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Prewiring Design Information Project

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A Study of Design Guidance for Prewiring Air Force Facilities

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The objective of this study was to evaluate draft guidance on a standard methodology of planning, designing, and installing distribution cabling within a facility for communication/computer systems. Research findings include:

1. The Electronics Industry Association (EIA) and Telecommunications Industry Association (TIA) have been working on three new wiring standards that are scheduled for publication during 1991.

2. Engineers believe the EIA/TIA standards will provide the guidance needed to design prewired buildings.

3. Existing military documents take precedence over commercial standards unless an Engineering Technical Letter is issued stating otherwise.

4. HQAFCC should initiate a proposal to determine if the new standards should be used throughout the Air Force. In that process, design engineers can determine the appropriateness of existing documents used by the Air Force to design prewired buildings.

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FOREWORD

This study was conducted for the Technology Integration Center (TIC), General Engineering Division, Systems Application Directorate, Headquarters Air Force Communications Command (HQAFCC) Scott Air Force Base, IL. The project order number is AFCC 90-17. The Technical Monitor is Ray Caros, TIC/APGD.

This research was performed by the Architectural Design and Management Team of the Facility Systems Division (FS) of the U.S. Army Construction Engineering Research Laboratory (USACERL). L. Michael Golish is the Team Leader and Dr. M. O'Connor is Chief of USACERL-FS. The technical editor was Gloria J. Wienke, Information Management Office.

COL Everett R. Thomas is Commander and Director of USACERL, and Dr. L.R. Shaffer is Technical Director.

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A STUDY OF DESIGN GUIDANCE FOR PREWIRING AIR FORCE FACILITIES

1 INTRODUCTION

Background

Currently, no single document exists that identifies standard communications prewiring requirements and/or design criteria for Air Force facilities. Further, there is no complete and thorough set of standards to use for Communications Design Criteria in the Military Construction Program (MCP) project book or project specifications. Lack of this guidance leads to wasted time and money generating new design criteria for each project. Headquarters Air Force Communications Command (HQAFCC) tasked the U.S. Army Construction Engineering Research Laboratory (USACERL) to help prepare documentation to fill this void.

Objective

The initial objective of this study was to begin work on a standard methodology of planning, designing, and installing distribution cabling within a facility for communication/computer systems in the form of a Prewiring Design Information Document. However, a literature search revealed that considerable work has been done recently on this subject. The subsequent objective was to evaluate this existing draft guidance.

Approach

Researchers conducted a literature search to find existing work done to date on prewiring. They found that two associations in Washington, D.C. have been working jointly on new wiring standards that seemed identical in scope to what USACERL researchers were tasked to do. Researchers obtained three draft standards developed by the Electronics Industry Association (EIA) and the Telecommunications Industry Association (TIA) and analyzed them in a variety of ways. Each standard was summarized and compared for content.

The second step of the investigation was to determine what resources were used, how much time was spent, and most importantly, how the Government was represented in the process of developing the standards.

The third step of the research involved contacting military engineers to discuss a prewiring design guide and the new draft standards.

The final step of the study was to compare the new draft commerical standards to existing documents used by engineers to design prewired Air Force facilities.

2 SUPPORT AND ANALYSIS

Early in 1985, many companies representing the telecommunications and computer industry expressed concern over the lack of a standard for telecommunications wiring systems in buildings. The Computer Communications Industry Association (CCIA) asked the Electronics Industry Association (EIA) to undertake the task of developing the required standard. EIA accepted the task and the project was assigned to the TR-41.8 committee (under Engineering Committee TR-41). The TR-41.8 committee was subdivded into three ad hoc working groups as follows:

1. TR-41.8.1 - Working Group on Commercial and Industrial Building Wiring Standard;

2. TR-41.8.2 - Working Group on Residential and Light Commercial Building Wiring Standard;

3. TR-41.8.3 - Working Group on Building Telecommunications Architecture.

These working groups developed a series of draft technical standards on building wiring for telecommunications products and services Each standard is discussed in the following sections.

EIA/TIA 568

Proposed standard EIA/TIA 568 entitled "Commercial Building Wiring Standard," was written to "establish performance and technical criteria for various wiring systems." This was accomplished through the explanation of telecommunications subsystems and the specification of these subsystems with their individual parts. Furthermore, these specifications are divided into two categories: mandatory and advisory criteria. Although the explanation is necessary for a clear understanding of wiring systems, the sections incorporating specifications are intended to be the main topic.

The first nine sections of this document consist of definitions and explanations of wiring elements, including horizontal wiring, backbone wiring, work area, telecommunications closet, equipment room, and entrance facilities. Although these definitions are brief, they do incorporate technical information (horizontal distances and recognized cables) where applicable.

The remainder of the document contains specifications of wiring elements, including horizontal cable, backbone cable, connectors, and connecting hardware and additional cable specifications in the appendix. Information on minimum acceptable requirements and enhancement suggestions is located in these sections and is referred to as mandatory and advisory criteria.

Mandatory criteria generally apply to protection, performance, administration, and compatibility. These criteria specify the absolute minimum acceptable requirements. Advisory or desirable criteria generally represent product goals. In some instances, these criteria are included to ensure universal product compatibility. In other cases, advisory criteria are presented when their attainment will enhance the general performance of the product in all its contemplated applications.

EIA/TIA 568 is a good standard for the specification of wiring elements. EIA/TIA 568 has a special relationship to EIA/TIA 569 in that building wiring cannot be standardized without also standardizing the architecture of the building into which wiring systems are installed.

EIA/TIA 569

The purpose of EIA/TIA 569 "Commercial Building Standard for Telecommunications Pathways and Spaces," is to standardize specific design and construction practices within and between commercial buildings that support telecommunications media and equipment. Standards are given for rooms/areas and pathways into and through which telecommunications equipment and media are installed.

During the life of any building, remodeling is more often the rule than the exception, and both telecommunications equipment and media can change dramatically. Telecommunications also encompass many other building systems including environmental control, security, audio, television, sensing, alarms, and paging. This standard recognizes that telecommunications embrace all low-voltage signal systems that convey information within buildings, and that these systems and needs may change over time. The standard must be as independent as possible from specific vendor equipment and media.

Telecommunications aspects are generally the pathways into which telecommunications media is placed and the rooms and areas of the building used to terminate media and install telecommunications equipment. Although the scope of the standard is limited to the telecommunications aspect of building design, it also directly influences the design of other building services such as electrical power and heating, ventilation, and air-conditioning (HVAC), and space allocation within the building. Field engineers indicated that one negative aspect of this standard relative to Government use is that space allocation on government projects will most likely be less than what EIA/TIA 569 recommends. This is not to say that the information in EIA/TIA 569 is not useful, but square footage allotments for telecommunications pathways and spaces may need modification for Government buildings.

The first half of the standard covers types, uses, and design guidelines for horizontal pathways and backbone pathways. The second half of the standard addresses design considerations for telecommunications closets, equipment rooms, and entrance facilities. The standard includes example floor layouts and configurations of spaces, square footage requirements, and site considerations. The standard also briefly discusses grounding, bonding, and fire stopping.

EIA/TIA 569 makes no specific recommendations among the design alternatives available for telecommunications pathways and spaces. The designer must properly select from among the alternatives based on the applications at hand and the constraints imposed.

To have a building successfully designed, constructed, and provisioned for telecommunications, it is imperative that the telecommunications design be incorporated during the preliminary architectural design phase. EIA/TIA 569 standard is designed to be used in conjunction with EIA/TIA 568, which is the standard that establishes performance and technical criteria for various wiring systems.

EIA/TIA 570

EIA/TIA standard 570, "Residential and Light Commercial Telecommunications Wiring Standard," applies to telecommunications wiring systems installed within an individual building with residential (single family or multioccupant) and light commercial end users. It also applies to mobile homes, marine construction, and other buildings to the extent practicable.

This standard describes a "premises" wiring system intended to connect one to four exchange access lines to various types of customer premises equipment. Some requirements, especially those on wire and

wiring topology, are new in anticipation of new telecommunications services. Technical criteria are given in the appendixes for installers and manufacturers.

Installation of wiring and telecommunications outlets beyond the exterior walls of a building is not discussed in this standard. These installations normally require wiring protection, the specification of which is beyond the scope of the standard. Backbone cable systems also are not covered by this standard. It does specify physical interfaces, connecting techniques, and installation methods for telecommunications wiring of individual buildings.

EIA/TIA 570 pertains to residential telecommunications wiring and has little relation to this research effort on commercial prewiring systems.

History

The history of EIA/TIA standards 568, 569, and 570 show that many people, companies, and organizations were involved in their development over a 4-year period. Below are the six major steps that take place in developing a standard:

1. A project is initiated,
2. A committee is formed,
3. A project number is issued,
4. Work begins,
5. Ballot process/Reviews are open,
6. Final publication.

George Lawrence, Chairman of the TR-41.8 committee that developed the standards, is employed by the AMP company. On August 30, 1990 he said EIA/TIA 568 is in the third ballot and will be published in 1991. Issues surrounding EIA/TIA 569 have been resolved and the standard is ready to be published.

EIA/TIA 568 and 569 will be the most applicable to the Air Force. U.S. Government limitations of space make EIA/TIA 569 appropriate with some modifications.

Representatives from American Telephone and Telegraph, Co., International Business Machines, Hewlett Packard, Digital Equipment Corporation, and other companies, along with architects, engineers, Government representatives, and the American Society of Architects, have all had input into the standards. The Committee of Standards Association for Canada will use EIA/TIA 568 and 569 with minor modifications. An international committee is trying to get EIA/TIA 568 used as a basis for an international standard. The Government representative for these standards is U.S. Department of Commerce, National Telecommunications and Information Administration, Institute for Telecommunication Sciences (NTIA/ITS), Boulder, CO (303) 497-5116.

Discussions With Field Engineers

Researchers contacted a number of people listed in the Statement of Work received from HQAFCC, to get their initial thoughts about USACERL's intent to produce a prewiring design information document.

Mr. Willard Allen, 485 EIG/EEWD, Griffiss Air Force Base (AFB), NY, indicated that the main prewiring standards used by the Air Force were distributed by Tinker AFB, OK, HQ Engineering Installation Division (EID); researchers need to coordinate efforts with that office. Mr. Allen also indicated he would like to participate in any reviews associated with this research. He was not aware of the EIA/TIA documentation effort.

Mr. Mario Diaz, 1845 EEG/EIBX, Tinker AFB, OK, indicated that customers, designers, and users would benefit from prewiring design guidance and that AFR 88-15[1] is being revised. Contractors and civil engineers will need to be involved in producing a prewiring design information document. Three control centers review all MCPs for every project in their geographical area.

1. 1843rd EEG, Wheeler AFB, HI,
2. 1845th EEG, Tinker AFB, OK,
3. 485th EIG, Griffiss AFB, NY.

Field engineers lack guidance on fiber optics inside buildings. They have a master of the MCP project book and add/delete as necessary for new projects.

Mr. Spencer Reed, HQ EID/EISS, Tinker AFB, OK, asked if USACERL was aware of the work being done by EIA. Mr. Reed had input into EIA/TIA 568. Mr. Reed feels that when EIA/TIA 568 and 569 are published, the Air Force will have the needed prewiring guidance. He indicated the need to have someone evaluate the standards in light of using them as part of the design process. A designer should use the standards on a project to test their practicality.

Technical Bulletin 90-02

The proposed standard Technical Bulletin (TB) 90-02[2] will be the most recent document concerning telecommunications prewiring to be produced by the Air Force Communications Command (AFCC). TB 90-02 is a revision of an earlier document (TB 86-07-EZ[3]) written by the AFCC and contains information on cable distribution systems, equipment rooms and closets, telecommunications cables, equipment power and connection outlets, and communications systems to support building occupants. Overlap of information exists between this document and EIA/TIA 568 and 569, but there are distinct differences.

This document defines and explains distribution facilities that concern service entrances, communications equipment rooms, riser systems, communications closets, and floor distribution systems. Several references are made to EIA/TIA 569 which provides more detailed information on the subject being reviewed. One exception, however, is in the discussion of floor distribution systems. In addition to a brief explanation of this subject, advantages and disadvantages of each system are given.

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[1] Air Force Regulation (AFR) 88-15, *Air Force Design Manual - Criteria and Standards for Air Force Construction*, Interim Draft (Headquarters U.S. Air Force [HQUSAF], January 1986).

[2] Technical Bulletin (TB) 90-02, *Building Communications Cabling and Distribution Systems* (HQUSAF, 30 May 1990).

[3] TB 86-07-EZ, *Building Communications Cabling and Distribution Systems* (Headquarters Air Force Communications Command [HQAFCC], May 1988).

This information can help engineers decide which type of distribution system is best for a given situation. Firestopping requirements and space provisions for future optic fiber installation are also discussed. Different communications systems are explained.

Building communications systems must support the user's current and future needs. This requires understanding several different types of communications systems to serve any one user best. Nine different systems are presented and briefly explained. The following cabling systems are also discussed: multipair telephone cable, fiber optic cable, and coaxial cable. The explanation of the fiber optic cable systems and coaxial cable systems covers basic general functions. Types of cables and color codes, connection hardware, and wiring diagrams are also discussed.

Integration with the building system is discussed in Section 4 of the document. Main topics include flexibility, expandability, and different considerations that should be taken for floor distribution methods. These additional considerations include tables that compare features, costs, and recommendations on the types of systems preferred for various facilities. Cable management is also discussed in this section. This discussion includes explanations of different types of management systems for different types of distribution methods.

Section 5 discusses connection to base cable plant, line concentration, and red/black facility design. Explanations are given for all of these additional factors.

The remainder of the document consists of appendixes that contain detailed information on topics discussed in previous sections. Such detailed information includes equations for the calculation of servable area, feeder duct capacity, and the number of feeder ducts required. The appendixes also included cable management for raised floor system, a duct fill chart, and a conduit fill chart. Appendix D is a preliminary planning requirement checklist, which could be very useful for organizing any wiring strategy.

Many similarities exist between TB 90-02 and EIA/TIA 568 and 569, including the explanation of such aspects as service entrance, communications equipment room, communications closet, distribution systems, horizontal distances, fill ratios, cabling systems, and cable management. Despite this overlap, the proposed technical bulletin would make a helpful addition to EIA/TIA 568 and 569 for its distinct differences. These differences include its explanation of the advantages and disadvantages of using one distribution system rather than another, its explanation of different communication systems, a more detailed discussion of cable management, and this technical bulletin's method of organizing technical information in the form of charts for easy reference.

Air Force Regulation 88-15

Part of Chapter 18, Section C, AFR 88-15 is dedicated to building prewiring. The general objective of this section is to present basic design criteria for communications ducting and cable systems. The criteria have been established using a sound and logical approach toward providing a communications duct and cable system that permits functional use and provides the flexibility needed to meet changing requirements. Standard design criteria for engineering a communications ducting and cable system (CDCS) for various types of Air Force facilities are described to provide the architectural engineer with guidelines to design a completely prewired building.

Although AFR 88-15 and the two proposed standards by EIA/TIA are both concerned with building prewiring, the information overlap is not significant. AFR 88-15 specifically states what is recommended for use in different types of Air Force facilities. These recommendations take precedence over commercial standards by EIA/TIA for two reasons: first, EIA/TIA 568 and 569 make no specific recommendations among the design alternatives available for telecommunications systems, and second, military standards take precedence over commercial standards in cases of conflicting criteria. Unless a document is issued to state otherwise, AFR 88-15 must be used with EIA/TIA 568 and 569 in the design of prewired buildings.

Engineering Technical Letter 87-9

ETL 87-9[1] is used to provide policy, programming, design, and construction management guidance for prewiring facilities to support communications and computer systems. This document provides a general description of prewiring. A large part of ETL 87-9 deals with project applicability, funding, and responsibilities. The responsibilities relative to prewiring are covered from a programming standpoint, through design, to final construction. For each of these phases, base-level (Base Civil Engineering [BCE]) and MAJCOM responsibilities are outlined. This document also includes a detailed listing of the Engineering Installation Activity Service Areas and a Project Book Checklist. As stated earlier, ETL 87-9 does not specify design criteria like standards EIA/TIA 568 and 569. Because there is little overlap of information between ETL 87-9 and the new standards, they do not need to be compared in that respect.

[1] Engineering Technical Letter (ETL) 87-9, *Prewiring* (HQUSAF, 21 October 1987).

3 FINDINGS AND RECOMMENDATION

Findings

The EIA and the TIA have been working on three new standards due to be published during 1991. The three standards are:

1. EIA/TIA 568 - Commercial Building Wiring Standard,
2. EIA/TIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces,
3. EIA/TIA 570 - Residential and Light Commercial Telecommunications Wiring Standard.

The process EIA and TIA used to create these standards has been a comprehensive effort taking several years to complete and involving many people and companies from various industries.

Field engineers indicate that once the standards (particularly EIA/TIA 568 and 569) are published, they will then have the guidance necessary to design prewired facilities.

Although TB 90-02 is similar to EIA/TIA 568 and 569, its distinct differences will make it a helpful and useful document to engineers in the field.

Chapter 18, Section C, Air Force Regulation (AFR) 88-15, contains some specific criteria for the design of prewired buildings. Because of military regulations, AFR 88-15 will take precedence over commercial standards unless the Air Force issues an Engineering Techical Letter (ETL) stating otherwise.

Although ETL 87-9 gives general guidance for prewiring facilities to support communications-computer systems, it does not give specific design criteria like the EIA/TIA standards.

Final Recommendation

Assembling a Prewiring Design Information Document would be a duplication of work done to date. The prewiring guidance needed by the Air Force will be available in the EIA/TIA standards listed above. HQAFCC should initiate a proposal to determine if EIA/TIA 568 and 569 should be used throughout the Air Force. In that process, design engineers can determine the appropriateness of current documents used to design prewired buildings (e.g., TB 90-02, AFR 88-15, Building Industry Consulting Service International [BICSI] manual,[5] etc.).

[5] *Telecommunications Distribution Methods Manual* (Building Industry Consulting Service International).

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