPS) for disaster relief operations

1 Scope

The IEPS enables the use of public Telecommunications by national authorities for emergency and disaster relief operations. It allows users, authorized by national authorities, to have access to the International Telephone Service, as described in ITU-T Rec. E.105 [1], while this service is restricted either due to damage, congestion or faults, or any combination of these. This Recommendation describes the functional requirements, features, access and the operational management of the IEPS.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[1] ITU-T Recommendation E.105 (1992), *International telephone service*.

3 Definitions

This Recommendation defines the following term:

3.1 IEPS user: User authorized by a national authority to have access to IEPS. The specific mechanism that a national authority uses to authorize a user is a national matter and is outside the scope of this Recommendation.

4 Abbreviations

This Recommendation uses the following abbreviations:

HPC High Priority Call

IEPS International Emergency Preference Scheme for Disaster Relief Operations

ISDN Integrated Services Digital Network

PIN Personal Identification Number

PLMN Public Land Mobile Network

PSTN Public Switched Telephone Network

RNMC Restrictive Network Management Control

5 Overall functional requirements

The primary goal for IEPS is to support crisis management arrangements. IEPS should significantly increase the ability of IEPS users to initiate and complete their communications (voice and data) via the PSTN, ISDN or PLMN irrespective of the bearer technology.

National preference schemes are intended for use in times of national crisis, but there could be occasions when an international preference scheme may need to be enabled while use of the respective national preference scheme would be unnecessary. An example of this is when intense international traffic is generated to a distant country in crisis. Therefore, international and national preference schemes need to be considered as independent and compatible.

IEPS users of a national preference scheme may not be eligible to gain access to the international scheme, but IEPS users of the international scheme should be able to use their own national preference scheme.

It is recognized that in some national systems, IEPS features may be permanently enabled.

IEPS users should be able to use their normal Telecommunications equipment in times of crisis. When making an IEPS call, the PSTN/ISDN/PLMN should not appear markedly different to an IEPS user.

Calls originated by IEPS users should be given priority through the networks involved when IEPS is enabled.

Under conditions of severe damage or congestion, countries should be able to effect network controls, particularly over incoming traffic, even though IEPS may have been invoked.

In order to ensure that an IEPS user can reliably call any other Telecommunications user, any restrictions to call completion should be overridden. This does not include pre-emption of any existing calls.

Access to public emergency services is not impacted by this Recommendation.

Countries may establish bilateral agreements with regard to the exchange of preference calls and the treatment of such calls.

Both the technical means and the management procedures for the initiation and operation of IEPS should be established and should be compatible with the existing national network traffic management schemes.

This preference scheme is only intended for use by IEPS users to be able to place calls with preference. Public emergency services, on the other hand, are intended for use by members of the general public to request services such as fire, police, and medical. They are often invoked by a short access code.

6 IEPS features

Calls from IEPS users should be suitably marked (see Note 1) at the network entrance and such markings should be associated with the call to completion (i.e., EPS calls should be marked from end to end).

NOTE 1 – **Call Marking**: A specific identifying mark is associated with the call which prompts operational elements of the public switched network to provide advantages in signalling, switching and traffic routing over non-marked calls. Call marking facilities are available in modern signalling networks and these can be used by the Telecommunications providers to allow call completion advantages to preference user's calls.

NOTE 2 – The call marking, marking interpretation and the processing arrangements will have to be specified and fully agreed at the gateway points. Arrangements to transfer the marked signals would also need to be agreed with non-participating intermediate service providers of the transit networks.

The essential network features for the successful operation of IEPS are:

a) priority dial tone;

b) priority call setup, including priority queuing schemes; and

c) exemption from restrictive management controls, such as call gapping.

A list of features that will enhance call completion are mentioned in Annex A.

All IEPS calls will be of the same call class such that there will be only one level of priority for IEPS calls, however, some implementations may provide enhanced service features by analyzing additional signalling information provided by the call initiator. For example, the country of call origination may have a multi-level preference scheme and may make an agreement with the country of call destination for this multi-level preference scheme to be mapped onto that of the country of destination. In such circumstances it is essential that the information relating to level of priority be carried transparently across the international network and presented to the destination network. Transit networks not supporting the IEPS concept should not be required to examine the preference information but should simply pass the signalling information without any change.

Pre-emption in the Public Network (i.e., terminating any existing call) should not be provided.

7 Operational management of the IEPS

Requests for enabling the IEPS should be coordinated between the involved countries. In each country, IEPS will be authorized by the national authority and it will be their responsibility to establish the necessary arrangements.

IEPS users are to be determined by national authorities. Some criteria a national authority may wish to consider for the selection of IEPS users can be found in Appendix I.

To optimize the success of these calls there should be exemption from any restrictive network management controls. There should be preferential access to network resources. These preferential calls might also circumvent terminating user-invoked network features that might prevent alerting such as, for example, do not disturb or call screening.

If a network element is not able to respond to the preferential call request, the routing of the call should not be adversely affected, nor should any preference indicators be removed.

Annex A

Features and techniques to enhance call completion

The features described in this annex may be used separately or in combination to increase the probability of the successful completion of calls, but IEPS is not necessarily dependent on them. The list is not exclusive and the use of these features is to be determined by each country, taking into account the capabilities of the networks being used.

No.	Essential features for IEPS	Feature requires call marking
1	Priority dial tone – wireline or wireless connections (Essential Line service)	No
2	Priority call setup message through signalling network with high priority call identifier (HPC identifier)	Yes
3	Priority indicator in bearer networks	Yes
4	Exemption from restrictive network management controls, such as call gapping (Exemption from RNMC)	Yes

No.	Optional features (F) and techniques (T) to enhance call completion	Feature requires call marking
5	Survivable access and egress from end user location to PSTN/ISDN/PLMN: (F)	
	a) Local exchange bypass; (T)	Yes
	b) Diverse PSTN/ISDN access from cellular; (T)	Yes
	c) Prescription override; (T)	Yes
	d) Avoidance routing; (T)	Yes
	e) Diverse routing. (T)	Yes
6	IEPS user verification (F)	Yes
7	Special announcements on call progress (F)	Yes
8	Special routing capabilities: (F)	
	a) Enhanced alternate routing; (T)	Yes

	b) Trunk queuing; (T) c) Off-hook trunk waiting; (T) d) Dynamic trunk reservation; (T) e) Trunk sub-grouping; (T) f) Automatic call rerouting; (T) g) PSTN/ISDN/PLMN partitioning. (T)	Yes Yes Yes Yes No No
9	Call forwarding (F)	Yes
10	Abbreviated dialling (F)	No
11	Attendant override (F)	Yes
12	Authorization codes (F)	No
13	Automatic call distribution (F)	No
14	Call-by-call service selection (F)	No
15	Call pickup (F)	No
16	Call transfer (F)	No
17	Call waiting (F)	No
18	Calling number identification (F)	No

A.1 Priority dial tone

This is a service arrangement that enhances the ability of IEPS users to receive priority over other users for the reception of dial tone. This is a restrictive treatment of non-IEPS users. Note that access denial systems are an extreme form of restrictive treatment by limiting dial tone to permitted lines only.

A.2 Priority call setup message through national and international signalling network with call identifier

This is a method of marking and identifying IEPS calls. As the IEPS call progresses through the networks, this identifier would enable special routing and preferential treatment to ensure the higher probability of call completion.

A.3 Priority indicator in bearer networks

This is a method of marking and identifying IEPS connection set ups and should cause priority allocation of bearer resources. As the IEPS connection set up progresses through the networks, this identifier could enable special routing and preferential treatment to ensure the higher probability of connection establishment. The preferential allocation of bearer resources should be maintained throughout the duration of the call.

A.4 Exemption from restrictive management controls

Network management is a set of control measures used to prevent or control degradation of network service. These measures are either expansive or protective. Expansive measures increase call routing choices by providing more capability than normal to carry excess traffic. Protective measures limit calls going into a switch or trunk group. An IEPS call should be exempt from restrictive controls, but should still benefit from expansive controls.

A.5 Survivable access and egress from end user location to PSTN/ISDN/PLMN

Techniques that enhance survivable access from the end user to the PSTN/ISDN/PLMN are described in a to e.

a) **Local exchange bypass**

The use of direct access services to, or egress services from, Switched Networks by using either bulk, wideband, switched, point-to-point, or circuit-by-circuit services. These services are available from providers such as cellular service providers, specialized service providers and satellite service providers.

b) **Diverse PSTN/ISDN access from PLMN**

This technique allows PLMNs to directly interconnect with other elements of PSTN/ISDN. This allows PLMN calls to be routed around failed or congested nodes. Network access diversity allows specifically identified calls to be routed to private or special purpose networks.

c) **Prescription override**

The ability to select an alternative carrier, e.g., by dialling a specific code or operating a selection key on the terminal instrument, or may be automatic for an IEPS call.

d) **Avoidance routing**

This technique, with limited availability, permits a user to enhance their survivability in PSTN/ISDN by directing the service provider to assign them to transmission facilities that avoid points of vulnerability such as earthquake zones or hurricane areas.

e) **Diverse routing**

This technique provides the user with a second route over physically separate facilities, which can be used if the primary route is unavailable.

A.6 IEPS user verification

This feature allows for the verification of the IEPS user. Personal Identification Numbers (PINs), line identification, authorization codes or call-back facilities could be used to verify the call as an authorized IEPS call.

A.7 Special announcements on call progress

This feature will provide recorded voice announcements to the user when calls cannot be completed or to provide problem and restoration information.

A.8 Special routing capabilities

Special routing capabilities that enhance call completion are described in a to g.

a) **Enhanced alternate routing**

Routing programs are used to provide special routing controls and paths within a network.

b) **Trunk queuing**

This technique would hold the IEPS call in queue until a trunk became available, then the first call in queue (the IEPS call) would have access to the next available trunk. The IEPS call would not receive an immediate "all trunks busy" tone.

c) **Off-hook trunk waiting**

This technique allows the IEPS caller to remain off-hook and the network continually searches, at predetermined intervals (i.e., several seconds) for an idle trunk if no idle trunk was found on the initial attempt.

d) **Dynamic trunk reservation**

This technique automatically reserves reservation of trunks for certain classes of calls under designated conditions. It could be implemented or activated in the following ways:

– IEPS calls could be allocated a variable number of trunks between switches according to demand;
– the use of network management control under predetermined conditions, to reserve trunks in an idle condition for the exclusive use of IEPS calls; and
– the designation of specific sub-groups within a trunk group that, under predetermined conditions, would be reserved for IEPS calls.

e) **Trunk sub-grouping**

This technique splits trunks into pre-assigned sub-groups; one for general use and another for IEPS use only. Under normal conditions, general use traffic could use either sub-group. During emergencies, only IEPS calls would use the IEPS sub-group. Overflow from the IEPS sub-group could be routed over the general use sub-group but the general calls would not be allowed to overflow to the IEPS sub-group.

f) **Automatic call rerouting**

This technique allows calls to be routed over other operator's networks.

g) **PSTN/ISDN/PLMN partitioning**

This is the use of hardware or software to separate traffic into specific functional groups for the purpose of providing special service capabilities such as enhanced call completion for IEPS calls.

A.9 Call forwarding

This feature enables calls to be rerouted automatically from one line to another, or to an attendant.

A.10 Abbreviated dialling

A feature by which a user can attempt a call by dialling a two- or three-digit code that instructs a database to obtain the actual desired number from a look-up table and transmit it into the network to connect the calling line to the called line.

A.11 Attendant override

A feature that allows the terminal equipment operator to interrupt a call that is in progress.

A.12 Authorization codes

Unique multi-digit codes used to allow an IEPS user privileged access to a network, system or device. If the code is validated the call is allowed to advance.

A.13 Automatic call distribution

A system designed to evenly distribute traffic by directing incoming calls over a group of terminals.

A.14 Call-by-call service selection

A feature that provides improved trunking efficiency between end-user location and end-office by allowing a variety of services to use the same trunk group and by distributing traffic over the total number of available trunks on a call-by-call basis.

A.15 Call pickup

This feature enables a connected extension to answer any ringing extension within an assigned call pickup group.

A.16 Call transfer

A feature whereby a call to a user's number is automatically transferred to one or more alternative numbers when the called number is busy or does not answer.

A.17 Call waiting

A feature that provides a distinctive audible tone to a busy user's line to notify the user when another caller is attempting to reach his/her number.

A.18 Calling number identification

A feature that provides the identification of the calling user's number by means of a visual or audible identification at the called terminal.

Appendix I

Criteria for the selection of IEPS users

IEPS users are to be determined by their national authorities. The criteria for selection that a national authority may wish to consider are listed as, but are not limited to, the following items:

- civil defense/"home defense", e.g., public warning systems;
- diplomatic and other vital governmental purposes;
- state security purposes including customs and immigration;
- emergency services by local authorities, including police, fire services, etc.;
- posts and Telecommunications service providers, for maintaining their service provision to other essential users;
- public utilities including energy, water supplies, etc.;
- medical services;
- air and sea rescue.

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	**Overall network operation, telephone service, service operation and human factors**
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks and open system communications
Series Y	Global information infrastructure, Internet protocol aspects and Next Generation Networks
Series Z	Languages and general software aspects for telecommunication systems

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