

*FM 5-424

Field Manual
No. 5-424

Headquarters
Department of the Army
Washington, DC, 25 June 1997

Theater of Operations Electrical Systems

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Distribution Restriction: Approved for public release; distribution is unlimited.

*This publication supersedes TM 5-760, 23 August 1968, and FM 20-31, 9 October 1987.

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Preface

Field Manual (FM) 5-424 is intended for use as a training guide and reference text for engineer personnel who are responsible for planning and executing theater of operations (TO) construction. The five parts of this manual provide practical information for military personnel in the design, layout, installation, and maintenance of exterior and interior electrical wiring and power-generation systems. Figures and tables dealing with electrical parts and equipment are contained in Appendix A; figures and tables dealing with electrical data are contained in Appendix B.

Technical Manuals (TMs) 5-301 (1-4 series), 5-302 (1-5 series), and 5-303 present the Engineer Functional Components System, which is based on the wiring techniques described in this manual. Future revision of the Engineer Functional Components System will change the wiring systems that are currently used to more modern methods of cable and conduit wiring.

The proponent of this publication is Headquarters (HQ), United States Army Engineer School (USAES). Send comments and recommendations on Department of the Army (DA) Form 2028 (Recommended Changes to Publications and Blank Forms) directly to Commandant, USAES, ATTN: ATSE-TD-D, Fort Leonard Wood, Missouri 65473-6650.

Unless this publication states otherwise, masculine nouns and pronouns do not refer exclusively to men.

Acknowledgement

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Part One. Basic Electrical Techniques

CHAPTER 1

Fundamentals

This manual emphasizes the constructional aspects of electric wiring. The term *phase* is used when referring to the angular displacement between two or more like quantities, either alternating electromotive force (EMF) or alternating current (AC). It is also used for distinguishing the different types of AC generators. For example, a machine designed to generate a single EMF wave is called a *single-phase alternator*, and one designed to generate two or more EMF waves is called a *polyphase alternator*.

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Power generators produce single- or three-phase voltages that can be used for electrical power systems at generated voltages or through transformer systems. Single-phase generators are normally used only for small lighting and single-phase motor loads. If the generated voltage is 120 volts, a two-wire system is used (*see Table B-1[A], page B-1*). In this situation, one conductor is grounded and the other is ungrounded, or hot. The generated single-phase voltage can be 240 volts. This voltage is normally used for larger single-phase motors. To provide power to lighting loads, the 240-volt phase is center-tapped to provide a three-wire, single-phase system (*see Table B-1[B]*). The center tap is the grounded neutral conductor. The voltage is 120 volts from this grounded conductor to either of the two ungrounded conductors. This is half of the total phase value. The voltage between the two ungrounded conductors is 240 volts. This system provides power for both lighting and single-phase, 240-volt motors.

The most common electrical system is the three-phase system. The generated EMFs are 120 degrees apart in phase. As shown in *Table B-1 (C, D, E)*, three-phase systems may be carried by three or four wires. If connected in a delta (Δ), the common phase voltage is 240 volts. Some systems generate 480 or 600 volts. If the delta has a grounded center-tap neutral, then a voltage equal to half the phase voltage is available. If the phases are Y-connected, then the phase voltage is equal to 1.73 times the phase-to-neutral voltage. The most common electrical system found in the military is the three-phase, four-wire, 208/120-volt system.

Single-phase, three-wire systems and three-phase, four-wire systems provide voltages for both lighting and power loads. If the load between each of the three phases or between the two ungrounded conductors and their grounded center-tap neutral are equal, a balanced circuit exists. When this occurs, no current is flowing in the neutral conductor. Because of this, two ungrounded conductors and one grounded neutral may be used to