

IEEE Guide for Microwave Communications System Development: Design, Procurement, Construction, Maintenance, and Operation

Sponsor

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Abstract: The needs and requirements specific to the design, procurement, construction, maintenance, and operation of a microwave system are addressed. Steps for a variety of applications have been included in this guide; however, users should select only those steps that apply to their particular system(s) and their procurement policies.

Keywords: communications infrastructure, digital microwave, loop system, microwave spurs, ring system, star system, teleconferencing, terrestrial microwave system

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Introduction

(This introduction is not part of IEEE Std 1404-1998, IEEE Guide for Microwave Communications System Development: Design, Procurement, Construction, Maintenance, and Operation.)

The Intelligent Transportation Society of America (ITS America) was organized to support the development of US Department of Transportation (USDOT) Intelligent Transportation Systems (ITS) and subsequently requested standards assistance from the IEEE. The first meeting of the IEEE Standards Coordinating Committee on Intelligent Transportation Systems (SCC32) was convened by John E. May at Newport Beach, California on 22 May 1992.

Traditional DOT electronic system construction and maintenance projects have been limited in scope to “local” systems and system control environments that do not require system-to-system communications. Each system has usually been a stand-alone system, and in many cases, proprietary design has negated the ability to communicate with an adjacent system(s). These electronic systems are relatively new to the DOT environment and most are traffic control systems. However, after the US Legislature passed the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), the need to communicate with many discrete traffic management systems over a large geographic area became essential if the concept of ITS was to become a reality. The key to cost-effective ITS systems is a cost-effective, highly reliable communications infrastructure. A terrestrial microwave system can be designed to meet these requirements.

This guide is the product of an SCC32 Working Group responsible for the development of a document that would provide guidance to the USDOT, as well as state and local transportation departments in developing a terrestrial microwave system, including the steps required for design, procurement, construction, maintenance, and operation.

At the time this guide was completed, the Working Group on Microwave Communications System Development: Design, Procurement, Construction, Maintenance, and Operation had the following members:

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Contents

1.	Overview.....	1
1.1	Scope.....	1
1.2	Purpose.....	1
2.	References.....	2
3.	Acronyms.....	3
4.	Professional assistance requirements.....	4
5.	Assignment of responsibility	4
5.1	Engineering.....	4
5.2	Procurement	4
5.3	Implementation	4
5.4	Operation.....	5
5.5	Maintenance.....	5
5.6	Legal	5
6.	Design requirements	5
6.1	User needs assessment	6
6.2	Channel requirements	9
6.3	Technical characteristics.....	10
6.4	Microwave path requirements.....	11
6.5	FAA notification and approval	12
6.6	FCC licensing requirements.....	13
6.7	Facility requirements	15
7.	Procurement	22
7.1	Information search [request for information (RFI)].....	22
7.2	Purchase concept.....	22
7.3	Procurement document	22
7.4	Pre-purchase conference	24
7.5	Proposal/bid evaluation.....	24
7.6	Contract negotiations and award of contract	24
8.	Construction.....	24
8.1	Pre-construction conference.....	25
8.2	Notice to proceed (NTP).....	25
8.3	Project implementation management.....	25
8.4	Permitting.....	25
8.5	Site inspections	25
8.6	Installation inspections.....	26
8.7	Performance verification.....	26
8.8	Final acceptance.....	27
9.	Maintenance.....	28

9.1	Quality level.....	28
9.2	Network monitor.....	28
9.3	In-house maintenance	28
9.4	Contract maintenance.....	28
9.5	Response time specifications	29
10.	Training.....	29
10.1	Administration	29
10.2	Operational.....	29
10.3	Manuals.....	29
10.4	Repair.....	30
10.5	On-site.....	30
10.6	Factory	30
11.	Operational requirements.....	30
11.1	System management	30
11.2	Maintenance	30
11.3	Training.....	30

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1. Overview

This document provides step-by-step guidance to individuals involved in the development of terrestrial microwave communications systems. Included are the requirements for the design, procurement, construction, maintenance, operation, and test of such systems.

1.1 Scope

This guide was developed in accordance with traditional microwave system development methods. This guide addresses the needs and requirements specific to the design, procurement, construction, maintenance, and operation of a microwave system. Steps for a variety of applications have been included in this guide; however, readers should select only those steps that apply to their particular system(s) and their procurement policies.

It is recommended that this guide be thoroughly reviewed and all steps not applicable to the needs of the user and/or project be deleted. The customized guide should then be used as a project-specific guide. Each step in the modified guide can then be used as a check-off item to ensure that all the requirements of the process have been fulfilled or completed.

1.2 Purpose

The purpose of this document is to provide a step-by-step guide for the development of a microwave communications system for the non-technical manager or purchasing agent or to serve as a handy checklist for the experienced communications engineer/technical manager.

This guide addresses the basic issues associated with each potential element of a microwave communications infrastructure construction project. It was the intent of the writers to provide a generic and basic

approach, addressing as many of the possible project elements, rather than provide a more detailed document that would be typical of a procedure or specification. This document is a guide and should not be used as the only source of information when designing, procuring, constructing, maintaining, and operating a microwave communications system.

The guide can be used by both the communications engineering professional who may wish to review one or more elements of microwave project design and by the non-technical manager/purchasing agent who desires to become familiar with the various aspects of microwave system project development.

2. References

This guide shall be used in conjunction with the following publications. If the following publications are superseded by an approved revision, the revision shall apply.

ANSI/EIA 195-C-1985, Electrical and Mechanical Characteristics for Terrestrial Microwave Relay System Antennas and Passive Reflectors.¹

ANSI/EIA 310-D-1992, Racks, Panels, and Associated Equipment.

ANSI/EIA/TIA 222-E-1991, Structural Standards for Steel Antenna Towers and Antenna Supporting Structures.

ANSI/NFPA 780-1997, Lightning Protection Code.²

ASCE 7-95 Minimum Design Loads for Buildings and Other Structures.³

EIA-252-A-1972, Standard Microwave Transmission Systems.⁴

EIA-368-1969, Frequency Division Multiplex Equipment Standard for Nominal 4 kHz Channel Bandwidths (Non-Compandored) and Wideband Channels (Greater than 4 kHz).

IEEE Std C62.41-1991 (Reaff 1995), IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.⁵

NFPA 70-1996, National Electrical Code[®] (NEC[®]).⁶

UL-752-1995, Bullet-Resisting Equipment.⁷

¹ANSI/EIA publications are available from Global Engineering, 1990 M Street NW, Suite 400, Washington, DC, 20036, USA. They are also available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

²NFPA publications are available from Publications Sales, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, USA.

³ASCE publications are available from American Society of Civil Engineers, 1015 15th Street NW, Suite 600, Washington DC 20005 USA.

⁴EIA publications are available from Global Engineering, 1990 M Street NW, Suite 400, Washington, DC, 20036, USA.

⁵IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

⁶The National Electrical Code is available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA. It is also available from Publications Sales, National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, USA.

⁷UL standards are available from Global Engineering, 1990 M Street NW, Suite 400, Washington, DC, 20036, USA.

3. Acronyms

AASHTO	American Association of State Highway and Transportation Officials
AGL	Above Ground Level
ANSI	American National Standards Institute
EPA	Environmental Protection Agency
ERP	Effective Radiated Power
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
HVAC	Heating, Ventilation, Air-conditioning
IEEE	Institute of Electrical and Electronics Engineers
I/O	Input/Output
ISO	International Organization for Standardization
ISTEA	Intermodal Surface Transportation Efficiency Act (1991)
ITS	Intelligent Transportation System [formerly Intelligent Vehicle Highway System (IVHS)]
ITS America	Intelligent Transportation Society of America [formerly the Intelligent Vehicle Highway Society (IVHS) of America]
ITU-R	International Telecommunications Union–Radio Communications Sector
ITU-T	International Telecommunications Union–Telecommunications Standardization Sector
IVHS	Intelligent Vehicle Highway System [replaced by Intelligent Transportation System (ITS)]
LP	Liquefied Petroleum
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Testing Laboratory
NTIA	National Telecommunications and Information Agency
NTP	Notice to Proceed
PCS	Personal Communications Service
RF	Radio Frequency
RFB	Request for Bid
RFI	Request for Information
RFP	Request for Proposal
UL	Underwriters Laboratories
UPS	Uninterruptible Power System
USGS	US Geological Survey
VSWR	Voltage Standing Wave Ratio

4. Professional assistance requirements

Professional assistance may be required for two specific reasons—first, to fulfill the need for technical assistance not available within the user organization, and second, to satisfy professional engineer licensing or certification required by either policy or law. In either case, the professional engineer, whether a qualified registered professional engineer or a communications engineer, should bring a level of expertise to the process that is both cost effective and time effective.

5. Assignment of responsibility

It is important to assign responsibility as early in the process as possible. Agencies in the public sector usually have policies, procedures, and laws governing the process for the assignment of authority and responsibility to programs addressed by this guide, whereas private sector planners may not have any predefined rules or policies. Therefore, the initial project activities, which include mission statements, budget issues, and work scopes, should clearly identify where the program authority and responsibility lies. It is important that technical and complex projects (e.g., microwave communications systems) be controlled by managers or engineers who are qualified communications specialists. Individuals or groups who do not practice communications engineering are not qualified and should not be considered.

5.1 Engineering

The individual or group selected to be responsible for the engineering design, maintenance, and operation of a microwave system should be a qualified communications engineer or communications engineering group. The individual or group should be a specialist or specialize in this area of electrical engineering. If qualified personnel are not internally available, engineering assistance should be acquired from an outside source.

5.2 Procurement

The procurement policies affecting each project should be considered in the design process. In addition, institutional standards should be considered and possibly changed or waived for some communications projects. It is best to identify any impediments in advance and obtain permits, license waivers, or design modifications before making a final commitment to the proposed project.

Failure to address institutional issues early in the conceptual and design phases can delay the project later on and almost always increases the final and/or long-term recurring costs of the project. Responsible engineering and management are necessary to prevent delays and minimize costs.

Given the policies and standards, it is necessary to establish the procurement methodology that is appropriate to the project. The owner may choose among competitive procurement [bid or request for proposal (RFP)], negotiated sole-source procurement, or operating lease.

5.3 Implementation

Implementation of a microwave communications system is an intensive technical effort. For most projects, successful implementation requires a dedicated project manager. This individual oversees activities such as scheduling, site acquisition and development, permitting, vendor/contractor coordination, receiving, inventory and storage of equipment and materials, construction supervision, Federal Aviation Administration (FAA) and Federal Communications Commission (FCC) compliance, system optimization, and performance verification. Time should be allocated for extensive field travel and regular progress meetings with the system vendor.

5.4 Operation

Operational issues include system management, site management, maintenance, and other issues associated with office management. System management includes resource allocation, maintenance strategies, and future growth requirements. Site management includes tower management, frequency and channel selection, and loading. Maintenance funding and resource allocation may be a shared responsibility between operations and maintenance. Other management issues are essentially office management requirements that should be defined and allocated budget funds.

NOTE—Tower management includes tower/site use agreements with other users.

5.5 Maintenance

Maintenance should be considered from the beginning of the project and effectively begins during system burn-in and should continue throughout the life of the system. Maintenance tactics, billing, training, network monitoring and control, response time, equipment and vehicle requirements, and preventive maintenance schedules are all directly associated with maintenance and indirectly associated with operation.

Two basic maintenance concepts are contract and in-house maintenance. Contract maintenance is performed by independent contractors who perform specific maintenance tasks delineated by a contractual agreement between the microwave system owner and the maintenance contractor(s). In-house maintenance is maintenance performed by personnel employed directly by the microwave system owner.

The development of maintenance capabilities (e.g., acquiring personnel, equipment, spare parts, and training) should be done sufficiently in advance so that the maintenance personnel will be ready to assume maintenance responsibility upon initial system start-up.

5.6 Legal

Legal issues will vary from project to project. It is recommended that site selection be considered a part of the initial design engineering and all FAA, FCC, Federal Highway Administration (FHWA), and local building and zoning permit approvals be obtained before advertising for bids. Unless all approvals are guaranteed, a project may be delayed or completion may be prevented due to a rejection by any one authority such as those delineated herein.

However, it should be recognized that large systems will present a logistical problem to the manager who attempts to obtain all licenses and permits prior to advertising for bids. FCC licenses will usually expire between the time of the bid and the completion of construction, maybe more than once. FAA studies also expire if the FCC license is not issued promptly. Therefore, large system planning should also include the legal issues associated with the logistical necessity of awarding a contract first and requiring the contractor to complete the FCC licensing before the construction notice to proceed (NTP) can be authorized. In all cases, the contract should have a cancellation clause, without penalty to the buyer, in the event that the FCC does not grant a license(s) for the system.

6. Design requirements

The design requirements of a terrestrial microwave system are directly driven by the needs of the owner(s) and user(s) and should be determined during the user needs assessment. Design requirements are affected by the volume and density of information that needs to be transported, the terrestrial characteristics of the area of operation, and geographic restrictions for the site locations.