INCH-POUND
MIL-HDBK-299(SH)
3 April 1989

MILITARY HANDBOOK

CABLE COMPARISON HANDBOOK
DATA PERTAINING TO ELECTRIC SHIPBOARD CABLE

AMSC N/A FSC 6145

DEPARTMENT OF DEFENSE
Washington, DC 20362-5101

Cable Comparison Handbook

1. This specification is approved for use within the Naval Sea Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

1. This document supplements departmental manuals, directives, military standards, and so forth, and provides basic information on shipboard cables. It contains listings of shipboard cables, data tables, and supersession information, and should provide valuable facts and guidance to personnel responsible for the design, handling, installation, and maintenance of shipboard cable.

2. The "Cable Comparison Handbook" was first published in 1946 to facilitate utilization of electrical shipboard cable, and to assist in the planning of cable installations. A reprint was issued in 1948, and revised editions were printed in 1953, 1956, 1960, 1964, 1975, and 1977. This 1988 edition contains information on current cables. The information is based on current data, Section 304 of the General Specifications for Ships of the United States Navy, and MIL-C-915, MIL-C-24640, and MIL-C-24643.

3. For many years most of the shipboard power and lighting cables for fixed installation used silicone-glass insulation, polyvinyl chloride jacket, aluminum armor, and watertight construction. It was determined that cables with all of these features were not necessary for many applications, especially for applications within watertight compartments and non-critical areas above the watertightness level. Therefore, for applications within watertight compartments and non-critical areas, a new family of non-watertight lower cost cables was designed. This new family of cables is electrically and dimensionally interchangeable with silicone-glass insulated cables of equivalent sizes, and is covered by MIL-C-915.

Additionally, cables jacketed with polyvinyl chloride presented the dangers of toxic fumes and dense, impenetrable smoke when undergoing combustion. These hazards became increasingly evident when an electrical fire smoldered through the cable ways aboard the DDG 19 (USS TATTNALL). Because of the overwhelming amount of smoke and fumes, firefighters were unable to effectively control the fire, and a large amount of damage resulted. A new family of low smoke, low toxic cable, constructed with a polyolefin jacket vice polyvinyl chloride jacket, conforms to rigid toxic and smoke indexes and effectively reduces the hazards associated with the polyvinyl chloride jacketed cables. The new low smoke cable is covered by MIL-C-24643.

A family of lightweight cables has also been introduced to aid in the elimination of excessive weight from the fleet. Considering the substantial amount of cable present on a ship or submarine, a reduction in cable weight will have a considerable impact on the overall load, thus improving performance and increasing efficiency. This new family of lightweight cables is constructed from cross-linked polyalkene and mica polyimide insulation, and a cross-linked polyolefin jacket. The lightweight cable is covered by MIL-C-24640.

4. Cables are listed in this handbook by general classification according to application and design. Electrical shipboard cables are under control of the Defense Industrial Supply Center, and are covered in Navy Stock List of General Stores, FSC 6145.

CONTENTS

CONTENTS - Continued

CONTENTS - Continued

APPENDIX

1. SCOPE

1.1 Scope. This handbook is intended to aid supply and installing activities in utilization of electric shipboard cable, particularly in the selection of alternate or substitute cables for use in lieu of specified types and sizes which might not be immediately available. It is also intended to aid in selecting currently available items for replacement of obsolete items. This handbook does not cover shore-use cable, magnet wire, coaxial cables, or radio frequency special cables used in connection with minesweeping and harbor defense.

2. REFERENCED DOCUMENTS

2.1 Government documents.

2.1.1 Specifications. Unless otherwise specified, the following specifications of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation form a part of this handbook to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-C-915 - Cable and Cord, Electrical, for Shipboard Use, General Specification for.
MIL-C-24640 - Cable, Electrical, Lightweight, for Shipboard Use, General Specification for.
MIL-C-24643 - Cable and Cord, Electrical, Low Smoke, for Shipboard Use, General Specification for.

(Copies of specifications required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Order of precedence. In the event of a conflict between the text of this handbook and the references cited herein, the text of this handbook shall take precedence.

3. DEFINITIONS

3.1 Ampacity. Ampacity is an electrical property denoting current carrying capacity.

3.2 Circuit integrity. Circuit integrity indicates cable construction and provides added protection that will allow that cable to function for a longer period under fire conditions.

4. GENERAL DESCRIPTION OF DATA AND CABLE TYPES

4.1 General description of date and cable types. General information concerning cable types is specified in 4.1.1 through 4.1.8, below.

4.1.1 Cable types and construction. A list of cable types and construction characteristics is provided in 5.1, 5.2, and 5.3. Cables listed are in accordance with MIL-C-24643 (for low smoke cable), MIL-C-24640 (for lightweight cable), and MIL-C-915 (for shipboard cables). Cables are listed alphabetically within application and design characteristics. This listing provides a brief description of the number of conductors and the type of insulation and jacketing employed in construction.

4.1.2 Identification information. A list of conductor identification methods employed for various types of cables is provided in 5.4.

4.1.3 Cable available through military specifications (tables I, II, and III). Tables I, II, and III provide a listing of cables, available through military specifications, according to general application. This list is intended to aid in the selection of cables for different applications.

4.1.4 Commercially-available cables (table IV). Table IV provides a list of commercially-available cables according to general application.

4.1.5 Supersession data (table V). Table V lists cable types alphabetically using MIL-C-915 cable designations. Cable types which were covered by previous specifications are listed with the corresponding present type.

4.1.6 Physical characteristics and electrical ratings of cables (tables VI, VII, and VIII). Tables VI, VII, and VIII contain information concerning physical characteristics and electrical ratings at normal operating temperatures. Cables must not be loaded in excess of these maximum ratings. Additional explanations applicable to tables VI, VII, and VIII are as follows:

(a) Cables are listed according to military specification sheet, functional category within that military specification sheet (such as watertight and non-watertight, flexing, and non-flexing, power and lighting, communications and electronics), and size and type designation within each table.

(b) Rated voltages are not listed for cable types designed for voice communication, analog or digital data transmission, or sending circuits such as sonar and pyrometer. The applicability of these types must be determined from additional circuit parameters such as signal waveform, frequency and peak amplitude, signal fidelity, pulse duration and recurrence frequency, attenuation, and frequency bandwidth.

(c) The notation Ind/Avg denotes that individual conductors can carry the current listed under Ind, provided the average of all currents in the individual conductors does not exceed the value listed under Avg.

(d) The measurement point for minimum radius of bend should be that surface of the cable jacket which is on the innermost portion of the cable bend. Dimensions listed are approximately eight times the overall diameter of the cable or cord. However, during installation or operation, a dimension of approximately twelve times the cable overall diameter for conduit bends, sheaves, and other curved surfaces around which the cable or cord may be pulled under tension should be used.

(e) Unless otherwise indicated, all conductors are of the same size. Unless otherwise indicated, all conductors are soft, annealed copper. For additional data covering conductor stranding and conductor dimensions, see MIL-C-915, MIL-C-24640, and MIL-C-24643.

4.1.7 Ampacity derating factors (table IX). Table IX lists ampacity derating factors for ambient temperatures above 50 degrees Celsius (°C) (see 5.9).

4.1.8 Ampacity ratings for degaussing cable. Table X lists the ampacity ratings (maximum amperes per conductor) for degaussing cables.

5. DETAILED REQUIREMENTS

5.1 Cable types and construction characteristics (as specified in MIL-C-24643) list. Cable types and construction characteristics (as specified in MIL-C-24643) are as follows:

LSCVSF - 400-Hertz (Hz) aircraft servicing: three ethylene propylene rubber insulated conductors and one uninsulated conductor, overall cross-linked polyolefin jacket.
LSDCOP - Double conductor, oil-resistant, portable cord: ethylene propylene rubber or cross-linked polyethylene insulation, and cross-linked polyolefin jacket.
LSDHOF - Double conductor, heat and oil-resistant, flexible: ethylene propylene rubber insulation, cross-linked polyolefin jacket.
LSDNW - Double conductor: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket, unarmored.
LSDNWA - Double conductor: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket, armored.
LSDPS - Double conductor, power: silicone rubber insulation, glass braid, silicone rubber jacket, armored.
LSDRW - Double conductor: cross-linked polyethylene insulation, cross-linked polyolefin jacket, unarmored.
LSDRWA - Double conductor: cross-linked polyethylene insulation, cross-linked polyolefin jacket, armored.
LSDSGA - Double conductor: silicone rubber and glass braid insulated, cross-linked polyolefin jacket, armored.
LSDSGU - Double conductor: silicone rubber and glass braid insulated, cross-linked polyolefin jacket, unarmored.
LSECM - Eight pairs shielded, and eight groups of seven conductors for each group: cross-linked polyethylene insulation for the conductors of each pair, braided shield over each pair; ethylene propylene rubber or cross-linked polyethylene insulation for the conductors of the groups of seven; crosslinked polyolefin jacket, unarmored.
LSECMA - Eight pairs shielded, and eight groups of seven conductors for each group: cross-linked polyethylene insulation for the conductors of each pair, braided shield over each pair; ethylene propylene rubber or cross-linked polyethylene insulation for the conductors of the groups of seven; cross-linked polyolefin jacket, armored.
LSFHOF - Four conductors, heat and oil-resistant, flexible: ethylene propylene rubber insulation, cross-linked polyolefin jacket.

LSFNW - Four conductors: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket, unarmored.

LSFNWA - Four conductors: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket, armored.

LSFPS - Four conductors, power: silicone rubber insulation, glass braid, silicone rubber jacket, armored.

LSFSGA - Four conductors: silicone rubber and glass insulated, cross-linked polyolefin jacket, armored.

LSFSGU - Four conductors: silicone rubber and glass insulated, cross-linked polyolefin jacket, unarmored.

LSMA - Multiple conductor: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket, armored.

LSMCOS - Multiple conductor, oil-resistant, shielded: ethylene propylene rubber or cross-linked polyethylene over pairs, or over assembly, cross-linked polyolefin jacket.

LSMDU - Multiple conductor, degaussing: ethylene propylene or cross-linked polyethylene insulation, cross-linked polyolefin jacket, unarmored.

LSMDY - Multiple conductor, degaussing: ethylene propylene or cross-linked polyethylene insulation, cross-linked polyolefin jacket, armored between double-layer jacket.

LSMHOF - Multiple conductor, heat and oil-resistant, flexible: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket.

LSMMOP - Multiple conductor, microphone, oil-resistant, portable: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket.

LSMNW - Multiple conductor: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket, unarmored.

LSMNWA - Multiple conductor: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket, armored.

LSMRI - Multiple conductor: ethylene propylene rubber or cross-linked polyethylene insulated, without fillers, no overall jacket.

LSMS - Multiple conductor, shielded: ethylene propylene rubber or cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, unarmored.

LSMSA - Multiple conductor, shielded: ethylene propylene rubber or cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, armored.

LSMSCA - Multiple conductor: silicone rubber insulated-glass braided conductors, cross-linked polyolefin jacket, armored.

LSMSCS - Multiple conductor: silicone rubber insulated-glass braided conductors, cross-linked polyolefin jacket, double overall shielded.

LSMSCU - Multiple conductor: silicone rubber insulated-glass braided conductors, cross-linked polyolefin jacket, unarmored.

LSMU - Multiple conductor: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket, unarmored.

LSMUS - Multiple conductor: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket, double overall shielded.

LSPBTM - Pyrometer base multiple pairs: ethylene propylene rubber or cross-linked polyethylene insulation on one copper and one constantan conductor, cross-linked polyolefin jacket, armored.

LSPBTMU - Pyrometer base multiple pairs: ethylene propylene rubber or cross-linked polyethylene insulation on one copper and one constantan conductor, cross-linked polyolefin jacket, unarmored.

LSPI - Position indicator: silicone rubber insulation, glass braid, shielded pairs, silicone rubber jacket, armored.

LSSHOF - Single conductor, heat and oil-resistant, flexible: ethylene propylene rubber insulation, cross-linked polyolefin jacket.

LSSRW - Single conductor, radio: cross-linked polyethylene insulation, cross-linked polyolefin jacket, unarmored.

LSSRWA - Single conductor, radio: cross-linked polyethylene insulation, cross-linked polyolefin jacket, armored.

LSSSF - Single conductor: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket.

LSSSGA - Single conductor: silicone rubber and glass tape insulated, cross-linked polyolefin jacket, armored.

LSSSGU - Single conductor: silicone rubber and glass tape insulated, cross-linked polyolefin jacket, unarmored.

LSTCJA - Thermocouple, type J, single pair: one iron and one constantan conductor, extruded silicone rubber insulated, glass braided, cross-linked polyolefin jacket, armored.

LSTCJU - Thermocouple, type J, single pair: one iron and one constantan conductor, extruded silicone rubber insulated, glass braided, cross-linked polyolefin jacket, unarmored.

LSTCJX - Thermocouple, type J, multiple pairs: extruded silicone rubber insulated, glass braid on one iron and one constantan conductor for each pair, silicone rubber jacket, armored.

LSTCKX - Thermocouple, type K, multiple pairs: extruded silicone rubber insulated, glass braid on one Chromel and one Alumel conductor for each pair, silicone rubber jacket, armored.

LSTCOP - Three conductors, oil-resistant, portable: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket.

LSTCTA - Thermocouple, type T, single pair: one copper and one constantan conductor, extruded silicone rubber insulated, glass braided, cross-linked polyolefin jacket, armored.

LSTCTU - Thermocouple, type T, single pair: one copper and one constantan conductor, extruded silicone rubber insulated, glass braided, cross-linked polyolefin jacket, unarmored.

LSTCTX - Thermocouple, type T, multiple pairs: extruded silicone rubber insulated, glass braid on one copper and one constantan conductor for each pair, cross-linked polyolefin jacket, armored.

LSTHOF - Three conductors, heat and oil-resistant, flexible: ethylene propylene rubber insulation, cross-linked polyolefin jacket.

LSTNW - Three conductors: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket, unarmored.

LSTNWA - Three conductors: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket, armored.

LSTPNW - Twisted pairs: ethylene propylene or cross-linked polyethylene insulation, cross-linked polyolefin jacket, unarmored.

LSTPNWA - Twisted pairs: ethylene propylene or cross-linked polyethylene insulation, cross-linked polyolefin jacket, armored.

LSTPS - Three conductors, power supply: silicone rubber insulation, glass braid, silicone rubber jacket, armored.

LSTRW - Three conductors, radio: cross-linked polyethylene insulation, cross-linked polyolefin jacket, unarmored.

LSTRWA - Three conductors, radio: cross-linked polyethylene insulation, cross-linked polyolefin jacket, armored.

LSTSGA - Three conductors: extruded silicone rubber and glass insulation, cross-linked polyolefin jacket, armored.

LSTSGU - Three conductors: extruded silicone rubber and glass insulation, cross-linked polyolefin jacket, unarmored.

LSTTOP - Twisted pairs, oil-resistant, portable: ethylene propylene rubber or cross-linked polyethylene insulation, cross-linked polyolefin jacket.

LSTTRS - Twisted pairs, radio, shielded, flexible: cross-linked polyethylene insulation, braided shield for each pair, cross-linked polyolefin jacket, unarmored.

LSTTRSA - Twisted pairs, radio, shielded, flexible: cross-linked polyethylene insulation, braided shield for each pair, cross-linked polyolefin jacket, armored.

LSTTSA - Twisted pairs: extruded silicone rubber and polyamide special purpose, cross-linked polyolefin jacket, armored.

LSTTSU - Twisted pairs: extruded silicone rubber and polyamide special purpose, cross-linked polyolefin jacket, unarmored.

LS1SA - Single, shielded: cross-linked polyethylene insulation, braided shield on each conductor, cross-linked polyolefin jacket, armored.

LS1SAU - Single, shielded: cross-linked polyethylene insulation, braided shield on each conductor, cross-linked polyolefin jacket, unarmored.

LS1SMA - Singles, shielded, multiple conductor: cross-linked polyethylene insulation, braided shield on each conductor, cross-linked polyolefin jacket, armored.

LS1SMU - Singles, shielded, multiple conductor: cross-linked polyethylene insulation, braided shield on each conductor, cross-linked polyolefin jacket, unarmored.

LS1SMWA - Singles, shielded, multiple conductor: cross-linked polyethylene insulation, braided shield over each conductor, cross-linked polyolefin jacket, armored.

LS1SMWU - Singles, shielded, multiple conductor: cross-linked polyethylene insulation, braided shield over each conductor, cross-linked polyolefin jacket, unarmored.

LS1SU - Singles, shielded: cross-linked polyethylene insulated, braided shield on each conductor, cross-linked polyolefin jacket, armored.

LS1SUA - Singles, shielded: cross-linked polyethylene insulated, braided shield on each conductor, cross-linked polyolefin jacket, unarmored.

LS1SWA - Singles, shielded: cross-linked polyethylene insulation, braided shield on each conductor, cross-linked polyolefin jacket, armored.

LS1SWU - Singles, shielded: cross-linked polyethylene insulation, braided shield on each conductor, cross-linked polyolefin jacket, unarmored.

LS1S50MA - Singles, shielded, 50-ohm, multiple conductor: cross-linked polyethylene insulation, braided shield on each conductor, cross-linked polyolefin jacket, armored.

LS1S50MU - Singles, shielded, 50-ohm, multiple conductor: cross-linked polyethylene insulation, braided shield on each conductor, cross-linked polyolefin jacket, unarmored.

LS1S50MUS - Singles, shielded, 50-ohm, multiple conductor: cross-linked polyethylene insulation, braided shield on each conductor, cross-linked polyolefin jacket, double overall shielded.

LS1S75MA - Singles, shielded, 75-ohm, multiple conductor: cross-linked polyethylene insulation, braided shield over each conductor, cross-linked polyolefin jacket, armored.

LS1S75MU - Singles, shielded, 75-ohm, multiple conductor: cross-linked polyethylene insulation, braided shield over each conductor, cross-linked polyolefin jacket, unarmored.

LS2A - Twisted pairs, shielded: cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, armored.

LS2AU - Twisted pairs, shielded: cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, unarmored.

LS2AUS - Twisted pairs, shielded: cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, double overall shielded.

LS2CS - Pairs, shielded: cross-linked polyethylene insulation, double braided shield overall, cross-linked polyolefin jacket.

LS2SA - Pairs, shielded: cross-linked polyethylene insulation, braided shield over each pair, cross-linked polyolefin jacket, armored.

LS2SJ - Pairs, shielded: ethylene propylene rubber or cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, unarmored.

LS2SJA - Pairs, shielded: ethylene propylene rubber or cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, armored.

LS2SU - Pairs, shielded: cross-linked polyethylene insulation, braided shield over each pair, cross-linked polyolefin jacket, unarmored.

LS2SUS - Pairs, shielded: cross-linked polyethylene insulation, braided shield over each pair, cross-linked polyolefin jacket, double overall shielded.

LS2SWA - Pairs, shielded: cross-linked polyethylene insulation, braided shield over each pair, cross-linked polyolefin jacket, armored.

LS2SWAU - Pairs, shielded: cross-linked polyethylene insulation, braided shield over each pair, cross-linked polyolefin jacket, unarmored.

LS2SWL-7 - Pairs, shielded: cross-linked polyethylene insulation, braided shield over each pair, cross-linked polyolefin jacket, unarmored.

LS2SWLA-7 - Pairs, shielded: cross-linked polyethylene insulation, braided shield over each pair, cross-linked polyolefin jacket, armored.

LS2SWU - Pairs, shielded: cross-linked polyethylene insulation, braided shield over each pair, cross-linked polyolefin jacket, unarmored.

LS2SWUA - Pairs, shielded: cross-linked polyethylene insulation, braided shield over each pair, cross-linked polyolefin jacket, armored.

LS2U - Pairs: cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, unarmored.

LS2UA - Pairs: cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, armored.

LS2UW-42 - Twisted pairs: cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, unarmored.

LS2UWA-42 - Twisted pairs: cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, armored.

LS2UWS-42 - Twisted pairs: cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, double overall shielded.

LS2WA - Pairs: cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, armored.

LS2WAU - Pairs: cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, unarmored.

LS3SA - Triads, shielded: cross-linked polyethylene insulation, braided shield over each triad, cross-linked polyolefin jacket, armored.

LS3SF - Triads, shielded, flexible: cross-linked polyethylene insulation, braided shield over each triad, polyester tape over the assembled triads, cross-linked polyolefin jacket.

LS3SJ - Triads, shielded: ethylene propylene rubber or cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, unarmored.

LS3SJA - Triads, shielded: ethylene propylene rubber or cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, armored.

LS3SU - Triads, shielded: cross-linked polyethylene insulation, braided shield over each triad, cross-linked polyolefin jacket, armored.

LS3SUS - Triads, shielded: cross-linked polyethylene insulation, braided shield over each triad, cross-linked polyolefin jacket, double overall shielded.

LS3SWA - Triads, shielded: cross-linked polyethylene insulation, braided shield over each triad, cross-linked polyolefin jacket, armored.

LS3SWU - Triads, shielded: cross-linked polyethylene insulation, braided shield over each triad, cross-linked polyolefin jacket, unarmored.

LS3SWUS - Triads, shielded: cross-linked polyethylene insulation, braided shield over each triad, cross-linked polyolefin jacket, double overall shielded.

LS3U - Triads: cross-linked polyethylene insulation, marker braid on each triad, cross-linked polyolefin jacket, unarmored.

LS3UA - Triads: cross-linked polyethylene insulation, marker braid on each triad, cross-linked polyolefin jacket, armored.

LS4NW8 - Four conductors: cross-linked polyethylene insulation or ethylene propylene rubber, cross-linked polyolefin jacket, unarmored.

LS4NWA8 - Four conductors: cross-linked polyethylene insulation or ethylene propylene rubber, cross-linked polyolefin jacket, armored.

LS4SJ - Four conductors, shielded: ethylene propylene rubber or cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, unarmored.

LS4SJA - Four conductors, shielded: ethylene propylene rubber or cross-linked polyethylene insulation, overall braided shield, cross-linked polyolefin jacket, armored.

LS5KVTSGA - 5000-volt, three conductors: silicone rubber and glass tape insulation, cross-linked polyolefin jacket, armored.

LS5KVTSGU - 5000-volt, three conductors: silicone rubber and glass tape insulation, cross-linked polyolefin jacket, unarmored.

LS6SGA - Six conductors: silicone and glass insulation, cross-linked polyolefin jacket, armored.

LS6SGU - Six conductors: silicone and glass insulation, cross-linked polyolefin jacket, unarmored.

LS7PS - Seven conductors, power supply: silicone rubber insulation, glass braid, silicone rubber jacket, armored.

LS7SGA - Seven conductors: silicone rubber and glass insulation, cross-linked polyolefin jacket, armored.

LS7SGU - Seven conductors: silicone rubber and glass insulation, cross-linked polyolefin jacket, unarmored.
LS8NW6 - Eight conductors: cross-linked polyethylene or ethylene propylene rubber insulation, cross-linked polyolefin jacket, unarmored.
LS8NWA6 - Eight conductors: cross-linked polyethylene or ethylene propylene rubber insulation, cross-linked polyolefin jacket, armored.

5.2 Cable types and construction characteristics (as specified in MIL-C-24640) list. Cable types and construction characteristics (as specified in MIL-C-24640) are as follows:

DX - Double conductor, power supply: cross-linked polyalkene insulation, cross-linked polyolefin jacket, unarmored.
DXA - Double conductor, power supply: cross-linked polyalkene insulation, cross-linked polyolefin jacket, armored.
DXW - Two conductors: mica polyimide insulation, cross-linked polyolefin jacket, unarmored.
DXOW - Two conductors: mica polyimide insulation, cross-linked polyolefin jacket, overall shielded.
DXWA - Two conductors: mica polyimide insulation, cross-linked polyolefin jacket, armored.
FX - Four conductors, power supply: cross-linked polyalkene insulation, cross-linked polyolefin fluoride jacket, unarmored.
FXA - Four conductors, power supply: cross-linked polyalkene insulation, cross-linked polyolefin fluoride jacket, armored.
FXW - Four conductors: mica polyimide insulation, cross-linked polyolefin jacket, unarmored.
FXOW - Four conductors: mica polyimide insulation, cross-linked polyolefin jacket, overall shielded.
FXWA - Four conductors: mica polyimide insulation, cross-linked polyolefin jacket, armored.
MXCW - Multi-conductor, control: mica polyimide insulation, cross-linked polyolefin jacket, unarmored.
MXCOW - Multi-conductor, control: mica polyimide insulation, cross-linked polyolefin jacket, overall shielded.
MXCWA - Multi-conductor, control: mica polyimide insulation, cross-linked polyolefin jacket, armored.
MXO - Multi-conductor, power supply: cross-linked polyalkene insulation, cross-linked polyolefin jacket, overall shielded.
MXSO - Multi-conductor; cross-linked polyalkene insulation, cross-linked polyolefin jacket, overall shielded.
TTX - Multi-pair, twisted: cross-linked polyalkene insulation, cross-linked polyolefin jacket, unarmored.
TTXA - Multi-pair, twisted: cross-linked polyalkene insulation, cross-linked polyolefin jacket, armored.
TTXS - Multi-pair, twisted, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, unarmored.
TTXSA - Multi-pair, twisted, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, armored.
TTXSO - Multi-pair, twisted, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, overall shielded.
TTXW - Multi-pair: mica polyimide insulation, cross-linked polyolefin jacket, unarmored.

TTXOW - Multi-pair: mica polyimide insulation, cross-linked polyolefin jacket, overall shielded.

TTXWA - Multi-pair: mica polyimide insulation, cross-linked polyolefin jacket, armored.

TX - Three conductor, power supply: cross-linked polyolefin insulation, cross-linked polyolefin jacket, unarmored.

TXA - Three conductor, power supply: cross-linked polyolefin insulation, cross-linked polyolefin jacket, armored.

TXW - Three conductor, power: mica polyimide insulation; cross-linked polyolefin jacket, unarmored.

TXOW - Three conductor, power: mica polyimide insulation; cross-linked polyolefin jacket, overall shielded.

TXWA - Three conductor, power: mica polyimide insulation; cross-linked polyolefin jacket, armored.

1XMSO - Multi-conductor, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, overall shielded.

1XSOW - Multi-conductor, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, overall shielded.

2XAO - Multi-pair, twisted: cross-linked polyalkene insulation, cross-linked polyolefin jacket, overall shielded.

2XO - Multi-pair, twisted: cross-linked polyalkene insulation, cross-linked polyolefin jacket, overall shielded.

2XOW - Multi-pair, twisted: cross-linked polyalkene insulation, cross-linked polyolefin jacket, overall shielded.

2XS - Multi-pair, twisted, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, unarmored.

2XSA - Multi-pair, twisted, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, armored.

2XSO - Multi-pair, twisted, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, overall shielded.

2XSAW - Multi-pair, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, unarmored.

2XSAOW - Multi-pair, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, overall shielded.

2XSAWA - Multi-pair, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, armored.

2XSXO - Multi-pair, twisted, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, overall shielded.

2XSW - Multi-pair, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, unarmored.

2XSOW - Multi-pair, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, overall shielded.

2XSWA - Multi-pair, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, armored.

3XS - Multi-triad, twisted, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, unarmored.

3XSA - Multi-triad, twisted, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, armored.

3XSW - Multi-triad, twisted, shielded: cross-linked polyalkene insulation cross-linked polyolefin jacket, unarmored.

3XSOW - Multi-triad, twisted, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, overall shielded.

3XSWA - Multi-triad, twisted, shielded: cross-linked polyalkene insulation, cross-linked polyolefin jacket, armored.

7XW - Seven conductors: mica polyimide insulation, cross-linked polyolefin jacket, unarmored.

7XWA - Seven conductors: mica polyimide insulation, cross-linked polyolefin jacket, armored.

5.3 Cable types and construction characteristics (as specified in MIL-C-915) list. Cable types and construction characteristics (as specified in MIL-C-915) are as follows:

CVSF - 400-Hz aircraft servicing: three synthetic rubber insulated conductors and one uninsulated conductor, overall polychloroprene jacket.

DLT - Divers lifeline and telephone: four rubber insulated conductors cabled around an insulated steel core, reinforced polychloroprene jacket overall.

DSS - Double conductor, shielded: rubber insulation, overall braided shield, polychloroprene or chlorosulfonated polyethylene jacket.

DSWS - Double conductor, shielded: rubber insulation, overall braided shield, polychloroprene jacket.

FSS - Four conductors, shielded: rubber insulated, overall braided shield, polychloroprene or chlorosulfonated polyethylene jacket.

JAS - Jet aircraft servicing: four rubber insulated conductors, two conductors Navy size 250, two conductors Navy size 6, reinforced polychloroprene jacket.

MCSF-4 - Multiple conductor, acoustic minesweeping, power: two American Wire Gauge (AWG) 6 and two AWG 1 conductors, rubber insulation, reinforced polychloroprene jacket.

MSP - Multiple conductor: fifty-nine conductors, sixteen AWG 22 having fluorocarbon insulation and a braided copper shield, eighteen AWG 20 having polyvinyl chloride insulation and a braided copper shield (nine singles, one triad and three pairs, each shielded), twenty-five Navy size 3 having polyvinyl insulation (eight pairs and three triads, each shielded), polychloroprene jacket.

MSPW - Multiple conductor: fifty-nine conductors; sixteen AWG 22 having fluorocarbon insulation and a braided copper shield, eighteen AWG 20 having polyvinyl chloride insulation and a braided copper shield (nine singles, one triad and three pairs, each shielded), twenty-five Navy size 3 having polyvinyl insulation (eight pairs and three triads, each shielded), polychloroprene jacket, watertight.

MWF - Multiple conductor: rubber or cross-linked polyethylene insulation, arctic type neoprene jacket.

S2S - Two conductors, shielded: cross-linked polyethylene insulations, braided shield, rubber insulation over shield, outer-braided shield; reinforced rubber, insulated, arctic type polychloroprene jacket.

THOF - Three conductors, heat and oil resistant, flexible: synthetic rubber insulation standard thermoplastic jacket on THOF-42, and polychloroprene jacket on THOF-400 and THOF-500.

TRF - Single conductor, flexible: rubber insulation, polychloroprene jacket.

TPUM-6 - Telephone, portable, multiple conductor: copper-clad steel conductors, polypropylene insulation, six pairs cabled, polyurethane jacket applied in two layers.

TRXF - Single conductor: polychloroprene jacket.
TSP - Twisted pairs: polyvinyl chloride insulated, special thermoplastic jacket, watertight, unarmored.
TSPA - Twisted pairs: polyvinyl chloride insulated, special thermoplastic jacket, watertight, armored.
TSS - Three conductors, special purpose, shielded: rubber insulation, overall braided shield, polychloroprene or chlorosulfonated polyethylene jacket.
1SWF - Singles, shielded: polyethylene insulation, braided shield on each conductor, arctic type polychloroprene jacket.
2SWF - Pairs, shielded, watertight, flexible: polythylene insulation, braided shield over each pair, arctic type polychloroprene jacket.
5SS - Five conductors, shielded, sonar: rubber insulation, braided shield on one conductor only, and a braided shield over the assembled five conductors, polychloroprene jacket overall.
7SS - Seven conductors, shielded: rubber insulation, overall braided shield, polychloroprene or chlorosulfonated polyethylene jacket.

5.4 Identification information. Conductors and groups of conductors, such as pairs and triads, are separately identified within a completed cable. The identification codes should be as specified in 5.4.1 through 5.4.9, inclusive.

5.4.1 Standard identification code (STD). The conductor identification code for standard cables should be as follows:

Color, conductor or group no.	Background or base color	First tracer color	Second tracer color
1	Black	---	---
2	White	---	---
3	Red	---	---
4	Green	---	---
5	Orange	---	---
6	Blue	---	---
7	White	Black	---
8	Red	Black	---
9	Green	Black	---
10	Orange	Black	---
11	Blue	Black	---
12	Black	White	---
13	Red	White	---
14	Green	White	---
15	Blue	White	---
16	Black	Red	---
17	White	Red	---
18	Orange	Red	---
19	Blue	Red	---
20	Red	Green	---

Color, conductor or group no.	Background or base color	First tracer color	Second tracer color
21	Orange	Green	---
22	Black	White	Red
23	White	Black	Red
24	Red	Black	White
25	Green	Black	White
26	Orange	Black	White
27	Blue	Black	White
28	Black	Red	Green
29	White	Red	Green
30	Red	Black	Green
31	Green	Black	Orange
32	Orange	Black	Green
33	Blue	White	Orange
34	Black	White	Orange
35	White	Red	Orange
36	Orange	White	Blue
37	White	Red	Blue
38	Brown	---	---
39	Brown	Black	---
40	Brown	White	---
41	Brown	Red	---
42	Brown	Green	---
43	Brown	Orange	---
44	Brown	Blue	---
45	White	Black	Blue
46	Red	White	Blue
47	Green	Orange	Red
48	Orange	Red	Blue
49	Blue	Red	Orange
50	Black	Orange	Red
51	White	Black	Orange
52	Red	Orange	Black
53	Green	Red	Blue
54	Orange	Black	Blue
55	Blue	Black	Orange
56	Black	Orange	Green
57	White	Orange	Green
58	Red	Orange	Green
59	Green	Black	Blue
60	Orange	Green	Blue

Color, conductor or group no.	Background or base color	First tracer color	Second tracer color
61	Blue	Green	Orange
62	Black	Red	Blue
63	White	Orange	Blue
64	Red	Black	Blue
65	Green	Orange	Blue
66	Orange	White	Red
67	Blue	White	Red
68	Black	Green	Blue
69	White	Green	Blue
70	Red	Green	Blue
71	Green	White	Red
72	Orange	Red	Black
73	Blue	Red	Black
74	Black	Orange	Blue
75	Red	Orange	Blue
76	Green	Red	Black
77	Orange	White	Green
78	Blue	White	Green
79	Red	White	Orange
80	Green	White	Orange
81	Blue	Black	Green
82	Orange	White	---
83	Green	Red	---
84	Black	Green	---
85	White	Green	---
86	Blue	Green	---
87	Black	Orange	---
88	White	Orange	---
89	Red	Orange	---
90	Green	Orange	---
91	Blue	Orange	---
92	Black	Blue	---
93	White	Blue	---
94	Red	Blue	---
95	Green	Blue	---
96	Orange	Blue	---
97	Yellow	---	---
98	Yellow	Black	---
99	Yellow	White	---
100	Yellow	Red	---

Color, conductor or group no.	Background or base color	First tracer color	Second tracer color
101	Yellow	Green	---
102	Yellow	Orange	---
103	Yellow	Blue	---
104	Black	Yellow	---
105	White	Yellow	---
106	Red	Yellow	---
107	Green	Yellow	---
108	Orange	Yellow	---
109	Blue	Yellow	---
110	Black	Yellow	Red
111	White	Yellow	Red
112	Green	Yellow	Red
113	Orange	Yellow	Red
114	Blue	Yellow	Red
115	Black	Yellow	White
116	Red	Yellow	White
117	Green	Yellow	White
118	Orange	Yellow	White
119	Blue	Yellow	White
120	Black	Yellow	Green
121	White	Yellow	Green
122	Red	Yellow	Green
123	Orange	Yellow	Green
124	Blue	Yellow	Green
125	Black	Yellow	Blue
126	White	Yellow	Blue
127	Red	Yellow	Blue

5.4.2 Telephone identification code (TEL). The conductor identification code for telephone cables should be as follows:

Color or conductor no.	Color	Color or conductor no.	Color
1	Black	7	Brown
2	White	8	Gray
3	Red	9	Yellow
4	Green	10	Purple
5	Orange	11	Tan
6	Blue	12	Pink

5.4.2.1 Conductor pairing. The pairing of conductors for forming pairs should be as follows:

Number 1 paired with numbers 2 through 12 for next eleven pairs.
Number 2 paired with numbers 3 through 12 for next ten pairs.
Number 3 paired with numbers 4 through 12 for next nine pairs.
Number 4 paired with numbers 5 through 12 for next eight pairs.
Number 5 paired with numbers 6 through 12 for next seven pairs.
Number 6 paired with numbers 7 through 12 for next six pairs.
Number 7 paired with numbers 8 through 12 for next five pairs.
Number 8 paired with numbers 9 through 12 for next four pairs.
Number 9 paired with numbers 10 through 12 for next three pairs.
Number 10 paired with numbers 11 through 12 for next two pairs.
Number 11 paired with number 12.

5.4.3 Special identification code (SPL). The special identification code should be the same conductor identification as specified in 5.4.2.

5.4.4 Twisted pair identification code. This code consists of numbers in sequence running from 1 through the number corresponding to the total quantity of twisted pairs in the cable. Both conductors in each pair must be numbered the same, denoting the sequence number of the pair. Distinction between the two conductors is provided by different colored insulation. Conductors of a cable with a single pair need not be numbered.

5.4.5 Twisted triad identification code. This code consists of numbers in sequence running from 1 through the number corresponding to the total quantity of twisted triads in the cable. Each of the three conductors must be numbered the same, denoting the sequence number of the triad. Distinction between the three conductors is provided by different colored insulation. Conductors of a cable with a single triad need not be numbered.

5.4.6 Letter identification code (LTR). The letter identification code consists of the letters A, B, C, and D printed in block type, and with black, white, red, and green ink, respectively.

5.4.7 Methods of applying identification.

5.4.7.1 Method 1. Identification method 1 consists of surface printing of both number and color designations. The legend should be printed in contrasting color: preferably white ink on black or dark background or black ink on white or light background. The legend is repeated at intervals not exceeding 3 inches. Alternate legends shall be inverted; for example:

10 ORANGE-BLACK 10 ORANGE-BLACK

The character type should be block or italic and have a height in accordance with the diameter over which it is applied as follows:

Diameter range (inch)	Height of character (inch, approximate)
0.045 to 0.070	0.025
.070 to .095	1/32
.095 to .115	3/64
.115 to .200	1/16
.190 to .250	5/64
.235 to .375	3/32
.330 and larger	1/8

5.4.7.2 Method 2. Identification method 2 uses opaque white polyester tapes which have been printed with both the number and color designation prior to application. The legend should be printed with black ink, and be repeated at intervals not exceeding 3 inches. The character type should be block, and should be approximately 3/32-inch high.

5.4.7.3 Method 3. Identification method 3 uses solid colors or solid base colors with tracers, as required. The base color may be either the color of the insulation or the color of a coating applied to the insulation. The tracers should be approximately 1/32-inch wide ink stripes of the required color and should be applied helically with 1-1/2 plus or minus 1/4-inch lay. If two tracers are required, the second tracer must be half the width of the first tracer.

5.4.7.4 Method 4. Identification method 4 uses colored braids. Tracers should consist of the required colors applied by three adjacent carriers. Where two tracers are required, they must be applied with reverse lay.

5.4.7.5 Method 5. Identification method 5 uses the printed letter on the outermost insulating tape or the printed letter on a polyester binder tape over the insulating tapes. The letters should be approximately 3/16-inch high and have been printed at intervals not exceeding 3 inches prior to the application of the tape to the conductor. If the insulating tapes are white, no printing is required on the B (white) conductor.

5.4.7.6 Method 6. Identification method 6 consists of numerals printed in ink on the conductor insulation. For conductors having a jacket directly over the insulation, the numerals may be printed in ink on the jacket, at the manufacturer's option. White ink must be used for a red or black background; black ink must be used for a white background. Numeral width should be proportional to the conductor's outside diameter (od) as follows:

Diameter range (inch)	Height of character (inch, approximate)
0.045 to 0.095	0.025
.096 to .120	3/64
.121 to .175	1/16
.176 to .330	3/32
.331 and larger	1/8

Numeral height should be two and one-half to three times numeral width. Each numeric legend should be underlined. Two-digit legends must have the bottom numeral underlined. Legends should be alternately inverted (see 5.4.7.1) and be repeated at intervals not greater than 1-1/2 inches.

5.4.8 Manufacturer's identification tape. Most cables and cords contain a continuous, thin, moisture-resistant marker tape, not less than 1/10-inch wide. Unless otherwise approved by the Naval Sea Systems Command (NAVSEA), the marker tape must be placed directly under the cable, cord binder tape, or jacket. The tape should be printed to show the following information at intervals not greater than 1 foot: name and location of manufacturer, year of manufacture, specification number (such as MIL-C-24643), and progressive serial number. The serial number is not necessarily a footage marker. A serial number must not be repeated by a manufacturer in any one year for any one type and size of cable or cord.

5.4.9 Year of manufacture. In order to facilitate storage and issue of cable on a first in, first out basis, cable reels, coils, and containers shipped by manufacturers must be marked to show the year of manufacture. Markings consist of a strip approximately 2-inches wide and colored as follows for the particular year of manufacture. These markings are repeated at 5-year intervals, as follows:

Year of manufacture	Identifying color
1979	Blue
1980	White
1981	Red
1982	Green
1983	Orange
1984	Blue
1985	White
1986	Red
1987	Green
1988	Orange
1989	Blue
1990	White
1991	Red
1992	Green
1993	Orange
1994	Blue
1995	White
1996	Red

TABLE I. MIL-C-24643 cable application data. 1/

Application	Cable type 2/ Non-flexing service	Cable type 2/ Repeated flexing service
General usage: For all portions of power, lighting, interior communication, weapons control and electronics systems, except where circuit parameters (such as audio or radio frequency, low-level microphone, synchro, scale voltage, and other types of signals) require special types of cable. Types LSMU, LS3U, LSDNW, LSTNW, LSFNW, LSMNW, LSSHOF, LSDHOF, LSTHOF, LSFHOF, LSMHOF, LSDCOP, LSTCOP, and LSMCOS should be used only for runs that are either totally within one compartment, or totally within two contiguous compartments. However, these type cables must not be used where a watertight deck or watertight bulkhead below flooding water level II (FWL-II) is penetrated. Type SG cable should be used for connections between the ship service generators and their respective switchboards and between sections of the ship service switchboards.	LSDNW LSTNW LSFNW LSMNW LSSSGU LSDSGU LSTSGU LSFSGU LS6SGU LS7SGU LSMSCU LSMU LS3U	LSSHOF LSDHOF LSTHOF LSFHOF LSMHOF LSDCOP LSTCOP LSMCOS
High voltage - 60 Hz: For 3000- and 5000-volt, three-phase power applications.	LS5KVT-SGU	
Casualty power.		LSTHOF-42
400-Hz power: For 400-Hz service for static frequency changer cables, bus ties, and feeders where cable of lower impedance is required to reduce voltage drop.	LS6SGU	
Audio and telephone: For audio, telephone, call bell, announcing, and alarm systems. May also be used for other interior communication and weapons control systems, provided ampere rating of the cable and voltage drop for the system are not exceeded. Types LSTPNW and LSTTOP should be used only for runs that are either totally within one compartment, or totally within two contiguous compartments. However, this type cable should not be used where a watertight deck or watertight bulkhead below FWL-II is penetrated.	LSTPNW LSTTSU	LSTTOP

See footnotes at end of table.

TABLE I. MIL-C-24643 cable application data. 1/ - Continued

Application	Cable type 2/ Non-flexing service	Cable type 2/ Repeated flexing service
Radio	LSSRW LSDRW LSTRW	
Radio frequency: For application up to 2 megahertz (MHz). Maximum total copper operating temperature must not exceed 75°C.		LSTTRS
Degaussing	LSSSGU LSDSGU LSTSGU LSFSGU LS6SGU LSMDU LSMDY LSMSCU	
Thermocouple and pyrometer temperature range: Type TCTX, 125 to 260°C Type TCJX, 150 to 540°C Type TCKX, 260 to 870°C	LSTCTX LSTCJX LSTCKX LSTCJU LSTCTU LSPBTMU	
Shielded circuits: For combat systems, interior communications, lighting, and power circuits, where shielding of 400 Hz (that is, synchro, pulse, scale voltage) signals, or other signals is required. Where a watertight deck or bulkhead below FWL-II is to be penetrated, types LS1SMWU, LS2SWAU, LS1SWU, LS2SWU, LS2UW, LS2WAU, or LS3SWU should be used.	LS1SAU LS1SMU LS1SMUW LS1SWU LS1SU LS1S50MU LS1S75MU LS2AU LS2SJ LS2SWAU LS2SWU	LSTTRS

See footnotes at end of table.

TABLE I. MIL-C-24643 cable application data. 1/ - Continued

Application	Cable type 2/	
	Non-flexing service	Repeated flexing service
Shielded circuits (continued)	LS2SU LS2UW LS2WAU LS2U LS3SJ LS3SU LS3SWU LS4SJ LSMS	
Microphone circuits		LSMCOS LSMMOP

1/ The order of listing of cables for general applications data has no significant meaning for their usage.

2/ Many cables are manufactured in variations of armored, unarmored, and unarmored with overall shielded (see 5.1). Armored cable is required to be used on all nuclear ships for propulsion plant and reactor compartments and is desirable in all other areas unless technically prohibited. The use of armored cable on non-nuclear ships is optional and to be determined by the overhaul shipyard, except armored cables shall not be installed in weather locations due to EMC considerations.

TABLE II. MIL-C-24640 cable application data. 1/

Application	Cable type 2/	
	Non-flexing service	Repeated flexing service
General usage: For all portions of power, lighting, interior communication, weapons control, and electronics systems, except where circuit parameters (such as, audio or radio frequency, low-level microphone, synchro, scale voltage, and other types of signals) require special types of cable. Types DX, TX, FX and MXO should be used only for runs that are either totally within one compartment, or totally within two contiguous compartments. However, these types of cable should not be used where a watertight deck or watertight bulkhead below FWL-II is penetrated.	DX TX FX DXW TXW FXW 7XW MXC MSCW	

See footnotes at end of table.

TABLE II. MIL-C-24640 cable application data. 1/ - Continued

Application	Cable type 2/	
	Non-flexing service	Repeated flexing service
Audio and telephone:		
For audio, telephone, call bell, announcing and alarm systems. May also be used for other interior communication and weapons control systems, provided ampere rating of the cable and voltage drop for the system are not exceeded. Type TTX should be used only for runs that are either totally within one compartment, or totally within two contiguous compartments. However, this type of cable should not be used where a watertight deck or watertight bulkhead below FWL-II is penetrated.	TTX TTXW	
Radio frequency:		
For applications up to two MHz. Maximum total copper operating temperature must not exceed 75°C.	TTXS	
Shielded circuits:		
For combat systems, interior communications, lighting, and power circuits where shielding of 400-Hz (synchro, pulse, scale voltage, and so forth) signals or other signals is required. Types 1XSOW, 2XSAW, 2XSW, 2XOW, and 3XSW must be used where a watertight deck or bulkhead below FWL-II is to be penetrated.	2XAO 1XMSO 2XS MXSO 3XS 2XO 2XSO 1XSOW 2XSAW 2XSW 2XOW 3XSW	

1/ The order of listing of cables for general applications data has no significant meaning for their usage.

2/ Many cables are manufactured in variations of armored, unarmored, and unarmored with overall shielding (see 5.2). Armored cable is required to be used on all nuclear ships for propulsion plant and reactor compartments and is desirable in all other areas unless technically prohibited. The use of armored cable on non-nuclear ships is optional and to be determined by the overhaul shipyard, except armored cables shall not be installed in weather locations due to EMC considerations.

TABLE III. MIL-C-915 cable application data. 1/

Application	Cable type 2/ Non-flexing service	Cable type 2/ Repeated flexing service
Outboard submersible: For hydrophones, transducers, outboard dial telephones, retractable antennae and similar equipment. Types MWF, 1SWF, and 2SWF are for hydrophones, transducers, and telephone lines in the weather. Types 1PR-A20E, 1PR-16, 7PR-16, 3PR-16, 1Q-16, ITR-16, and 7SPR-16S are only for submarine outboard use.	MSPW TSPA 1PR-A20E 1PR-16 7PR-16 2SPR-16 3PR-16 1Q-16 ITR-16 7SPR-16S	MSP TSP 5S5 S2S DSS FSS TSS MWF DSWS MCSF 1SWF 2SWF TPUM
Welding electrode circuit		TRF TRXF
Shore-to-ship power		THOF-400 THOF-500
Diver's line and telephone		DLT
400-Hz aircraft servicing		CVSF-4
DC aircraft servicing		JAS-250

1/ The order of listing of cables for general application data has no significant meaning for their usage.

2/ Many cables are manufactured in variations of armored, unarmored, and unarmored with overall shielding (see 5.3).

TABLE IV. Commercial cable application data. 1/

Application	Cable type repeated flexing service
Cords for portable tools and equipment: For power supply to electric typewriters, office machines, electric drills, sanders, portable extension lights, and similar equipment. Safety ground conductors must be green.	Underwriters approved S, SO, ST, SJ, SJO, SJT

1/ The order of listing of cables for general application data has no significant meaning for their usage.

TABLE V. Supersession data.

Previous or present type, and applicable MIL-C-915 specification sheet number	Present type, and applicable specification sheet number	Obsolete type, and detail specification number
CVSF-4.................../1	CVSF-4............MIL-C-915/1	None
CVSF-4.................../1	LSCVSF-4..........MIL-C-24643/1	None
DCOP.................../3	LSDCOP............MIL-C-24643/2	None
DHOF.................../6	LSDHOF............MIL-C-24643/3	None
DLT.................../5	DLT...............MIL-C-915/5	None
DNW/A.................../68	LSDNW/A...........MIL-C-24643/48	None
DPS.................../40	LSDPS.............MIL-C-24643/26	DPS.......MIL-C-23206/3
DRW/A.................../73	LSDRW/A...........MIL-C-24643/53	DHRF......MIL-C-915/4
DSGU/A.................../29	LSDSGU/A..........MIL-C-24643/15	DSGA......MIL-C-2194/2
DSGU/A.................../29	LSDSGU/A..........MIL-C-24643/15	DHFA......MIL-C-2194/2
DSS.................../8	DSS...............MIL-C-915/8	None
DSWS.................../7	DSWS..............MIL-C-915/7	None
ECM/A.................../54	LSECM/A...........MIL-C-24643/38	ECM.......MIL-C-24145/14
FHOF.................../6	LSFHOF............MIL-C-24643/63	None
FNW/A.................../70	LSFNW/A...........MIL-C-24643/50	None
FPS.................../40	LSFPS.............MIL-C-24643/26	FPS.......MIL-C-23206/3
FSGU/A.................../31	LSFSGU/A..........MIL-C-24643/17	FSGA......MIL-C-2194/4
FSGU/A.................../31	LSFSGU/A..........MIL-C-24643/17	FHFA......MIL-C-2194/4
FPS.................../40	LSFPS.............MIL-C-24643/26	None
FSS.................../8	FSS...............MIL-C-915/8	None
JAS.................../9	JAS...............MIL-C-915/9	None
MCOS.................../11	LSMCOS............MIL-C-24643/4	None
MCSF.................../10	MCSS..............MIL-C-915/10	None
MDU.................../12	LSMDU.............MIL-C-24643/5	None
MDY.................../13	LSMDY.............MIL-C-24643/6	None
MHOF.................../14	LSMHOF............MIL-C-24643/7	MHFF......MIL-C-915
MMOP.................../15	LSMMOP............MIL-C-24643/8	None
MNW/A.................../71	LSMNW/A...........MIL-C-24643/51	MNW.......MIL-C-915/71
MRI-D.................../16	LSMRI-D...........MIL-C-24643/9	None
MRI-T.................../16	LSMRI-T...........MIL-C-24643/9	
MS/A.................../50	LSMS/A............MIL-C-24643/34	MS........MIL-C-24145/10
MS/A.................../50	LSMS/A............MIL-C-24643/34	MA........MIL-C-24145/10

TABLE V. Supersession data. - Continued

Previous or present type, and applicable MIL-C-915 specification sheet number	Present type, and applicable specification sheet number	Obsolete type, and detail specification number
MSCU/A/S................/32	LSMSCU/A/S.........MIL-C-24643/18	MSCA......MIL-C-2194/5
MSCU/A/S................/32	LSMSCU/A/S.........MIL-C-24643/18	MHFA......MIL-C-2194/5
MSP....................../67	MSP...............MIL-C-915/67	None
MSPW...................../66	MSPW..............MIL-C-915/66	None
MU/A/S.................../43	LSMU/A/S...........MIL-C-24643/29	MA........MIL-C-24145/3
MWF....................../58	MWF...............MIL-C-915/58	MWF.......MIL-C-24145/18
PBTM...................../17	LSPBTM............MIL-C-24643/10	None
PBTMU..................../17	LSPBTMU...........MIL-C-24643/10	None
PI......................./39	LSPI..............MIL-C-24643/25	PI........MIL-C-23206/2
SHOF...................../6	LSSHOF............MIL-C-24643/3	None
SRW/A..................../73	LSSRW/A...........MIL-C-24643/53	SHFR......MIL-C-915/4
SSF....................../18	LSSSF.............MIL-C-24643/11	None
SSGU/A.................../28	LSSSGU/A..........MIL-C-24643/14	SHGA......MIL-C-2194/1
SSGU/A.................../28	LSSSGU/A..........MIL-C-24643/14	SSGA......MIL-C-2194/1
S2S....................../61	S2S...............MIL-C-915/61	S2S.......MIL-C-24145/21
TCJU/A.................../35	LSTCJU/A..........MIL-C-24643/21	TCJA......MIL-C-2194/10
TCJX...................../38	LSTCJX............MIL-C-24643/24	TCJX......MIL-C-23206/1
TCKX...................../38	LSTCKX............MIL-C-24643/24	TCKX......MIL-C-23206/1
TCOP...................../3	LSTCOP............MIL-C-24643/2	None
TCTU/A.................../35	LSTCTU/A..........MIL-C-24643/21	TCTA......MIL-C-2194/10
TCTU/A.................../35	LSTCTU/A..........MIL-C-24643/21	PBTX......MIL-C-915
TCTX...................../38	LSTCTX............MIL-C-24643/24	TCTX......MIL-C-23206/1
THOF...................../6	LSTHOF............MIL-C-24643/3	None
THOF-42................../6	THOF-42...........MIL-C-915/6	None
THOF-400................./6	THOF-400..........MIL-C-915/6	None
THOF-500................./6	THOF-500..........MIL-C-915/6	
TNW/A..................../69	LSTNW/A...........MIL-C-24643/49	TNW.......MIL-C-915/69
TPNW/A.................../72	LSTPNW/A..........MIL-C-24643/52	None
TPS....................../40	LSTPS.............MIL-C-24643/26	TPS.......MIL-C-23206/3
TPUM-6.................../79	TPUM-6............MIL-C-915/79	TPU.......MIL-C-915/19
TRF....................../20	TRF...............MIL-C-915/20	None
TRW/A..................../73	LSTRW/A...........MIL-C-24643/53	THFR......MIL-C-915/9
TRXF...................../21	TRXF..............MIL-C-915/21	None

TABLE V. Supersession data. - Continued

Previous or present type, and applicable MIL-C-915 specification sheet number	Present type, and applicable specification sheet number	Obsolete type, and detail specification number
TSGU/A................../30	LSTSGU/A..........MIL-C-24643/16	THFA......MIL-C-2194/3
TSGU/A................../30	LSTSGU/A..........MIL-C-24643/16	TSGA......MIL-C-2194/3
TSP/A.................../22	TSP/A.............MIL-C-915/21	TSP.......MIL-C-915/22
TSS...................../8	TSS...............MIL-C-915/8	None
TTOP..................../24	LSTTOP............MIL-C-24643/12	None
TTRS/A................../25	LSTTRS/A..........MIL-C-24643/13	TTRS......MIL-C-915/25
TTSU/A................../37	LSTTSU/A..........MIL-C-24643/23	TTSA......MIL-C-2194/12
TTSU/A................../37	LSTTSU/A..........MIL-C-24643/23	TTHFWA....MIL-C-915/23
1SA/U.................../57	LS1SA/U...........MIL-C-24643/41	1SA.......MIL-C-24145/17
1SMU/A................../56	LS1SMU/A..........MIL-C-24643/40	1SMU......MIL-C-24145/10
1SMWU/A................./65	LS1SMWU/A.........MIL-C-24643/47	1SMWA.....MIL-C-24145/2
1SU/A.................../59	LS1SU/A...........MIL-C-24643/42	1SU.......MIL-C-24145/1
1SWF..................../47	1SWF..............MIL-C-915/47	1SWF......MIL-C-24145/7
1SWU/A................../44	LS1SWU/A..........MIL-C-24643/30	1SWA......MIL-C-24145/4
1S50MU/A/S............../42	LS1S50MU/A/S......MIL-C-24643/28	1S50MA....MIL-C-24145/2
1S75MU/A................/55	LS1S75MU/A........MIL-C-24643/39	1S75MA....MIL-C-24145/15
2AU/A/S................./41	LS2AU/A/S.........MIL-C-24643/27	2A........MIL-C-24145/1
2CS...................../80	LS2CS.............MIL-C-24643/58	None
2SJ/A.................../60	LS2SJ/A...........MIL-C-24643/43	DBSP......MIL-C-915/2
2SU/A/S................./45	LS2SU/A/S.........MIL-C-24643/31	None
2SWA/U................../46	LS2SWA/U..........MIL-C-24643/32	2SWA......MIL-C-24145/6
2SWF..................../48	2SWF..............MIL-C-915/48	2SWF......MIL-C-24145/8
2SWL/A................../77	LS2SWL/A..........MIL-C-24643/56	None
2SWU/A................../49	LS2SWU/A..........MIL-C-24643/33	2SWU......MIL-C-24145/9
2U/A..................../63	LS2U/A............MIL-C-24643/45	2U........MIL-C-24145/23
2UW/A/S................./78	LS2UW/A/S.........MIL-C-24643/57	None
2WAU/A................../64	LS2WAU/A..........MIL-C-24643/46	2WA.......MIL-C-24145/24
3SF...................../62	LS3SF.............MIL-C-24643/44	3SF.......MIL-C-24145/22
3SJ/A.................../60	LS3SJ/A...........MIL-C-24643/43	TBSP......MIL-C-915/2
3SJ/A.................../60	LS3SJ/A...........MIL-C-24643/43	3SJ.......MIL-C-24145/20
3SU/A/S................./51	LS3SU/A/S.........MIL-C-24643/35	3SA.......MIL-C-21145/11
3SWU/A/S................/52	LS3SWU/A/S........MIL-C-24643/36	3SWA......MIL-C-24145/12

TABLE V. Supersession data. - Continued

Previous or present type, and applicable MIL-C-915 specification sheet number	Present type, and applicable specification sheet number	Obsolete type, and detail specification number
3U/A..................../53	LS3U/A............MIL-C-24643/37	3U........MIL-C-24145/13
4NW8/A................../76	LS4NW8/A..........MIL-C-24643/55	None
4SJ/A.................../60	LS4SJ/A...........MIL-C-24643/43	FBSP......MIL-C-915/2
4SJ/A.................../60	LS4SJ/A...........MIL-C-24643/43	4SJ.......MIL-C-24145/20
5KVTSGU/A.............../36	LS5KVTSGU/A.......MIL-C-24643/22	5KVTSGA...MIL-C-2194/11
5SS...................../74	5SS...............MIL-C-915/74	None
6SGU/A................../33	LS6SGU/A..........MIL-C-24643/19	6SGA......MIL-C-2194/6
7PS...................../40	LS7PS.............MIL-C-24643/26	7PS.......MIL-C-23206/3
7SGU/A................../34	LS7SGU/A..........MIL-C-24643/20	7SGA......MIL-C-2194/9
7SS...................../8	7SS...............MIL-C-915/8	None
8NW6/A................../75	LS8NW6/A..........MIL-C-24643/54	None

5.5 Brief explanation of cable ratings and characteristics tables.

5.5.1 First five columns. Each cable is identified by the Military specification and specification sheet number in the left hand column, followed by the type designation, conductor size (AWG or MCM), number of conductors, and conductor cross sectional area (circular mils).

5.5.2 Overall diameter. The "overall diameter" is the overall measurement of the finished cable, and should be the determining dimension in selecting the proper deck or bulkhead stuffing tube size, or multi-cable transit inserts. This diameter is also the determining dimension for stuffing tubes for equipment.

5.5.3 Rated voltage, ampacity, and minimum radius of bend. Electrical characteristics are given under columns headed "Rated voltage" and "Ampacity". "Minimum radius of bend", which is approximately eight times the overall diameter, is also given. Cables must not be used in excess of these ratings.

5.5.4 Conductor identification. The letters in the conductor identification column represent the identification, and the number represents the method of applying the identification. For example, STD-1 means standard identification applied by method 1, which is printing of the number and color designation on the outer surface of the insulation or jacket of each conductor. TEL-3 means telephone identification applied by method 3, which is colored insulation on each conductor. The abbreviations used are as follows:

STD - Standard identification code
TEL - Telephone identification code
SPL - Special identification code
LTR - Letter identification code

5.6 Cable classification (MIL-C-24643). Cables specified in MIL-C-24643 are listed in table VI under the following general classifications:

(a) Watertight (with circuit integrity), non-flexing service:

(1) Power and lighting.
(2) Control.
(3) Electronic, communication, and instrumentation.

(b) Watertight, non-flexing service:

(1) Power and lighting.
(2) Electronic, communication, and instrumentation.

(c) Non-watertight (with circuit integrity), non-flexing service:

(1) Electronic, communication, and instrumentation.

(d) Non-watertight, non-flexing service:

(1) Power and lighting.
(2) Control.
(3) Electronic, communication, and instrumentation.

(e) Non-watertight, flexing service:

(1) Power and lighting.
(2) Control.
(3) Electronic, communication, and instrumentation.

TABLE VI (a)(1). MIL-C-24643 cable ratings and characteristics, watertight (with circuit integrity), non-flexing service, (power, and lighting).

MIL-C-	Cable type designation		Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	Ampacity, each conductor (amps, max) dc or 60 Hz 50°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 40°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 50°C Ambient	NSN 6145-01
24643/19	LS6SGA-	100	0	6	105.600	1.650	2.919	10.0	LTR-5	1000	136	127	272	250	203-0370
	LS6SGA-	125	00	6	133.100	1.840	3.600	11.5	LTR-5	1000	160	147	299	275	201-9513
	LS6SGA-	150	000	6	167.800	2.010	4.468	12.0	LTR-5	1000	188	173	326	300	201-9514
	LS6SGA-	200	0000	6	211.600	2.250	5.613	13.5	LTR-5	1000	219	202	369	340	201-9515
24643/19	LS6SGU-	100	0	6	105.600	1.600	2.820	10.0	LTR-5	1000	136	127	272	250	201-9511
	LS6SGU-	125	00	6	133.100	1.790	3.490	11.5	LTR-5	1000	160	147	299	275	201-9512
	LS6SGU-	150	000	6	167.800	1.960	4.339	12.0	LTR-5	1000	188	173	326	300	203-2370
	LS6SGU-	200	0000	6	211.600	2.200	5.479	13.5	LTR-5	1000	219	202	369	340	203-0369
24643/26	LS7PS-	6	12	7	6.530	0.775	0.361	4.5	STD-4	600	35/20 1/	—	—	—	#811-8376 4/
24643/20	LS7SGA-	3	16	7	2.580	.595	.177	4.0	STD-1	1000	15/11	14/10 1/	15/11 1/	14/10 1/	201-9518
	LS7SGA-	4	14	7	4.110	.645	.231	4.0	STD-1	1000	26/14	24/13	26/14	24/13	201-9519
24643/20	LS7SGU-	3	16	7	2.580	.545	.152	4.0	STD-1	1000	15/11	14/10	15/11	14/10	201-9516
	LS7SGU-	4	14	7	4.110	.595	.198	4.0	STD-1	1000	26/14	24/13	26/14	24/13	201-9517
24643/26	LSDPS-	3	16	2	2.580	.455	.121	3.0	STD-4	600	10	—	10	—	156-9511
	LSDPS-	4	14	2	4.110	.489	.141	3.0	STD-4	600	20	—	20	—	#977-6159 4/
	LSDPS-	6	12	2	6.530	.585	.194	3.5	STD-4	600	28	—	28	—	158-2118
	LSDPS-	9	10	2	10.380	.628	.232	4.0	STD-4	600	41	—	41	—	#542-6699 4/
	LSDPS-	14	9	2	13.090	.730	.323	4.5	STD-4	600	54	—	54	—	154-4372
24643/15	LSDSGA-	3	16	2	2.580	.441	.109	3.0	STD-1	1000	13	12	13	12	202-9501
	LSDSGA-	4	14	2	4.110	.477	.133	3.0	STD-1	1000	22	20	22	20	203-0367
	LSDSGA-	9	10	2	10.380	.594	.230	4.0	STD-1	1000	44	41	44	41	202-9502
	LSDSGA-	14	9	2	13.090	.720	.297	4.0	STD-1	1000	60	55	60	55	202-9503
	LSDSGA-	23	7	2	20.820	.831	.410	5.0	STD-1 3/	1000	78	72	78	72	202-9504
	LSDSGA-	50	3	2	52.620	.961	.740	6.0	LTR-5	1000	126	116	126	116	204-4855
	LSDSGA-	75	1	2	83.690	1.124	1.086	7.0	LTR-5	1000	168	155	168	155	210-2343
	LSDSGA-	100	0	2	105.600	1.217	1.289	7.5	LTR-5	1000	199	183	199	183	204-4856
	LSDSGA-	200	0000	2	211.600	1.633	2.458	10.0	LTR-5	1000	308	284	288	266	204-4857
	LSDSGA-	300	300	2	300.000	1.891	3.326	11.5	LTR-5	1000	413	380	347	319	204-4858
	LSDSGA-	400	400	2	413.600	2.119	4.408	13.0	LTR-5	1000	492	453	337	310	203-0368

See footnotes at end of table.

TABLE VI (a)(1). MIL-C-24643 Cable ratings and characteristics, watertight (with circuit integrity), non-flexing service, (power and lighting). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of con-ductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/15	LSDSGU- 3	16	2	2.580	.391	0.086	3.0	STD-1	1000	13	12	13	12	202-8463
	LSDSGU- 4	14	2	4.110	.427	.106	3.0	STD-1	1000	22	20	22	20	202-2795
	LSDSGU- 9	10	2	10.380	.544	.194	4.0	STD-1	1000	44	41	44	41	202-2796
	LSDSGU- 14	9	2	13.090	.670	.259	4.0	STD-1	1000	60	55	60	55	202-2797
	LSDSGU- 23	7	2	20.820	.781	.363	5.0	STD-1 2/	1000	78	72	78	72	202-2798
	LSDSGU- 50	3	2	52.620	.911	.681	6.0	LTR-5	1000	126	116	126	116	202-3476
	LSDSGU- 75	1	2	83.690	1.074	1.018	7.0	LTR-5	1000	168	155	168	155	202-3477
	LSDSGU- 100	0	2	105.600	1.167	1.217	7.5	LTR-5	1000	199	183	199	183	203-5390
	LSDSGU- 200	0000	2	211.600	1.583	2.360	10.0	LTR-5	1000	308	284	288	266	205-3628
	LSDSGU- 300	300	2	300.000	1.841	3.213	11.5	LTR-5	1000	413	380	347	319	203-5391
	LSDSGU- 400	400	2	413.600	2.069	4.282	13.0	LTR-5	1000	492	453	337	310	202-8464
24643/26	LSFPS- 14	9	4	13.090	0.815	0.452	5.0	STD-4	600	42	—	—	—	156-8790
24643/17	LSFSGA- 3	16	4	2.580	.497	.154	3.0	STD-1	1000	11	10	11	10	202-3481
	LSFSGA- 4	14	4	4.410	.563	.204	3.5	STD-1	1000	18	17	18	17	202-3482
	LSFSGA- 9	10	4	10.380	.680	.336	4.5	STD-1	1000	39	36	39	36	202-3483
	LSFSGA- 23	7	4	20.820	.940	.517	5.5	STD-1 2/	1000	69	64	69	64	202-3484
	LSFSGA- 50	3	4	52.620	1.100	1.076	6.5	LTR-5	1000	110	101	110	101	203-3299
	LSFSGA- 75	1	4	83.690	1.290	1.289	8.0	LTR-5	1000	148	136	148	136	202-3485
	LSFSGA- 100	0	4	105.600	1.408	1.412	8.5	LTR-5	1000	174	160	170	157	202-8465
	LSFSGA- 150	000	4	167.800	1.675	3.188	10.0	LTR-5	1000	235	216	224	206	202-8466
	LSFSGA- 200	0000	4	211.600	1.870	3.922	11.0	LTR-5	1000	271	250	254	234	202-3511
24643/17	LSFSGU- 3	16	4	2.580	0.447	0.126	3.0	STD-1	1000	11	10	11	10	202-3509
	LSFSGU- 4	14	4	4.110	.513	.172	3.5	STD-1	1000	18	17	18	17	210-2344
	LSFSGU- 9	10	4	10.380	.630	.296	4.5	STD-1	1000	39	36	39	36	202-3510
	LSFSGU- 23	7	4	20.820	.890	.460	5.5	STD-1 2/	1000	69	64	69	64	202-3479
	LSFSGU- 50	3	4	52.620	1.050	1.015	6.5	LTR-5	1000	110	101	110	101	205-3629
	LSFSGU- 75	1	4	83.690	1.240	1.486	8.0	LTR-5	1000	148	136	148	136	202-6955
	LSFSGU- 100	0	4	105.600	1.358	1.820	8.5	LTR-5	1000	174	160	170	157	202-6956
	LSFSGU- 150	000	4	167.800	1.625	3.105	10.0	LTR-5	1000	235	216	224	206	202-6957
	LSFSGU- 200	0000	4	211.600	1.820	3.819	11.0	LTR-5	1000	271	250	254	234	202-3480
24643/14	LSSSGA- 50	3	1	52.620	.570	.316	3.5	—	1000	149	137	149	137	202-9492

See footnotes at end of table.

TABLE VI (a)(1). MIL-C-24643 cable ratings and characteristics, watertight (with circuit integrity), non-flexing service, (power and lighting). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max): dc or 60 Hz, 40°C Ambient	dc or 60 Hz, 50°C Ambient	400 Hz, 40°C Ambient	400 Hz, 50°C Ambient	NSN 6145-01
24643/14	LSSSGA-75	1	1	83.690	0.652	0.454	4.0	—	1000	197	181	197	181	202-9493
	LSSSGA-100	0	1	105.600	.719	.550	4.5	—	1000	232	214	232	214	202-9494
	LSSSGA-200	0000	1	211.600	.922	1.022	5.5	—	1000	361	332	—	—	202-9495
	LSSSGA-300	300	1	300.000	1.051	1.369	6.5	—	1000	467	430	—	—	202-9496
	LSSSGA-400	400	1	413.600	1.168	1.833	7.0	—	1000	575	530	—	—	202-9497
	LSSSGA-650	650	1	650.000	1.421	2.801	8.5	—	1000	785	722	—	—	204-4854
	LSSSGA-800	800	1	800.000	1.535	3.429	9.5	—	1000	940	865	—	—	202-9498
	LSSSGA-1000	1000	1	1000.000	1.670	4.223	10.0	—	1000	1090	950	—	—	202-9499
	LSSSGA-1600	1600	1	1600.000	2.060	6.489	12.5	—	1000	1450	1270	—	—	202-9500
	LSSSGA-2000	2000	1	2000.000	2.260	7.755	13.5	—	1000	1630	1450	—	—	201-9496
24643/14	LSSSGU-50	3	1	52.620	0.520	0.281	3.5	—	1000	149	137	149	137	203-5396
	LSSSGU-75	1	1	83.690	.602	.414	4.0	—	1000	197	181	197	181	203-0379
	LSSSGU-100	0	1	105.600	.669	.510	4.5	—	1000	232	214	232	214	205-3647
	LSSSGU-200	0000	1	211.600	.872	.967	5.5	—	1000	361	332	—	—	202-8471
	LSSSGU-300	300	1	300.000	1.001	1.309	6.5	—	1000	467	430	—	—	203-6576
	LSSSGU-400	400	1	413.600	1.118	1.763	7.0	—	1000	575	530	—	—	206-2230
	LSSSGU-650	650	1	650.000	1.371	2.716	8.5	—	1000	785	722	—	—	203-6577
	LSSSGU-800	800	1	800.000	1.485	3.338	9.5	—	1000	940	865	—	—	204-2246
	LSSSGU-1000	1000	1	1000.000	1.620	4.123	10.0	—	1000	1090	950	—	—	203-6578
	LSSSGU-1600	1600	1	1600.000	2.010	6.368	12.5	—	1000	1450	1270	—	—	205-3648
	LSSSGU-2000	2000	1	2000.000	2.210	7.622	13.5	—	1000	1630	1450	—	—	204-4869
24643/26	LSTPS-3	16	3	2.580	0.475	0.129	3.0	STD-4	600	10	—	10	—	#088-9141 4/
	LSTPS-4	14	3	4.110	.553	.160	3.5	STD-4	600	17	—	17	—	159-6656
	LSTPS-6	12	3	6.530	.620	.229	4.0	STD-4	600	23	—	23	—	155-6691
	LSTPS-9	10	3	10.380	.657	.299	4.0	STD-4	600	36	—	36	—	#542-6700 4/
	LSTPS-14	9	3	13.090	.751	.411	4.5	STD-4	600	47	—	47	—	155-6692
	LSTPS-23	7	3	20.820	.866	.579	5.5	STD-4	600	64	—	64	—	154-0989
	LSTPS-30	5	3	33.090	.989	.738	6.0	STD-4	600	77	—	77	—	157-0923
24643/16	LSTSGA-3	16	3	2.580	.461	.128	3.0	STD-1	1000	11	10	11	10	202-0678
	LSTSGA-4	14	3	4.410	.499	.156	3.0	STD-1	1000	18	17	18	17	202-0679
	LSTSGA-9	10	3	10.380	.625	.278	4.0	STD-1	1000	39	36	39	36	202-0680
	LSTSGA-14	9	3	13.090	.768	.356	4.5	STD-1	1000	51	47	51	47	202-0681
	LSTSGA-23	7	3	20.820	.862	.492	5.0	STD-1	1000	69	64	69	64	202-0682

See footnotes at end of table.

TABLE VI (a)(1). MIL-C-24643 cable ratings and characteristics, watertight (with circuit integrity), non-flexing service, (power and lighting). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/16	LSTSGA- 50	3	3	52.620	1.019	0.947	6.5	STD-1	1000	110	101	110	101	202-0683
	LSTSGA- 75	1	3	83.690	1.184	1.388	7.5	STD-1	1000	148	136	148	136	203-4030
	LSTSGA- 100	0	3	105.600	1.316	1.696	8.0	STD-1	1000	174	160	174	160	202-0684
	LSTSGA- 150	000	3	167.800	1.565	2.558	9.5	STD-1	1000	235	216	224	206	202-0685
	LSTSGA- 200	0000	3	211.600	1.719	3.197	10.5	STD-1	1000	271	250	254	234	202-0686
	LSTSGA- 300	300	3	300.000	2.007	4.356	12.0	STD-1	1000	348	320	292	269	202-0687
	LSTSGA- 400	400	3	413.600	2.253	5.829	13.5	STD-1	1000	435	400	298	274	202-0688
24643/16	LSTSGU- 3	16	3	2.580	0.411	0.099	3.0	STD-1	1000	11	10	11	10	201-9497
	LSTSGU- 4	14	3	4.110	.449	.125	3.0	STD-1	1000	18	17	18	17	201-9498
	LSTSGU- 9	10	3	10.380	.575	.241	4.0	STD-1	1000	39	36	39	36	201-9499
	LSTSGU- 14	9	3	13.090	.718	.313	4.5	STD-1	1000	51	47	51	47	202-3478
	LSTSGU- 23	7	3	20.820	.812	.443	5.0	STD-1	1000	69	64	69	64	201-9500
	LSTSGU- 50	3	3	52.620	.969	.886	6.5	STD-1	1000	110	101	110	101	201-9053
	LSTSGU- 75	1	3	83.690	1.134	1.313	7.5	STD-1	1000	148	136	148	136	201-9501
	LSTSGU- 100	0	3	105.600	1.266	1.618	8.0	STD-1	1000	174	160	174	160	201-9502
	LSTSGU- 150	000	3	167.800	1.515	2.465	9.5	STD-1	1000	235	216	224	206	202-9505
	LSTSGU- 200	0000	3	211.600	1.669	3.086	10.5	STD-1	1000	271	250	254	234	202-0676
	LSTSGU- 300	300	3	300.000	1.957	4.237	12.0	STD-1	1000	348	320	292	269	202-0677
	LSTSGU- 400	400	3	413.600	2.203	5.695	13.5	STD-1	1000	435	400	298	274	202-9506
24643/22	LSSKVTSGA- 100	0	3	105.600	1.790	2.417	11.8	LTR-5	5000	174	160	—	—	201-6514
	LSSKVTSGA- 150	000	3	167.800	2.000	3.073	13.0	LTR-5	5000	235	216	—	—	201-6515
	LSSKVTSGA- 250	250	3	250.000	2.270	4.429	14.5	LTR-5	5000	315	290	—	—	201-9054
	LSSKVTSGA- 350	350	3	350.000	2.500	5.562	15.9	LTR-5	5000	391	360	—	—	201-9055
	LSSKVTSGA- 400	400	3	413.600	2.650	6.551	16.5	LTR-5	5000	435	400	—	—	202-2050
24643/22	LSSKVTSGU- 100	0	3	105.600	1.740	2.310	11.8	LTR-5	5000	174	160	—	—	201-6510
	LSSKVTSGU- 150	000	3	167.800	1.950	2.964	13.0	LTR-5	5000	235	216	—	—	203-6566
	LSSKVTSGU- 250	250	3	250.000	2.220	4.294	14.5	LTR-5	5000	315	290	—	—	201-6511
	LSSKVTSGU- 350	350	3	350.000	2.450	5.417	15.9	LTR-5	5000	391	360	—	—	201-6512
	LSSKVTSGU- 400	400	3	413.600	2.600	6.190	16.5	LTR-5	5000	435	400	—	—	201-6513

See footnotes at end of table.

TABLE VI (a)(2). MIL-C-24643 cable ratings and characteristics, watertight (with circuit integrity), non-flexing service, (control). - Continued

MIL-C-	Cable type designation		Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/18	LSMSCA-	7	18	7	1.620	0.534	0.176	3.5	STD-1	1000	12/8 1/	9/6 1/	12/8 1/	9/6 1/	202-2046
	LSMSCA-	10	18	10	1.620	.672	.267	4.0	STD-1	1000	12/8	9/6	12/8	9/6	202-2047
	LSMSCA-	14	18	14	1.620	.718	.324	4.5	STD-1	1000	12/8	9/6	12/8	9/6	202-2048
	LSMSCA-	19	18	19	1.620	.788	.401	5.0	STD-1	1000	12/8	9/6	12/8	9/6	202-2049
	LSMSCA-	24	18	24	1.620	.905	.522	5.5	STD-1	1000	12/6	9/5	12/6	9/5	203-5392
	LSMSCA-	30	18	30	1.620	.951	.596	5.5	STD-1	1000	12/6	9/5	12/6	9/5	205-3630
	LSMSCA-	37	18	37	1.620	1.055	.707	6.0	STD-1	1000	12/6	9/5	12/6	9/5	205-3631
	LSMSCA-	44	18	44	1.620	1.164	.861	7.0	STD-1	1000	12/5	9/4	12/5	9/4	201-9506
	LSMSCA-	61	18	61	1.620	1.300	1.058	8.0	STD-1	1000	12/4	9/3	12/4	9/3	201-9507
	LSMSCA-	91	18	91	1.620	1.530	1.600	9.0	STD-1	1000	12/4	9/3	12/4	9/3	201-9508
24643/18	LSMSCS-	7	18	7	1.620	0.544	0.244	6.5	STD-1	1000	12/8	9/6	12/8	9/6	201-9509
	LSMSCS-	10	18	10	1.620	.682	.349	8.5	STD-1	1000	12/8	9/6	12/8	9/6	202-3486
	LSMSCS-	14	18	14	1.620	.728	.403	9.0	STD-1	1000	12/8	9/6	12/8	9/6	202-6960
	LSMSCS-	19	18	19	1.620	.798	.509	9.5	STD-1	1000	12/8	9/6	12/8	9/6	202-6961
	LSMSCS-	24	18	24	1.620	.915	.630	11.5	STD-1	1000	12/6	9/5	12/6	9/5	202-6962
	LSMSCS-	30	18	30	1.620	.961	.727	12.0	STD-1	1000	12/6	9/5	12/6	9/5	202-6963
	LSMSCS-	37	18	37	1.620	1.065	.810	13.0	STD-1	1000	12/6	9/5	12/6	9/5	202-6964
	LSMSCS-	44	18	44	1.620	1.174	.991	14.0	STD-1	1000	12/5	9/4	12/5	9/4	201-9510
	LSMSCS-	61	18	61	1.620	1.310	1.227	16.0	STD-1	1000	12/4	9/3	12/4	9/3	202-6965
	LSMSCS-	91	18	91	1.620	1.540	1.887	18.5	STD-1	1000	12/4	9/3	12/4	9/3	202-6966
24643/18	LSMSCU-	7	18	7	1.620	0.484	0.148	3.5	STD-1	1000	12/8	9/6	12/8	9/6	202-2041
	LSMSCU-	10	18	10	1.620	.622	.227	4.0	STD-1	1000	12/8	9/6	12/8	9/6	201-9503
	LSMSCU-	14	18	14	1.620	.668	.280	4.5	STD-1	1000	12/8	9/6	12/8	9/6	201-9504
	LSMSCU-	19	18	19	1.620	.738	.354	5.0	STD-1	1000	12/8	9/6	12/8	9/6	201-9505
	LSMSCU-	24	18	24	1.620	.855	.467	5.5	STD-1	1000	12/6	9/5	12/6	9/5	202-6958
	LSMSCU-	30	18	30	1.620	.901	.539	5.5	STD-1	1000	12/6	9/5	12/6	9/5	202-6959
	LSMSCU-	37	18	37	1.620	1.002	.648	6.0	STD-1	1000	12/6	9/5	12/6	9/5	202-2042
	LSMSCU-	44	18	44	1.620	1.114	.793	7.0	STD-1	1000	12/5	9/4	12/5	9/4	202-2043
	LSMSCU-	61	18	61	1.620	1.250	.982	8.0	STD-1	1000	12/4	9/3	12/4	9/3	202-2044
	LSMSCU-	91	18	91	1.620	1.480	1.510	9.0	STD-1	1000	12/4	9/3	12/4	9/3	202-2045

See footnotes at end of table.

TABLE VI (a)(3). MIL-C-24643 cable ratings and characteristics, watertight (with circuit integrity), non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/21	LSTCJA- 4	14	2	4.110	0.480	0.136	3.0	—	—	—	—	—	—	203-6565
24643/21	LSTCJU- 4	14	2	4.110	.430	.117	3.0	—	—	—	—	—	—	201-9520
24643/24	LSTCJX- 3	16	6	2.828	.742	.231	4.0	—	—	—	—	—	—	#977-6160 4/
	LSTCJX- 7	16	14	2.828	.983	.515	5.5	—	—	—	—	—	—	157-2037
	LSTCJX- 12	16	24	2.828	1.269	.844	6.5	—	—	—	—	—	—	#931-8420 4/
24643/24	LSTCKX- 1	16	2	2.828	0.456	.108	2.5	—	—	—	—	—	—	#598-9397 4/
	LSTCKX- 3	16	6	2.828	.742	.257	4.0	—	—	—	—	—	—	#948-4135 4/
	LSTCKX- 7	16	14	2.828	.983	.520	5.5	—	—	—	—	—	—	#901-6242 4/
	LSTCKX- 12	16	24	2.828	1.269	.844	6.5	—	—	—	—	—	—	#542-6703 4/
24643/21	LSTCTA- 4	14	2	4.110	0.480	.136	3.0	—	—	—	—	—	—	201-8818
24643/21	LSTCTU- 4	14	2	4.110	.430	.117	3.0	—	—	—	—	—	—	201-9521
24643/24	LSTCTX- 1	21	2	0.895	.350	.108	2.0	—	—	—	—	—	—	156-8817
	LSTCTX- 3	21	6	.895	.552	.262	3.5	—	—	—	—	—	—	#542-6704 4/
	LSTCTX- 7	21	14	.895	.731	.515	4.0	—	—	—	—	—	—	#577-3358 4/
	LSTCTX- 12	21	24	.895	.964	.844	5.0	—	—	—	—	—	—	#542-6705 4/
24643/23	LSTTSA- 1.5	22	3	.640	.380	.083	2.5	TEL-6	300	—	—	—	—	201-9540
	LSTTSA- 3	22	6	.640	.500	.137	3.0	TEL-6	300	—	—	—	—	202-0692
	LSTTSA- 5	22	10	.640	.590	.195	3.5	TEL-6	300	—	—	—	—	202-0693
	LSTTSA- 10	22	20	.640	.725	.296	4.0	TEL-6	300	—	—	—	—	201-9541
	LSTTSA- 15	22	30	.640	.850	.415	5.0	TEL-6	300	—	—	—	—	201-9542
	LSTTSA- 20	22	40	.640	.920	.504	5.5	TEL-6	300	—	—	—	—	201-9543
	LSTTSA- 30	22	60	.640	1.130	.742	6.0	TEL-6	300	—	—	—	—	202-9537
	LSTTSA- 40	22	80	.640	1.250	.930	7.0	TEL-6	300	—	—	—	—	201-9544
	LSTTSA- 50	22	100	.640	1.450	1.193	7.5	TEL-6	300	—	—	—	—	202-9538
	LSTTSA- 60	22	120	.640	1.500	1.317	8.0	TEL-6	300	—	—	—	—	201-9545
24643/23	LSTTSU- 1.5	22	3	.640	0.330	0.066	2.5	TEL-6	300	—	—	—	—	202-9528
	LSTTSU- 3	22	6	.640	.450	.113	3.0	TEL-6	300	—	—	—	—	202-9529
	LSTTSU- 5	22	10	.640	.540	.167	3.5	TEL-6	300	—	—	—	—	202-9530
	LSTTSU- 10	22	20	.640	.675	.262	4.0	TEL-6	300	—	—	—	—	202-9531
	LSTTSU- 15	22	30	.640	.800	.379	5.0	TEL-6	300	—	—	—	—	202-9532
	LSTTSU- 20	22	40	.640	.870	.461	5.5	TEL-6	300	—	—	—	—	202-9533
	LSTTSU- 30	22	60	.640	1.080	.697	6.0	TEL-6	300	—	—	—	—	202-9534
	LSTTSU- 40	22	80	.640	1.200	.874	7.0	TEL-6	300	—	—	—	—	202-9535

See footnotes at end of table.

TABLE VI (a)(3). MIL-C-24643 cable ratings and characteristics, watertight (with circuit integrity), non-flexing service (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation		Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max)				NSN 6145-01
											dc or 60 Hz		400 Hz		
											40°C Ambient	50°C Ambient	40°C Ambient	50°C Ambient	
24643/23	LSTTSU-	50	22	100	0.640	1.400	1.148	7.5	TEL-6	300	—	—	—	—	202-9536
	LSTTSU-	60	22	120	.640	1.450	1.267	8.0	TEL-6	300	—	—	—	—	204-4264

See footnotes at end of table.

TABLE VI (b)(1). MIL-C-24643 cable ratings and characteristics, watertight, non-flexing service (power and lighting). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max): dc or 60 Hz, 40°C Ambient	dc or 60 Hz, 50°C Ambient	400 Hz, 40°C Ambient	400 Hz, 50°C Ambient	NSN 6145-01
24643/53	LSDRW	14	2	4.110	0.670	0.298	3.0	STD-1	3000	26	24	—	—	201-9057
24643/53	LSDRWA	14	2	4.110	.720	.336	6.0	STD-1	3000	26	24	—	—	201-9058
24643/5	LSMDU-6	12	19	6.530	1.000	1.143	8.0	STD-1	600	—	—	—	—	202-2780
	LSMDU-14	9	19	13.090	1.395	1.783	9.5	STD-1	600	—	—	—	—	202-2781
	LSMDU-23	7	19	20.820	1.765	2.566	10.5	STD-1	600	—	—	—	—	202-2782
	LSMDU-40	4	19	41.740	2.040	4.191	12.5	STD-1	600	—	—	—	—	203-0366
	LSMDU-60	2	19	66.360	2.330	5.843	14.0	STD-1	600	—	—	—	—	202-2783
24643/6	LSMDY-6	12	19	6.530	1.190	1.360	7.0	STD-1	600	—	—	—	—	202-2784
	LSMDY-14	9	19	13.090	1.570	2.041	9.5	STD-1	600	—	—	—	—	203-5387
	LSMDY-23	7	19	20.820	1.960	2.978	12.0	STD-1	600	—	—	—	—	202-2785
	LSMDY-40	4	19	41.740	2.240	4.480	13.5	STD-1	600	—	—	—	—	202-2786
	LSMDY-60	2	19	66.360	2.525	6.471	15.0	STD-1	600	—	—	—	—	202-2787
24643/53	LSTRW	14	3	4.110	0.710	0.323	4.5	STD-1	3000	24	22	—	—	201-9523
24643/53	LSTRWA	14	3	4.110	.760	.353	4.5	STD-1	3000	24	22	—	—	201-9524
24643/53	LSSRW	14	1	4.110	.400	.106	3.0	STD-1	3000	32	30	—	—	202-2054
24643/53	LSSRWA	14	1	4.110	.450	.134	3.0	STD-1	3000	32	30	—	—	201-9056

See footnotes at end of table.

TABLE VI (b)(2). MIL-C-24643 cable ratings and characteristics, watertight, non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/47	LS1SMWA- 70	22	70	0.700	1.605	2.052	10.0	STD-1	600	—	—	—	—	202-3535
24643/47	LS1SMWU- 70	22	70	.700	1.555	1.565	10.0	STD-1	600	—	—	—	—	202-3534
24643/30	LS1SWA- 2	22	2	.700	0.505	0.120	3.5	STD-2	600	—	—	—	—	205-3661
24643/30	LS1SWA- 14	22	14	.700	.920	.506	5.5	STD-2	600	—	—	—	—	205-3662
	LS1SWA- 20	22	20	.700	1.080	.658	6.5	STD-2	600	—	—	—	—	205-3663
	LS1SWA- 30	22	30	.700	1.250	.942	7.5	STD-2	600	—	—	—	—	203-0381
24643/30	LS1SWU- 2	22	2	.700	0.455	.103	3.5	STD-2	600	—	—	—	—	203-5406
	LS1SWU- 14	22	14	.700	.870	.463	5.5	STD-2	600	—	—	—	—	203-5407
	LS1SWU- 20	22	20	.700	1.030	.618	6.5	STD-2	600	—	—	—	—	203-5408
	LS1SWU- 30	22	30	.700	1.200	.885	7.5	STD-2	600	—	—	—	—	205-3660
24643/32	LS2SWA- 3	22	6	.700	0.370	.206	4.5	STD-2	600	—	—	—	—	202-9554
	LS2SWA- 7	22	14	.700	.710	.298	4.5	STD-2	600	—	—	—	—	202-9555
	LS2SWA- 10	22	20	.700	.880	.422	5.0	STD-2	600	—	—	—	—	202-7767
	LS2SWA- 14	22	28	.700	.980	.618	6.0	STD-2	600	—	—	—	—	205-5182
	LS2SWA- 19	22	38	.700	1.090	.793	6.5	STD-2	600	—	—	—	—	202-7768
	LS2SWA- 24	22	48	.700	1.260	1.030	7.5	STD-2	600	—	—	—	—	204-4873
	LS2SWA- 30	22	60	.700	1.330	1.256	8.0	STD-2	600	—	—	—	—	203-7624
	LS2SWA- 37	22	74	.700	1.430	1.545	8.5	STD-2	600	—	—	—	—	202-3529
	LS2SWA- 44	22	88	.700	1.600	1.905	9.0	STD-2	600	—	—	—	—	202-3530
	LS2SWA- 61	22	122	.700	1.790	2.317	10.0	STD-2	600	—	—	—	—	203-4068
24643/32	LS2SWAU- 3	22	6	.700	0.520	0.175	3.5	STD-2	600	—	—	—	—	204-5540
	LS2SWAU- 7	22	14	.700	.660	.257	4.5	STD-2	600	—	—	—	—	202-9552
	LS2SWAU- 10	22	20	.700	.830	.370	5.0	STD-2	600	—	—	—	—	204-4872
	LS2SWAU- 14	22	28	.700	.930	.556	6.0	STD-2	600	—	—	—	—	202-3537
	LS2SWAU- 19	22	38	.700	1.040	.731	6.5	STD-2	600	—	—	—	—	202-9553
	LS2SWAU- 24	22	48	.700	1.210	.957	7.5	STD-2	600	—	—	—	—	202-3538
	LS2SWAU- 30	22	60	.700	1.280	1.174	8.0	STD-2	600	—	—	—	—	202-3539
	LS2SWAU- 37	22	74	.700	1.380	1.462	8.5	STD-2	600	—	—	—	—	203-0391
	LS2SWAU- 44	22	88	.700	1.550	1.812	9.0	STD-2	600	—	—	—	—	202-7766
	LS2SWAU- 61	22	122	.700	1.740	2.214	10.0	STD-2	600	—	—	—	—	205-5181
24643/56	LS2SWL- 7	16	14	2.580	0.910	0.427	7.3	STD-2	600	—	—	—	—	209-7450
24643/56	LS2SWLA- 7	16	14	2.580	.960	.467	7.3	STD-2	600	—	—	—	—	205-3645
24643/33	LS2SWU- 1	18	2	1.620	.255	.103	2.0	STD-2	600	—	—	—	—	205-3632

See footnotes at end of table.

TABLE VI (b)(2). MIL-C-24643 cable ratings and characteristics, watertight, non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/33	LS2SWU- 3	18	6	1.620	0.710	0.207	4.0	STD-2	600	—	—	—	—	203-0371
	LS2SWU- 7	18	14	1.620	.910	.358	5.0	STD-2	600	—	—	—	—	204-0543
	LS2SWU- 12	18	24	1.620	1.200	.700	6.5	STD-2	600	—	—	—	—	204-6993
	LS2SWU- 19	18	38	1.620	1.380	.810	8.0	STD-2	600	—	—	—	—	204-0544
	LS2SWU- 24	18	48	1.620	1.590	1.042	9.0	STD-2	600	—	—	—	—	210-9472
	LS2SWU- 30	18	60	1.620	1.760	1.256	9.5	STD-2	600	—	—	—	—	205-3633
	LS2SWU- 37	18	74	1.620	1.870	1.512	10.5	STD-2	600	—	—	—	—	205-3634
	LS2SWU- 61	18	122	1.620	2.300	2.321	13.5	STD-2	600	—	—	—	—	204-6994
24643/33	LS2SWUA- 1	18	2	1.620	0.305	0.130	2.0	STD-2	600	—	—	—	—	202-9507
	LS2SWUA- 3	18	6	1.620	.760	.228	4.0	STD-2	600	—	—	—	—	203-5393
	LS2SWUA- 7	18	14	1.620	.960	.392	5.0	STD-2	600	—	—	—	—	204-8927
	LS2SWUA- 12	18	24	1.620	1.250	.745	6.5	STD-2	600	—	—	—	—	204-8928
	LS2SWUA- 19	18	38	1.620	1.420	.842	8.0	STD-2	600	—	—	—	—	205-9307
	LS2SWUA- 24	18	48	1.620	1.640	1.070	9.0	STD-2	600	—	—	—	—	204-0545
	LS2SWUA- 30	18	60	1.620	1.810	1.289	9.5	STD-2	600	—	—	—	—	205-5935
	LS2SWUA- 37	18	74	1.620	1.920	1.552	10.5	STD-2	600	—	—	—	—	205-9308
	LS2SWUA- 61	18	122	1.620	2.350	2.367	13.5	STD-2	600	—	—	—	—	204-6995
24643/57	LS2UW- 42	26	84	0.278	0.790	0.493	6.5	TEL-3	—	—	—	—	—	202-7000
24643/57	LS2UWA- 42	26	84	.278	.840	.559	6.5	TEL-3	—	—	—	—	—	202-7001
24643/57	LS2UWS- 42	26	84	.278	.840	.665	10.0	TEL-3	—	—	—	—	—	202-7002
24643/46	LS2WA- 40	22	80	.700	1.420	1.030	4.0	TEL-3	600	—	—	—	—	202-3533
24643/46	LS2WAU- 40	22	80	.700	1.370	0.741	5.0	TEL-3	600	—	—	—	—	202-3532
24643/36	LS3SWA- 3	18	9	1.620	0.705	.309	4.5	STD-2	600	—	—	—	—	203-0373
	LS3SWA- 7	18	21	1.620	.990	.587	6.0	STD-2	600	—	—	—	—	202-9018
	LS3SWA- 10	18	30	1.620	1.230	.865	7.5	STD-2	600	—	—	—	—	204-4260
	LS3SWA- 14	18	42	1.620	1.330	1.133	8.5	STD-2	600	—	—	—	—	203-7602
	LS3SWA- 19	18	57	1.620	1.500	1.442	9.0	STD-2	600	—	—	—	—	203-7603
	LS3SWA- 24	18	72	1.620	1.790	1.905	10.5	STD-2	600	—	—	—	—	203-7604
	LS3SWA- 30	18	90	1.620	1.910	2.266	11.0	STD-2	600	—	—	—	—	203-7605
	LS3SWA- 37	18	111	1.620	2.010	2.781	12.0	STD-2	600	—	—	—	—	203-7606
	LS3SWA- 44	18	132	1.620	2.290	3.399	13.0	STD-2	600	—	—	—	—	203-6567
24643/36	LS3SWU- 3	18	9	1.620	0.655	0.298	4.5	STD-2	600	—	—	—	—	204-4862
	LS3SWU- 7	18	21	1.620	.940	.528	6.0	STD-2	600	—	—	—	—	202-9011

See footnotes at end of table.

TABLE VI (b)(2). MIL-C-24643 cable ratings and characteristics, watertight, non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/36	LS3SWU- 10	18	30	1.620	1.180	0.791	7.5	STD-2	600	—	—	—	—	202-9012
	LS3SWU- 14	18	42	1.620	1.280	1.052	8.5	STD-2	600	—	—	—	—	202-9013
	LS3SWU- 19	18	57	1.620	1.450	1.353	9.0	STD-2	600	—	—	—	—	202-9014
24643/36	LS3SWU- 24	18	72	1.620	1.760	1.799	10.5	STD-2	600	—	—	—	—	202-9015
	LS3SWU- 30	18	90	1.620	1.860	2.156	11.0	STD-2	600	—	—	—	—	205-5175
	LS3SWU- 37	18	111	1.620	1.990	2.664	12.0	STD-2	600	—	—	—	—	202-9016
	LS3SWU- 44	18	132	1.620	2.240	3.278	13.0	STD-2	600	—	—	—	—	202-9017
24643/36	LS3SWUS- 3	18	9	1.620	0.715	0.429	8.5	STD-2	600	—	—	—	—	204-4863
	LS3SWUS 7	18	21	1.620	1.000	.712	12.0	STD-2	600	—	—	—	—	203-6568
	LS3SWUS- 10	18	30	1.620	1.240	.988	15.0	STD-2	600	—	—	—	—	204-4261
	LS3SWUS- 14	18	42	1.620	1.340	1.315	16.0	STD-2	600	—	—	—	—	203-6569
	LS3SWUS- 19	18	57	1.620	1.510	1.691	18.0	STD-2	600	—	—	—	—	203-6570
	LS3SWUS- 24	18	72	1.620	1.800	2.068	21.5	STD-2	600	—	—	—	—	203-2371
	LS3SWUS- 30	18	90	1.620	1.920	2.479	23.0	STD-2	600	—	—	—	—	203-4031
	LS3SWUS- 37	18	111	1.620	2.050	3.063	25.0	STD-2	600	—	—	—	—	203-5395
	LS3SWUS- 44	18	132	1.620	2.300	3.605	28.0	STD-2	600	—	—	—	—	203-8502
24643/38	LSECM	20	16	1.111	1.370	1.545	11.0	STD-2	600	—	—	—	—	202-3527
		18	56	1.620	—	—	—	—	—	—	—	—	—	—
24643/38	LSECMA	20	16	1.111	1.420	1.600	11.5	STD-2	600	—	—	—	—	202-3528
		18	56	1.620	—	—	—	—	—	—	—	—	—	—
24643/10	LSPBTM- 5	22	10	0.640	0.590	0.167	3.5	TEL-3	600	—	—	—	—	205-3654
	LSPBTM- 15	22	30	.640	.800	.331	5.0	TEL-3	600	—	—	—	—	205-3655
	LSPBTM- 30	22	60	.640	1.030	.544	6.5	TEL-3	600	—	—	—	—	203-6581
24643/10	LSPBTMU- 5	22	10	.640	0.540	.131	3.5	TEL-3	600	—	—	—	—	202-7765
	LSPBTMU- 15	22	30	.640	.750	.283	5.0	TEL-3	600	—	—	—	—	203-6580
	LSPBTMU- 30	22	60	.640	.980	.484	6.5	TEL-3	600	—	—	—	—	202-2830

See footnotes at end of table.

TABLE VI (c)(1). MIL-C-24643 cable ratings and characteristics, non-watertight (with circuit integrity), non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/25	LSPI- 3	18	6	1.620	0.685	0.285	4.5	STD-4	—	—	—	—	—	#161-1520
	LSPI- 7	18	14	1.620	.900	.505	5.5	STD-4	—	—	—	—	—	#495-3384
	LSPI- 12	18	24	1.620	1.155	1.372	7.0	STD-4	—	—	—	—	—	#163-7375

See footnotes at end of table.

TABLE VI (d)(1). MIL-C-24643 cable ratings and characteristics, non-watertight, non-flexing service, (power and lighting). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	Ampacity, each conductor (amps, max) dc or 60 Hz 50°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 40°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 50°C Ambient	NSN 6145-01
24643/48	LSDNW- 3	16	2	2.580	0.390	0.071	2.0	STD-1	1000	13	12	13	12	202-3513
	LSDNW- 4	14	2	4.110	.430	.092	2.0	STD-1	1000	22	20	22	20	203-0376
	LSDNW- 9	10	2	10.380	.545	.179	2.5	STD-1	1000	44	41	44	41	202-3514
	LSDNW- 14	9	2	13.090	.610	.204	3.0	STD-1	1000	60	55	60	55	203-4032
	LSDNW- 23	7	2	20.820	.690	.292	3.5	STD-1	1000	78	72	78	72	202-3515
	LSDNW- 50	3	2	52.620	.910	.603	4.5	STD-1	1000	126	116	126	116	202-3516
	LSDNW- 75	1	2	83.690	1.080	.882	5.0	STD-1	1000	168	155	168	155	202-3517
	LSDNW- 100	0	2	105.600	1.170	1.058	5.5	STD-1	1000	199	183	199	183	202-3492
24643/48	LSDNWA- 3	16	2	2.580	0.440	0.090	2.0	STD-1	1000	13	12	13	12	202-3493
	LSDNWA- 4	14	2	4.410	.480	.112	2.0	STD-1	1000	22	20	22	20	202-3494
	LSDNWA- 9	10	2	10.380	.595	.209	2.5	STD-1	1000	44	41	44	41	202-3495
	LSDNWA- 14	9	2	13.090	.660	.230	3.0	STD-1	1000	60	55	60	55	202-3496
	LSDNWA- 23	7	2	20.820	.740	.329	3.5	STD-1	1000	78	72	78	72	202-3497
	LSDNWA- 50	3	2	52.620	.960	.660	4.0	STD-1	1000	126	116	126	116	202-3498
	LSDNWA- 75	1	2	83.690	1.130	.939	5.0	STD-1	1000	168	155	168	155	202-3499
	LSDNWA- 100	0	2	105.600	1.220	1.126	5.5	STD-1	1000	199	183	199	183	202-3500
24643/50	LSFNW- 3	16	4	2.580	0.447	0.104	2.0	STD-1	1000	11	10	11	10	203-6571
	LSFNW- 4	14	4	4.110	.513	.141	2.0	STD-1	1000	18	17	18	17	203-6572
	LSFNW- 9	10	4	10.380	.630	.268	2.5	STD-1	1000	39	36	39	36	203-6573
	LSFNW- 23	7	4	20.820	.830	.482	4.0	STD-1	1000	69	64	69	64	203-6574
24643/50	LSFNWA- 3	16	4	2.580	0.497	.126	2.0	STD-1	1000	11	10	11	10	203-6575
	LSFNWA- 4	14	4	4.110	.563	.164	2.0	STD-1	1000	18	17	18	17	203-6482
	LSFNWA- 9	10	4	10.380	.680	.302	2.5	STD-1	1000	39	36	39	36	206-7007
	LSFNWA- 23	7	4	20.820	.880	.527	4.0	STD-1	1000	69	64	69	64	203-6483
24643/49	LSTNW- 3	16	3	2.580	.411	.085	1.5	STD-1	1000	11	10	11	10	202-3501
	LSTNW- 4	14	3	4.110	.449	.107	2.0	STD-1	1000	18	17	18	17	203-4033
	LSTNW- 9	10	3	10.380	.625	.240	2.5	STD-1	1000	39	36	39	36	202-3502
	LSTNW- 14	9	3	13.090	.670	.271	2.5	STD-1	1000	51	47	51	47	202-3503
	LSTNW- 23	7	3	20.820	.760	.390	3.5	STD-1	1000	69	64	69	64	202-3504
	LSTNW- 50	3	3	52.620	.969	.793	4.5	STD-1	1000	110	101	110	101	202-3505
	LSTNW- 75	1	3	83.690	1.134	1.200	5.0	STD-1	1000	148	136	148	136	202-3506
	LSTNW- 100	0	3	105.600	1.266	1.452	6.0	STD-1	1000	174	160	174	160	202-3507
	LSTNW- 150	000	3	167.800	1.515	2.218	7.0	STD-1	1000	235	216	235	216	202-3508

See footnotes at end of table.

TABLE VI (d)(1). MIL-C-24643 cable ratings and characteristics, non-watertight, non-flexing service, (power and lighting). - Continued

MIL-C-	Cable type designation		Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	Ampacity, each conductor (amps, max) dc or 60 Hz 50°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 40°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 50°C Ambient	NSN 6145-01
24643/49	LSTNWA-	3	16	3	2.580	0.461	0.107	1.5	STD-1	1000	11	10	11	10	203-4034
	LSTNWA-	4	14	3	4.110	.499	.130	2.0	STD-1	1000	18	17	18	17	203-3518
	LSTNWA-	9	10	3	10.380	.675	.271	2.5	STD-1	1000	39	36	39	36	202-3519
	LSTNWA-	14	9	3	13.090	.720	.306	2.5	STD-1	1000	51	47	51	47	202-3520
	LSTNWA-	23	7	3	20.820	.810	.427	3.5	STD-1	1000	69	64	69	64	202-3521
	LSTNWA-	50	3	3	52.620	1.019	.868	4.5	STD-1	1000	110	101	110	101	202-3522
	LSTNWA-	75	1	3	83.690	1.184	1.276	5.0	STD-1	1000	148	136	148	136	202-3523
	LSTNWA-	100	0	3	105.600	1.316	1.510	6.0	STD-1	1000	174	160	174	160	202-3524
	LSTNWA-	150	000	3	167.800	1.565	2.277	7.0	STD-1	1000	235	216	235	216	202-3525
24643/43	LS2SJ-	7	7	2	20.820	0.615	0.288	2.5	STD-3	1000	56	49	56	49	205-3636
	LS2SJ-	9	9	2	13.090	.545	.232	2.5	STD-3	1000	42	35	42	35	202-7749
	LS2SJ-	11	10	2	10.380	.460	.164	2.5	STD-3	1000	31	25	16	14	202-6974
	LS2SJ-	12	12	2	6.530	.430	.134	2.0	STD-3	1000	23	17	16	14	202-7748
	LS2SJ-	14	14	2	3.831	.350	.083	2.0	STD-3	1000	16	14	16	14	202-7747
	LS2SJ-	16	16	2	2.426	.325	.074	2.0	STD-3	1000	13	11	—	—	202-7746
	LS2SJ-	18	18	2	1.900	.310	.060	1.5	STD-3	1000	10	8	—	—	202-6973
	LS2SJ-	20	20	2	1.216	.290	.056	1.5	STD-3	1000	6	5	—	—	202-7769
	LS2SJ-	22	22	2	0.754	.275	.050	1.0	STD-3	1000	3	2	—	—	205-3665
24643/43	LS2SJA-	7	7	2	20.820	.665	.325	2.5	STD-3	600	56	49	56	49	205-3640
	LS2SJA-	9	9	2	13.090	.595	.271	2.5	STD-3	600	42	35	42	35	205-5176
	LS2SJA-	11	10	2	10.380	.510	.200	2.5	STD-3	600	31	25	16	14	205-3639
	LS2SJA-	12	12	2	6.530	.480	.163	2.0	STD-3	600	23	17	16	14	208-6876
	LS2SJA-	14	14	2	3.831	.400	.105	2.0	STD-3	600	16	14	16	14	203-0375
	LS2SJA-	16	16	2	2.426	.375	.093	2.0	STD-3	600	13	11	—	—	205-3638
	LS2SJA-	18	18	2	1.900	.360	.076	1.5	STD-3	600	10	8	—	—	203-0374
	LS2SJA-	20	20	2	1.216	.340	.071	1.5	STD-3	600	6	5	—	—	205-3667
	LS2SJA-	22	22	2	0.754	.325	.063	1.5	STD-3	600	3	2	—	—	205-3666
24643/43	LS3SJ-	9	9	3	13.090	.620	.310	3.5	STD-3	600	33	27	33	27	202-7753
	LS3SJ-	12	12	3	6.530	.455	.170	2.5	STD-3	600	21	15	21	15	202-7752
	LS3SJ-	14	14	3	3.831	.370	.101	2.0	STD-3	600	14	12	14	12	202-7751
	LS3SJ-	16	16	3	2.426	.340	.085	2.0	STD-3	600	11	10	11	10	205-3637
	LS3SJ-	18	18	3	1.900	.325	.076	2.0	STD-3	600	9	7	9	7	202-7750
	LS3SJ-	20	20	3	1.216	.300	.064	1.5	STD-3	600	6	5	6	5	202-7771

See footnotes at end of table.

TABLE VI(d)(1). MIL-C-24643 cable ratings and characteristics, non-watertight, non-flexing service, (power and lighting). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
	LS3SJ- 22	22	3	0.754	0.285	0.054	1.5	STD-3	600	3	2	3	2	202-7770
24643/43	LS3SJA- 9	9	3	13.090	.670	.350	3.5	STD-3	600	33	27	33	27	202-7754
	LS3SJA- 12	12	3	6.530	.505	.207	2.5	STD-3	600	21	15	21	15	202-6976
	LS3SJA- 14	14	3	3.831	.420	.128	2.0	STD-3	600	14	12	14	12	206-9745
	LS3SJA- 16	16	3	2.426	.390	.107	2.0	STD-3	600	11	10	11	10	205-3642
	LS3SJA- 18	18	3	1.900	.375	.096	2.0	STD-3	600	9	7	9	7	205-3641
	LS3SJA- 20	20	3	1.216	.350	.081	1.5	STD-3	600	6	5	6	5	205-3669
	LS3SJA- 22	22	3	0.754	.335	.068	1.5	STD-3	600	3	2	3	2	205-3668
24643/43	LS4SJ- 14	14	4	3.831	.395	.128	2.5	STD-3	600	11	9	—	—	202-6975
	LS4SJ- 16	16	4	2.426	.360	.079	2.5	STD-3	600	9	7	—	—	204-4867
	LS4SJ- 20	20	4	1.216	.320	.048	2.0	STD-3	600	6	5	—	—	202-7772
24643/43	LS4SJA- 14	14	4	3.831	.445	.158	2.5	STD-3	600	11	9	—	—	205-3643
	LS4SJA- 16	16	4	2.426	.410	.133	2.5	STD-3	600	9	7	—	—	202-6977
	LS4SJA- 20	20	4	1.216	.370	.091	2.0	STD-3	600	6	5	—	—	202-6999

See footnotes at end of table.

TABLE VI (d)(2). MIL-C-24643 cable ratings and characteristics, non-watertight, non-flexing service, (control). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/55	LS4NW8- 8	8	4	16.510	0.740	0.612	6.0	STD-1	—	—	—	—	—	210-2345
24643/55	LS4NWA8- 8	8	4	16.510	.790	.691	6.0	STD-1	—	—	—	—	—	205-9306
24643/54	LS8NW6- 6	12	8	6.530	.670	.366	5.5	STD-1	—	—	—	—	—	201-9059
24643/54	LS8NWA6- 6	12	8	6.530	.720	.413	5.5	STD-1	—	—	—	—	—	201-9060
24643/51	LSMNW- 7	18	7	1.620	.400	.088	1.5	STD-1	1000	12/8 [1/]	9/6 [1/]	12/8 [1/]	9/6 [1/]	202-9019
	LSMNW- 10	18	10	1.620	.495	.127	1.5	STD-1	1000	12/8	9/6	12/8	9/6	204-6997
	LSMNW- 14	18	14	1.620	.535	.155	2.0	STD-1	1000	12/8	9/6	12/8	9/6	205-3644
	LSMNW- 19	18	19	1.620	.590	.198	2.0	STD-1	1000	12/8	9/6	12/8	9/6	203-8503
	LSMNW- 24	18	24	1.620	.685	.259	2.5	STD-1	1000	12/6	9/5	12/6	9/5	202-9020
	LSMNW- 30	18	30	1.620	.725	.300	2.5	STD-1	1000	12/6	9/5	12/6	9/5	202-9021
	LSMNW- 37	18	37	1.620	.785	.361	3.0	STD-1	1000	12/6	9/5	12/6	9/5	202-9022
	LSMNW- 44	18	44	1.620	.890	.447	3.5	STD-1	1000	12/5	9/4	12/5	9/4	202-9023
24643/51	LSMNWA- 7	18	7	1.620	.450	.111	1.5	STD-1	1000	12/8	9/6	12/8	9/6	202-9024
	LSMNWA- 10	18	10	1.620	.545	.154	1.5	STD-1	1000	12/8	9/6	12/8	9/6	202-9025
	LSMNWA- 14	18	14	1.620	.585	.181	2.0	STD-1	1000	12/8	9/6	12/8	9/6	202-9026
	LSMNWA- 19	18	19	1.620	.640	.231	2.0	STD-1	1000	12/8	9/6	12/8	9/6	203-9430
	LSMNWA- 24	18	24	1.620	.735	.292	2.5	STD-1	1000	12/6	9/5	12/6	9/5	203-9431
	LSMNWA- 30	18	30	1.620	.775	.339	2.5	STD-1	1000	12/6	9/5	12/6	9/5	202-9027
	LSMNWA- 37	18	37	1.620	.835	.395	3.0	STD-1	1000	12/6	9/5	12/6	9/5	203-9432
	LSMNWA- 44	18	44	1.620	.940	.489	3.5	STD-1	1000	12/5	9/4	12/5	9/4	202-6978
24643/34	LSMS- 37	16	37	2.580	.800	.618	5.0	STD-1	300	11/5	9/3	11/5	9/3	201-9522
24643/34	LSMSA- 37	16	37	2.580	.850	.676	5.0	STD-1	300	11/5	9/3	11/5	9/3	202-6967
24643/29	LSMU- 14	20	14	1.111	.400	.132	3.0	STD-1	300	—	—	—	—	205-9320
24643/29	LSMUS- 14	20	14	1.111	.460	.217	5.5	STD-1	300	—	—	—	—	204-0570
24643/29	LSMA- 14	20	14	1.111	.450	.160	3.0	STD-1	300	—	—	—	—	204-0569

See footnotes at end of table.

TABLE VI (d)(3). MIL-C-24643 cable ratings and characteristics, non-watertight, non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation		Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	Ampacity, each conductor (amps, max) dc or 60 Hz 50°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 40°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 50°C Ambient	NSN 6145-01
24643/28	LS1S5OMA-	16	22	16	0.700	0.875	0.360	5.5	STD-1	300	—	—	—	—	205-3656
	LS1S5OMA-	20	22	20	.700	.955	.417	6.0	STD-1	300	—	—	—	—	205-3657
	LS1S5OMA-	40	22	40	.700	1.235	.756	7.5	STD-1	300	—	—	—	—	205-3658
	LS1S5OMA-	70	22	70	.700	1.605	1.798	10.0	STD-1	300	—	—	—	—	205-3659
24643/28	LS1S5OMU-	16	22	16	.700	0.825	0.329	5.5	STD-1	300	—	—	—	—	202-9539
	LS1S5OMU-	20	22	20	.700	.905	.381	6.0	STD-1	300	—	—	—	—	208-5465
	LS1S5OMU-	40	22	40	.700	1.185	.710	7.5	STD-1	300	—	—	—	—	203-6582
	LS1S5OMU-	70	22	70	.700	1.555	1.751	10.5	STD-1	300	—	—	—	—	203-3308
24643/28	LS1S5OMUS-	16	22	16	.700	0.885	0.444	10.5	STD-1	300	—	—	—	—	202-9540
	LS1S5OMUS-	20	22	20	.700	.965	.514	11.5	STD-1	300	—	—	—	—	202-9541
	LS1S5OMUS-	40	22	40	.700	1.245	.887	15.0	STD-1	300	—	—	—	—	202-9542
	LS1S5OMUS-	70	22	70	.700	1.615	2.188	19.5	STD-1	300	—	—	—	—	203-6583
24643/39	LS1S75MA-	8	22	8	.700	1.080	0.612	6.5	STD-2	300	—	—	—	—	202-3531
24643/39	LS1S75MU-	8	22	8	.700	1.030	.552	6.5	STD-2	300	—	—	—	—	202-8476
24643/41	LS1SA-	44	22	44	1.111	1.040	.698	6.5	STD-2	600	—	—	—	—	203-4069
24643/41	LS1SAU-	44	22	44	1.111	0.990	.638	6.5	STD-2	600	—	—	—	—	205-5183
24643/40	LS1SMA-	5	22	5	0.700	.550	.156	4.5	STD-2	600	—	—	—	—	202-0695
24643/40	LS1SMU-	5	22	5	.700	.500	.128	3.0	STD-2	600	—	—	—	—	202-0694
24643/42	LS1SU-	36	20	32	1.111	.985	.642	6.0	STD-2	600	—	—	—	—	203-4065
			18	4	1.620	—	—	—	—	—	—	—	—	—	—
	LS1SU-	60	20	60	1.111	1.310	1.060	10.0	STD-2	600	—	—	—	—	202-9047
24643/42	LS1SUA-	36	20	32	1.111	1.035	0.702	6.0	STD-2	600	—	—	—	—	203-4066
			18	4	1.620	—	—	—	—	—	—	—	—	—	—
	LS1SUA-	60	20	60	1.111	1.360	1.102	10.0	STD-2	600	—	—	—	—	205-3664
24643/27	LS2A-	40	22	80	0.700	1.420	0.741	4.0	TEL-3	600	—	—	—	—	202-8474
24643/27	LS2AU-	40	22	80	.700	1.370	.721	4.0	TEL-3	600	—	—	—	—	202-8473
24643/27	LS2AUS-	40	22	80	.700	1.430	.901	17.0	TEL-3	600	—	—	—	—	202-8475
24643/58	LS2CS-	6	26	12	.278	0.430	.126	5.5	STD-6	300	—	—	—	—	203-9466
	LS2CS-	18	26	36	.278	.590	.235	7.0	STD-6	300	—	—	—	—	202-9058
	LS2CS-	42	26	84	.278	.800	.419	9.5	STD-6	300	—	—	—	—	203-9467
	LS2CS-	60	26	120	.278	.930	.562	11.5	STD-6	300	—	—	—	—	202-9059
	LS2CS-	77	26	154	.278	1.070	.651	13.0	STD-6	300	—	—	—	—	203-9468
24643/31	LS2SA-	3	22	6	.700	0.570	.206	3.5	STD-2	600	—	—	—	—	202-9546

See footnotes at end of table.

TABLE VI (d)(3). MIL-C-24643 cable ratings and characteristics, non-watertight, non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/31	LS2SA- 7	22	14	0.700	0.710	0.298	4.5	STD-2	600	—	—	—	—	203-7621
	LS2SA- 10	22	20	.700	.880	.422	5.0	STD-2	600	—	—	—	—	203-7622
	LS2SA- 14	22	28	.700	.980	.618	6.0	STD-2	600	—	—	—	—	204-7020
	LS2SA- 19	22	38	.700	1.090	.793	6.5	STD-2	600	—	—	—	—	203-7623
	LS2SA- 24	22	48	.700	1.260	1.030	7.5	STD-2	600	—	—	—	—	203-0383
	LS2SA- 30	22	60	.700	1.330	1.256	7.5	STD-2	600	—	—	—	—	203-0384
	LS2SA- 37	22	74	.700	1.430	1.545	11.5	STD-2	600	—	—	—	—	203-0385
	LS2SA- 44	22	88	.700	1.600	1.905	13.0	STD-2	600	—	—	—	—	203-0386
	LS2SA- 61	22	122	.700	1.790	2.317	14.5	STD-2	600	—	—	—	—	203-4067
24643/31	LS2SU- 3	22	6	.700	0.520	0.170	3.5	STD-2	600	—	—	—	—	203-0382
	LS2SU- 7	22	14	.700	.660	.255	4.5	STD-2	600	—	—	—	—	202-9543
	LS2SU- 10	22	20	.700	.830	.368	5.0	STD-2	600	—	—	—	—	202-9544
	LS2SU- 14	22	28	.700	.930	.558	6.0	STD-2	600	—	—	—	—	204-8939
	LS2SU- 19	22	38	.700	1.040	.732	6.5	STD-2	600	—	—	—	—	203-7618
	LS2SU- 24	22	48	.700	1.210	.953	7.5	STD-2	600	—	—	—	—	204-2281
	LS2SU- 30	22	60	.700	1.280	1.176	8.0	STD-2	600	—	—	—	—	203-7619
	LS2SU- 37	22	74	.700	1.380	1.459	8.5	STD-2	600	—	—	—	—	202-9545
	LS2SU- 44	22	88	.700	1.550	1.809	9.0	STD-2	600	—	—	—	—	204-4871
	LS2SU- 61	22	122	.700	1.740	2.209	10.0	STD-2	600	—	—	—	—	203-7620
24643/31	LS2SUS- 3	22	6	.700	0.580	0.261	7.0	STD-2	600	—	—	—	—	203-0387
	LS2SUS- 7	22	14	.700	.720	.367	8.5	STD-2	600	—	—	—	—	204-4265
	LS2SUS- 10	22	20	.700	.890	.496	11.0	STD-2	600	—	—	—	—	203-0388
	LS2SUS- 14	22	28	.700	.990	.753	12.0	STD-2	600	—	—	—	—	202-9547
	LS2SUS- 19	22	38	.700	1.100	.915	13.5	STD-2	600	—	—	—	—	203-0399
	LS2SUS- 24	22	48	.700	1.270	1.191	15.5	STD-2	600	—	—	—	—	202-9548
	LS2SUS- 30	22	60	.700	1.340	1.470	16.0	STD-2	600	—	—	—	—	202-9549
	LS2SUS- 37	22	74	.700	1.440	1.823	17.5	STD-2	600	—	—	—	—	202-9550
	LS2SUS- 44	22	88	.700	1.610	2.080	19.5	STD-2	600	—	—	—	—	202-9551
	LS2SUS- 61	22	122	.700	1.800	2.540	22.0	STD-2	600	—	—	—	—	203-0390

See footnotes at end of table.

TABLE VI (d)(3). MIL-C-24643 cable ratings and characteristics, non-watertight, non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/45	LS2U- 10	26	20	0.278	0.480	.118	4.0	TEL-3	300	—	—	—	—	202-8477
	LS2U- 15	26	30	.278	.560	.164	5.0	TEL-3	300	—	—	—	—	202-8478
	LS2U- 19	26	38	.278	.580	.185	6.0	TEL-3	300	—	—	—	—	202-9048
	LS2U- 30	26	60	.278	.700	.257	7.0	TEL-3	300	—	—	—	—	202-9049
	LS2U- 45	26	90	.278	.870	.360	8.5	TEL-3	300	—	—	—	—	202-9050
	LS2U- 60	26	120	.278	.960	.442	10.0	TEL-3	300	—	—	—	—	202-9051
24643/45	LS2UA- 10	26	20	.278	.530	.143	4.0	TEL-3	300	—	—	—	—	202-9052
	LS2UA- 15	26	30	.278	.610	.191	5.0	TEL-3	300	—	—	—	—	202-9053
	LS2UA- 19	26	38	.278	.630	.216	6.0	TEL-3	300	—	—	—	—	202-9054
	LS2UA- 30	26	60	.278	.750	.290	7.0	TEL-3	300	—	—	—	—	202-9055
	LS2UA- 45	26	90	.278	.920	.394	8.5	TEL-3	300	—	—	—	—	202-9056
	LS2UA- 60	26	120	.278	1.010	.483	10.0	TEL-3	300	—	—	—	—	202-9057
24643/35	LS3SA- 3	18	9	1.620	0.750	.309	4.5	STD-2	600	—	—	—	—	202-9509
	LS3SA- 7	18	21	1.620	.960	.587	6.0	STD-2	600	—	—	—	—	203-5394
	LS3SA- 10	18	30	1.620	1.240	.865	7.5	STD-2	600	—	—	—	—	202-3489
	LS3SA- 14	18	42	1.620	1.340	1.133	8.5	STD-2	600	—	—	—	—	202-3512
	LS3SA- 19	18	57	1.620	1.480	1.442	9.0	STD-2	600	—	—	—	—	202-0689
	LS3SA- 24	18	72	1.620	1.720	1.905	10.5	STD-2	600	—	—	—	—	202-6968
	LS3SA- 30	18	90	1.620	1.820	2.266	11.0	STD-2	600	—	—	—	—	202-6969

See footnotes at end of table.

TABLE VI (d)(3). MIL-C-24643 cable ratings and characteristics, non-watertight, non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/35	LS3SA- 37	18	111	1.620	1.980	2.781	12.0	STD-2	600	—	—	—	—	205-5174
	LS3SA- 44	18	132	1.620	2.200	3.399	13.0	STD-2	600	—	—	—	—	202-9510
24643/35	LS3SU- 3	18	9	1.620	0.700	0.262	4.5	STD-2	600	—	—	—	—	202-3487
	LS3SU- 7	18	21	1.620	.910	.528	6.5	STD-2	600	—	—	—	—	203-3300
	LS3SU- 10	18	30	1.620	1.190	.791	7.5	STD-2	600	—	—	—	—	202-8467
	LS3SU- 14	18	42	1.620	1.290	1.054	5.5	STD-2	600	—	—	—	—	202-8468
	LS3SU- 19	18	57	1.620	1.430	1.353	9.0	STD-2	600	—	—	—	—	202-3488
	LS3SU- 24	18	72	1.620	1.670	1.799	10.5	STD-2	600	—	—	—	—	202-8469
	LS3SU- 30	18	90	1.620	1.770	2.266	11.0	STD-2	600	—	—	—	—	202-9508
	LS3SU- 37	18	111	1.620	1.930	2.664	12.0	STD-2	600	—	—	—	—	202-8470
	LS3SU- 44	18	132	1.620	2.150	3.273	13.0	STD-2	600	—	—	—	—	203-0372
24643/35	LS3SUS- 3	18	9	1.620	0.760	0.444	9.5	STD-2	600	—	—	—	—	202-6970
	LS3SUS- 7	18	21	1.620	.970	.792	12.0	STD-2	600	—	—	—	—	202-0690
	LS3SUS- 10	18	30	1.620	1.250	1.081	15.0	STD-2	600	—	—	—	—	202-0691
	LS3SUS- 14	18	42	1.620	1.350	1.416	16.5	STD-2	600	—	—	—	—	202-3490
	LS3SUS- 19	18	57	1.620	1.490	1.802	18.0	STD-2	600	—	—	—	—	202-6971
	LS3SUS- 24	18	72	1.620	1.730	2.190	21.0	STD-2	600	—	—	—	—	204-4859
	LS3SUS- 30	18	90	1.620	1.830	2.605	22.0	STD-2	600	—	—	—	—	204-4860
	LS3SUS- 37	18	111	1.620	1.990	3.301	24.0	STD-2	600	—	—	—	—	202-6972

See footnotes at end of table.

TABLE VI (d)(3). MIL-C-24643 cable ratings and characteristics, non-watertight, non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation		Conductor size: AWG or MCM	Number of con-ductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps. max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/35	LS3SUS-	44	18	132	1.620	2.210	3.908	26.5	STD-2	600	—	—	—	—	204-4861
24643/37	LS3U-	3	18	9	1.620	0.620	0.123	4.5	STD-4	300	—	—	—	—	203-9429
	LS3U-	7	18	21	1.620	.810	.288	5.5	STD-4	300	—	—	—	—	205-3635
	LS3U-	12	18	36	1.620	1.090	.491	7.5	STD-4	300	—	—	—	—	204-4864
24643/37	LS3UA-	3	18	9	1.620	0.670	.138	5.5	STD-4	300	—	—	—	—	204-4865
	LS3UA-	7	18	21	1.620	.860	.315	5.5	STD-4	300	—	—	—	—	204-4866
	LS3UA-	12	18	36	1.620	1.140	.522	7.5	STD-4	600	—	—	—	—	204-6996
24643/9	LSMRI-	D1.5	20	2	1.020	.075	.010	—	STD-3	—	3	3	—	—	202-7764
	LSMRI-	D2.5	16	2	2.580	.102	.022	—	STD-3	—	8	6	—	—	208-5455
	LSMRI-	T2.5	16	3	2.580	.102	.033	—	STD-3	—	7	6	—	—	205-3627
24643/52	LSTPNW-	1.5	22	3	0.640	.235	.024	1.0	TEL-3	300	—	—	—	—	205-3670
	LSTPNW-	3	22	6	.640	.310	.039	1.0	TEL-3	300	—	—	—	—	205-3671
	LSTPNW-	5	22	10	.640	.365	.059	1.5	TEL-3	300	—	—	—	—	205-3672
	LSTPNW-	10	22	20	.640	.470	.104	1.5	TEL-3	300	—	—	—	—	206-7518
	LSTPNW-	15	22	30	.640	.530	.138	2.0	TEL-3	300	—	—	—	—	205-3673
	LSTPNW-	20	22	40	.640	.575	.172	2.0	TEL-3	300	—	—	—	—	205-3674
	LSTPNW-	30	22	60	.640	.680	.255	2.5	TEL-3	300	—	—	—	—	201-8819
	LSTPNW-	40	22	80	.640	.765	.328	3.0	TEL-3	300	—	—	—	—	201-8820
24643/52	LSTPNWA-	1.5	22	3	.640	.285	.032	1.0	TEL-3	300	—	—	—	—	201-8821
	LSTPNWA-	3	22	6	.640	.360	.062	1.0	TEL-3	300	—	—	—	—	201-9546
	LSTPNWA-	5	22	10	.640	.415	.074	1.5	TEL-3	300	—	—	—	—	201-8822
	LSTPNWA-	10	22	20	.640	.520	.126	1.5	TEL-3	300	—	—	—	—	201-9547
	LSTPNWA-	15	22	30	.640	.580	.161	2.0	TEL-3	300	—	—	—	—	201-9548
	LSTPNWA-	20	22	40	.640	.625	.201	2.0	TEL-3	300	—	—	—	—	201-9549
	LSTPNWA-	30	22	60	.640	.730	.288	2.5	TEL-3	300	—	—	—	—	201-9550
	LSTPNWA-	40	22	80	.640	.815	.370	3.0	TEL-3	300	—	—	—	—	205-9321

See footnotes at end of table.

TABLE VI (c)(1). MIL-C-24643 cable ratings and characteristics, non-watertight, flexing service, (power and lighting). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/1	LSCVSF- 4	3	3	52.620	1.450	1.328	9.0	STD-3	600	100	75	100	75	202-9490
		5	1	33.090	—	—	-	—	—	—	—	—	—	—
24643/3	LSDHOF- 3	16	2	2.580	0.425	0.101	3.0	STD-3 [1/]	600	23	21	23	21	201-9494
	LSDHOF- 4	14	2	4.110	.460	.117	3.5	STD-3 [1/]	600	30	28	30	28	202-7745
	LSDHOF- 6	12	2	6.530	.510	.150	4.0	STD-3 [1/]	600	41	37	41	37	202-2036
	LSDHOF- 9	9	2	9.045	.570	.172	4.5	STD-3 [1/]	600	50	45	50	45	202-2037
	LSDHOF- 14	14	2	14.070	.705	.293	5.0	STD-3 [1/]	600	60	54	60	54	203-0365
	LSDHOF- 23	7	2	22.910	.860	.395	6.5	STD-3 [1/]	600	80	72	80	72	202-2038
	LSDHOF- 30	5	2	33.090	.960	.690	7.5	STD-3 [1/]	600	90	83	90	83	202-2039
	LSDHOF- 83	83	2	84.230	1.450	1.359	11.0	STD-3 [1/]	600	169	152	169	152	202-0661
	LSDHOF- 250	250	2	252.700	2.100	2.811	17.0	STD-3 [1/]	600	322	287	285	254	202-0662
	LSDHOF- 400	400	2	413.500	2.500	4.532	20.0	STD-3 [1/]	600	422	382	290	262	202-0663
24643/3	LSFHOF- 3	16	4	2.580	0.480	0.130	4.0	STD-3 [1/]	600	17	16	17	16	201-9495
	LSFHOF- 4	14	4	4.110	.550	.165	4.5	STD-3 [1/]	600	23	21	23	21	202-0672
	LSFHOF- 9	9	4	9.045	.660	.281	5.5	STD-3 [1/]	600	36	34	36	34	202-0673
	LSFHOF- 42	42	4	42.110	1.380	1.210	11.0	STD-3 [1/]	600	79	73	79	73	202-0674
	LSFHOF- 60	60	4	61.260	1.510	1.550	12.0	STD-3 [1/]	600	95	80	95	80	202-9491
	LSFHOF- 133	133	4	137.800	2.000	2.863	16.0	STD-3 [1/]	600	163	148	155	140	202-0675
24643/3	LSSHOF- 3	16	1	2.580	0.210	0.027	1.5	STD-3 [1/]	600	20	18	20	18	201-9530
	LSSHOF- 23	7	1	20.820	.460	.143	3.5	STD-3 [1/]	600	88	80	88	80	201-9531
	LSSHOF- 60	60	1	61.260	.600	.341	5.0	STD-3 [1/]	600	162	153	162	153	201-9532
	LSSHOF- 150	150	1	153.100	.870	.769	7.0	STD-3 [1/]	600	285	263	285	263	210-4000
	LSSHOF- 200	200	1	199.100	.980	.966	8.0	STD-3 [1/]	600	323	306	—	—	201-9533
	LSSHOF- 250	250	1	252.700	1.085	1.318	8.5	STD-3 [1/]	600	397	362	—	—	202-2051
	LSSHOF- 500	500	1	500.000	1.450	2.585	11.5	STD-3 [1/]	600	602	578	—	—	202-2052
	LSSHOF- 650	650	1	650.000	1.610	3.090	13.0	STD-3 [1/]	600	698	658	—	—	202-2053
	LSSHOF- 800	800	1	812.700	1.670	3.306	13.5	STD-3 [1/]	600	803	732	—	—	201-9534
24643/11	LSSSF- 300	300	1	300.000	1.100	1.287	6.6	—	600	—	—	—	—	204-5529
24643/3	LSTHOF- 3	16	3	2.580	0.450	0.094	3.5	STD-3 [1/]	600	19	17	19	17	202-0664
	LSTHOF- 4	14	3	4.110	.480	.136	4.0	STD-3 [1/]	600	25	23	25	23	205-3626
	LSTHOF- 6	12	3	6.530	.550	.179	4.5	STD-3 [1/]	600	33	31	33	31	202-0665
	LSTHOF- 9	9	3	9.045	.600	.201	5.0	STD-3 [1/]	600	38	34	38	34	202-0666
	LSTHOF- 14	14	3	14.070	.750	.346	6.0	STD-3 [1/]	600	50	46	50	46	202-0667

See footnotes at end of table.

TABLE VI (c)(1). MIL-C-24643 cable ratings and characteristics, non-watertight, flexing service, (power and lighting). - Continued

MIL-C-	Cable type designation		Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24643/3	LSTHOF-	23	7	3	22.910	0.900	0.506	7.0	STD-3 3/	600	70	64	70	64	202-0668
	LSTHOF-	42	42	3	42.110	1.250	.986	10.0	STD-3 3/	600	93	86	93	86	202-0669
	LSTHOF-	150	150	3	153.100	1.820	2.470	13.5	STD-3 3/	600	197	180	197	180	203-5384
	LSTHOF-	250	250	3	252.700	2.240	3.872	18.0	STD-3 3/	600	287	264	—	—	202-0670
	LSTHOF-	400	400	3	413.500	2.800	6.128	22.0	STD-3 3/	600	400	365	315	265	202-0671
	LSTHOF-	500	500	3	500.000	3.100	7.313	25.0	STD-3 3/	600	500	450	350	275	202-2040
	LSTHOF-	600	600	3	600.000	3.150	7.983	25.0	STD-3 3/	600	600	550	—	—	203-5385

See footnotes at end of table.

TABLE VI (c)(2). MIL-C-24643 cable ratings and characteristics, non-watertight, flexing service, (control). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	Ampacity, each conductor (amps, max) dc or 60 Hz 50°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 40°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 50°C Ambient	NSN 6145-01
24643/7	LSMHOF- 7	16	7	2.580	0.500	0.164	4.0	STD-1	600	11/7 1/	9/6 1/	11/7 1/	9/6 1/	202-2788
	LSMHOF- 10	16	10	2.580	.585	.224	4.5	STD-1	600	11/7	9/6	11/7	9/6	203-5388
	LSMHOF- 14	16	14	2.580	.635	.290	5.0	STD-1	600	11/7	9/6	11/7	9/6	202-2789
	LSMFOF- 19	16	19	2.580	.705	.360	5.5	STD-1	600	11/7	9/6	11/7	9/6	202-2790
	LSMHOF- 24	16	24	2.580	.795	.457	6.5	STD-1	600	11/7	9/6	11/7	9/6	202-2791
	LSMHOF- 30	16	30	2.580	.835	.541	6.5	STD-1	600	11/7	9/6	11/7	9/6	202-2792
	LSMHOF- 37	16	37	2.580	.925	.674	7.5	STD-1	600	11/5	9/4	11/5	9/4	202-2793
	LSMHOF- 44	16	44	2.580	1.000	.771	8.0	STD-1	600	11/4	9/3	11/4	9/3	203-5389
	LSMHOF- 61	16	61	2.580	1.175	1.125	9.5	STD-1	600	11/3	9/2	11/3	9/2	202-2794

See footnotes at end of table.

TABLE VI (c)(3). MIL-C-24643 cable ratings and characteristics, non-watertight, non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation		Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft approx (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	Ampacity dc or 60 Hz 50°C Ambient	Ampacity 400 Hz 40°C Ambient	Ampacity 400 Hz 50°C Ambient	NSN 6145-01
24643/44	LS3SF-	7	18	21	1.620	1.040	0.618	2.0	STD-2	600	—	—	—	—	202-3491
24643/2	LSDCOP-	1	20	2	1.020	0.250	.031	—	STD-3	300	—	—	—	—	202-9527
	LSDCOP-	1.5	18	2	1.620	.315	.050	—	STD-3	300	—	—	—	—	202-2776
	LSDCOP-	2	18	2	1.620	.330	.052	—	STD-3	300	—	—	—	—	202-2777
24643/4	LSMCOS-	2	18	2	1.620	.460	.130	—	SPL-3	600	5/5 1/	4/4 1/	5/5 1/	4/4 1/	203-5386
	LSMCOS-	4	18	4	1.620	.510	.167	—	SPL-3	600	5/3	4/2	5/3	4/2	202-2778
	LSMCOS-	5	20	5	1.020	.390	.091	—	SPL-3	600	2.5/1	2/1	2.5/1	2/1	203-5400
	LSMCOS-	6	20	6	1.020	.480	.102	—	SPL-3	600	2.5/1	2/1	2.5/1	2/1	202-2828
	LSMCOS-	7	18	7	1.620	.595	.237	—	SPL-3	600	5/2.5	4/2.5	5/2.5	4/2.5	202-2779
24643/8	LSMMOP-	5	24	5	0.404	.305	.059	—	STD-3	300	3/1	2/1	—	—	202-2829
24643/2	LSTCOP-	2	18	3	1.620	.345	.067	—	STD-3	300	6	5	—	—	203-5383
24643/12	LSTTOP-	3	20	6	1.020	.480	.113	4.0	TEL-3	300	5/4	4/3	5/4	4/3	201-9538
	LSTTOP-	5	20	10	1.020	.590	.154	5.0	TEL-3	300	5/3	4/2	5/3	4/2	202-6998
	LSTTOP-	10	20	20	1.020	.700	.259	5.5	TEL-3	300	5/2	4/1	5/2	4/1	201-9539
	LSTTOP-	15	20	30	1.020	.830	.383	6.5	TEL-3	300	5/1	4/0.5	5/1	4/0.5	202-3536
24643/13	LSTTRS-	2	20	4	1.020	.680	.233	1.0	STD-2	300	—	—	—	—	202-2831
	LSTTRS-	4	20	8	1.020	.740	.281	1.1	STD-2	300	—	—	—	—	203-5401
	LSTTRS-	6	20	12	1.020	.880	.388	1.5	STD-2	300	—	—	—	—	202-2832
	LSTTRS-	8	20	16	1.020	.990	.474	1.7	STD-2	300	—	—	—	—	202-2833
	LSTTRS-	10	20	20	1.020	1.080	.561	2.0	STD-2	300	—	—	—	—	202-2834
	LSTTRS-	12	20	24	1.020	1.100	.611	2.0	STD-2	300	—	—	—	—	202-2835
	LSTTRS-	16	20	32	1.020	1.190	.723	2.2	STD-2	300	—	—	—	—	203-5402
24643/13	LSTTRSA-	2	20	4	1.020	0.730	.297	4.5	STD-2	300	—	—	—	—	202-2836
	LSTTRSA-	4	20	8	1.020	.790	.394	5.0	STD-2	300	—	—	—	—	203-5403
	LSTTRSA-	6	20	12	1.020	.930	.470	5.5	STD-2	300	—	—	—	—	202-2837
	LSTTRSA-	8	20	16	1.020	1.040	.521	6.5	STD-2	300	—	—	—	—	203-5404
	LSTTRSA-	10	20	20	1.020	1.130	.557	7.0	STD-2	300	—	—	—	—	203-5405
	LSTTRSA-	12	20	24	1.020	1.150	.608	7.0	STD-2	300	—	—	—	—	210-2346
	LSTTRSA-	16	20	32	1.020	1.240	.764	7.5	STD-2	300	—	—	—	—	202-8472

1/ Ind/Avg indicates the maximum current for each conductor (Ind), and the maximum current (Avg) for each conductor when all conductors in the cable are used.
2/ May be STD-1 or LTR-5, manufacturer's option.
3/ May be STD-3 or STD-4, manufacturer's option.
4/ 6145-00

5.7 Cable classification (MIL-C-24640). Cables specified in MIL-C-24640 are listed in table VII under the following general classifications:

(a) Watertight (with circuit integrity), non-flexing service:

(1) power.
(2) control.
(3) electronic, communication, and instrumentation.

(b) Watertight, non-flexing service:

(1) electronic, communication, and instrumentation.

(c) Non-watertight, non-flexing service:

(1) power.
(2) electronic, communication and instrumentation.

TABLE VII (a)(1). MIL-C-24640 cable ratings and characteristics, watertight (with circuit integrity), non-flexing service, (power).

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24640/22	7XW- 3	16	7	2.580	0.339	0.105	3.0	STD-1	600	15/11 1/	14/10 1/	15/11 1/	14/10 1/	224-8321
	7XW- 4	14	7	4.110	.404	.155	3.5	STD-1	600	26/14	24/13	26/14	24/13	224-8322
24640/22	7XWA- 3	16	7	2.580	.389	.138	3.0	STD-1	600	15/11	14/10	15/11	14/10	225-1379
	7XWA- 4	14	7	4.110	.454	.203	3.5	STD-1	600	26/14	24/13	26/14	24/13	225-1380
24640/19	DXOW- 3	16	2	2.580	.316	.088	4.0	STD-1	600	13	12	13	12	225-2664
	DXOW- 4	14	2	4.110	.354	.112	4.5	STD-1	600	22	20	22	20	225-6382
24640/19	DXW- 3	16	2	2.580	.257	.048	2.0	STD-1	600	13	12	13	12	224-9185
	DXW- 4	14	2	4.110	.303	.068	2.5	STD-1	600	22	20	22	20	224-8317
24640/19	DXWA- 3	16	2	2.580	.307	.067	2.0	STD-1	600	13	12	13	12	224-8318
	DXWA- 4	14	2	4.110	.353	.089	2.5	STD-1	600	22	20	22	20	226-5011
24640/21	FXOW- 3	16	4	2.580	.350	.116	4.2	STD-1	600	11	10	11	10	—
	FXOW- 4	14	4	4.110	.394	.146	5.0	STD-1	600	11	10	11	10	—
24640/21	FXW- 3	16	4	2.580	.286	.069	3.0	STD-1	600	11	10	11	10	225-2153
	FXW- 4	14	4	4.110	.339	.102	3.0	STD-1	600	18	17	18	17	225-2154
24640/21	FXWA- 3	16	4	2.580	.336	.095	3.0	STD-1	600	11	10	11	10	224-8319
	FXWA- 4	14	4	4.110	.389	.128	3.0	STD-1	600	18	17	18	17	224-8320
24640/20	TXOW- 3	16	3	2.980	.329	.100	4.0	STD-1	600	11	10	11	10	—
	TXOW- 4	14	3	4.110	.369	.130	4.5	STD-1	600	18	17	18	17	—
24640/20	TXW- 3	16	3	2.580	.266	.057	3.0	STD-1	600	11	10	11	10	225-2665
	TXW- 4	14	3	4.110	.314	.087	3.0	STD-1	600	18	17	18	17	225-2151
24640/20	TXWA- 3	16	3	2.580	.316	.084	3.0	STD-1	600	11	10	11	10	225-2152
	TXWA- 4	14	3	4.110	.364	.125	3.0	STD-1	600	18	17	18	17	231-3926

See footnote at end of table.

TABLE VII (a)(2). MIL-C-24640 cable ratings and characteristics, watertight (with circuit integrity), non-flexing service, (control). - Continued

MIL-C-	Cable type designation		Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24640/23	MXCOW-	7	18	7	1.620	0.366	0.134	4.5	STD-1	600	12/8 [1]	9/6 [1]	—	—	227-9946
	MXCOW-	10	18	10	1.620	.447	.184	5.5	STD-1	600	12/8	9/6	—	—	229-0031
	MXCOW-	14	18	14	1.620	.474	.219	6.0	STD-1	600	12/8	9/6	—	—	225-3450
	MXCOW-	19	18	19	1.620	.515	.267	6.5	STD-1	600	12/8	9/6	—	—	225-3451
	MXCOW-	24	18	24	1.620	.601	.350	7.5	STD-1	600	12/6	9/5	—	—	225-2161
	MXCOW-	30	18	30	1.620	.630	.399	7.5	STD-1	600	12/6	9/5	—	—	225-2162
	MXCOW-	37	18	37	1.620	.670	.466	8.0	STD-1	600	12/6	9/5	—	—	225-2163
	MXCOW-	44	18	44	1.620	.751	.553	9.0	STD-1	600	12/5	9/4	—	—	225-2164
	MXCOW-	61	18	61	1.620	.817	.694	10.0	STD-1	600	12/4.5	9/3.5	—	—	225-2165
24640/23	MXCW-	7	18	7	1.620	.319	.087	2.5	STD-1	600	12/8	9/6	—	—	225-3448
	MXCW-	10	18	10	1.620	.405	.136	3.5	STD-1	600	12/8	9/6	—	—	224-8233
	MXCW-	14	18	14	1.620	.434	.166	3.5	STD-1	600	12/8	9/6	—	—	225-1381
	MXCW-	19	18	19	1.620	.474	.208	4.0	STD-1	600	12/8	9/6	—	—	226-3691
	MXCW-	24	18	24	1.620	.560	.281	4.5	STD-1	600	12/6	9/5	—	—	224-8323
	MXCW-	30	18	30	1.620	.589	.325	4.5	STD-1	600	12/6	9/5	—	—	225-2155
	MXCW-	37	18	37	1.620	.630	.384	5.0	STD-1	600	12/6	9/5	—	—	225-2156
	MXCW-	44	18	44	1.620	.708	.472	5.5	STD-1	600	12/5	9/4	—	—	225-2157
	MXCW-	61	18	61	1.620	.785	.612	6.5	STD-1	600	12/4.5	9/3.5	—	—	225-2158
24640/23	MXCWA-	7	18	7	1.620	.369	.110	2.5	STD-1	600	12/8	9/6	—	—	226-2052
	MXCWA-	10	18	10	1.620	.455	.177	3.5	STD-1	600	12/8	9/6	—	—	225-2666
	MXCWA-	14	18	14	1.620	.485	.216	3.5	STD-1	600	12/6	9/5	—	—	225-2667
	MXCWA-	19	18	19	1.620	.524	.264	4.0	STD-1	600	12/6	9/5	—	—	225-2668
	MXCWA-	24	18	24	1.620	.610	.337	4.5	STD-1	600	12/6	9/5	—	—	225-2669
	MXCWA-	30	18	30	1.620	.639	.385	4.5	STD-1	600	12/6	9/5	—	—	225-2159
	MXCWA-	37	18	37	1.620	.680	.453	5.0	STD-1	600	12/6	9/5	—	—	225-0961
	MXCWA-	44	18	44	1.620	.758	.548	5.5	STD-1	600	12/5	9/4	—	—	225-2160
	MXCWA-	61	18	61	1.620	.835	.564	6.5	STD-1	600	12/4.5	9/3.5	—	—	225-3449

See footnote at end of table.

TABLE VII (a)(3). MIL-C-24640 cable ratings and characteristics, watertight (with circuit integrity), non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24640/24	TTXOW- 1.5	22	3	0.640	0.273	0.068	3.5	TEL-6	600	—	—	—	—	226-8808
	TTXOW- 3	22	6	.640	.359	.108	4.5	TEL-6	600	—	—	—	—	228-4262
	TTXOW- 5	22	10	.640	.406	.134	5.0	TEL-6	600	—	—	—	—	237-1290
	TTXOW- 15	22	30	.640	.600	.299	7.5	TEL-6	600	—	—	—	—	231-3926
	TTXOW- 20	22	40	.640	.662	.361	8.0	TEL-6	600	—	—	—	—	226-8809
	TTXOW- 30	22	60	.640	.772	.480	9.5	TEL-6	600	—	—	—	—	229-0032
	TTXOW- 40	22	80	.640	.887	.631	11.0	TEL-6	600	—	—	—	—	226-4565
24640/24	TTXW- 1.5	22	3	.640	.195	.026	1.5	TEL-6	600	—	—	—	—	225-2205
	TTXW- 3	22	6	.640	.307	.062	2.5	TEL-6	600	—	—	—	—	225-2206
	TTXW- 5	22	10	.640	.357	.091	3.0	TEL-6	600	—	—	—	—	225-2207
	TTXW- 10	22	20	.640	.492	.168	4.0	TEL-6	600	—	—	—	—	225-2208
	TTXW- 15	22	30	.640	.569	.231	4.5	TEL-6	600	—	—	—	—	225-2209
	TTXW- 20	22	40	.640	.621	.283	5.0	TEL-6	600	—	—	—	—	225-9664
	TTXW- 30	22	60	.640	.738	.407	6.0	TEL-6	600	—	—	—	—	237-1289
	TTXW- 40	22	80	.640	.852	.526	7.0	TEL-6	600	—	—	—	—	226-6028
24640/24	TTXWA- 1.5	22	3	.640	.245	.041	1.5	TEL-6	600	—	—	—	—	226-6029
	TTXWA- 3	22	6	.640	.357	.084	2.5	TEL-6	600	—	—	—	—	225-3453
	TTXWA- 5	22	10	.640	.407	.119	3.5	TEL-6	600	—	—	—	—	226-6030
	TTXWA- 10	22	20	.640	.542	.209	4.5	TEL-6	600	—	—	—	—	226-6031
	TTXWA- 15	22	30	.640	.619	.270	5.0	TEL-6	600	—	—	—	—	226-6032
	TTXWA- 20	22	40	.640	.671	.328	5.5	TEL-6	600	—	—	—	—	226-7410
	TTXWA- 30	22	60	.640	.788	.463	6.0	TEL-6	600	—	—	—	—	226-6033
	TTXWA- 40	22	80	.640	.902	.593	7.0	TEL-6	600	—	—	—	—	228-0701

See footnote at end of table.

TABLE VII (b)(1). MIL-C-24640 cable ratings and characteristics, watertight, non-flexing service, (electronic, communication, and instrumentation).

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	Ampacity, dc or 60 Hz 50°C Ambient	Ampacity, 400 Hz 40°C Ambient	Ampacity, 400 Hz 50°C Ambient	NSN 6145-01
24640/14	1XSOW-2	22	2	0.640	0.314	0.083	4.0	—	600	—	—	—	—	225-2199
	1XSOW-14	22	14	.640	.506	.233	6.0	—	600	—	—	—	—	225-2200
	1XSOW-20	22	20	.640	.584	.307	7.0	—	600	—	—	—	—	231-4589
	1XSOW-30	22	30	.640	.662	.429	8.0	—	600	—	—	—	—	225-2201
24640/17	2XOW-6	26	12	.278	.363	.107	4.5	—	600	—	—	—	—	224-8341
	2XOW-18	26	36	.278	.504	.201	6.0	—	600	—	—	—	—	224-9205
	2XOW-24	26	48	.278	.588	.266	7.0	—	600	—	—	—	—	225-8952
	2XOW-42	26	84	.278	.686	.365	8.5	—	600	—	—	—	—	225-8953
	2XOW-60	26	120	.278	.802	.485	10.5	—	600	—	—	—	—	225-8954
	2XOW-77	26	154	.278	.906	.615	11.0	—	600	—	—	—	—	225-8955
24640/15	2XSAOW-3	22	6	.640	.437	.153	5.5	—	600	—	—	—	—	225-1396
	2XSAOW-7	22	14	.640	.550	.253	7.5	—	600	—	—	—	—	225-1397
	2XSAOW-10	22	20	.640	.681	.362	8.5	—	600	—	—	—	—	224-9204
	2XSAOW-14	22	28	.640	.743	.442	9.0	—	600	—	—	—	—	225-1398
	2XSAOW-19	22	38	.640	.817	.543	10.0	—	600	—	—	—	—	225-1399
	2XSAOW-24	22	48	.640	.952	.720	11.5	—	600	—	—	—	—	225-2204
	2XSAOW-30	22	60	.640	1.020	.833	12.5	—	600	—	—	—	—	229-8306
	2XSAOW-37	22	74	.640	1.090	.971	13.0	—	600	—	—	—	—	224-8340
24640/15	2XSAW-3	22	6	.640	0.396	.112	3.5	STD-2	600	—	—	—	—	225-2202
	2XSAW-7	22	14	.640	.497	.195	4.0	STD-2	600	—	—	—	—	225-2203
	2XSAW-14	22	28	.640	.691	.384	5.5	STD-2	600	—	—	—	—	225-1394
24640/15	2XSAWA-3	22	6	.640	.446	.148	3.5	STD-2	600	—	—	—	—	224-9202
	2XSAWA-7	22	14	.640	.547	.244	4.0	STD-2	600	—	—	—	—	224-9203
	2XSAWA-14	22	28	.640	.741	.445	5.0	STD-2	600	—	—	—	—	225-1395
24640/16	2XSOW-3	18	6	1.620	.525	.227	6.5	STD-2	600	—	—	—	—	224-8311
	2XSOW-7	18	14	1.620	.656	.401	8.0	STD-2	600	—	—	—	—	224-8312
	2XSOW-12	18	24	1.620	.864	.626	10.5	STD-2	600	—	—	—	—	224-8313
	2XSOW-19	18	38	1.620	1.010	.884	12.5	STD-2	600	—	—	—	—	224-9181
	2XSOW-30	18	60	1.620	1.270	1.378	15.5	STD-2	600	—	—	—	—	225-1376
24640/16	2XSW-1	18	2	1.620	0.258	0.053	2.0	STD-2	600	—	—	—	—	224-8308
	2XSW-3	18	6	1.620	.470	.167	4.0	STD-2	600	—	—	—	—	224-8309
	2XSW-7	18	14	1.620	.617	.318	5.0	STD-2	600	—	—	—	—	225-8947
24640/16	2XSWA-1	18	2	1.620	.308	.069	2.0	STD-2	600	—	—	—	—	229-8294

See footnote at end of table.

TABLE VII (b)(1). MIL-C-24640 cable ratings and characteristics, watertight, non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of con-ductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24640/16	2XSWA- 3	18	6	1.620	0.520	0.210	4.0	STD-2	600	—	—	—	—	225-8948
	2XSWA- 7	18	14	1.620	.667	.375	5.0	STD-2	600	—	—	—	—	224-8310
24640/18	3XSOW- 3	18	9	1.620	.559	.271	7.0	STD-2	600	—	—	—	—	224-9182
	3XSOW- 7	18	21	1.620	.711	.472	8.5	STD-2	600	—	—	—	—	224-9183
	3XSOW- 10	18	30	1.620	.901	.702	11.0	STD-2	600	—	—	—	—	224-8314
	3XSOW- 14	18	42	1.620	.968	.860	12.0	STD-2	600	—	—	—	—	224-8315
	3XSOW- 19	18	57	1.620	1.090	1.127	13.0	STD-2	600	—	—	—	—	224-8316
	3XSOW- 24	18	72	1.620	1.300	1.489	16.0	STD-2	600	—	—	—	—	224-9184
24640/18	3XSW- 3	18	9	1.620	0.508	0.202	4.0	STD-2	600	—	—	—	—	225-8949
	3XSW- 7	18	21	1.620	.668	.387	5.5	STD-2	600	—	—	—	—	225-8950
	3XSW- 10	18	30	1.620	.865	.613	7.0	STD-2	600	—	—	—	—	225-4894
	3XSW- 14	18	42	1.620	.941	.770	7.5	STD-2	600	—	—	—	—	225-2660
24640/18	3XSWA- 3	18	9	1.620	.558	.255	4.0	STD-2	600	—	—	—	—	225-2661
	3XSWA- 7	18	21	1.620	.718	.458	5.5	STD-2	600	—	—	—	—	228-4261
	3XSWA- 10	18	30	1.620	.915	.701	7.0	STD-2	600	—	—	—	—	225-2662
	3XSWA- 14	18	42	1.620	.991	.873	7.5	STD-2	600	—	—	—	—	225-2663

See footnote at end of table.

TABLE VII (c)(1). MIL-C-24640 cable ratings and characteristics non-watertight, non-flexing service, (power). - Continued

MIL-C-	Cable type designation		Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	Ampacity, each conductor (amps, max) dc or 60 Hz 50°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 40°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 50°C Ambient	NSN 6145-01
24640/1	DX-	3	16	2	2.580	0.241	0.039	2.0	STD-1	600	13	12	13	12	224-6905
	DX-	4	14	2	4.110	.286	.057	2.5	STD-1	600	22	20	22	20	224-6906
24640/1	DXA-	3	16	2	2.580	.291	.054	2.0	STD-1	600	13	12	13	12	224-9180
	DXA-	4	14	2	4.110	.336	.074	2.5	STD-1	600	22	20	22	20	224-6907
24640/3	FX-	3	16	4	2.580	.282	.063	2.5	STD-1	600	11	10	11	10	224-6912
	FX-	4	14	4	4.110	.335	.093	3.0	STD-1	600	18	17	18	17	224-6913
24640/3	FXA-	3	16	4	2.580	.332	.080	2.5	STD-1	600	13	12	13	12	224-6914
	FXA-	4	14	4	4.110	.383	.113	3.0	STD-1	600	22	20	22	20	225-2147
24640/2	TX-	3	16	3	2.580	.261	.052	2.0	STD-1	600	11	10	11	10	224-6908
	TX-	4	14	3	4.110	.310	.076	2.5	STD-1	600	18	17	18	17	224-6909
24640/2	TXA-	3	16	3	2.580	.311	.068	2.0	STD-1	600	11	10	11	10	224-6910
	TXA-	4	14	3	4.110	.360	.095	2.5	STD-1	600	18	17	18	17	224-6911

See footnote at end of table.

TABLE VII (c)(2). MIL-C-24640 cable ratings and characteristics non-watertight, non-flexing service, (electronic, communication, and instrumentation). - *Continued*

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24640/7	1XMSO- 7	22	7	0.640	0.370	0.113	4.5	STD-1	600	—	—	—	—	226-2650
	1XMSO- 16	22	16	.640	.507	.208	6.0	STD-1	600	—	—	—	—	226-2651
	1XMSO- 70	22	70	.640	.925	.661	11.0	STD-1	600	—	—	—	—	226-7409
24640/6	2XAO- 2	22	2	.640	.331	.079	4.0	—	600	—	—	—	—	225-0964
	2XAO- 7	22	7	.640	.422	.125	5.0	—	600	—	—	—	—	225-0965
	2XAO- 10	22	10	.640	.511	.170	6.0	—	600	—	—	—	—	224-8337
	2XAO- 18	22	18	.640	.611	.245	7.5	—	600	—	—	—	—	224-8338
	2XAO- 40	22	40	.640	.858	.449	10.5	—	600	—	—	—	—	225-0966
24640/12	2XO- 6	26	12	.278	.329	.082	4.0	—	600	—	—	—	—	225-2196
	2XO- 18	26	36	.278	.449	.140	5.5	—	600	—	—	—	—	225-4904
	2XO- 24	26	48	.278	.509	.171	6.0	—	600	—	—	—	—	224-9199
	2XO- 42	26	84	.278	.609	.245	7.5	—	600	—	—	—	—	224-9200
	2XO- 60	26	120	.278	.691	.312	8.5	—	600	—	—	—	—	225-2197
	2XO- 77	26	154	.278	.785	.395	9.5	—	600	—	—	—	—	225-2198
24640/9	2XS- 2	22	4	.640	.332	.061	3.0	STD-2	600	—	—	—	—	225-0967
	2XS- 3	22	6	.640	.350	.074	3.0	STD-2	600	—	—	—	—	225-2193
	2XS- 7	22	14	.640	.455	.132	4.0	STD-2	600	—	—	—	—	225-0968
	2XS- 10	22	20	.640	.579	.193	5.0	STD-2	600	—	—	—	—	225-0969
	2XS- 14	22	28	.640	.627	.240	5.0	STD-2	600	—	—	—	—	225-1387
	2XS- 19	22	38	.640	.694	.308	5.5	STD-2	600	—	—	—	—	225-3452
	2XS- 24	22	48	.640	.818	.390	6.5	STD-2	600	—	—	—	—	224-9191
	2XS- 30	22	60	.640	.866	.468	7.0	STD-2	600	—	—	—	—	224-9192
24640/9	2XSA- 2	22	4	.640	.382	.081	3.0	STD-2	600	—	—	—	—	225-1388
	2XSA- 3	22	6	.640	.400	.102	3.0	STD-2	600	—	—	—	—	225-1389
	2XSA- 7	22	14	.640	.505	.176	4.0	STD-2	600	—	—	—	—	225-1390
	2XSA- 10	22	20	.640	.629	.229	5.0	STD-2	600	—	—	—	—	225-1391
	2XSA- 14	22	28	.640	.677	.280	5.0	STD-2	600	—	—	—	—	225-1392
	2XSA- 19	22	38	.640	.744	.360	5.5	STD-2	600	—	—	—	—	225-6388
	2XSA- 24	22	48	.640	.868	.443	6.5	STD-2	600	—	—	—	—	225-2194
	2XSA- 30	22	60	.640	.916	.531	7.0	STD-2	600	—	—	—	—	224-9193
24640/9	2XSO- 3	22	6	.640	.410	.117	5.0	STD-2	600	—	—	—	—	224-9194
	2XSO- 7	22	14	.640	.510	.184	6.0	STD-2	600	—	—	—	—	224-9195
	2XSO- 10	22	20	.640	.640	.262	8.0	STD-2	600	—	—	—	—	224-9196

See footnote at end of table.

TABLE VII (c)(2). MIL-C-24640 cable ratings and characteristics, non-watertight, non-flexing service, (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
24640/9	2XSO- 14	22	28	0.640	0.686	0.301	8.5	STD-2	600	—	—	—	—	224-9197
	2XSO- 19	22	38	.640	.765	.383	9.5	STD-2	600	—	—	—	—	224-9198
	2XSO- 30	22	60	.640	.937	.554	11.5	STD-2	600	—	—	—	—	225-2195
24640/13	2XSXO- 4	26	4 PAIR	.278	.359	.101	4.5	STD-2	600	—	—	—	—	224-9201
24640/11	3XS- 7	18	7 TRIADS	1.620	.647	.289	8.0	STD-2	600	—	—	—	—	225-2150
24640/11	3XSA- 7	18	7 TRIADS	1.620	.697	.342	8.5	STD-2	600	—	—	—	—	225-8946
24640/8	MXO- 10	20	10	1.020	.377	.118	4.5	STD-2	600	—	—	—	—	227-5743
	MXO- 14	20	14	1.020	.410	.147	5.0	STD-2	600	—	—	—	—	224-8339
24640/10	MXSO- 2	16	2	2.580	.304	.076	4.0	STD-1	600	—	—	—	—	225-2148
	MXSO- 9	16	9	2.580	.458	.176	5.5	STD-1	600	—	—	—	—	225-2149
	MXSO- 21	16	21	2.580	.596	.329	7.5	STD-1	600	—	—	—	—	225-1377
	MXSO- 37	16	37	2.580	.694	.473	8.5	STD-1	600	—	—	—	—	225-1378
24640/4	TTX- 3	20	3 PAIR	1.020	.320	.062	2.5	TEL-3	600	5/4.0 1/	4/3.0 1/	5/4.0 1/	4/3.0 1/	225-2190
	TTX- 15	20	15 PAIR	1.020	.591	.221	5.0	TEL-3	600	5/0.6	4/0.5	5/0.6	4/0.5	225-1393
24640/4	TTXA- 3	20	3 PAIR	1.020	.370	.082	2.5	TEL-3	600	5/4.0	4/3.0	5/4.0	4/3.0	225-2191
	TTXA- 15	20	15 PAIR	1.020	.641	.275	5.0	TEL-3	600	5/0.6	4/0.5	5/0.6	4/0.5	224-6916
24640/5	TTXS- 2	20	2 PAIR	1.020	.361	.074	3.0	STD-2	600	—	—	—	—	224-6917
	TTXS- 4	20	4 PAIR	1.020	.424	.115	3.5	STD-2	600	—	—	—	—	226-5038
24640/5	TTXSA- 2	20	2 PAIR	1.020	.411	.100	3.5	STD-2	600	—	—	—	—	224-8334
	TTXSA- 4	20	4 PAIR	1.020	.474	.150	4.0	STD-2	600	—	—	—	—	224-8335
24640/5	TTXSO- 2	20	2 PAIR	1.020	.416	.126	5.0	STD-2	600	—	—	—	—	224-8336
	TTXSO- 6	20	6 PAIR	1.020	.546	.216	6.5	STD-2	600	—	—	—	—	225-2192
	TTXSO- 8	20	8 PAIR	1.020	.633	.284	8.0	STD-2	600	—	—	—	—	225-0963
	TTXSO- 10	20	10 PAIR	1.020	.675	.311	8.0	STD-2	600	—	—	—	—	226-7408

1/ Ind/Avg indicates the maximum current for each conductor (Ind), and the maximum current (Avg) for each conductor when all conductors in the cable are used.

5.8 Cable classification (MIL-C-915). Cables specified in MIL-C-915 are listed in table VIII under the following general classifications:

(a) Watertight, flexing service:

(1) power.
(2) control.
(3) electronic, communication and instrumentation.

(b) Non-watertight, flexing service:

(1) power and lighting.
(2) electronic, communication, and instrumentation.

(c) Non-watertight, non-flexing service:

(1) electronic, communication, and instrumentation.

(d) Watertight, non-flexing service:

(1) electronic, communication, and instrumentation.

TABLE VIII (a)(1). MIL-C-915 cable ratings and characteristics watertight, flexing service, (power).

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
915/7	DSWS- 4	14 —	2 —	4.110 —	0.800 —	0.050 —	3.0 —	STD-1 —	HIGH VOLTAGE	— —	— —	— —	— —	#776-8513 —
915/10	MCSF- 4	6 1	2 2	26.240 83.690	1.500 —	1.625 —	12.0 —	STD-3 —	600 —	— —	— —	— —	— —	#802-2059 —

TABLE VIII (a)(2). MIL-C-915 cable ratings and characteristics, watertight, flexing service (control).

MIL-C-	Cable type designation		Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	Ampacity, each conductor (amps, max) dc or 60 Hz 50°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 40°C Ambient	Ampacity, each conductor (amps, max) 400 Hz 50°C Ambient	NSN 6145-01
915/58	MWF-	7	18	7	1.620	0.500	0.145	1.5	STD-1	600	1.5	1.5	1.5	1.5	#995-2543
	MWF-	10	18	10	1.620	.635	.230	2.0	STD-1	600	2.0	2.0	2.0	2.0	162-4794
	MWF-	14	18	14	1.620	.635	.250	2.0	STD-1	600	2.0	2.0	2.0	2.0	#985-8320
	MWF-	19	18	19	1.620	.745	.350	2.5	STD-1	600	2.5	2.5	2.5	2.5	#983-8639
	MWF-	24	18	24	1.620	.836	.430	2.5	STD-1	600	2.5	2.5	2.5	2.5	#985-8318
	MWF-	30	18	30	1.620	.945	.550	3.0	STD-1	600	3.0	3.0	3.0	3.0	#084-1342
	MWF-	37	18	37	1.620	1.045	.680	3.5	STD-1	600	3.5	3.5	3.5	3.5	154-4373

TABLE VIII (a)(3). MIL-C-915 cable ratings and characteristics watertight, flexing service (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
915/47	1SWF- 2	22	2	0.700	0.625	0.188	2.0	STD-2	300	—	—	—	—	#051-4825
915/48	2SWF- 3	22	6	.700	.625	.200	2.0	STD-2	300	—	—	—	—	158-6329
	2SWF- 4	22	8	.700	.625	.211	2.0	STD-2	300	—	—	—	—	#985-7926
	2SWF- 7	22	14	.700	.815	.366	2.5	STD-2	300	—	—	—	—	#964-4662
	2SWF- 24	22	48	.700	1.250	.620	7.5	STD-2	300	—	—	—	—	
915/8	7SS- 2	18	7	1.620	0.625	.185	1.5	SPL-3	600	—	—	—	—	#905-6797
915/8	DSS- 2	18	2	1.620	.390	.120	1.0	SPL-3	600	6	5	—	—	#914-9973
	DSS- 3	16	2	2.580	.500	.160	1.5	SPL-3	600	9	8	—	—	#912-2616
	DSS- 4	14	2	4.110	.500	.180	1.5	SPL-3	600	13	11	—	—	#913-2401
915/8	FSS- 2	18	4	1.620	.500	.180	1.5	SPL-3	600	5	4	—	—	#913-2402
	FSS- 3	16	4	2.580	.500	.210	1.5	SPL-3	600	8	7	—	—	159-6655
	FSS- 4	14	4	4.110	.625	.240	2.0	SPL-3	600	13	11	—	—	#985-7843
915/61	S2S	18	1	1.620	.500	1.000	3.0	SPL-3	600	—	—	—	—	155-3526
915/79	TPUM- 6	16	12	1.700	.925	0.125	7.5	TEL-1	600	—	—	—	—	156-7864
915/8	TSS- 2	18	3	1.620	.400	.140	1.0	SPL-3	600	6	5	—	—	162-2600
	TSS- 3	16	3	2.580	.500	.180	1.5	SPL-3	600	9	8	—	—	159-8619
	TSS- 4	14	3	4.110	.500	.200	1.5	SPL-3	600	13	11	—	—	#905-6795

TABLE VIII (b)(1). MIL-C-915 cable ratings and characteristics, non-watertight, flexing service, (power and lighting). - Continued

MIL-C-	Cable type designation		Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
915/1	CVSP-	4	5	1	33.090	1.450	1.300	9.0	STD-3 1/	600	100	75	100	75	#191-2037
			3	3	52.620	—	—	—	—	—	—	—	—	—	
915/9 3/	JAS-	250	12	2	6.530	1.260	0.917	10.0	STD-4	600	—	—	—	—	#753-2264
			250	2	250.000	2.480	—	20.0	STD-3	600	—	—	—	—	
915/6	THOF-	42	42	3	42.100	1.250	.958	10.0	STD-3 1/	600	93	86	93	86	#202-0669
	THOF-	400	400	3	413.500	2.800	5.950	22.0	STD-3 1/	600	400	365	315	265	#202-0671
	THOF-	500	500	3	500.000	3.100	7.100	25.0	STD-3 1/	600	500	450	350	275	#202-2040
915/20	TRF-	105	0	1	105.600	0.760	0.510	6.0	—	600	143	121	—	—	#943-7407
	TRF-	133	00	1	133.100	.810	.618	6.5	—	600	167	141	—	—	#956-3451
	TRF-	168	000	1	167.800	.860	.704	7.0	—	600	201	170	—	—	#928-9103
915/21	TRXF-	84	1	1	83.700	.600	.360	5.0	—	125	130	110	—	—	#914-9010
	TRXF-	105	1	1	105.600	.680	.460	5.5	—	125	143	121	—	—	#913-2065
	TRXF-	133	1	1	133.100	.750	.567	6.0	—	125	167	141	—	—	#914-0517
915/5	DLT		18	4	1.620	.710	.050	6.0	STD-3	300	—	—	—	—	#574-2040

See footnotes at end of table.

TABLE VIII (b)(2). MIL-C-915 cable ratings and characteristics, non-watertight, flexing service (electronic, communication and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max) dc or 60 Hz 40°C Ambient	dc or 60 Hz 50°C Ambient	400 Hz 40°C Ambient	400 Hz 50°C Ambient	NSN 6145-01
915/74	SSS	18	5	1.620	0.560	0.240	2.0	STD-3	600	—	—	—	—	155-4488

See footnotes at end of table.

TABLE VIII (c)(1). MIL-C-915 cable ratings and characteristics, non-watertight, non-flexing service (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: AWG or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max)				NSN 6145-01
										dc or 60 Hz		400 Hz		
										40°C Ambient	50°C Ambient	40°C Ambient	50°C Ambient	
915/67	MSP	22	16	0.700	1.635	1.500	10.5	—	—	—	—	—	—	#791-3234
		20	18	1.111	—	—	—	—	—	—	—	—	—	—
		16	25	2.580	—	—	—	—	—	—	—	—	—	—

See footnotes at end of table.

TABLE VIII (d)(1). MIL-C-915 cable ratings and characteristics, watertight, non-flexing service (electronic, communication, and instrumentation). - Continued

MIL-C-	Cable type designation	Conductor size: awg or MCM	Number of conductors in cable	Area of each conductor (MCM)	Cable overall diameter max. (inches)	Cable weight per ft maximum (lbs)	Radius of bend min. (inches)	CDR ID	Rated voltage, max. (RMS)	Ampacity, each conductor (amps, max)				NSN 6145-01
										dc or 60 Hz		400 Hz		
										40°C Ambient	50°C Ambient	40°C Ambient	50°C Ambient	
915/66	MSPW	22 20 16	16 18 25	0.700 1.111 2.580	1.635 — —	1.500 — —	10.5 — —	STD-2 — —	— — —	— — —	— — —	— — —	— — —	#791-3233 — —
915/22	TSP- 11 TSP- 31	22 22	22 62	0.640 .640	0.730 1.062	0.275 .611	4.5 6.5	— —	300 300	4/1 2/ —	3/0.5 3/ —	— —	— —	#916-7217 #940-8711
915/22	TSPA- 11 TSPA- 31	22 22	22 62	.640 .640	0.780 1.112	.310 .650	4.0 6.5	— —	300 300	4/1 —	3/0.5 —	— —	— —	156-9581 155-8741

1/ Indentification may be STD-3 or STD-4, manufacturer's option.
2/ Ind/Avg indicates the maximum current for each conductor (Ind), and the maximum current (Avg) for each conductor when all conductors in the cable are used.
3/ Oval shape, minor and major diameter.

5.9 Ampacity rating. To obtain the ampacity rating for an ambient temperature of either 60 or 70°C, first determine the ampacity rating for 40°C ambient from tables VI, VII, or VIII. Then multiply that value by the applicable derating factor shown in table IX. Cables listed in this table should not be used in ambient temperatures above 70°C. Cables not listed in this table should not be used in ambient temperatures above 60°C. The ampacity derating factor does not change for those cables listed with armored variants.

TABLE IX. Ampacity derating factors for ambient temperatures above 50°C.

Cable type	Ambient temperature (°C) 60	70
LSDHOF	0.78	0.67
LSDNW DX	.78	.67
LSDSGU DWX	.80	.69
DSS	.63	--
FRW	.78	.67
LSFSGU FXW	.80	.69
FSS	.63	--
LSMDU	.72	--
LSMHOF	.80	.69
LSMNW	.78	.67
LSMSCU MXCW	.80	.69
LSSHOF	.78	.67
LSTHOF	.78	.67
LSTNW	.78	.67
TRF	.63	--
TRXF	.63	--
LSTSGU TXW	.80	.69
TSS	.63	--
LS5KVTSGU	.80	.69
LS6SGU	.80	.69
LS7SGU 7XW	.80	.69
7SS	.63	--

TABLE X. Ampacities of degaussing cables.

(Maximum amperes for each conductor, at 40 and 50°C ambient temperatures)

Cable type and size	1 cable in air		2 cables in air		3 or 4 cables in air		5 to 7 cables in air		1 cable in conduit of 8 or more cables in air	
	40°	50°	40°	50°	40°	50°	40°	50°	40°	50°
LSDSGU/A-14	66	61	60	56	55	51	49	46	46	43
23	86	79	79	73	72	67	64	60	61	56
50	139	128	128	119	117	109	104	97	98	90
75	185	171	170	159	156	146	139	130	132	122
100	219	201	202	187	184	171	164	153	155	143
200	339	312	312	290	285	265	254	237	241	222
LSTSGU/A-9	43	40	39	36	34	30	29	27	27	26
14	56	52	51	48	47	44	42	39	40	37
23	76	70	70	65	64	59	57	53	54	50
50	121	111	111	103	102	94	91	84	86	79
75	163	150	150	140	137	128	122	114	116	106
100	191	176	176	164	160	150	143	134	136	125
150	259	238	238	221	218	202	194	181	184	169
200	298	275	274	256	250	234	224	209	212	195
300	383	352	352	324	322	296	287	264	276	253
400	478	440	440	405	401	370	358	330	344	317
LSFSGU/A-9	43	40	41	38	38	36	36	34	34	32
23	76	70	72	67	68	63	64	60	61	56
50	121	112	115	107	109	101	103	95	97	90
75	163	151	154	144	146	136	138	129	130	121
100	191	178	182	169	172	160	162	151	153	142
150	258	240	245	228	232	216	220	204	207	192
200	298	277	283	263	268	249	253	235	238	221
LS6SGU/A-100	163	153	150	140	136	127	122	114	116	108
125	192	173	175	163	160	147	144	133	136	125
150	225	204	207	190	188	173	169	156	160	147
200	250	243	235	222	219	202	188	182	177	172
LSMDU-6	15	14	14	13	14	12	13	12	12	11
14	25	22	24	21	22	20	21	19	20	18
23	34	30	32	28	30	27	29	25	27	24
40	49	43	46	41	44	39	41	37	39	36
60	65	59	62	57	58	54	55	52	51	50

TABLE X. Ampacities of degaussing cables. - Continued

(Maximum amperes for each conductor, at 40 and 50°C ambient temperatures)

Cable type and size	1 cable in air		2 cables in air		3 or 4 cables in air		5 to 7 cables in air		1 cable in conduit of 8 or more cables in air	
	40°	50°	40°	50°	40°	50°	40°	50°	40°	50°
LSMDY-6	15	14	14	13	14	12	13	12	12	11
14	25	22	24	21	22	20	21	19	20	18
23	34	30	32	28	30	27	29	25	27	24
40	49	43	46	41	44	39	41	37	39	36
60	65	59	62	57	58	54	55	52	51	50
LSMSCU/A/S-7	9	8	8.5	7.5	8	7	7.5	7	7	6.5
10	9	8	8.5	7.5	8	7	7.5	7	7	6.5
14	9	8	8.5	7.5	8	7	7.5	7	7	6.6
19	9	8	8.5	7.5	8	7	7.5	7	7	6.6
24	9	8	8.5	7.5	8	7	7.5	7	7	6.5
30	9	8	8.5	7.5	8	7		7	7	6.5
37	9	8	8.5	7.5	8	7	7.5	7	7	6.5
44	5.5	5	5.0	4.5	5	4.5	4.5	4	4.5	4.0

6. NOTES

6.1 Subject term (key word) listing.

Ampacity
Cable, degaussing
Cable, flexing service
Cable, non-flexing service
Codes, identification
Conductor, multiple
Insulation
Jacket, armored
Jacket, unarmored
Non-watertight
Shield, braided
Watertight

Preparing activity:
Navy - SH
(Project 6145-N328)

APPENDIX

ELECTRICAL CABLE VOLTAGE DROP CALCULATIONS FOR POWER AND LIGHTING SYSTEMS

10. SCOPE

10.1 Scope. This appendix is intended for use as a guide in determining voltage drops for cables used in alternating current (ac) and direct current (dc) power, lighting, interior communications, weapons control and electronic systems.

20. REFERENCED DOCUMENTS

20.1 Government documents.

This paragraph is not applicable to this appendix.

20.2 Other publications. The following documents form a part of this handbook to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted shall be those listed in the issue of the DoDISS specified in the solicitation. The issues of documents which have not been adopted shall be those in effect on the date of the cited DoDISS.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
- B 8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
- B 258 - Standard Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wires Used as Electrical Conductors.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(Nongovernment standards are generally available for reference from libraries. They are also distributed among nongovernment standards bodies and using Federal agencies.)

30. DEFINITIONS

30.1 Symbols and abbreviations. Selected symbols and abbreviations used in this appendix are as follows:

- E - E is the symbol for sending end or bus (normally switchboard) voltage. It is line-to-neutral rated voltage for three-phase ac systems (line-to-line rated voltage divided by the square root of 3), and three-wire dc systems, and line-to-line rated voltage for dc and single phase alternating current systems.
- V - V is the abbreviation for receiver or load voltage.
- L - L is the abbreviation for the length, in feet, of a single conductor in circuits having equal conductor lengths in all legs of the circuit.
- cmil - Cmil is the abbreviation for the circular mil cross-sectional area of a single leg of the circuit.

pf - Pf is the abbreviation for power factor of the load.

θ - The symbol θ represents the angle between the load voltage vector and the load current vector.

β - The symbol β represents the angle between the resistance vector and the impedance vector for a cable (cable impedance angle).

α - The symbol α represents the value of β subtracted from $\theta (\alpha = \theta - \beta)$.

α - The symbol α also represents the temperature coefficient of resistance at measured temperature.

δ - The symbol δ represents density.

ρ - The symbol ρ represents resistivity.

D% - The symbol D% represents the total voltage drop expressed as a percent of the rated voltage E.

DF - The abbreviation DF represents the drop factor, which is used in simplified equations for calculating voltage drops.

I - The abbreviation I represents the current, in amperes, flowing in one leg of the circuit.

Iavg - The abbreviation Iavg represents the average of current, in amperes, flowing in the outside conductors of a three-wire dc circuit, assuming a 25 percent current unbalance.

I_{LL} - The abbreviation I_{LL} represents the difference between two line currents in a three-phase circuit.

K - The abbreviation K represents the apparent power, in volt-amperes, for one phase of a circuit ($K = V \times I$).

W - The abbreviation W represents the resistive power, in watts, for one leg of a circuit ($W = V \times I \times \cos\theta$).

W_{LL} - The abbreviation W_{LL} represents the net of resistive power in two legs of a circuit.

U - The abbreviation U represents the reactive power, in vars, for one leg of a circuit ($U = V \times I \times \sin\theta$).

U_{LL} - The abbreviation U_{LL} represents the net of reactive power in two legs of a circuit.

R - The abbreviation R represents the total cable resistance, in ohms, for each leg of a circuit.

X - The abbreviation X represents the total cable reactance, in ohms, for each leg of a circuit.

Z - The abbreviation Z represents the total cable impedance, in ohms, for each leg of a circuit (equal to the square root of the sum of the cable resistance for each leg squared and cable reactance for each leg squared).

z - The abbreviation z represents the impedance, in ohms, for each leg of a circuit for 1 foot of cable.

40. GENERAL DESCRIPTION OF EQUATIONS AND CALCULATIONS

40.1 General description of voltage drop equations. Tables XI and XII contain equations for calculating voltage drops in ac and dc circuits, respectively. Table XI (for ac circuits) contains detailed methods for calculating voltage drops for all service types, and simplified methods for calculating voltage drops for power and lighting services. The simplified methods involve the use of a drop factor (DF) which shall be selected from tables XIII, XIV, XV, XVI, XVII, and XVIII, as applicable. These drop factors were calculated using the impedance characteristics of type LSTSGA and LS6SGA cables in accordance with MIL-C-24643. Although calculations are based upon full coverage aluminum-armored cables (armored cables represent worst case impedance values) they may be used for equivalent size unarmored cables. The tabulated drop factors for type LSTSGA cable may be used for other cable types with similar impedance characteristics, including lightweight cables in accordance with MIL-C-24640. For any nonsimilar cables, drop factors may be calculated by using the impedance characteristics of the cable in the appropriate equation contained herein which derive from the simplified method specified in 50.1 for power systems, 50.2 for lighting systems (I and I_{LL} method), and 50.3 for lighting systems (watts and vars method).

TABLE XI. Voltage drop equations for ac circuits.

Type of service	Detailed method equation	Simplified method equation
Single phase, all types of service	$D\% = 2(100)L\left(\frac{Iz}{E}\right)\cos\alpha$	Lighting service only: $D\% = 2L \times I \times DF$ (from table XVII) OR $D\% = 4L \times W \times DF$ (from table XVIII)
Three-phase, all service types except power	$D\% = \sqrt{3}(100)L\left(\frac{Iz}{E}\right)\cos\alpha$	Lighting service only: $D\% = L \times I_{LL} \times DF$ (from type XVII) OR $D\% = L \times 2W_{LL} \times DF$ (from table XVIII)
Three-phase, power service (see note)	$D\% = \left[100\ \frac{IzL(\cos\alpha)}{E} + \left(\frac{IzL}{E}\right)^2 \frac{\sin^2\alpha}{2}\right]$	$D\% = L \times I \times DF$ (from table XIII, XIV, or XV as appropriate)

NOTE: This equation may be used on power systems through 4160 volts.

TABLE XII. Voltage drop equations for dc circuits.

Type of service	Equation
Two-wire, all service types except power	$D\% = \frac{RES \times I \times 2L \times 100}{cmil \times E}$ $= \frac{2400 \times I \times L}{cmil \times E}$ where RES = 12, which is the resistivity of copper at an assumed operating temperature of 45°C
Two-wire, power service	$D\% = \frac{RES \times I \times 2L \times 100}{cmil \times E}$ $= \frac{2600 \times I \times L}{cmil \times E}$ where RES = 13, which is the resistivity of copper at an assumed operating temperature of 65°C
Three-wire, lighting service	$D\% = \frac{RES \times (Iavg + 0.25\ Iavg) \times L \times 100}{cmil \times E}$ $= \frac{1500 \times Iavg \times L}{cmil \times E}$ where RES = 12, which is the resistivity of copper at an assumed operating temperature of 45°C
Three-wire, power service	$D\% = \frac{RES \times (Iavg + 0.25\ Iavg) \times L \times 100}{cmil \times E}$ $= \frac{1625 \times Iavg \times L}{cmil \times E}$ where RES = 13, which is the resistivity of copper at an assumed operating temperature of 65°C

TABLE XIII. Drop factors for LSTSGA cable, 450-volt, three-phase, 60-Hz power systems. 1/

Cable characteristics						Drop factor values at power factors (cos θ) below 2/									
Size	Area cmil	Ohms per 1000 feet 3/			Angle β (degrees)	1.0	0.95	0.90	0.85	0.80	0.70	0.60	0.50	0.40	0.30
		R 4/	X 5/	Z											
3	2,580	4.872	0.043	4.872	0.51	187.5	179.6	171.4	163.2	155.1	139.1	123.6	108.9	95.7	85.3
4	4,110	3.058	.041	3.059	.77	117.7	112.9	107.8	102.7	97.7	87.7	77.9	68.7	60.4	53.8
9	10,380	1.211	.034	1.211	1.61	46.6	44.9	43.0	41.0	39.0	35.1	31.3	27.7	24.3	21.6
14	13,090	0.960	.034	0.961	2.03	37.0	35.7	34.2	32.6	31.1	28.0	25.0	22.1	19.5	17.3
23	20,820	.604	.032	.605	3.03	23.2	22.5	21.6	20.7	19.8	17.9	16.0	14.2	12.5	11.1
50	52,620	.241	.027	.243	6.39	9.3	9.2	8.9	8.5	8.2	7.5	6.8	6.1	5.4	4.7
75	83,690	.153	.026	.155	9.63	5.9	5.9	5.8	5.6	5.4	5.0	4.5	4.1	3.7	3.2
100	105,600	.121	.026	.124	12.09	4.7	4.8	4.7	4.5	4.4	4.1	3.7	3.4	3.1	2.7
150	167,800	.076	.025	.080	18.12	3.0	3.1	3.1	3.0	2.9	2.8	2.6	2.4	2.2	2.0
200	211,600	.061	.025	.066	22.42	2.4	2.5	2.5	2.5	2.5	2.3	2.2	2.2	1.9	1.7
300	300,000	.043	.025	.050	30.33	1.7	1.9	1.9	1.9	1.9	1.8	1.8	1.7	1.6	1.5
400	413,600	.031	.025	.040	38.89	1.2	1.4	1.5	1.5	1.5	1.5	1.5	1.4	1.4	1.3

1/ See 40.1 for unarmored cable and other cable types.
2/ Multiply values by 10^{-5} for drop factors.
3/ Derivations of R, X, and Z shall be as specified in 50.4.
4/ Conductor resistance at 65°C.
5/ Based upon full coverage aluminum-armored cables.

TABLE XIV. Drop factors for LSTSGA cable, 450-volt, three-phase, 400-Hz power systems. 1/

Cable characteristics						Drop factor values at power factors (cos θ) below 2/									
Size	Area cmil	Ohms per 1000 feet 3/			Angle β (degrees)	1.0	0.95	0.90	0.85	0.80	0.70	0.60	0.50	0.40	0.30
		R 4/	X 5/	Z											
3	2,580	4.872	0.286	4.881	3.36	187.6	182.2	175.1	167.6	160.1	144.9	129.8	115.2	101.6	89.9
4	4,110	3.058	.274	3.071	5.12	117.8	115.4	111.3	106.9	102.4	93.2	83.9	74.9	66.2	58.5
9	10,380	1.211	.229	1.232	10.71	46.7	47.1	46.0	44.6	43.1	39.9	36.5	33.0	29.6	26.3
14	13,090	0.960	.221	0.985	12.96	37.1	37.8	37.1	36.1	35.0	32.6	30.0	27.3	24.6	22.0
23	20,820	.604	.211	.640	19.26	23.4	24.6	24.5	24.1	23.6	22.3	20.9	19.3	17.7	16.0
50	52,620	.241	.181	.302	36.88	9.5	11.1	11.4	11.6	11.6	11.5	11.2	10.8	10.3	9.7
75	83,690	.153	.173	.231	48.48	6.3	7.8	8.3	8.6	8.7	8.9	8.9	8.7	8.5	8.2
100	105,600	.129	.176	.218	53.83	5.4	7.0	7.5	7.8	8.1	8.3	8.4	8.3	8.2	8.0
150	167,800	.083	.168	.188	63.63	3.9	5.3	5.9	6.2	6.5	6.9	7.1	7.2	7.2	7.1
200	211,600	.069	.168	.182	67.65	3.4	4.9	5.4	5.8	6.1	6.5	6.8	6.9	7.0	7.0
300	300,000	.061	.173	.183	70.55	3.3	4.7	5.3	5.7	6.0	6.5	6.8	7.0	7.0	7.1
400	413,600	.073	.166	.181	66.31	3.5	4.9	5.5	5.9	6.2	6.6	6.8	6.9	7.0	6.9

1/ See 40.1 for unarmored cable and other cable types.
2/ Multiply values by 10^{-5} for drop factors.
3/ Derivations of R, X, and Z shall be as specified in 50.4.
4/ Conductor resistance at 65°C.
5/ Based upon full coverage aluminum-armored cables.

TABLE XV. Drop factors for LS6SGA cable, 450-volt, three-phase, 400-Hz power system. 1/

Cable characteristics						Drop factor values at power factors (cos θ) below 2/									
Size	Area 3/ cmil	Ohms per 1000 feet 4/			Angle β (degrees)	1.0	0.95	0.90	0.85	0.80	0.70	0.60	0.50	0.40	0.30
		R 5/	X 6/	Z											
100	211,200	0.064	0.088	0.109	53.83	2.7	3.5	3.8	3.9	4.0	4.2	4.2	4.2	4.1	4.0
125	266,200	.052	.086	.101	58.83	2.3	3.0	3.3	3.5	3.6	3.8	3.9	3.9	3.8	3.8
150	335,600	.042	.084	.094	63.64	1.9	2.7	2.9	3.1	3.3	3.4	3.6	3.6	3.6	3.6
200	423,200	.035	.084	.091	67.65	1.7	2.4	2.7	2.9	3.1	3.3	3.4	3.5	3.5	3.5

1/ See 40.1 for unarmored cable and other cable types.
2/ Multiply values by 10^{-5} for drop factors.
3/ For type 6SG cable at 400 Hz, two physically opposite conductors are connected in parallel for each phase.
4/ Derivations of R, X, and Z shall be as specified in 50.4.
5/ Conductor resistance at 65°C.
6/ Based upon full coverage aluminum-armored cables.

TABLE XVI. Cable characteristics - LSTSGA cable - interior communications, weapons control and electronic systems. 1/

Size	Area cmil	60 Hz Ohms per 1000 feet 2/				400 Hz Ohms per 1000 feet 2/			
		R 3/	X 4/	Z	Angle β (degrees)	R 2/	X 3/	Z	Angle β (degrees)
3	2,580	4.546	0.043	4.546	0.54	4.546	0.287	4.555	3.61
4	4,110	2.853	.041	2.853	.82	2.853	.274	2.866	5.49
9	10,380	1.130	.034	1.131	1.72	1.130	.229	1.153	11.46
14	13,090	0.896	.034	0.897	2.17	0.896	.224	0.924	14.04
23	20,820	.562	.032	.563	3.26	.563	.211	.601	20.54
50	52,620	.525	.027	.227	6.84	.225	.181	.289	38.81
75	83,690	.143	.026	.145	10.30	.143	.173	.224	50.42
100	105,600	.113	.026	.116	12.96	.120	.176	.213	55.71
150	167,800	.071	.025	.075	19.40	.077	.168	.185	65.38
200	211,600	.057	.025	.062	23.68	.064	.168	.180	69.15
300	300,000	.041	.026	.049	32.38	.059	.173	.183	71.17
400	413,600	.028	.025	.038	41.76	.068	.166	.179	67.72

1/ See 40.1 for unarmored cable and other cable types.
2/ Derivations of R, X, and Z as specified in 50.4.
3/ Conductor resistance at 45°C.
4/ Based upon full coverage aluminum-armored cables.

TABLE XVII. Drop factors 1/ for LSTSGA cable, 120-volt, three-phase or single-phase, 60-Hz lighting systems (using I and I_{LL}). 2/

Size	Drop factor values 3/ at power factor angle θ (single-phase) of angle α 4/ (three-phase). (Angles in degrees below)													
	-70	-65	-60	-55	-50	-45	-40	-30	-20	-10	0	10	20	30
3	130.7	160.5	189.2	216.4	242.0	265.7	287.4	324.1	351.0	367.1	372.2	365.9	348.5	320.5
4	83.1	101.8	119.8	136.8	152.8	167.6	181.2	204.0	220.7	230.7	233.6	229.5	218.4	200.6
9	34.3	41.7	48.7	55.4	61.7	67.4	72.7	81.5	87.9	91.6	92.5	90.6	86.0	78.7
14	27.7	33.5	39.1	44.4	49.3	53.8	58.0	64.9	69.9	72.7	73.4	71.8	68.0	62.1
23	18.3	21.9	25.3	28.6	31.7	34.5	37.0	41.3	44.2	45.9	46.1	45.0	42.4	38.6
50	8.4	9.8	11.2	12.4	13.6	14.6	15.6	17.1	18.1	18.5	18.4	17.8	16.5	14.8
75	6.0	6.9	7.7	8.5	9.2	9.8	10.4	11.2	11.7	11.9	11.7	11.1	10.3	9.0
100	5.2	5.9	6.5	7.1	7.6	8.1	8.5	9.1	9.5	9.5	9.3	8.8	8.0	6.9
150	4.0	4.4	4.7	5.1	5.4	5.6	5.8	6.1	6.2	6.1	5.8	5.4	4.8	4.0
200	3.6	3.9	4.1	4.4	4.6	4.8	4.9	5.1	5.1	4.9	4.6	4.2	3.6	3.0
300	3.2	3.3	3.5	3.6	3.8	3.8	3.9	3.9	3.8	3.6	3.3	2.8	2.3	1.7
400	2.8	2.9	3.0	3.1	3.1	3.1	3.1	3.1	2.9	2.7	2.4	2.0	1.5	1.0

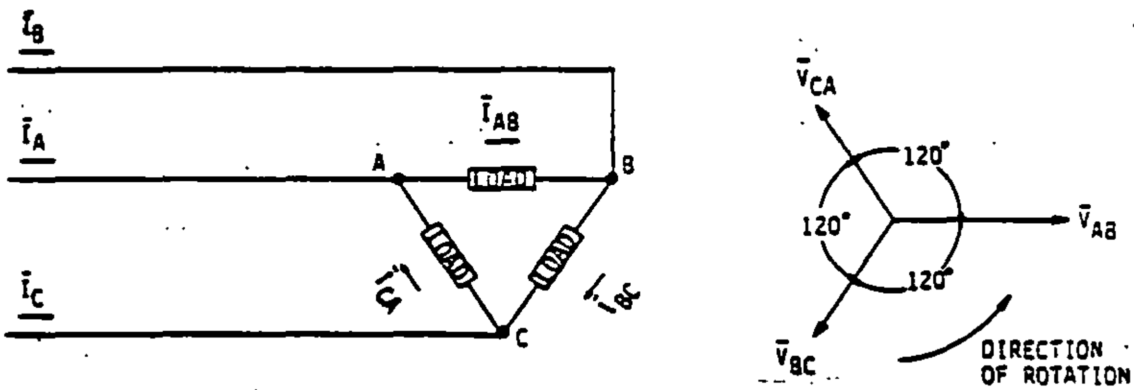
1/ 45°C ambient.
2/ See 40.1 for unarmored cable, and other cable types.
3/ Multiply values by 10^{-5} for drop factors. Cable characteristics at 60 Hz in table XVI were used calculating the drop factors.
4/ See 50.2 for definition of angle α. Negative angle indicates current lags behind referenced voltage (lagging load); positive angle indicates current leads referenced voltage (leading load).

TABLE XVIII. Drop factors 1/ for LSTSGA cable, 120-volt, three-phase or single-phase, 60-Hz lighting systems (using watts and vars). 2/

Size	Drop factor values 3/ at power factor angle θ (single-phase) of angle α 4/ (three-phase). (Angles in degrees below)													
	-70	-65	-60	-55	-50	-45	-40	-30	-20	-10	0	10	20	30
3	166.1	165.2	164.5	164.0	163.7	163.4	163.1	162.7	162.4	162.1	161.8	161.5	161.3	160.9
4	105.7	104.8	104.2	103.7	103.4	103.1	102.8	102.4	102.1	101.8	101.6	101.3	101.0	100.7
9	43.6	42.9	42.4	42.0	41.7	41.5	41.3	40.9	40.7	40.4	40.2	40.0	39.8	39.5
14	35.2	24.5	34.0	33.6	33.3	33.1	32.9	32.6	32.3	32.1	31.9	31.7	31.5	31.2
23	23.2	22.5	22.0	21.7	21.4	21.2	21.0	20.7	20.5	20.3	20.1	19.8	19.6	19.4
50	10.7	10.1	9.7	9.4	9.2	9.0	8.8	8.6	8.4	8.2	8.0	7.8	7.7	7.4
75	7.7	7.1	6.7	6.4	6.2	6.0	5.9	5.6	5.4	5.3	5.1	4.9	4.7	4.5
100	6.7	6.1	5.7	5.4	5.2	5.0	4.8	4.6	4.4	4.2	4.0	3.9	3.7	3.5
150	5.1	4.5	4.1	3.8	3.6	3.5	3.3	3.1	2.9	2.7	2.5	2.4	2.2	2.0
200	4.5	4.0	3.6	3.3	3.1	2.9	2.8	2.5	2.3	2.2	2.0	1.9	1.7	1.5
300	4.0	3.4	3.1	2.8	2.5	2.4	2.2	2.0	1.8	1.6	1.4	1.3	1.1	0.9
400	3.5	3.0	2.6	2.3	2.1	1.9	1.8	1.5	1.4	1.2	1.0	0.9	0.7	0.5

1/ 45°C ambient.
2/ See 40.1 for unarmored cable and other cable types.
3/ Multiply value in table by 10^{-7} for drop factor. The drop factors in this table are equal to the drop factors in table XVII divided by 2 x V x cosθ, where V = 115 volts.
4/ See 50.2 for definition of angle α. Negative angle indicates current lags behind referenced voltage (lagging load); positive angle indicates current leads referenced voltage (leading load).

40.2 Three-phase line currents for single-phase loads. In order to determine the line currents for a three-phase feeder serving single-phase loads (such as lighting circuits), phase currents shall be combined vectorially. This may be accomplished in the following manner, with reference to the following diagram.



LOAD indicates the total of single-phase load for each phase.

$\bar{I}_{AB}$, $\bar{I}_{BC}$, and $\bar{I}_{CA}$ are currents in each phase.

$\bar{I}_A$, $\bar{I}_B$, and $\bar{I}_C$ are currents in each line.

V_{AB}, V_{BC}, and V_{CA} are phase voltages.

The bar over the V and I indicate they are vectors. V and I without the bars indicate scalars (magnitude only).

Total phase currents $\bar{I}AB$, $\bar{I}BC$, and $\bar{I}CA$ shall be calculated by summing vectorially the currents for the loads in each respective phase. The phase voltages V_{AB}, V_{BC}, and V_{CA} shall be derived by the following:

$$\bar{V}_{AB} = V_{AB} \angle 0^\circ$$

$$\bar{V}_{BC} = V_{BC} \angle -120^\circ$$

$$\bar{V}_{CA} = V_{CA} \angle 120^\circ$$

If the power factor angles of the currents in AB, BC, and CA phases are θ_{AB}, θ_{BC}, and θ_{CA}, referencing the phase currents with the respective voltages, then:

$$\bar{I}_{AB} = I_{AB} \underline{/ (0^\circ - \theta_{AB})}$$

$$\bar{I}_{BC} = I_{BC} \underline{/ (-120^\circ - \theta_{BC})}$$

$$\bar{I}_{CA} = I_{CA} \underline{/ (120^\circ - \theta_{CA})}$$

The line currents I_A, I_B, and I_C shall then be calculated using the following equations:

$$\bar{I}_A = \bar{I}_{AB} - \bar{I}_{CA}$$

$$\bar{I}_B = \bar{I}_{BC} - \bar{I}_{AB}$$

$$\bar{I}_C = \bar{I}_{CA} - \bar{I}_{BC}$$

Note that if all three-phase currents are equal to magnitude ($I_{AB} = I_{BC} = I_{CA}$), and are 120 electrical degrees out of phase from each other, then $I_A = I_B = I_C = \sqrt{3}\, I_{AB}$ (where $I_{AB} = I_{BC} = I_{CA}$). This simplified method of calculating the current may be used to estimate its value only if there is a small imbalance between the three-phase currents.

40.3 Lighting system calculations using watts and vars. For lighting systems, watts (W and W_{LL}) and vars (U and U_{LL}) can be used instead of amperes (I and I_{LL}) in voltage drop equations to avoid the necessity of calculating all phase and line currents. This is an advantage when watt and var values of connected loads are known. They represent the resistive (real) and reactive (imaginary) components of volt-ampere vectors, and may be added vectorially.

For single-phase circuits, watts (W) and vars (U) shall be the sums of the connected load values.

For three-phase circuits, volt-ampere (K) vectors may be handled in the same manner as the current (I) vectors. The same subscript notation is applicable, and is used herein. Equations may also be written to express scalar values of W, W_{LL}, U, and U_{LL} in terms of phase watts and vars. Care shall be exercised in using these equations, because some signs are different for inductive and capacitive loads. The equations below are for inductive loads (see 50.3 for derivations).

$$W_A = W_{AB} + 0.5\, W_{CA} - 0.866\, U_{CA}$$

$$W_B = W_{BC} + 0.5\, W_{AB} - 0.866\, U_{AB}$$

$$W_C = W_{CA} + 0.5\, W_{BC} - 0.866\, U_{BC}$$

$$U_A = U_{AB} + 0.5\, U_{CA} + 0.866\, W_{CA}$$

$$U_B = U_{BC} + 0.5\, U_{AB} + 0.866\, W_{AB}$$

$$U_C = U_{CA} + 0.5\, U_{BC} + 0.866\, W_{BC}$$

$$2W_{LL(AB)} = 4W_{AB} + W_{BC} + W_{CA} + 1.73\ (U_{BC} - U_{CA})$$

$$2W_{LL(BC)} = 4W_{BC} + W_{CA} + W_{AB} + 1.73\ (U_{CA} - U_{AB})$$

$$2W_{LL(CA)} = 4W_{CA} + W_{AB} + W_{BC} + 1.73\ (U_{AB} - U_{CA})$$

$$2U_{LL(AB)} = -[4U_{AB} + U_{BC} + U_{CA} - 1.73\ (W_{BC} - W_{CA})]$$

$$2U_{LL(BC)} = -[4U_{BC} + U_{CA} + U_{AB} - 1.73\ (W_{CA} - W_{AB})]$$

$$2U_{LL(CA)} = -[4U_{CA} + U_{AB} + U_{BC} - 1.73\ (W_{AB} - W_{CA})]$$

Where total load on each of the three phases is capacitive, the signs of the last terms in the equations listed above shall be reversed. Similar sets of equations may be written for combinations of inductive and capacitive loads.

For checking current carrying capacity of conductors, only the largest phase volt-amperes (K) value shall be considered. General equations shall be as follows:

$$K = \sqrt{W^2 + U^2}$$

$$I = \frac{K}{V} = \frac{K}{115} = \left(\frac{W}{115}\right)\left(\frac{1}{\cos\theta}\right)$$

$$\theta = \cos^{-1}\left(\frac{W}{K}\right) \text{ or } \tan^{-1}\left(\frac{U}{W}\right)$$

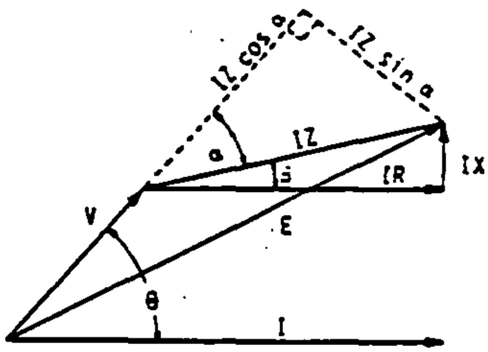
$$\alpha_{LL} = \cos^{-1}\left(\frac{W_{LL}}{K_{LL}}\right) \text{ or } \tan^{-1}\left(\frac{U_{LL}}{W_{LL}}\right)$$

Note: α_{LL} is a positive angle if U_{LL} is positive; α_{LL} is numerically greater than 90 degrees if W_{LL} is negative.

50. DETAILED DESCRIPTIONS OF EQUATIONS AND CALCULATIONS (DERIVATIONS)

50.1 Power systems - derivation of drop factors (DF). This section contains the derivation of the equations used to calculate drop factors for voltage drop calculations in power systems. Tables XIII and XIV contain drop factors for type LSTSGA cable which were calculated by using the derived equation. Similarly, the drop factors shown in table XV for type LS6SGA cable were calculated by also using this equation. This equation may be used to calculate drop factors for other types of cables, if the cable impedance characteristics are known.

Voltage relations for voltage drop calculations may be indicated in a vector diagram as follows:



From the diagram:

$$E^2 = (V + IZ\cos\alpha)^2 + (IZ\sin\alpha)^2 \qquad \text{(equation 1)}$$

From equation 1:

$$V = -IZ\cos\alpha + \sqrt{E^2 - I^2Z^2\sin^2\alpha} \qquad \text{(equation 2)}$$

Voltage drop is given by the equation:

$$D\% = \left(\frac{E - V}{E}\right)100 = \left(1 - \frac{V}{E}\right)100 \qquad \text{(equation 3)}$$

Substituting for V in equation 3 from equation 2:

$$D\% = 100\left[1 + \frac{IZ\cos\alpha}{E} - \sqrt{1 - \left(\frac{IZ}{E}\right)^2 \sin^2\alpha}\right] \qquad \text{(equation 4)}$$

$\sqrt{1 - \left(\frac{IZ}{E}\right)^2 \sin^2\alpha}$ may be expressed (approximately) by the first two terms of its binomial series expansion which are:

$$1 - \frac{1}{2}\left[\left(\frac{IZ}{E}\right)^2 \sin^2\alpha\right]$$

Substituting into equation 4:

$$D\% = 100\left[\left(\frac{IZ}{E}\right)\cos\alpha + \left(\frac{IZ}{E}\right)^2 \frac{\sin^2\alpha}{2}\right] \qquad \text{(equation 5)}$$

Let

$$A = \frac{100(z)\cos\alpha}{E}$$

Then,

$$L \times A = \frac{100(Z)\cos\alpha}{E}, \text{ since } z = \frac{Z}{L},$$

and let

$$B = \frac{100(z)^2\sin^2\alpha}{2E^2}$$

Then,

$$L^2 \times B = \frac{100(Z)^2\sin^2\alpha}{2E^2}$$

Equation 5 may then be rewritten as follows:

$$D\% = I \times L \times A + (I \times L)^2 B \qquad \text{(equation 6)}$$

Let drop factor (DF) be defined as follows:

$$DF = A + (I \times L \times B) \qquad \text{(equation 7)}$$

Then equation 6 may be written as follows:

$$D\% = I \times L \times DF, \qquad \text{(equation 8)}$$

Since $2E^2 >> E$, $A >> B$, for $A >> B$, equation 8 becomes $d_o\% \cong I \times L \times A$, where $d_o\%$ = assumed voltage drop.

Therefore,

$$IL \cong \frac{d_o\%}{A}$$

Substituting this value into equation 7 as follows:

$$DF = A\left[1 + \left(\frac{d_o\%\,(B)}{A^2}\right)\right], \text{ and } DF = \frac{(z)\cos\alpha}{E}\left[100 + \left(\frac{d_o\%\,\sin^2\alpha}{2\cos^2\alpha}\right)\right]$$

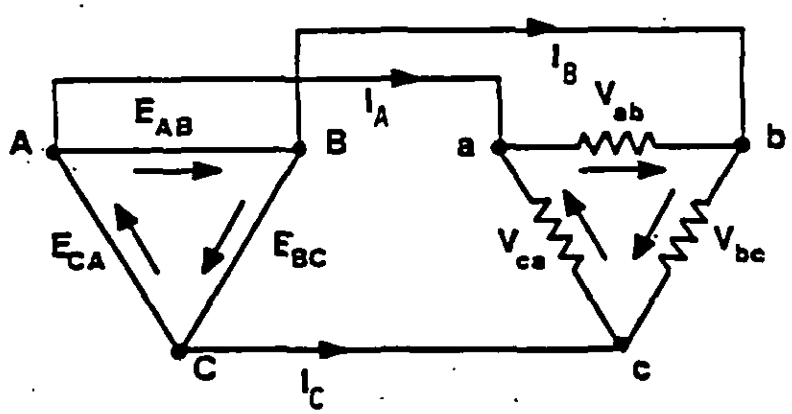
(equation 9)

Substituting into equation 8 as follows:

$$D\% = I \times L \times \frac{(z)\cos\alpha}{E}\left[100 + \left(\frac{d_o\% \tan^2\alpha}{2}\right)\right]$$

Therefore, drop factors shown in tables XIII, XIV, and XV are calculated from equation 9 by using the appropriate cable impedance characteristics and load power factors. The assumed voltage drop (d_o%) equals 10 for the drop factors generated in these tables. The percentage voltage drop (D%) for a given load condition and length of cable may be calculated by multiplying the appropriate drop factor value as shown in (tables XIII, XIV, and XV) by the length of cable.

50.2 Lighting systems - derivation of drop factors (DF). This section contains the derivation of the equations used to calculate voltage drop calculations in lighting systems. Table XVII contains drop factors for type LSTSGA cable which were calculated using the derived equation. This equation may be used to calculate drop factors for other cables, if the cable characteristics are known. The circuit for a three-phase lighting system may be represented as follows:



Voltage loop equations may be written for loops BAabB, CBbcC, and ACcaA as follows:

$$-E_{AB} + Z_L I_A + V_{ab} - Z_L I_B = 0$$

$$-E_{BC} + Z_L I_B + V_{bc} - Z_L I_C = 0$$

$$-E_{CA} + Z_L I_C + V_{ca} - Z_L I_A = 0$$

where Z_L = impedance, in ohms for each phase of both cable and load.

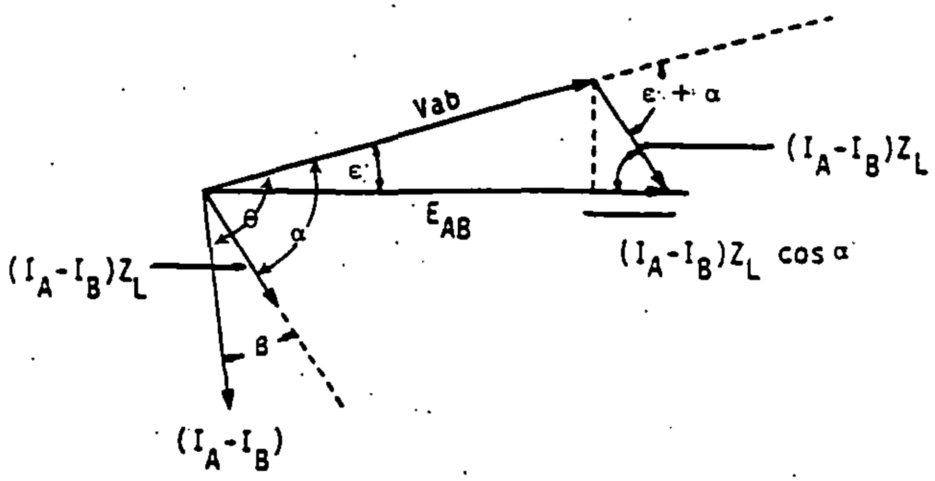
The above loop equations may be rewritten as follows:

$$E_{AB} - V_{ab} = (I_A - I_B)\, Z_L$$

$$E_{BC} - V_{bc} = (I_B - I_C)\, Z_L$$

$$E_{CA} - V_{ca} = (I_C - I_A)\, Z_L$$

For the first equation in the above set of three, a vector diagram may be drawn as follows:



Since angle ϵ is very small,

$$\cos(\epsilon + \alpha) \cong \cos\alpha$$

and $Vab \cong Vab \cos\alpha$

Therefore, from the vector diagram,

$$V_{ab} \cong E_{AB} - (I_A - I_B)Z_L \cos\alpha \qquad \text{(equation 1)}$$

The general equation for voltage drops is given by:

$$D\% = \left(\frac{E - V}{E}\right)100 = \left(1 - \frac{V}{E}\right)100 \qquad \text{(equation 2)}$$

For phase AB specifically, equation 1 may be written as

$$D\% = \left(1 - \frac{V_{ab}}{E_{AB}}\right)100 \qquad \text{(equation 3)}$$

Substituting in equation 3 from equation 1 for V_{ab},

$$D\% = \left(1 - 1 + \frac{(I_A - I_B)\ Z_L\ \cos\alpha}{E_{AB}}\right) x\ 100$$

Since $\theta = \alpha + \beta$.

and $\ell \cong \alpha + \beta$.

Therefore,

$$D\% = \left(\frac{(I_A - I_B)Z_L \cos\theta}{E_{AB}}\right) x\ 100 \qquad \text{(equation 4)}$$

Equation 4 may be generalized by letting I_{LL} represent the difference in line currents (I_A-I_B, I_B-I_C or I_C-I_A), and E represent the line-to-line rated source voltage (E_{AB}, E_{BC}, or E_{CA}).

Equation 4 may then be written as follows:

$$D\% = I_{LL} \times Z_L \times \frac{\cos\theta}{E} \times 100 \qquad \text{(equation 5)}$$

Since $z_L = \frac{Z_L}{L}$, equation 5 may be rewritten as follows:

$$D\% = I_{LL} \times L \times z_L \times \frac{\cos\theta}{E} \times 100 \qquad \text{(equation 6)}$$

Let drop factor (DF) be defined as follows:

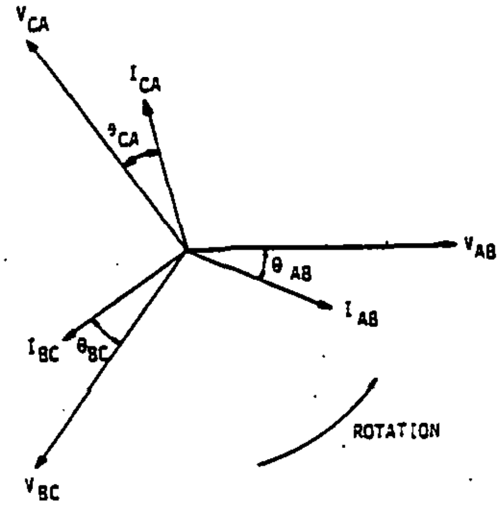
$$DF = z_L \times \frac{\cos\theta}{E} \times 100 \qquad \text{(equation 7)}$$

Substituting equation 7 into equation 6,

$$D\% = I_{LL} \times L \times DF \qquad \text{(equation 8)}$$

Therefore, drop factors in table XVII are calculated from equation 7 by using appropriate cable impedance characteristics and load power factors. The entries of table XVII are prepared for a given power factor using the relationship $\theta = \alpha + \beta$ from the vector diagram in 50.2.

50.3 <u>Lighting systems - derivation of drop factors (DF) using load watts and vars</u>. This section contains the derivation of the equations used to calculate voltage drop in lighting systems by the load watts and vars method. Table XVIII contains drop factors for type LSTSGA cable which were calculated using the derived equations. The equations may be used to calculate drop factors for other cable types, if the cable characteristics are known. The following vector diagram is used in derivation of the equations:



K, the total power (real and imaginary) for each phase, may be found by multiplying phase current by phase voltage. For example, for phase AB,

$$K_{AB} = V_{AB} I_{AB}$$

In rectangular form, $K_{AB} = V_{AB}\,(1+j0) \times I_{AB}\,(\cos\theta_{AB} + j\sin\theta_{AB})$

$$K_{AB} = V_{AB} I_{AB} \cos\theta_{AB} + jV_{AB} I_{AB} \sin\theta_{AB} \quad \text{(equation 1)}$$

Since $V_{AB} I_{AB} \cos\theta_{AB} = W_{AB}$, and

$$V_{AB} I_{AB} \sin\theta_{AB} = U_{AB},$$

Equation 1 may be written as follows:

$$K_{AB} = W_{AB} + jU_{AB}$$

K_{BC} and K_{CA} may be referenced to the same axis as K_{AB}; for inductive loads, their vector values shall be as follows:

$$K_{BC} \cos\,(-120^\circ - \theta_{BC}) \text{ and}$$

$$K_{CA} \cos\,(120^\circ - \theta_{CA})$$

Using the trigonometric identity as follows:

$$\cos(\theta_1 - \theta_2) = \cos\theta_1 \cos\theta_2 + \sin\theta_1 \sin\theta_2$$

These terms can be written as follows:

$$K_{BC}[\cos(-120°)\cos(\theta_{BC}) + \sin(-120°)\sin(\theta_{BC})]$$

and

$$K_{CA}[\cos 120° \cos\theta_{CA} + \sin 120° \sin\theta_{BC}]$$

and since

$$\sin(-120°) = -0.866 \text{ and } \cos(-120°) = -0.5$$

and

$$\sin 120° = 0.866 \text{ and } \cos 120° = -0.5$$

the equation becomes

$$K_{BC}(-0.5\cos\theta_{BC} - 0.866\sin\theta_{BC}) \text{ and}$$

$$K_{CA}(-0.5\cos\theta_{CA} + 0.866\sin\theta_{CA})$$

As indicated above, these two quantities can be rewritten as follows:

$$-0.5W_{BC} - 0.866U_{BC} \quad \text{and}$$

$$-0.5W_{CA} + 0.866U_{CA}$$

Since line A volt-amperes is the difference between phase AB volt-amperes and phase CA volt-amperes, then:

$$K_A = K_{AB} - K_{CA}$$

and

$$W_A = W_{AB} - W_{CA}$$

Substituting for W_{AB} and W_{CA},

$$W_A = K_{AB}\cos\theta_{AB} - K_{CA}\cos(120° - \theta_{CA})$$

$$W_A = W_{AB} - (-0.5W_{CA} + 0.866U_{CA})$$

$$W_A = W_{AB} + 0.5W_{CA} - 0.866U_{CA} \qquad \text{(equation 2)}$$

Similarly for W_B,

$$W_B = W_{BC} - W_{AB}$$

$$= K_{BC}(-0.5\cos\theta_{BC} - 0.866\sin\theta_{BC}) - W_{AB}$$

$$= -W_{AB} - 0.5W_{BC} - 0.866U_{BC} \qquad \text{(equation 3)}$$

Since $W_{LL(AB)} = W_A - W_B$

Substituting from equations 2 and 3,

$$W_{LL(AB)} = 2W_{AB} + 0.5\ (W_{BC} + W_{CA}) + 0.866\ (U_{BC} - U_{CA})$$

and

$$2W_{LL(AB)} = 4W_{AB} + W_{BC} + W_{CA} + 1.73\ (U_{BC} - U_{CA})$$

By an analysis similar to that shown above, the equation for 2 $U_{LL}(AB)$ may be found.

Equations for $W_{LL(BC)}$, $W_{LL(CA)}$, $U_{LL(BC)}$ and $U_{LL(CA)}$ may be found by referring the K vectors to the same axis of V_{BC} for $W_{LL(BC)}$ and $U_{LL(BC)}$, and V_{CA} for $W_{LL(CA)}$ and $U_{LL(CA)}$. Equations for capacitive loads, or mixed inductive and capacitive loads, may also be derived by assigning the proper sign to each phase angle (negative for inductive and positive for capacitive) in determining values of cosine and sine ($\pm$ 120° $\pm$ θ). It should be noted that if these equations are divided by load voltage, V, similar expressions involving resistive and reactive components of current will result. In some cases, use of these equations may be more convenient than the vector rotation method when currents are used in calculations.

The general voltage drop equation for lighting systems as derived in 50.2 is

$$D\% = I_{LL} \times L \times DF \qquad \text{(equation 4)}$$

Since $W_{LL} = I_{LL}$ (V) (cosα), substituting $2W_{LL} = 2I_{LL}$ (V) (cosα) into equation 4 will give

$$D\% = \frac{L \times 2W_{LL} \times DF}{2(V)\ \cos\alpha} \qquad \text{(equation 5)}$$

Let a new drop factor (DF') be defined as follows:

$$DF' = \frac{DF}{2(V)\ \cos\alpha}$$

Therefore,

$$D\% = L \times 2W_{LL} \times DF'$$

The three-phase voltage drop equation (equation 5) may be rewritten, without angle, in accordance with the following derivation:

As shown in 50.2,

$$DF = z_L \times \frac{\cos(\alpha + \beta)}{E} \times 100,$$

where $\theta = \alpha + \beta$

Substituting for DF in equation 5,

$$D\% = \frac{L \times W_{LL} \times z_L (\cos\alpha \cos\beta \pm \sin\alpha \sin\beta) \times 100}{E(V) \cos\alpha}$$

Using a trigonometric identity,

$$D\% = \frac{100 \times L \times W_{LL} \times z_L (\cos\alpha \cos\beta \pm \sin\alpha \sin\beta)}{E(V) \cos\alpha}$$

$$= \frac{100 \times L \times K_{LL} \times (R \cos\alpha \pm X \sin\alpha)}{E(V)}$$

$$= \frac{100 \times L \times (RW_{LL} \pm XU_{LL})}{120 \times 115}$$

$D\% = 725 (L) (RW_{LL} \pm XU_{LL}) \times 10^{-5}$, where R and X are cable constants as shown in table XIV. Plus is used in the above equation for inductive loads, and minus is used for capacitive loads. In order to calculate the percentage voltage drop, entries in table XVIII may be used with the value of power specified and length of the cable.

50.4 Derivation of resistance and reactance values for cables. This section contains the derivation of values for cable resistance and reactance used in tables XIII, XIV, XV, and XVI. The cables identified in this document have conductor diameters of standard AWG, rather than Navy sizes. Navy sizes are close to equivalent AWG sizes. However, the differences are enough to affect cable impedance values.

The ideal method of determining resistance and reactance values for particular cable types is by test measurements. In the absence of test data, however, these values may be derived mathematically.

50.4.1 Calculation of resistance values for cables. The method used herein for calculating the resistance of electrical cables is based upon the one specified in ASTM B 258 and ASTM B 8. This general method may be used to calculate with reasonable accuracy the resistance of any cable with concentric-lay-stranded conductors. The overall approach is as follows:

(1) Calculate dc resistance at 20°C for solid conductors using ASTM B 258.
(2) Adjust for concentric-lay-stranded conductors using ASTM B 8.
(3) Adjust for ac resistance by multiplying by the ac/dc resistance ratio at the desired frequency (60 or 400 Hz).
(4) Adjust to temperature for which cable service is designed. As specified in ASTM B 258, dc resistance at 20°C in ohms per 1000 feet is given by:

$$R_{dc} = \left(\frac{\rho}{d^2 \times \delta}\right) 105.35$$

where ρ (resistivity) is 875.20 ohm-pounds per mile squared, and is δ (density) 8.89 grams per centimeter cubed. Therefore,

$$Rdc = \frac{10{,}371.47}{d^2}$$

where d is the diameter of the conductor in mils. Therefore, the following chart for type SG-equivalent solid conductors shall be generated.

Designation	Dia. (mils)	R_{dc} (ohms per 1000 ft) at 20°C
SG-3	50.8	4.018
SG-4	64.1	2.522
SG-9	101.9	0.999
SG-14	114.4	.792
SG-23	144.3	.498
SG-50	229.4	.197
SG-75	289.3	.124
SG-100	324.9	.098
SG-150	409.6	.062
SG-200	460.0	.049
SG-300	547.7	.035
SG-400	643.1	.025

This data for solid conductors must be adjusted for concentric-lay-stranded SG conductors. Because of the lay in stranded conductors, the resistance for each unit length of a stranded conductor is slightly greater than that for an equivalent diameter solid conductor. ASTM B 8 provides a precise mathematical method for deriving the multiplying factor (k, in percent) that is used to modify dc resistance of a solid conductor for an equivalent concentric-lay-stranded conductor. A lay factor (m_{ind}) is determined for each wire in a concentric-lay-stranded conductor from

$$m_{ind} = \sqrt{1 + (9.8696/n^2)}.$$

where n equals the length of lay/diameter of helical path of wire. The lay factor m for the complete stranded conductor is the numerical average of the lay factors (m_{ind}) for each of the individual wires in the conductor. Finally, the increment factor k is calculated from

$$K = 100 (m-1)$$

K is the percentage value increase in resistance of a solid conductor for an equivalent concentric-lay-stranded conductor. In lieu of performing many calculations based upon detailed conductor geometry, which would be required by the above method, the following nominal increment factors may be used:

Number of strands	Increment factor (percent)
7	3
19	4
37	5
61	5
91	5
127	5

Therefore, concentric-lay-stranding of a solid conductor results in a nominal increase in electrical resistance from 3 to 5 percent, depending upon the number of strands in a conductor. The above chart for dc resistance of solid conductors may be used to generate a chart for concentric-lay-stranded conductors by applying the above increment factors.

Designation	Number of strands	R_{dc} (ohms per 1000 ft) at 20°C
SG-3	7	4.139
SG-4	7	2.598
SG-9	7	1.029
SG-14	7	0.816
SG-23	7	.513
SG-50	19	.205
SG-75	37	.130
SG-100	61	.103
SG-150	61	.065
SG-200	61	.052
SG-300	91	.037
SG-400	127	.026

The following ac/dc resistance ratios were calculated (dc resistance values were adjusted to 65°C, since the ac resistance values were at that temperature).

Designation	Ac/dc ratio at 60 Hz	Ac/dc ratio at 400 Hz
SG-3	1.00	1.00
SG-4	1.00	1.00
SG-9	1.00	1.00
SG-14	1.00	1.00
SG-23	1.00	1.00

Designation	Ac/dc ratio at 60 Hz	Ac/dc ratio at 400 Hz
SG-50	1.00	1.00
SG-75	1.00	1.00
SG-100	1.00	1.06
SG-150	1.00	1.09
SG-200	1.00	1.14
SG-300	1.00	1.43
SG-400	1.00	2.35

Therefore, the above chart for dc resistance of concentric-lay-stranded conductors may be used to generate a chart of ac resistances, 60 and 400 Hz at 20°C, by multiplication of the appropriate ac/dc resistance ratio.

Designation	Ac resistance, 60 Hz (ohms per 1000 ft)	Ac resistance, 400 Hz (ohms per 1000 ft)
SG-3	4.139	4.139
SG-4	2.598	2.598
SG-9	1.029	1.029
SG-14	0.816	0.816
SG-23	.513	.513
SG-50	.205	.205
SG-75	.130	.130
SG-100	.103	.109
SG-150	.065	.071
SG-200	.052	.059
SG-300	.037	.053
SG-400	.026	.061

Finally, ac resistances must be adjusted for the design temperature of cable service. Resistance values at a selected temperature may be calculated from measured resistance values at another temperature by

$$R_t = R_{to} \; [1 + \alpha \, (t - t_o)]$$

Where:

R_t = required resistance.
R_{to} = measured resistance.
t = temperature at which resistance is required.
t_o = temperature at which resistance was measured.
α = temperature coefficient of resistance at measured temperature.

For t_o = 20°C, α = 0.00393 per 1°C, and t_o = 25°C, α = 0.00385 per 1°C.

For tables XIII (60 Hz) and XIV (400 Hz), the applicable temperature value is 65°C. Therefore, resistances in the above chart must be multiplied by

$$1 + 0.00393 \, (65-20) = 1.177$$

The following data results:

Designation	Ac resistance, 60 Hz (ohms per 1000 ft)	Ac resistance, 400 Hz (ohms per 1000 ft)
SG-3	4.872	4.872
SG-4	3.058	3.058
SG-9	1.211	1.211
SG-14	0.96	0.96
SG-23	.604	.604
SG-50	.241	.241
SG-75	.153	.153
SG-100	.121	.129
SG-150	.076	.083
SG-200	.061	.069
SG-300	.043	.061
SG-400	.031	.073

These are the resistance values shown in tables XIII (60 Hz) and XIV (400 Hz).

For table XVI, the applicable temperature value is 45°C. Therefore, resistances at 20°C must be multiplied by

$$1 + 0.00393\,(45-20) = 1.098$$

The following data results:

Designation	Ac resistance, 60 Hz (ohms per 1000 ft)	Ac resistance, 400 Hz (ohms per 1000 ft)
SG-3	4.456	4.456
SG-4	2.853	2.853
SG-9	1.130	1.130
SG-14	0.896	0.896
SG-23	.562	.563
SG-50	.225	.225
SG-75	.143	.143
SG-100	.113	.120
SG-150	.071	.077
SG-200	.057	.064
SG-300	.041	.059
SG-400	.029	.068

These are the resistance values shown in table XVI.

For type 6SG cable shown in table XV, two conductors are connected in parallel for each phase of a three-phase circuit. Therefore, the resistance for each phase is one-half of the ac resistance (at 400 Hz) calculated earlier at the required design temperature of 65°C. Resulting values are as follows:

Designation	Ac resistance, 400 Hz (ohms per 1000 ft)
6SG-100	0.064
6SG-125	0.052
6SG-150	0.042
6SG-200	0.035

50.4.2 Calculation of reactance values for cables. Calculation of cable reactances is much more complicated than the calculation of cable resistances. The principal reason for this is that cable reactances are not only dependent upon the geometry of the conductors in the cable, but also on the cable's external environment (for example, conducting armor material and proximity to surrounding steel). The following inductance (reactance divided by the quantity of two times the frequency times π) values are for Navy size cables.

Designation	Inductance (millihenries per 1000 ft)
SG-3	0.109
SG-4	.104
SG-9	.098
SG-14	.085
SG-23	.080
SG-50	.074
SG-75	.072
SG-100	.072
SG-150	.069
SG-200	.069
SG-300	.069
SG-400	.066

In terms of the magnitude of impedance for a cable, these values of inductance are relatively insignificant in comparison to resistance, except for large size cables at 400 Hz. Consequently, in the absence of reactance data, reasonably accurate voltage drops can be calculated on the basis of resistance alone for cables with relatively insignificant inductance. In order to quantify the effect on reactance in converting from Navy sizes to AWG sizes, the ratio of the change in the ratio of the distance between the center of conductors and the conductor diameter for each size is used as a multiplying factor to determine a new inductance value. While this method may not be precise, it does provide (on an order of magnitude basis) a reasonable inductance value for AWG sizes based upon the data for Navy sizes. Conductor diameters are derived from MIL-C-915 for old ratio and MIL-C-24643 for new ratio. New inductance values are as follows:

Designation	Old ratio	New ratio	New inductance (millihenries per 1000 ft)
SG-3	2.17	2.26	0.113
SG-4	1.88	1.97	.109
SG-9	1.73	1.61	.091
SG-14	1.92	2.02	.089

Designation	Old ratio	New ratio	New inductance (millihenries per 1000 ft)
SG-23	1.81	1.89	.083
SG-50	1.31	1.28	.073
SG-75	1.28	1.22	.068
SG-100	1.25	1.21	.069
SG-150	1.22	1.19	.067
SG-200	1.23	1.20	.067
SG-300	1.19	1.19	.069
SG-400	1.16	1.16	.066

From these adjusted new inductance values, reactances at 60 and 400 Hz may be calculated to produce the following data:

Designation	Ac resistance, 60 Hz (ohms per 1000 ft)	Ac resistance, 400 Hz (ohms per 1000 ft)
SG-3	0.043	0.286
SG-4	.041	.274
SG-9	.034	.229
SG-14	.034	.221
SG-23	.032	.211
SG-50	.027	.181
SG-75	.026	.173
SG-100	.026	.176
SG-150	.025	.168
SG-200	.025	.168
SG-300	.025	.173
SG-400	.025	.166

Since two conductors are connected in parallel for each phase, the reactance per phase is one-half of reactance at 400 Hz. The reactance values used for 6SG cable are as follows:

Designation	Ac resistance, 400 Hz (ohms per 1000 ft)
6SG-100	0.088
6SG-125	.086
6SG-150	.084
6SG-200	.084

Finally, impedance values are calculated by taking the square root of the sum of the resistance squared and reactance squared.

INDEX

Cable Information

Cable Ratings and Characteristics

INDEX - Continued

INDEX - Continued

Appendix

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER MIL-HDBK-299(SH)	2. DOCUMENT TITLE CABLE COMPARISON HANDBOOK DATA PERTAINING TO ELECTRIC SHIPBOARD CABLE
3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)* ☐ VENDOR ☐ USER ☐ MANUFACTURER ☐ OTHER *(Specify)*:
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NOTICE 1
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MILITARY HANDBOOK

CABLE COMPARISON HANDBOOK
DATA PERTAINING TO ELECTRICAL SHIPBOARD CABLE

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v	15 Octover 1991	v	3 April 1989
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vii	15 October 1991	--	NEW PAGE
viii	15 October 1991	--	NEW PAGE
75	15 October 1991	75	3 April 1989
76	15 October 1991	76	3 April 1989
77	15 October 1991	77	3 April 1989
78	15 October 1991	78	3 April 1989
79	15 October 1991	79	3 April 1989
80	15 October 1991	80	3 April 1989
81	15 October 1991	81	3 April 1989
82	15 October 1991	82	3 April 1989
83	15 October 1991	83	3 April 1989
84	15 October 1991	84	3 April 1989
85	15 October 1991	85	3 April 1989
86	15 October 1991	86	3 April 1989
87	15 October 1991	87	3 April 1989
88	15 October 1991	88	3 April 1989
89	15 October 1991	89	3 April 1989
90	15 October 1991	90	3 April 1989
91	15 October 1991	91	3 April 1989
92	15 October 1991	92	3 April 1989
93	15 October 1991	93	3 April 1989
94	15 October 1991	94	3 April 1989
95	15 October 1991	95	3 April 1989
96	15 October 1991	96	3 April 1989
97	15 October 1991	97	3 April 1989
98	15 October 1991	98	3 April 1989
99	15 October 1991	99	3 April 1989
100	15 October 1991	100	3 April 1989
101	15 October 1991	101	3 April 1989
102	15 October 1991	102	3 April 1989
103	15 October 1991	103	3 April 1989
104	15 October 1991	104	3 April 1989

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105	15 October 1991	105	3 April 1989
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107	15 October 1991	--	NEW PAGE
108	15 October 1991	--	NEW PAGE
109	15 October 1991	--	NEW PAGE
110	15 October 1991	--	NEW PAGE
111	15 October 1991	--	NEW PAGE
112	15 October 1991	--	NEW PAGE
113	15 October 1991	--	NEW PAGE
114	15 October 1991	--	NEW PAGE
115	15 October 1991	--	NEW PAGE
116	15 October 1991	--	NEW PAGE
117	15 October 1991	--	NEW PAGE
118	15 October 1991	--	NEW PAGE
119	15 October 1991	--	NEW PAGE
120	15 October 1991	--	NEW PAGE
121	15 October 1991	--	NEW PAGE
122	15 October 1991	--	NEW PAGE
123	15 October 1991	--	NEW PAGE
124	15 October 1991	--	NEW PAGE
125	15 October 1991	--	NEW PAGE
126	15 October 1991	--	NEW PAGE
127	15 October 1991	--	NEW PAGE
128	15 October 1991	--	NEW PAGE
129	15 October 1991	--	NEW PAGE
130	15 October 1991	--	NEW PAGE
131	15 October 1991	--	NEW PAGE
132	15 October 1991	--	NEW PAGE
133	15 October 1991	--	NEW PAGE
134	15 October 1991	--	NEW PAGE
135	15 October 1991	--	NEW PAGE
136	15 October 1991	--	NEW PAGE
137	15 October 1991	--	NEW PAGE
138	15 October 1991	--	NEW PAGE
139	15 October 1991	--	NEW PAGE
140	15 October 1991	--	NEW PAGE
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CONTENTS- Continued

TABLES

Supersedes page v of 3 April 1989.

CONTENTS - Continued

TABLES

FIGURES

Supersedes page vi of 3 April 1989.

CONTENTS - Continued

APPENDIX

NEW PAGE.

CONTENTS - Continued

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ELECTRICAL CABLE VOLTAGE DROP CALCULATIONS

10. SCOPE

10.1 Scope. This appendix is intended for use as a guide to determining cable voltage drops for alternating current (ac) and direct current (dc) power, lighting, electronic, interior communication, and weapon control systems.

20. REFERENCED DOCUMENTS

20.1 Government documents.

This paragraph is not applicable to this appendix.

20.2 Nongovernment publications. The following documents form a part of this handbook to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation.

American Society For Testing And Materials (ASTM)

ASTM B 8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft. (DoD adopted)

ASTM B 258 - Standard Specification for Standard Nominal Diameters and Cross-Sectional Areas of AWG Sizes of Solid Round Wire Used as Electrical Conductors.

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia PA 19103)

(Nongovernment standards and other publications are normally available from the organizations that prepare or distribute the documents. These documents may be available in or through libraries or other informational services).

30. DEFINITIONS

30.1 Symbols and Abbreviations. The symbols and abbreviations used in this appendix are as follows:

Symbols	Parameter	Units
A	- Cross-sectional area of a conductor.	Cmil
D%	- Cable voltage drop expressed in percent with respect to system or source voltage.	--
DF	- Cable drop factor for equation using current.	$(\text{Amp.ft})^{-1}$
DF′	- Cable drop factor for equation using power.	$(\text{Watt.ft})^{-1}$
d	- Conductor diameter.	Mils
E	- Line-to-neutral rated voltage at the switchboard of a three-phase system or rated voltage of a single single-phase or dc system.	Volt
E_x	- Line-to-line rate voltage of a three-phase system (E_{AB}, E_{BC}, E_{CA}).	Volt
I	- Line current (I_A, I_B or I_C).	Ampere
I_{LO}	- Resultant load currents for each phase (leg) of a three-phase, delta circuit (I_{AB}, I_{BC} or I_{CA}).	Ampere
I_x	- Difference in two line currents of a three-phase system ($I_A - I_B$, $I_B - I_C$, $I_C - I_A$).	Ampere
L	- Cable length.	Feet
P	- Real power for each phase (leg) load of a three-phase delta circuit (P_{AB}, P_{BC}, or P_{CA}).	Watt
P_x	- Net real power in two lines of a three-phase, delta system ($P_A - P_B$, $P_B - P_C$, $P_C - P_A$).	Watt
pf	- Load power factor.	--
Q	- Reactive power for each phase (leg) load of a three-phase, delta circuit (Q_{AB}, Q_{BC} or Q_{CA}).	Var

Supersedes page 76 of 3 April 1989.

Q_x	- Net reactive power in two lines of a three-phase, delta system ($Q_A - Q_B$, $Q_B - Q_C$, $Q_C - Q_A$).	Var
R	- Total cable resistance per phase.	Ohm
R_{dc}	- Conductor dc resistance.	Ohm
S	- Apparent power for each phase (leg) load of a three-phase, delta circuit (S_{AB}, S_{BC} or S_{CA}).	Volt-amp
V	- Terminal voltage or load voltage.	Volt
V_{AN}	- Line-to-neutral terminal load voltage for phase A of a three-phase four-wire system.	Volt
X	- Total cable reactance per phase.	Ohm
Z	- Total cable impedance per phase.	Ohm
z	- Cable impedance per phase per foot.	Ohm/ft
Z_{LO}	- Load impedance in each phase (leg) of a three-phase delta circuit (Z_{AB}, Z_{BC}, Z_{CA}).	Ohm
Z_{AN}	- Load impedance in phase A of a three-phase, four-wire (wye) circuit.	Ohm
α	- Angle between terminal load voltage and cable voltage drop (IZ) .	Degree
α_x	- Angle between terminal load voltage and cable voltage drop (I_xZ).	Degree
β	- Cable impedance angle.	Degree
σ	- Mass density of a selected material.	g/cm^3
θ	- Load power factor angle or angle between load voltage and line current.	Degree
θ_x	- Angle between terminal load voltage and current I_x.	Degree
ρ	- Resistivity of a selected material at desired operating temperature.	Ohm.ft
ρ_o	- Resistivity of a selected material at 20°C.	Ohm.ft

Supersedes page 77 of 3 April 1989.

40. GENERAL EQUATIONS FOR CABLE VOLTAGE DROP CALCULATIONS

40.1 Voltage drop calculations for dc systems. The voltage drop for dc circuits is calculated from the following equations as derived in section 80.

40.1.1 Two-wire circuits.

- For all systems except power.

$$D\% = 22.78\left(\frac{IL}{AE}\right) * 100 \qquad (80\text{-}5)$$

- For power systems only.

$$D\% = 24.42\left(\frac{IL}{AE}\right) * 100 \qquad (80\text{-}6)$$

40.2 Voltage drop calculations for ac systems. The voltage drops for ac circuits are calculated from the following equations as derived in appropriate sections 90, 100, 110, and 120:

40.2.1 Single-phase circuits.

- For all systems.

$$D\% = 2IL\left(\frac{z\cos(\alpha)}{E}\right) * 100 \qquad (90\text{-}9)$$

40.2.2 Three-phase circuits.

- Voltage drop in each line for balanced systems such as electronic, interior communication, weapon control systems.

$$D\% = \sqrt{3}I_{LO}L\left(\frac{z\cos(\alpha)}{E}\right) * 100 \qquad (90\text{-}10)$$

- Voltage drop in each line for all systems.

Supersedes page 78 of 3 April 1989.

$$D\% = IL\left(\frac{z\cos(\alpha)}{E}\right) * 100 \qquad (100\text{-}10)$$

- Voltage drop in each phase for all systems.

$$D\% = I_xL\left(\frac{z\cos(\alpha_x)}{E_x}\right) * 100 \qquad (100\text{-}17)$$

40.3 Voltage drop calculations using drop factors. The following simplified equations are used for percent drop calculations in lighting and power systems in conjunction with the cable drop factors listed in tables XIII through XVII.

40.3.1 Lighting systems.

40.3.1.1 Single-phase circuit.

$D\% = 2IL(DF)$	Table XVI.
$D\% = 2PL(DF')$	Table XVII.

40.3.1.2 Three-phase circuit.

$D\% = I_xL(DF)$	Table XVI.
$D\% = P_xL(DF')$	Table XVII.

40.3.2 Power Systems.

40.3.2.1 Three-phase circuit. The drop in each line is:

$D\% = IL(DF)$	Tables XIII, XIV, and XV.

Where:

- I, I_{LO}, I_x, θ, α, θ_x, and α_x are calculated in section 50.
- P and P_x are calculated in 110.
- DF and DF' are calculated and tabulated in 70.1.

50. CURRENT CALCULATIONS FOR AC SYSTEMS

50.1 Single-phase circuits. The line current (I) used in the voltage drop equations is the scalar magnitude of current (I_{LO}) obtained by adding vectorially all load currents in the branch:

$$I = I_{LO}$$

The angles Θ, α, and β are calculated from the following equations as derived in section 90.:

$$\Theta = \cos^{-1}(pf), \quad \beta = \tan^{-1}(X/R)$$

$$\alpha = -\Theta + \beta \qquad (90\text{-}2)$$

Θ is positive if the load power factor (pf) is lagging.
Θ is negative if the load power factor (pf) is leading.

50.2 Three-phase-delta circuits.

50.2.1 Balanced systems. If the system is balanced, the magnitude of the line current is equal to:

$$I = \sqrt{3}I_{LO} = \sqrt{3}I_{AB} = \sqrt{3}I_{BC} = \sqrt{3}I_{CA}$$

The total load currents $\overline{I}_{AB}$, $\overline{I}_{BC}$, and $\overline{I}_{CA}$ are the vectorial sum of all the currents in their respective phase (leg) loads. If the load power factor angles in legs AB, BC, and CA are Θ_{AB}, Θ_{BC}, and Θ_{CA} respectively, the phase load currents can be written as:

$$\overline{I}_{AB} = I_{AB}\underline{/(0°-\Theta_{AB})}, \ \overline{I}_{BC} = I_{BC}\underline{/(-120°-\Theta_{BC})}, \ \overline{I}_{CA} = I_{CA}\underline{/(120°-\Theta_{CA})}$$

Similarly, the phase voltages $\overline{V}_{AB}$, $\overline{V}_{BC}$, and $\overline{V}_{CA}$ are defined as:

$$\overline{V}_{AB} = V_{AB}\underline{/0°}, \ \overline{V}_{BC} = V_{BC}\underline{/-120°}, \text{ and } \overline{V}_{CA} = V_{CA}\underline{/120°}$$

Supersedes page 80 of 3 April 1989.

50.2.2 Balanced/unbalaced systems. If the system is unbalanced or balanced, the magnitude of line currents I and the associated angles Θ and α are calculated from the following equations as derived in section 100:

$$\bar{I}_A = \bar{I}_{AB} - \bar{I}_{CA}, \qquad (100\text{-}7)$$

$$\theta_A = 0° - \underline{/I_A}$$

$$\alpha_A = -\theta_A + \beta$$

$$\bar{I}_B = \bar{I}_{BC} - \bar{I}_{AB}, \qquad (100\text{-}8)$$

$$\theta_B = -120° - \underline{/I_B}$$

$$\alpha_B = -\theta_B + \beta$$

$$\bar{I}_C = \bar{I}_{CA} - \bar{I}_{BC}, \qquad (100\text{-}9)$$

$$\theta_C = 120° - \underline{/I_C}$$

$$\alpha_C = -\theta_C + \beta$$

The currents I_x and the associated angles Θ_x and α_x are calculated as follows:

$$\bar{I}_{x(AB)} = \bar{I}_A - \bar{I}_B, \qquad (100\text{-}12)$$

$$\theta_{x(AB)} = 0° - \underline{/I_{x(AB)}}$$

$$\alpha_{x(AB)} = -\theta_{x(AB)} + \beta$$

$$\bar{I}_{x(BC)} = \bar{I}_B - \bar{I}_C \qquad (100\text{-}13)$$

$$\theta_{x(BC)} = -120° - \underline{/I_{x(BC)}}$$

$$\alpha_{x(BC)} = -\theta_{x(BC)} + \beta$$

Supersedes page 81 of 3 April 1989.

$$\bar{I}_{x(CA)} = \bar{I}_C - \bar{I}_{A'} \qquad (100\text{-}14)$$

$$\Theta_{x(CA)} = 120° - \underline{/I}_{x(CA)}$$

$$\alpha_{x(CA)} = -\Theta_{x(CA)} + \beta$$

50.3 Three-phase four-wire circuits. The individual line currents (I) are calculated from the following equation as derived in section 120.:

$$I = I_{LO} = \frac{V_{AN}}{Z_{AN}} \qquad (120\text{-}3)$$

50.4 Example of voltage drop calculations. The following example is a sample calculation of percent voltage drop for a three-phase lighting system (See figures 3 and 4 in section 100).

Step 1.

Determine the load current (I_{LO}) in each phase by adding vectorially all the connected load currents in that phase. Let assume the total load current for each phase as follows:

$$I_{AB} = 6.16A$$

$$I_{BC} = 5.7A$$

$$I_{CA} = 9.5A$$

Also the following parameters are given in Table XVI:

Cable type : LSTSGU-9
Length: $L = 45ft$
Impedance: $z = 1.120(10^{-3})\ \Omega/ft$
Angle: $\beta = 1.82°$

Supersedes page 82 of 3 April 1989.

Step 2.

Calculate phase load currents. Let the terminal load voltages be:

$$\bar{V}_{AB} = V_{AB}\underline{/0^\circ}$$

$$\bar{V}_{BC} = V_{BC}\underline{/-120^\circ}$$

$$\bar{V}_{CA} = V_{CA}\underline{/120^\circ}$$

Assume load power factor for each phase of 0.80 lagging, the phase currents with respect to their respective terminal voltages can be written as follows:

$$\bar{I}_{AB} = I_{AB}\underline{/0^\circ - \Theta_{AB}} = 6.16\underline{/-37^\circ}$$

$$\bar{I}_{BC} = I_{BC}\underline{/-120^\circ - \Theta_{BC}} = 5.7\underline{/-157^\circ}$$

$$\bar{I}_{CA} = I_{CA}\underline{/120^\circ - \Theta_{CA}} = 9.5\underline{/83^\circ}$$

Where $\Theta_{AB} = \Theta_{BC} = \Theta_{CA} = \cos^{-1}(0.80) = 37^\circ$.

Step 3.

Determine line current I, angles Θ and angle α from equations (100-7), (100-8), and (100-9) respectively after converting the phase currents from their polar forms to rectangular forms.

$$\bar{I}_{AB} = 6.16\underline{/-37^\circ} = 4.92 - j3.71$$

$$\bar{I}_{BC} = 5.7\underline{/-157^\circ} = -5.25 - j2.23$$

$$\bar{I}_{CA} = 9.5\underline{/83^\circ} = 1.16 + j9.43$$

The line currents are calculated as follows:

$$\bar{I}_A = \bar{I}_{AB} - \bar{I}_{CA}, \qquad (100\text{-}7)$$

$$= (4.92 - j3.71) - (-1.16 + j9.43)$$

Supersedes page 83 of 3 April 1989.

$$\bar{I}_A = 3.76 - j13.14$$
$$= 13.67\underline{/285.97°}$$

and,

$$\Theta_A = 360° - 285.97°$$
$$= 74.03°$$

$$\alpha_A = -74.03° + 1.82°,$$
$$= -72.21°$$

$$\bar{I}_B = \bar{I}_{BC} - \bar{I}_{AB}, \qquad (100\text{-}8)$$
$$= (-5.25 - j2.23) - (4.92 - j3.71)$$
$$= -10.17 + j1.48$$
$$= 10.28\underline{/171.72°}$$

and,

$$\Theta_B = -120° - 171.72°$$
$$= -291.72°$$

$$\alpha_B = -(-291.72°) + 1.82°,$$
$$= 293.54°,$$

$$\bar{I}_C = \bar{I}_{CA} - \bar{I}_{BC}, \qquad (100\text{-}9)$$
$$= (1.16 + j9.43) - (-5.25 - j2.23)$$
$$= 6.41 + j11.66$$
$$= 13.31\underline{/61.20°}$$

and,

$$\Theta_C = 120° - 61.20°$$
$$= 58.8°$$

$$\alpha_C = -58.80° + 1.82°,$$
$$= -56.98°,$$

Step 4.

The drop in each line from the switchboard to the load is calculated as follows:

$$D_A\% = I_A L \left(\frac{z\cos(\alpha_A)}{E} \right) * 100, \qquad (100\text{-}10)$$

Supersedes page 84 of 3 April 1989.

$$D_A\% = (13.67)(45)\left(\frac{(1.120 * 10^{-3})\cos(-72.21°)}{(120/\sqrt{3})}\right) * 100$$
$$= 0.30\%$$

$$D_B\% = I_B L\left(\frac{z\cos(\alpha_B)}{E}\right) * 100, \qquad (100\text{-}10)$$

$$= (10.28)(45)\left(\frac{(1.120 * 10^{-3})\cos(293.54°)}{(120/\sqrt{3})}\right) * 100$$
$$= 0.30\%$$

$$D_C\% = I_C L\left(\frac{z\cos(\alpha_C)}{E}\right) * 100, \qquad (100\text{-}10)$$

$$= (13.30)(45)\left(\frac{(1.120 * 10^{-3})\cos(-57.98°)}{(120/\sqrt{3})}\right) * 100$$
$$= 0.53\%$$

The total drop ($D_T\%$) in this portion of cable is the combination of the drops in the lines:

$$D_T\% = D_A\% + D_B\% + D_C\%$$
$$= 0.30\% + 0.30\% + 0.53\%$$
$$= 1.13\%$$

<u>Step 5</u>.

If the voltage drop in each phase is desired, the currents I_x must be determined from the following equations:

The current in loop E_{AB} is:

$$\overline{I}_{x(AB)} = \overline{I}_A - \overline{I}_B, \qquad (100\text{-}12)$$
$$= (3.76 - j13.14) - (-10.17 + j1.48)$$
$$= 13.93 - j14.62$$
$$= 20.19\underline{/313.62°}$$

Supersedes page 85 of 3 April 1989.

$$\overline{I}_{x(AB)} = 13.93 - j14.62$$
$$= 20.19\underline{/313.62°}$$

and,

$$\Theta_{x(AB)} = 360° - 313.62°$$
$$= 46.38°$$

$$\alpha_{x(AB)} = -46.38° + 1.82°$$
$$= -44.54°$$

The current in loop E_{BC} is:

$$\overline{I}_{x(BC)} = \overline{I}_B - \overline{I}_C, \qquad (100\text{-}13)$$

$$= (-10.17 + j1.48) - (6.41 + j11.66)$$
$$= -16.58 - j10.18$$
$$= 19.46\underline{/238.45°}$$

and,

$$\Theta_{x(BC)} = -120° - 238.45°$$
$$= -358.45°$$

$$\alpha_{x(BC)} = -(-358.45°) + 1.82°$$
$$= 360.27°$$

The current in loop E_{CA} is:

$$\overline{I}_{x(CA)} = \overline{I}_C - \overline{I}_A, \qquad (100\text{-}14)$$

$$= (6.41 + j11.66) - (3.76 - j13.14)$$
$$= 2.65 + j24.80$$
$$= 24.94\underline{/83.9°}$$

and,

$$\Theta_{x(CA)} = 120° - 83.90°$$
$$= 36.1°$$

$$\alpha_{x(CA)} = -36.1° + 1.82°$$
$$= -34.28°$$

Step 6.

The percent drop in each phase is calculated as follows:

$$D_{AB}\% = (20.19)(45)\left(\frac{(1.120)(10^{-3})\cos(-44.54°)}{120}\right) * 100$$

$$= 0.60\%$$

$$D_{BC}\% = I_{x(BC)} L\left(\frac{z\cos(\alpha_{x(BC)})}{E_{BC}}\right) * 100, \qquad (100\text{-}17)$$

$$= (19.46)(45)\left(\frac{(1.120)(10^{-3})\cos(360.27°)}{120}\right) * 100$$

$$= 0.82\%$$

$$D_{CA}\% = I_{x(CA)} L\left(\frac{z\cos(\alpha_{x(CA)})}{E_{CA}}\right) * 100, \qquad (100\text{-}17)$$

$$= (24.94)(45)\left(\frac{(1.120)(10^{-3})\cos(-34.28°)}{120}\right) * 100$$

$$= 0.87\%$$

The drop in this portion of the cable is the combination of the results in step 6 as follows:

$$D_T(\%) = 1/2(D_{AB}\% + D_{BC}\% + D_{CA}\%)$$

$$= 1/2(0.60\% + 0.82\% + 0.87\%)$$

$$= 1.14\%$$

60. VOLTAGE DROP CALCULATIONS FOR UNBALANCED SYSTEMS BY SYMMETRICAL COMPONENT METHOD

To calculate cable voltage drop for unbalanced system, the line currents supplying the loads must be calculated. Assume all three phase loads are unbalanced. Therefore, the phase load currents are different and must be calculated individually. From the phase load currents, the

Supersedes page 87 of 3 April 1989.

individual line currents will be calculated. From the line currents, the voltage drop in each line will be determined. All necessary equations are derived in section 130.

60.1 Calculation Procedure. The step by step procedure for the percent drop determination is as follows:

Step 1.

Locate or determine the following necessary parameters:

- Vectorial sum of all load currents for each phase.
- Real power for each phase load.
- Load power factor for each phase.
- Load impedance for each phase.
- Rated load voltage for each phase.

Step 2.

Calculate the load current for each phase. Two methods will be used. If real power, power factor, and rated voltage of the loads are given, use the following equations:

$$\overline{I}_{AB} = [P_{AB}/V_{AB}\cos(\Theta_{AB})]\underline{/(0 - \Theta_{AB})}°, \qquad (130\text{-}31)$$

$$\overline{I}_{BC} = [P_{BC}/V_{BC}\cos(\Theta_{BC})]\underline{/(-120 - \Theta_{BC})}°, \qquad (130\text{-}32)$$

$$\overline{I}_{CA} = [P_{CA}/V_{CA}\cos(\Theta_{CA})]\underline{/(120 - \Theta_{CA})}°, \qquad (130\text{-}33)$$

If the impedances and rated voltages of the loads are given, use the following equations:

$$\overline{I}_{AB} = \overline{V}_{AB}/\ \overline{Z}_{AB}, \qquad (130\text{-}34)$$

$$\overline{I}_{BC} = \overline{V}_{BC}/\ \overline{Z}_{BC}, \qquad (130\text{-}35)$$

$$\overline{I}_{CA} = \overline{V}_{CA}/\ \overline{Z}_{CA}, \qquad (130\text{-}36)$$

Supersedes page 88 of 3 April 1989.

Step 3.

Calculate the positive and negative sequence currents. Take phase AB as reference, the positive and negative sequence currents are calculated as follows:

$$\bar{I}_{AB1} = (1/3)\ (\bar{I}_{AB} + a\bar{I}_{BC} + a^2\bar{I}_{CA}), \qquad (130\text{-}29)$$

$$\bar{I}_{AB2} = (1/3)\ (\bar{I}_{AB} + a^2\bar{I}_{BC} + a\bar{I}_{CA}), \qquad (130\text{-}30)$$

Where:

$$a = 1\underline{/120°}\ , \qquad a^2 = 1\underline{/240°}$$

Note: In a three-phase and three-wire system, the zero sequence currents are zero as shown in section 130.

Step 4.

Calculate the sequence components of line currents from the following equations:

$$\bar{I}_{A1} = \bar{I}_{AB1}(\sqrt{3}\underline{/-30°}), \qquad (130\text{-}8)$$

$$\bar{I}_{A2} = \bar{I}_{AB2}(\sqrt{3}\underline{/30°}), \qquad (130\text{-}11)$$

$$\bar{I}_{B1} = \bar{I}_{AB1}(\sqrt{3}\underline{/-150°}), \qquad (130\text{-}14)$$

$$\bar{I}_{B2} = \bar{I}_{AB2}(\sqrt{3}\underline{/150°}), \qquad (130\text{-}17)$$

$$\bar{I}_{C1} = \bar{I}_{AB1}(\sqrt{3}\underline{/90°}), \qquad (130\text{-}21)$$

$$\bar{I}_{C2} = \bar{I}_{AB2}(\sqrt{3}\underline{/-90°}), \qquad (130\text{-}25)$$

Step 5.

The line currents flowing into each node of the delta connected loads as shown in figure 7 are calculated as follows:

$$\bar{I}_{A} = \bar{I}_{AB1}(\sqrt{3}\underline{/-30°}) + \bar{I}_{AB2}(\sqrt{3}\underline{/30°}), \qquad (130\text{-}26)$$

Supersedes page 89 of 3 April 1989.

$$\bar{I}_B = \bar{I}_{AB1}(\sqrt{3}\underline{/-150°}) + \bar{I}_{AB2}(\sqrt{3}\underline{/150°}), \qquad (130\text{-}27)$$

$$\bar{I}_C = \bar{I}_{AB1}(\sqrt{3}\underline{/90°}) + \bar{I}_{AB2}(\sqrt{3}\underline{/-90°}), \qquad (130\text{-}28)$$

The corresponding angles Θ and α are calculated from equations derived in section 100.:

$$\Theta_A = 0° - \underline{/I_{A-}}, \quad \alpha_A = -\Theta_A + \beta, \qquad (100\text{-}7)$$

$$\Theta_B = -120° - \underline{/I_{B-}}, \quad \alpha_B = -\Theta_B + \beta, \qquad (100\text{-}8)$$

$$\Theta_C = 120° - \underline{/I_{C-}}, \quad \alpha_C = -\Theta_C + \beta, \qquad (100\text{-}9)$$

Step 6.

If the cable length and cable impedance are known, the voltage drop in each line is:

$$D\% = IL\left(\frac{z\cos(\alpha)}{E}\right) * 100, \qquad (100\text{-}10)$$

60.2 Example of Voltage Drop Calculations.

Step 1.

The following parameters are given:

$$\bar{V}_{AB} = 118\underline{/0°},\ \bar{V}_{BC} = 118\underline{/-120°},\ \bar{V}_{CA} = 118\underline{/120°}$$

$$P_{AB} = 3400W,\ P_{BC} = 2500W,\ P_{CA} = 2900W.$$

$$E_{AB} = E_{BC} = E_{CA} = 120V$$

All load power factors (pf) = 0.80 lagging. From Table XVI, use LSTSGU-50 cable with $z = 0.223(10^{-3})\Omega/ft$, $\beta = 7.8°$

Supersedes page 90 of 3 April 1989.

Step 2.

Calculate the phase currents from the following equations:

$$\bar{I}_{AB} = [P_{AB}/V_{AB}\cos(\Theta_{AB})]\underline{/(0 - \Theta_{AB})^\circ}, \quad (130\text{-}31)$$

$$= [3400/(118)(0.8)]\underline{/(0^\circ - 37^\circ)}$$

$$= 36\underline{/-37^\circ}$$

$$\bar{I}_{BC} = [P_{BC}/V_{BC}\cos(\Theta_{BC})]\underline{/(-120 - \Theta_{BC})^\circ}, \quad (130\text{-}32)$$

$$= [2500/(118)(0.8)]\underline{/-120^\circ - 37^\circ}$$

$$= 26.5\underline{/-157^\circ}$$

$$\bar{I}_{CA} = [P_{CA}/V_{CA}\cos(\Theta_{CA})]\underline{/(120 - \Theta_{CA})^\circ}, \quad (130\text{-}33)$$

$$= [2900/(118)(0.8)]\underline{/120^\circ - 37^\circ}$$

$$= 30.7\underline{/83^\circ}$$

Step 3.

Calculate the positive and negative sequences of $\bar{I}_{AB}$ from the following equations:

$$\bar{I}_{AB1} = (1/3)(\bar{I}_{AB} + a\bar{I}_{BC} + a^2\bar{I}_{CA}), \quad (130\text{-}29)$$

$$= (1/3)[36.0\underline{/-37^\circ} + (1\underline{/120^\circ})(26.5\underline{/-157^\circ}) + (1\underline{/240^\circ})(30.7\underline{/83^\circ})]$$

$$= 31.0\underline{/-37^\circ}$$

$$\bar{I}_{AB2} = (1/3)(\bar{I}_{AB} + a^2\bar{I}_{BC} + a\bar{I}_{CA}), \quad (130\text{-}30)$$

$$= (1/3)[36.0\underline{/-37^\circ} + (1\underline{/240^\circ})(26.5\underline{/-157^\circ}) + (1\underline{/120^\circ})(30.7\underline{/83^\circ})$$

$$= 2.6\underline{/-62.5^\circ}$$

Supersedes page 91 of 3 April 1989.

Step 4.

Calculate the sequence components of line currents from the following equations:

$$\bar{I}_{A1} = \bar{I}_{AB1}(\sqrt{3}\angle{-30°}), \quad (130\text{-}8)$$

$$= (31.0\angle{-37°})(\sqrt{3}\angle{-30°})$$

$$= 53.7\angle{-67°}$$

$$\bar{I}_{A2} = \bar{I}_{AB2}(\sqrt{3}\angle{30°}), \quad (130\text{-}11)$$

$$= (2.6\angle{-62.5°})(\sqrt{3}\angle{30°})$$

$$= 4.5\angle{-32.5°}$$

$$\bar{I}_{B1} = \bar{I}_{AB1}(\sqrt{3}\angle{-150°}), \quad (130\text{-}14)$$

$$= (31.0\angle{-37°})(\sqrt{3}\angle{-150°})$$

$$= 53.7\angle{-187°}$$

$$\bar{I}_{B2} = \bar{I}_{AB2}(\sqrt{3}\angle{150°}), \quad (130\text{-}17)$$

$$= (2.6\angle{-62.5°})(\sqrt{3}\angle{150°})$$
$$= 4.5\angle{87.5°}$$

$$\bar{I}_{C1} = \bar{I}_{AB1}(\sqrt{3}\angle{90°}), \quad (130\text{-}21)$$

$$= (31.0\angle{-37°})(\sqrt{3}\angle{90°})$$
$$= 53.7\angle{53°}$$

$$\bar{I}_{C2} = \bar{I}_{AB2}(\sqrt{3}\angle{-90°}), \quad (130\text{-}25)$$

$$= (2.6\angle{-62.5°})(\sqrt{3}\angle{-90°})$$
$$= 4.5\angle{-152.5°}$$

Supersedes page 92 of 3 April 1989.

Step 5.

Calculate the line currents $\bar{I}_A$, $\bar{I}_B$, and $\bar{I}_C$ from the sequence currents as follows:

$$\bar{I}_A = \bar{I}_{A0} + \bar{I}_{A1} + \bar{I}_{A2}, \qquad (130\text{-}26)$$

$$= 0 + 53.7\underline{/-67°} + 4.5\underline{/-32.5°}$$
$$= 24.78 - j51.85$$
$$= 57.47\underline{/-64.46°}$$

Then,

$$\Theta_A = 0° - (-64.46°)$$
$$= 64.46°$$

$$\alpha_A = -\Theta_A + \beta$$

$$= -64.46° + 7.8°$$
$$= -56.66°$$

$$\bar{I}_B = \bar{I}_{B0} + \bar{I}_{B1} + \bar{I}_{B2}, \qquad (130\text{-}27)$$
$$= 0 + 53.7\underline{/-187°} + 4.5\underline{/87.5°}$$
$$= - 53.10 + j11.04$$
$$= 54.24\underline{/168.26°}$$

Then,

$$\Theta_B = -120° - 168.26°$$
$$= -288.26°$$

$$\alpha_B = -\Theta_B + \beta$$

$$= 288.26° + 7.8°$$
$$= 296.06°$$

$$\bar{I}_C = \bar{I}_{C0} + \bar{I}_{C1} + \bar{I}_{C2}, \qquad (130\text{-}28)$$

$$= 0 + 53.7\underline{/53°} + 4.5\underline{/-152.5°}$$
$$= 28.33 + j40.81$$
$$= 49.68\underline{/55.24°}$$

Then,

$$\Theta_C = 120° - 55.24°$$
$$= 64.76°$$

$$\alpha_C = -\Theta_C + \beta$$

$$= -64.76° + 7.8°$$
$$= -56.96°$$

Supersedes page 93 of 3 April 1989.

Step 6.

Determine the percent voltage drops in the lines, and compare the results.

$$D_A\% = I_A L \left(\frac{z\cos(\alpha_A)}{E}\right) * 100, \qquad (100\text{-}10)$$

$$= (57.47)(65)\left(\frac{(0.223)(10^{-3})\cos(-56.66°)}{120/\sqrt{3}}\right) * 100$$

$$= 0.66\%$$

$$D_B\% = I_B L \left(\frac{z\cos(\alpha_B)}{E}\right) * 100, \qquad (100\text{-}10)$$

$$= (54.24)(65)\left(\frac{(0.223)(10^{-3})\cos(296.06°)}{120/\sqrt{3}}\right) * 100$$

$$= 0.50\%$$

$$D_C\% = I_A L \left(\frac{z\cos(\alpha_C)}{E}\right) * 100, \qquad (100\text{-}10)$$

$$= (49.68)(65)\left(\frac{(0.223)(10^{-3})\cos(-56.96°)}{120/\sqrt{3}}\right) * 100$$

$$= 0.57\%$$

The drop in this portion of cable is obtained by combining the drop in the individual lines (phase):

$$D_T\% = D_A\% + D_B\% + D_C\%$$

$$= 0.66\% + 0.50\% + 0.57\%$$

$$= 1.73\%$$

70. CABLE IMPEDANCES AND DROP FACTORS

The drop factors and impedances are calculated based on the

Supersedes page 94 of 3 April 1989.

characteristics of LSTSGU and LS6SGU cables in accordance with MIL-C-24643. The tabulated drop factors for these cables may be used for other types of cables with similar impedance characteristics including lightweight cables in accordance with MIL-C-24640.

70.1 Drop factor calculations. The drop factors in tables XIII through XVII for power and lighting systems are calculated from the following equations derived in sections 90, 100, and 110:

70.1.1 Power systems.

$$DF = \left(\frac{z\cos(\alpha)}{E} + \frac{(2)\,z\tan(\alpha)\sin(\alpha)}{200E} \right) * 100, \qquad (90\text{-}13)$$

70.1.2 Lighting systems.

70.1.2.1 Single-phase Circuits.

- For equations using Current I.

$$DF = \left(\frac{z\cos(\alpha)}{E} \right) * 100, \qquad (100\text{-}20)$$

- For equations using Power P.

$$DF' = \left(\frac{1}{V\cos(\Theta)} \right) \left(\frac{z\cos'(\alpha)}{E} \right) * 100, \qquad (110\text{-}26)$$

70.1.2.2 Three-phase Circuits.

- For equations using Current I_x.

$$DF = \left(\frac{z\cos(\alpha_x)}{E_x} \right) * 100, \qquad (100\text{-}19)$$

Supersedes page 95 of 3 April 1989.

TABLE XI. Impedances for LSTSGU cable, 60Hz electronics and communications.

Size	Cable characteristics				
	A 1/ Cmil	R 2/,3/ Ohms per 100 feet	X 3/	Z	B °C
3	2580	4.503	0.043	4.503	0.55
4	4110	2.825	0.040	2.825	0.81
9	10380	1.119	0.036	1.120	1.82
14	13090	0.887	0.041	0.888	2.63
23	20820	0.558	0.039	0.559	4.02
50	52620	0.221	0.030	0.223	7.81
75	83690	0.138	0.030	0.141	12.07
100	105600	0.110	0.029	0.114	14.92
150	167800	0.069	0.029	0.075	22.58
200	211600	0.055	0.029	0.062	27.80
300	300000	0.040	0.029	0.049	35.75
400	413600	0.029	0.029	0.041	44.80

TABLE XII. Impedances for LSTSGU cable, 400 Hz electronics and communications.

Size	Cable characteristics				
	A 1/ Cmil	R 2/,3/ Ohms per 1000 feet	X 3/	Z	B °C
3	2580	4.503	0.288	4.512	3.66
4	4110	2.825	0.267	2.838	5.40
9	10380	1.119	0.237	1.144	11.98
14	13090	0.887	0.271	0.928	17.01
23	20820	0.558	0.262	0.616	25.12
50	52620	0.221	0.202	0.299	42.44
75	83690	0.143	0.197	0.243	53.98
100	105600	0.116	0.195	0.227	59.29
150	167800	0.077	0.191	0.206	68.10
200	211600	0.065	0.194	0.204	71.44
300	300000	0.051	0.192	0.199	75.14
400	413600	0.042	0.192	0.196	77.65

1/ Conductor cross-sectional areas are based on MIL-C-24643.
2/ Resistances are derived at a temperature of 45°C.
3/ Resistances and reactances per phase are calculated in section 140.

Supersedes page 96 of 3 April 1989.

TABLE XIII. Drop factors for LSTSGU cable, 450V, three-phase, 60Hz power systems. 1/

Size	Cable characteristics					Drop factors at cos (θ) 2/ below (multiply by 10^{-5})														
	A 3/ Cmil	R 4/,5/ Ohms per 1000 feet	X 4/	Z	θ °C	1.0	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30
3	2580	4.827	0.043	4.827	0.51	185.8	177.2	168.4	159.4	150.4	141.5	132.5	123.5	114.8	106.0	97.1	88.2	79.7	71.1	62.0
4	4110	3.028	0.040	3.028	0.76	116.5	111.3	105.8	100.2	94.6	89.1	83.5	77.9	72.4	66.9	61.3	55.7	50.4	45.1	39.9
9	10380	1.199	0.036	1.200	1.70	46.1	44.3	42.2	40.1	37.9	35.8	33.6	31.4	29.3	27.1	24.9	22.7	20.6	18.5	16.4
14	13090	0.951	0.041	0.952	2.45	36.6	35.3	33.7	32.0	30.4	28.7	27.0	25.3	23.6	21.9	20.1	18.4	16.8	15.1	13.4
23	20820	0.598	0.039	0.599	3.75	23.0	22.4	21.4	20.4	19.4	18.4	17.3	16.3	15.2	14.2	13.1	12.0	11.0	9.9	8.9
50	52620	0.237	0.030	0.239	7.29	9.1	9.0	8.7	8.4	8.0	7.6	7.3	6.9	6.5	6.1	5.7	5.3	4.9	4.4	4.0
75	83690	0.148	0.030	0.151	11.27	5.7	5.8	5.6	5.4	5.2	5.0	4.8	4.6	4.4	4.1	3.9	3.6	3.4	3.1	2.9
100	105600	0.118	0.029	0.122	13.94	4.5	4.7	4.6	4.5	4.3	4.2	4.0	3.8	3.7	3.5	3.3	3.1	2.9	2.7	2.9
150	167800	0.074	0.029	0.079	21.20	2.9	3.1	3.0	3.0	2.9	2.9	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	1.9
200	211600	0.059	0.029	0.066	26.18	2.3	2.5	2.5	2.5	2.5	2.4	2.4	2.3	2.3	2.2	2.1	2.0	1.9	1.9	1.8
300	300000	0.042	0.029	0.051	34.44	1.6	1.9	1.9	2.0	2.0	1.9	1.9	1.9	1.9	1.8	1.8	1.7	1.7	1.6	1.6
400	413600	0.031	0.029	0.042	42.89	1.2	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.4

1/ Drop factor equations are derived in section 90.
2/ θ is the load power factor angle or angle between load terminal voltage and line current.
3/ Conductor cross-sectional areas are based on MIL-C-24643.
4/ Resistances and reactances per phase are calculated in section 140.
5/ Resistances are derived at a temperature of 65°C.

TABLE XIV. Drop factors for LSTSGU cable, 450V, three-phase, 400Hz power systems. 1/

Size	Cable characteristics					Drop factors at cos (θ) 2/ below (multiply by 10^{-5})														
	A 3/ Cmil	R 4/,5/ Ohms per 1000 feet	X 4/	Z	θ °C	1.0	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30
3	2580	4.827	0.288	4.836	3.42	185.8	180.1	172.4	164.2	155.9	147.6	139.1	130.5	122.1	113.5	104.9	96.2	87.8	79.3	71.0
4	4110	3.028	0.267	3.040	5.04	116.6	114.0	109.6	104.7	99.8	94.7	89.5	84.3	79.2	73.9	68.5	63.2	58.0	52.7	47.0
9	10380	1.199	0.237	1.222	11.20	46.2	46.7	45.6	44.1	42.5	40.8	39.0	37.2	35.3	33.4	31.4	29.4	27.4	25.4	23.0
14	13090	0.951	0.271	0.989	15.92	36.6	38.0	37.5	36.6	35.6	34.4	33.2	31.9	30.5	29.1	27.6	26.1	24.6	23.0	21.0
23	20820	0.598	0.262	0.653	23.63	23.1	25.0	25.1	24.9	24.5	23.9	23.3	22.7	21.9	21.2	20.3	19.5	18.6	17.7	16.7
50	52620	0.237	0.202	0.311	40.46	9.2	11.1	11.6	11.9	12.0	12.0	11.9	11.8	11.7	11.5	11.3	11.1	10.8	10.5	10.2
75	83690	0.153	0.197	0.249	52.12	6.0	8.0	8.6	9.0	9.3	9.4	9.5	9.6	9.6	9.6	9.5	9.4	9.3	9.2	9.0
100	105600	0.124	0.195	0.231	57.59	4.9	6.9	7.6	8.0	8.3	8.6	8.7	8.8	8.9	8.9	8.9	8.9	8.8	8.7	8.6
150	167800	0.082	0.191	0.208	66.82	3.3	5.4	6.1	6.6	7.0	7.3	7.5	7.7	7.8	7.9	8.0	8.0	8.0	8.0	8.0
200	211600	0.069	0.194	0.206	70.38	2.9	4.9	5.7	6.2	6.6	6.9	7.2	7.4	7.6	7.7	7.8	7.9	7.9	7.9	7.9
300	300000	0.054	0.192	0.200	74.31	2.3	4.4	5.2	5.7	6.1	6.5	6.8	7.0	7.2	7.3	7.5	7.5	7.6	7.7	7.7
400	413600	0.045	0.192	0.197	76.80	2.0	4.1	4.8	5.4	5.9	6.2	6.5	6.8	7.0	7.1	7.3	7.4	7.5	7.5	7.6

1/ Drop factor equations are derived in section 90.
2/ θ is the load power factor angle or angle between load terminal voltage and line current.
3/ Conductor cross-sectional areas are based on MIL-C-24643.
4/ Resistances and reactances per phase are calculated in section 140.
5/ Resistances are derived at a temperature of 65°C.

Supersedes page 98 of 3 April 1989.

Supersedes page 99 of 3 April 1989.

TABLE XV. Drop factors for LS6SGU cable, 450V, three-phase, 400Hz power systems. 1/

Size	Cable characteristics					Drop factors at cos (θ) 2/ below (multiply by 10^{-5})														
	A 3/ Cmil	R 4/,5/ Ohms per 1000 feet	X 4/	Z	θ °C	1.0	0.95	0.90	0.85	0.80	0.75	0.70	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30
100	211200	0.062	0.098	0.116	57.60	2.4	3.5	3.8	4.0	4.2	4.3	4.4	4.4	4.4	4.5	4.4	4.4	4.4	4.4	4.3
125	266200	0.049	0.097	0.109	63.29	2.0	3.0	3.3	3.6	3.8	3.9	4.0	4.1	4.1	4.2	4.2	4.2	4.2	4.2	4.1
150	335600	0.041	0.096	0.104	66.83	1.7	2.7	3.0	3.3	3.5	3.6	3.7	3.8	3.9	3.9	4.0	4.0	4.0	4.0	4.0
200	423200	0.035	0.097	0.103	70.12	1.5	2.5	2.9	3.1	3.3	3.5	3.6	3.7	3.8	3.9	3.9	3.9	4.0	4.0	4.0

1/ Drop factor equations are derived in section 90.
2/ θ is the load power factor angle or angle between load terminal voltage and line current.
3/ Conductor cross-sectional areas are based on MIL-C-24643.
4/ Resistances and reactances per phase are calculated in section 140.
5/ Resistances are derived at a temperature of 65°C.

TABLE XVI. Drop factors for LSTSGU cable, 120V, three-phase/single-phase, 60Hz lighting systems using I or I_x. 1/

Size	Cable characteristics					Drop factors at angle θ 2/ for single-phase loads or θ_x 3/ for three-phase loads (multiply by 10^{-5})														
	A 4/ Cmil	R5/,6/ Ohms per 1000 feet	X 5/	Z	B °C	-70	-65	-60	-55	-50	-45	-40	-30	-20	-10	0	10	20	30	40
3	2580	4.503	0.043	4.503	0.55	125.0	155.3	184.5	212.3	238.4	262.8	285.1	323.2	351.4	368.9	375.2	370.2	353.9	326.8	289.8
4	4110	2.825	0.040	2.825	0.81	77.4	96.5	114.8	132.3	148.8	164.1	178.2	202.2	220.1	231.3	235.4	232.4	222.4	205.5	182.5
9	10380	1.119	0.036	1.120	1.82	29.1	36.7	44.1	51.1	57.7	63.8	69.5	79.3	86.6	91.3	93.2	92.3	88.6	82.2	73.3
14	13090	0.887	0.041	0.888	2.63	22.1	28.2	34.0	39.6	44.9	49.9	54.4	62.3	68.3	72.2	73.9	73.4	70.6	65.7	58.8
23	20820	0.558	0.039	0.559	4.02	12.8	16.7	20.4	24.0	27.4	30.6	33.5	38.6	42.6	45.2	46.5	46.4	44.8	41.9	37.7
50	52620	0.221	0.030	0.223	7.81	3.9	5.5	7.0	8.5	9.9	11.2	12.5	14.7	16.4	17.7	18.4	18.6	18.2	17.2	15.7
75	83690	0.138	0.030	0.141	12.07	1.6	2.6	3.6	4.6	5.5	6.4	7.2	8.7	10.0	10.9	11.5	11.8	11.6	11.2	10.4
100	105600	0.110	0.029	0.114	14.92	0.8	1.7	2.5	3.3	4.0	4.8	5.5	6.7	7.8	8.6	9.2	9.5	9.4	9.2	8.6
150	167800	0.069	0.029	0.075	22.58	0.3	0.3	0.8	1.3	1.9	2.4	2.9	3.8	4.6	5.2	5.8	6.1	6.2	6.2	5.9
200	211600	0.055	0.029	0.062	27.80	0.7	0.3	0.2	0.6	1.1	1.5	2.0	2.8	3.5	4.1	4.6	4.9	5.1	5.2	5.1
300	300000	0.040	0.029	0.049	35.75	1.1	0.8	0.4	0.1	0.3	0.7	1.0	1.7	2.3	2.9	3.3	3.7	4.0	4.1	4.1
400	413600	0.029	0.029	0.041	44.80	1.4	1.2	0.9	0.6	0.3	0.0	0.3	0.9	1.5	2.0	2.4	2.8	3.1	3.3	3.4

1/ Drop factor equations are derived in section 100.
2/ *θ is the load power factor angle or angle between load terminal voltage and line current I.*
3/ θ_x is the angle between load terminal voltage and current I_x.
4/ Conductor cross-sectional areas are based on MIL-C-24643.
5/ Resistances and reactances per phase are calculated in section 140.
6/ Resistances are derived at a temperature of 45°C.

Supersedes page 100 of 3 April 1989.

TABLE XVII. Drop factors for LSTSGU cable, 120V, three-phase/single-phase, 60Hz lighting systems using P or P_x. 1/

Size	Cable characteristics					Drop factors at angle θ 2/ for single-phase loads or $θ_x$ 3/ for three-phase loads (multiply by 10^{-5})														
	A 4/ Cmil	R 5/,6/ Ohms per 1000 feet	X 5/	Z	B °C	-70	-65	-60	-55	-50	-45	-40	-30	-20	-10	0	10	20	30	40
3	2580	4.503	0.043	4.503	0.55	317.7	319.6	320.9	321.8	322.6	323.2	323.7	324.5	325.2	325.8	326.3	326.9	327.4	328.1	328.9
4	4110	2.825	0.040	2.825	0.81	196.7	198.5	199.7	200.6	201.2	201.8	202.3	203.0	203.7	204.2	204.7	205.2	205.8	206.4	207.1
9	10380	1.119	0.036	1.120	1.82	74.0	75.6	76.6	77.4	78.0	78.5	78.9	79.6	80.1	80.6	81.1	81.5	82.0	82.6	83.3
14	13090	0.887	0.041	0.888	2.63	56.2	58.0	59.2	60.1	60.8	61.3	61.8	62.6	63.2	63.8	64.3	64.8	65.3	66.0	66.8
23	20820	0.558	0.039	0.559	4.02	32.6	34.3	35.5	36.4	37.0	37.6	38.1	38.8	39.4	39.9	40.4	40.9	41.5	42.1	42.8
50	52620	0.221	0.030	0.223	7.81	10.0	11.3	12.2	12.9	13.4	13.8	14.2	14.7	15.2	15.6	16.0	16.4	16.8	17.3	17.9
75	83690	0.138	0.030	0.141	12.07	4.1	5.4	6.3	6.9	7.5	7.9	8.2	8.8	9.2	9.6	10.0	10.4	10.8	11.2	11.8
100	105600	0.110	0.029	0.114	14.92	2.1	3.4	4.3	4.9	5.4	5.8	6.2	6.7	7.2	7.6	8.0	8.3	8.7	9.2	9.8
150	167800	0.069	0.029	0.075	22.58	0.7	0.5	1.4	2.0	2.5	2.9	3.3	3.8	4.2	4.6	5.0	5.4	5.8	6.2	6.7
200	211600	0.055	0.029	0.062	27.80	1.8	0.5	0.3	1.0	1.5	1.9	2.2	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.7
300	300000	0.040	0.029	0.049	35.75	2.8	1.6	0.7	0.1	0.4	0.8	1.1	1.7	2.1	2.5	2.9	3.3	3.7	4.1	4.6
400	413600	0.029	0.029	0.041	44.80	3.6	2.4	1.5	0.9	0.4	0.0	0.4	0.9	1.3	1.7	2.1	2.5	2.9	3.3	3.9

1/ Drop factor equations are derived in section 110.
2/ θ is the load power factor angle or angle between P and S vectors.
3/ $θ_x$ is the angle between P_x and apparent power S_x vectors.
4/ Conductor cross-sectional areas are based on MIL-C-24643.
5/ Resistances and reactances per phase are calculated in section 140.
6/ Resistances are derived at a temperature of 45°C.

- For equation using Power P_x.

$$DF' = \left(\frac{1}{V\cos(\Theta_x)}\right)\left(\frac{z\cos(\alpha_x)}{E_x}\right) * 100, \qquad (110\text{-}23)$$

The drop factors for other cables not listed in the tables can be also calculated from the above equations if the cable characteristic are given.

80. DERIVATION OF VOLTAGE DROP EQUATIONS FOR DC SYSTEMS

80.1 Single-wire circuits. The R_{dc} resistance for a single wire in dc systems is:

$$R_{dc} = \left(\frac{\rho L}{A}\right) \qquad (80\text{-}1)$$

Where:

ρ = Conductor resistivity (copper) of a cable at desired operating temperature (t).
L = Cable length.
A = Conductor cross-sectional area in circular mil(cmil).

The standard nominal cross-sectional area of a conductor in circular mils is calculated in accordance with the following equation:

$$A = d^2, \qquad (80\text{-}2)$$

Where:

d = conductor diameter in mils.

The conductor resistivity (copper) at operating temperature (t) is given by:

$$\rho = \rho_o[1 + 0.00393(t - t_o)], \qquad (80\text{-}3)$$

From section 140, the conductor resistivity (copper) at 20°C is:

$$\rho_o = 10.371\ \Omega.\text{cmil/ft}$$

Supersedes page 102 of 3 April 1989.

At t = 65°C,

$$\rho = 10.371[1 + 0.00393(65 - 20)]$$

$$= 12.21\Omega.\text{cmil/ft}$$

At t = 45°C,

$$\rho = 10.371[1 + 0.00393(45 - 20)]$$
$$= 11.39\ \Omega.\text{cmil/ft}$$

With respect to the system voltage, the percent voltage drop in a single line is :

$$D\% = \left(\frac{IR_{dc}}{E}\right) * 100 \qquad (80\text{-}4)$$

80.2 <u>Two-wire circuits</u>.

In a two-wire circuit, the percent drop in equation (80-4) must be multiplied by 2 to include the drop in the return path:

- For all systems except power.

$$D\% = 2\left(\frac{IR_{dc}}{E}\right) * 100$$

At 45°C, the resistance R_{dc} is:

$$R_{dc} = 11.39\left(\frac{L}{A}\right)$$

Then,

$$D\% = 22.78\left(\frac{IL}{AE}\right) * 100 \qquad (80\text{-}5)$$

- For power system only.

$$D\% = 2\left(\frac{IR_{dc}}{E}\right) * 100$$

Supersedes page 103 of 3 April 1989.

$$D\% = 2\left(\frac{12.21IL}{AE}\right) * 100$$

$$= 24.42\left(\frac{IL}{AE}\right) * 100 \qquad (80\text{-}6)$$

90. <u>DERIVATION OF VOLTAGE DROP EQUATIONS FOR SINGLE-PHASE/POWER SYSTEMS</u>

The derivation of equations is based on Navy shipboard power systems and following assumptions:

- Cable impedance is purely resistive and inductive.
- The terminal load voltage is used as reference at V/0°.

Let derive the voltage drop equations based on the following figures:

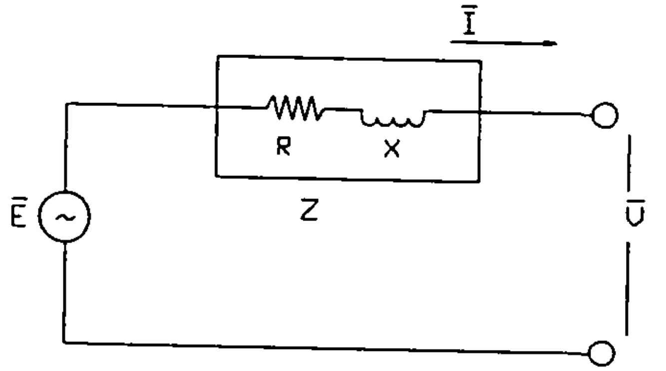

Figure 1. Single-phase circuit representation.

Supersedes page 104 of 3 April 1989.

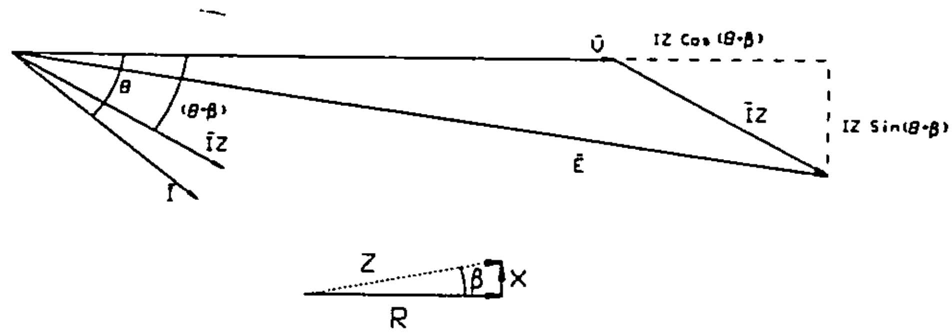

Figure 2. Single-phase Voltage & Current Phasor diagram.

From the above figures, define:

Θ = Load power factor angle or angle between load voltage and line current.
β = Cable impedance angle.

$= \tan^{-1}(X/R)$

The relationship between the sending bus and the terminal load voltage is as follows:

$$\bar{E} = \overline{IZ} + \bar{V}, \qquad (90\text{-}1)$$

$$\bar{E} = (I\underline{/-\Theta})(Z\underline{/\beta}) + V\underline{/0°}$$

$$\bar{E} = IZ\underline{/(-\Theta + \beta)} + V\underline{/0°}$$

Let $\alpha = -\Theta + \beta, \qquad (90\text{-}2)$

$$\bar{E} = IZ\cos(\alpha) + jIZ\sin(\alpha) + V$$

$$\bar{E} = (IZ\cos(\alpha) + V) + jIZ\sin(\alpha)$$

$$E = \sqrt{(IZ\cos(\alpha) + V)^2 + I^2Z^2\sin^2(\alpha)}, \qquad (90\text{-}3)$$

Supersedes page 105 of 3 April 1989.

The cable voltage drop in percent is calculated as follows:

$$D\% = \left(\frac{E - V}{E}\right) * 100$$

$$= \left(1 - \frac{V}{E}\right) * 100, \qquad (90\text{-}4)$$

From equation (90-3), the terminal load voltage is:

$$V = \sqrt{E^2 - I^2Z^2\sin^2(\alpha)} - IZ\cos(\alpha)$$

Substitute V into equation (90-4) and simplify:

$$D\% = \left[1 - \frac{\sqrt{E^2 - I^2Z^2 \sin^2(\alpha)}}{E} + \frac{IZ\cos(\alpha)}{E}\right] * 100$$

$$D\% = \left[1 - \sqrt{\frac{E^2 - I^2Z^2 \sin^2(\alpha)}{E^2}} + \frac{IZ\cos(\alpha)}{E}\right] * 100$$

$$D\% = \left[1 - \sqrt{1 - \frac{I^2Z^2 \sin^2(\alpha)}{E^2}} + \frac{IZ\cos(\alpha)}{E}\right] * 100, \qquad (90\text{-}5)$$

Set Z = zL, the exact equation for voltage drop is:

$$D\% = \left[1 - \sqrt{1 - \frac{I^2L^2z^2\sin^2(\alpha)}{E^2}} + \frac{ILz\cos(\alpha)}{E}\right] * 100, \qquad (90\text{-}6)$$

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The rule for approximation by binomial expansion can be applied to simplify equation (90-6):

$$(1 \pm x)^n = 1 \pm nx + \frac{n(n-1)x^2}{2!} \pm \frac{n(n-1)(n-2)x^3}{3!} + \ldots, (x^2 < 1)$$

In the above expression, let:

$$x^2 = \left(\frac{I^2L^2z^2\sin^2(\alpha)}{E^2}\right)^2$$ which is approximately equal to zero.

Therefore, the term in equation (90-6) can be written:

$$\sqrt{1 - \frac{I^2L^2z^2\sin^2(\alpha)}{E^2}} = 1 - \frac{1}{2}\left(\frac{I^2L^2z^2\sin^2(\alpha)}{E^2}\right), \qquad (90\text{-}7)$$

Substitute equation (90-7) into equation (90-6):

$$D\% = \left[1 - \left(1 - \frac{1}{2}\left(\frac{I^2L^2z^2\sin^2(\alpha)}{E^2}\right)\right) + \frac{ILz\cos(\alpha)}{E}\right] * 100$$

The voltage drop equation reduces to:

$$D\% = IL\left(\frac{z\cos(\alpha)}{E} + \frac{ILz^2\sin^2(\alpha)}{2E^2}\right) * 100, \qquad (90\text{-}8)$$

Since the quantity $\sin^2(\alpha)/2E^2$ is very small with respect to $\cos(\alpha)/E$, It can be neglected and the acceptable equation for the voltage drop is obtained:

$$D\% = IL\left(\frac{z\cos(\alpha)}{E}\right) * 100, \qquad (90\text{-}9)$$

NEW PAGE.

Since it is a single-phase circuit, equation (90-9) must be multiplied by 2 to include the drop in the return path.

Equation (90-9) can also be used to determine the percent drop in the individual lines for three-phase balanced systems such as electronic, internal communication, and weapon control systems with the substitution of line current by $\sqrt{3}I_{LO}$:

$$D\% = \sqrt{3}I_{LO}L\left(\frac{z\cos(\alpha)}{E}\right) * 100, \qquad (90\text{-}10)$$

Where I_{LO} is the resultant load current in each phase.

In equation (90-8), since $(z/E)\cos(\alpha) >> (z^2/2E^2)\sin^2(\alpha)$, and by setting D% equal to the assumed drop (AD), an estimate of (IL) may be determined as follows:

$$(AD) = IL[(z/E)\cos(\alpha)] * 100$$

Solve for IL:

$$IL = [(AD)E/100z\cos(\alpha)], \qquad (90\text{-}11)$$

Substitute equation (90-11) into equation (90-8) for IL in the bracket:

$$D\% = IL\left(\frac{z\cos(\alpha)}{E} + \frac{(AD)Ez^2\sin^2(\alpha)}{200zE^2\cos(\alpha)}\right) * 100$$

Simplification of the above equation gives the voltage drop equation which includes the assumed drop (AD) in the systems:

$$D\% = IL\left(\frac{z\cos(\alpha)}{E} + \frac{(AD)z\tan(\alpha)\sin(\alpha)}{200E}\right) * 100, \qquad (90\text{-}12)$$

The assumed drop (AD) for a 60 Hz or 400 Hz power system at normal operation is 2 percent.

In equation (90-12), let define the drop factor as:

NEW PAGE.

$$DF = \left(\frac{z\cos(\alpha)}{E} + \frac{(AD)\,z\tan(\alpha)\sin(\alpha)}{200E} \right) * 100, \qquad (90\text{-}13)$$

Equation (90-12) can be rewritten in the simple form:

$$D\% = IL(DF), \qquad (90\text{-}14)$$

As before, the percent drop for a single-phase circuit in equation (90-14) must be multiplied by 2 to include the drop in the return path:

$$D\% = 2IL(DF), \qquad (90\text{-}15)$$

100. DERIVATION OF VOLTAGE DROP EQUATIONS FOR THREE-PHASE/LIGHTING SYSTEMS

In order to determine the best cable selection for three-phase systems, voltage drop calculations for all phases should be performed. The combination of the individual drops will be the drop of the cable. The following equation derivations are for a three-phase lighting system in delta configuration.

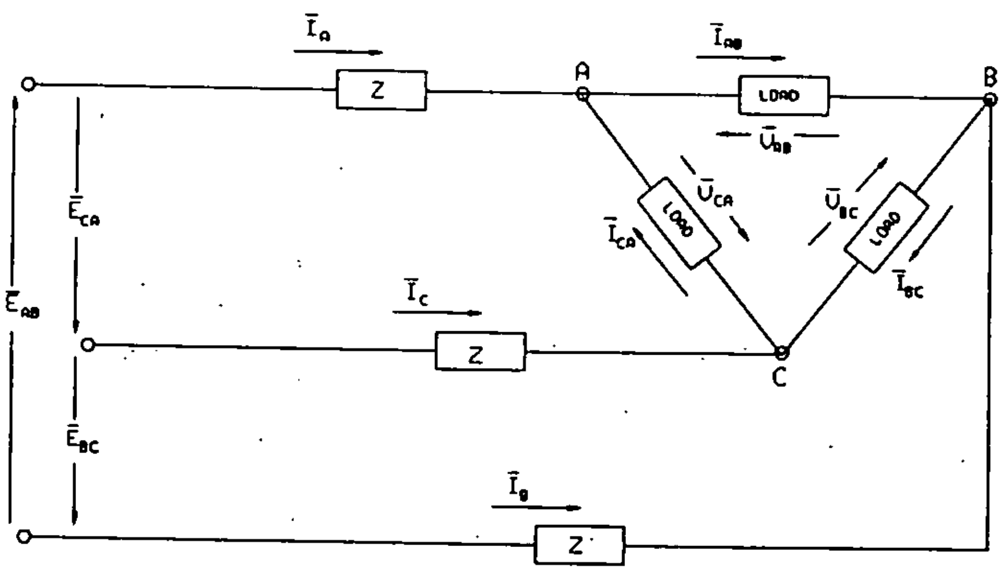

Figure 3. Three-phase circuit representation.

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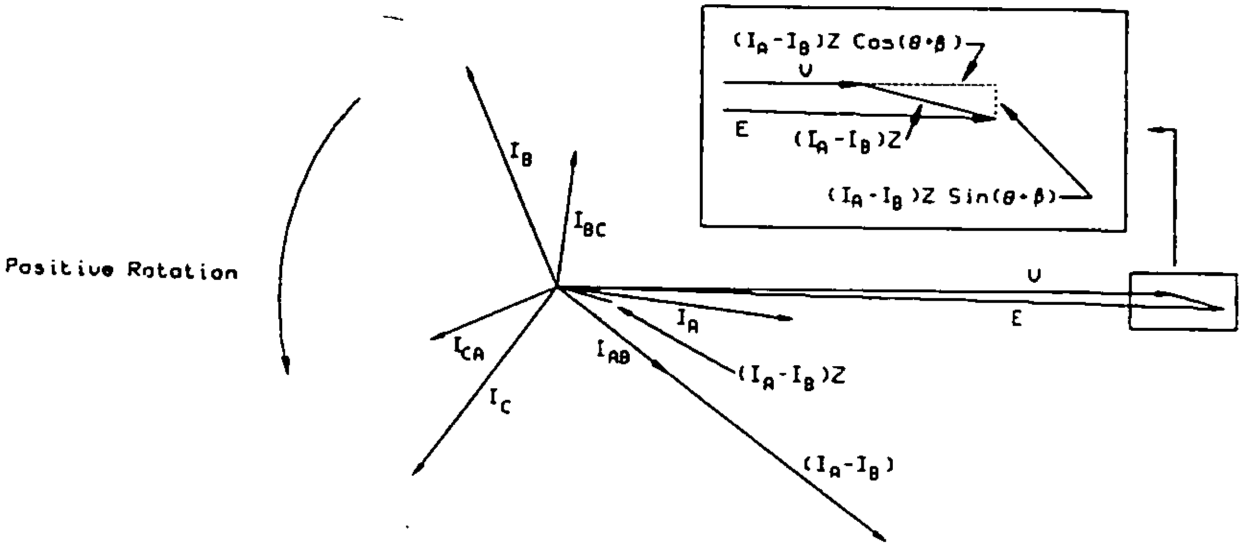

Figure 4. Three-phase voltage and current phasor diagram.

From figure 3., the voltage loop method gives:

$$\overline{E}_{AB} - \overline{I}_A\overline{Z} - \overline{V}_{AB} + \overline{I}_B\overline{Z} = 0, \quad (100\text{-}1)$$

$$\overline{E}_{BC} - \overline{I}_B\overline{Z} - \overline{V}_{BC} + \overline{I}_C\overline{Z} = 0, \quad (100\text{-}2)$$

$$\overline{E}_{CA} - \overline{I}_C\overline{Z} - \overline{V}_{CA} + \overline{I}_A\overline{Z} = 0, \quad (100\text{-}3)$$

Regroup the above equations as follows:

$$\overline{E}_{AB} = \overline{V}_{AB} + \overline{Z}(\overline{I}_A - \overline{I}_B), \quad (100\text{-}4)$$

$$\overline{E}_{BC} = \overline{V}_{BC} + \overline{Z}(\overline{I}_B - \overline{I}_C), \quad (100\text{-}5)$$

$$\overline{E}_{CA} = \overline{V}_{CA} + \overline{Z}(\overline{I}_C - \overline{I}_A), \quad (100\text{-}6)$$

Next, the difference in line current terms in equations (100-4) through (100-6) must be solved. From figures 3 and 4:

NEW PAGE.

$$\bar{I}_A = \bar{I}_{AB} - \bar{I}_{CA}, \qquad (100\text{-}7)$$

$$\Theta_A = 0° - \underline{/I_A}$$

$$\alpha_A = -\Theta_A + \beta$$

$$\bar{I}_B = \bar{I}_{BC} - \bar{I}_{AB}, \qquad (100\text{-}8)$$

$$\Theta_B = -120° - \underline{/I_B}$$

$$\alpha_B = -\Theta_B + \beta$$

$$\bar{I}_C = \bar{I}_{CA} - \bar{I}_{BC}, \qquad (100\text{-}9)$$

$$\Theta_C = 120° - \underline{/I_C}$$

$$\alpha_C = -\Theta_C + \beta$$

Where:

$\underline{/I_A}$, $\underline{/I_B}$, $\underline{/I_C}$: angle of $\bar{I}_A$, $\bar{I}_B$, and $\bar{I}_C$.

Θ_A : angle between $\bar{V}_{AB}$ and $\bar{I}_A$.

Θ_B : angle between $\bar{V}_{BC}$ and $\bar{I}_B$

Θ_C : angle between $\bar{V}_{CA}$ and $\bar{I}_C$.

The phase load currents are expressed as:

$$\bar{I}_{AB} = I_{AB}\underline{/(0°-\Theta_{AB})}$$

$$\bar{I}_{BC} = I_{BC}\underline{/(-120°-\Theta_{BC})}$$

$$\bar{I}_{CA} = I_{CA}\underline{/(120°-\Theta_{CA})}$$

From equations (100-7), (100-8), and (100-9), the percent voltage drop in each line is computed as follows:

$$D\% = IL\left(\frac{z\cos(\alpha)}{E}\right) * 100, \qquad (100\text{-}10)$$

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Let the drop factor as follow:

$$DF = \left(\frac{z\cos(\alpha)}{E}\right) * 100,$$

Equation (100-10) reduces to:

$$D\% = IL(DF), \qquad (100\text{-}11)$$

The difference in line currents $\overline{I}_x$ are computed as follows:

$$\overline{I}_{x(AB)} = \overline{I}_A - \overline{I}_B, \qquad (100\text{-}12)$$
$$= \overline{I}_{AB} - \overline{I}_{BC} - \overline{I}_{CA} + \overline{I}_{AB}$$
$$= 2\overline{I}_{AB} - \overline{I}_{BC} - \overline{I}_{CA}$$

and $\Theta_{x(AB)} = 0° - \underline{/I}_{x(AB)}-$

$$\alpha_{x(AB)} = -\Theta_{x(AB)} + \beta$$

$$\overline{I}_{x(BC)} = \overline{I}_B - \overline{I}_C \qquad (100\text{-}13)$$
$$= \overline{I}_{BC} - \overline{I}_{CA} - \overline{I}_{AB} + \overline{I}_{BC}$$
$$= 2\overline{I}_{BC} - \overline{I}_{CA} - \overline{I}_{AB}$$

and $\Theta_{x(BC)} = -120° - \underline{/I}_{x(BC)}-$

$$\alpha_{x(BC)} = -\Theta_{x(BC)} + \beta$$

$$\overline{I}_{x(CA)} = \overline{I}_C - \overline{I}_A, \qquad (100\text{-}14)$$
$$= \overline{I}_{CA} - \overline{I}_{AB} - \overline{I}_{BC} + \overline{I}_{CA}$$
$$= 2\overline{I}_{CA} - \overline{I}_{AB} - \overline{I}_{BC}$$

and $\Theta_{x(CA)} = 120° - \underline{/I}_{x(CA)}-$

$$\alpha_{x(CA)} = -\Theta_{x(CA)} + \beta$$

Where:

$\Theta_{x(AB)}$: Angle between $\overline{V}_{AB}$ and $\overline{I}_{x(AB)}$.

NEW PAGE.

$\Theta_{x(BC)}$: Angle between $\overline{V}_{BC}$ and $\overline{I}_{x(BC)}$.

$\Theta_{x(CA)}$: Angle between $\overline{V}_{CA}$ and $\overline{I}_{x(CA)}$.

From equations (100-4), (100-5), and (100-6), the general equation for the percent drop in the individual phase is:

$$D\% = \frac{|\overline{E}_x| - |\overline{V}|}{E_x} * 100, \qquad (100\text{-}15)$$

The magnitude of $\overline{V}$ may be approximated as:

$$V = E_x - I_x Z\cos(\alpha_x)$$

Substitution of V in equation (100-15) gives:

$$D\% = I_x Z\left(\frac{\cos(\alpha_x)}{E_x}\right) * 100 \qquad (100\text{-}16)$$

Let Z = zL, equation (100-16) becomes:

$$D\% = I_x L\left(\frac{z\cos(\alpha_x)}{E_x}\right) * 100 \qquad (100\text{-}17)$$

For example, the percent drop in phase AB is:

$$D_{AB}\% = I_{x(AB)} L\left(\frac{z\cos(\alpha_{x(AB)})}{E_{AB}}\right) * 100$$

Equation (100-17) can also be written as:

$$D\% = I_x L(DF) \qquad (100\text{-}18)$$

With,

$$DF = \left(\frac{z\cos(\alpha_x)}{E_x}\right) * 100, \qquad (100\text{-}19)$$

For a single-phase system, equation (100-19) becomes:

$$DF = \left(\frac{z\cos(\alpha)}{E}\right) * 100, \qquad (100\text{-}20)$$

Then, the percent drop equation is as follows:

$$D\% = 2IL(DF) \qquad (100\text{-}21)$$

110. DERIVATION OF VOLTAGE DROP EQUATIONS FOR THREE-PHASE/LIGHTING SYSTEMS USING WATTS AND VARS

In lighting systems, the use of watts (P) and vars (Q) instead of currents (I) in voltage drop equations avoids necessity for calculating all phase and line currents. This is an advantage when real and reactive power or the apparent power (S) and power factor of connected loads are known.

Consider a balanced three-phase voltage and current vector diagram below:

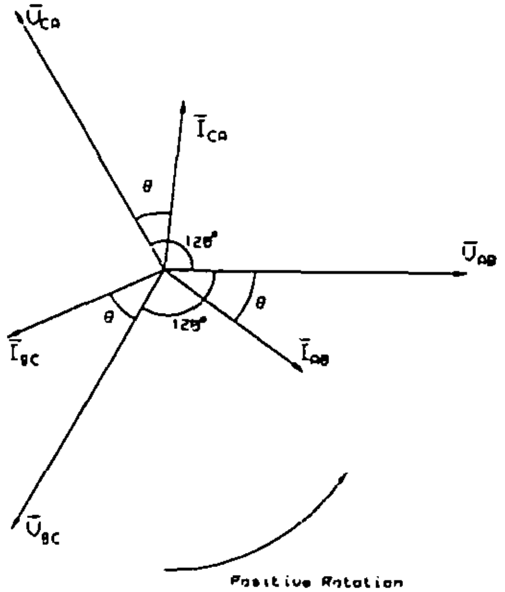

Figure 5. Three-phase voltage and current phasor diagram.

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Assume all phase loads are inductive. The total complex power for each phase can be determined as follows:

$$\bar{S} = \bar{V}\,\bar{I}_L^{*}$$

Where $\bar{I}_L^{*}$ is the complex conjugate of $\bar{I}_L$.

The apparent power (S) for each phase (leg) is defined as:

$$S = |\,S\,| = \bar{V}I_L$$

For phase AB:

$$S_{AB} = V_{AB}I_{AB}$$

In rectangular form:

$$S_{AB} = V_{AB}(1 + j0) * I_{AB}[\cos(\Theta_{AB}) + j\sin(\Theta_{AB})]$$

$$S_{AB} = V_{AB}I_{AB}\cos(\Theta_{AB}) + jV_{AB}I_{AB}\sin(\Theta_{AB}), \qquad (110\text{-}1)$$

Since,

$$P_{AB} = V_{AB}I_{AB}\cos(\Theta_{AB}), \quad Q_{AB} = V_{AB}I_{AB}\sin(\Theta_{AB})$$

Equation (110-1) becomes:

$$S_{AB} = P_{AB} + jQ_{AB}, \qquad (110\text{-}2)$$

The apparent powers S_{BC} for phase BC and S_{CA} for phase CA can be referenced to the same axis as S_{AB}. For inductive loads, their horizontal projections are:

$$S_{BC}\cos(-120° - \Theta_{BC}) \quad \text{and} \quad S_{CA}\cos(120° - \Theta_{CA})$$

From the trigonometric identity:

$$\cos(\Theta_1 - \Theta_2) = \cos(\Theta_1)\cos(\Theta_2) + \sin(\Theta_1)\sin(\Theta_2)$$

$$S_{BC}\cos(-120° - \Theta_{BC}) = S_{BC}[\cos(-120°)\cos(\Theta_{BC}) + \sin(-120°)\sin(\Theta_{BC})$$

$$= S_{BC}[-(1/2)\cos(\Theta_{BC}) - (\sqrt{3}/2)\sin(\Theta_{BC})]$$

NEW PAGE.

For phase CA:

$$S_{CA}\cos(120° - \Theta_{CA}) = S_{CA}[\cos(120°)\cos(\Theta_{CA}) + \sin(120°)\sin(\Theta_{CA})$$
$$= S_{CA}[-(1/2)\cos(\Theta_{CA}) + (\sqrt{3}/2)\sin(\Theta_{CA})]$$

As indicated above, the two quantities can be rewritten:

$$S_{BC}\cos(-120° - \Theta_{BC}) = -(1/2)P_{BC} - (\sqrt{3}/2)Q_{BC}$$

$$S_{CA}\cos(120° - \Theta_{CA}) = -(1/2)P_{CA} + (\sqrt{3}/2)Q_{CA}$$

The apparent power S_A and real power P_A in line A (or at node A) can be calculated as follows:

$$S_A = S_{AB} - S_{CA}, \qquad P_A = P_{AB} - P_{CA}$$

Substitute P_{CA} in the above equation:

$$P_A = P_{AB} - S_{CA}\cos(120° - \Theta_{CA})$$
$$= P_{AB} - (1/2)P_{CA} + (\sqrt{3})Q_{CA})$$
$$= P_{AB} + (1/2)P_{CA} - (\sqrt{3})Q_{CA}, \qquad (110\text{-}3)$$

For lines B and C:

$$P_B = P_{BC} - P_{AB}$$
$$= P_{BC} + (1/2)P_{AB} - (\sqrt{3})Q_{AB}, \qquad (110\text{-}4)$$

$$P_C = P_{CA} - P_{BC}$$
$$= P_{CA} + (1/2)PBC - (\sqrt{3})Q_{BC}, \qquad (110\text{-}5)$$

Similarly,

$$Q_A = Q_{AB} - Q_{CA}$$
$$= Q_{AB} + (1/2)Q_{CA} - (\sqrt{3}/2)P_{CA}, \qquad (110\text{-}6)$$
$$Q_B = Q_{BC} - Q_{AB},$$
$$= Q_{BC} + (1/2)Q_{AB} - (\sqrt{3}/2)P_{AB}, \qquad (110\text{-}7)$$

$$Q_C = Q_{CA} - Q_{BC},$$
$$= Q_{CA} + (1/2)Q_{BC} - (\sqrt{3}/2)P_{BC}, \quad (110\text{-}8)$$

The net power P_x at two nodes of a three-phase delta connected load is as follows:

Phase AB:

$$P_{x(AB)} = P_A - P_B, \quad (110\text{-}9)$$

In equation (110-4) for line B, P_B can be expressed as:

$$P_B = P_{BC} - P_{AB}$$
$$= S_{BC}[-(1/2)\cos(\Theta_{BC}) - (\sqrt{3}/2)\sin(\Theta_{BC})] - P_{AB}$$
$$= - P_{AB} - (1/2)P_{BC} - (\sqrt{3}/2)Q_{BC}, \quad (110\text{-}10)$$

Substitute P_A and P_B in equation (110-9), equation for P_x in phase AB is obtained:

$$P_{x(AB)} = 2P_{AB} + (1/2)(P_{BC} + P_{CA}) + (\sqrt{3}/2)(Q_{BC} - Q_{CA}), \quad (110\text{-}11)$$

For phases BC and CA:

$$P_{x(BC)} = 2P_{BC} + (1/2)(P_{CA} + P_{AB}) + (\sqrt{3}/2)(Q_{CA} - Q_{AB}), \quad (110\text{-}12)$$
$$P_{x(CA)} = 2P_{CA} + (1/2)(P_{AB} + P_{BC}) + (\sqrt{3}/2)(Q_{AB} - Q_{BC}), \quad (110\text{-}13)$$

Similarly, Q_x can be shown as:

$$Q_{x(AB)} = -[2Q_{AB} + (1/2)(Q_{BC} + Q_{CA}) - (\sqrt{3}/2)(P_{BC} - P_{CA})], \quad (110\text{-}14)$$
$$Q_{x(BC)} = -[2Q_{BC} + (1/2)(Q_{CA} + Q_{AB}) - (\sqrt{3}/2)(P_{CA} - P_{AB})], \quad (110\text{-}15)$$
$$Q_{x(CA)} = -[2Q_{CA} + (1/2)(Q_{AB} + Q_{BC}) - (\sqrt{3}/2)(P_{AB} - P_{BC})], \quad (110\text{-}16)$$

Equations for capacitive loads, or mixed inductive and capacitive loads can also be derived by assigning the proper sign to each phase angle (negative for inductive loads and positive for capacitive loads) in determining the cosine and sine of (± 120° ± Θ). Therefore, for capacitive loads, the signs of the last terms in equations (110-11) through (110-16) should be reversed.

It should be noted that if these equations are divided by load voltage V, similar expressions involving resistive and reactive components of current will result. In some cases, the use of these equations may be more convenient than the vector rotation method when currents are used in the calculations.

For checking current carrying capacity of conductors, only the largest phase apparent power (S) or (S_x) needs to be considered. The general equations are:

$$S = \sqrt{P^2 + Q^2} \qquad S_x = \sqrt{P_x^2 + Q_x^2}, \qquad (110\text{-}17)$$

$$I = \frac{S}{V} = \left(\frac{P}{V}\right)\left(\frac{1}{\cos(\Theta)}\right) \qquad I_x = \frac{S_x}{V} = \left(\frac{P_x}{V}\right)\left(\frac{1}{\cos(\Theta_x)}\right), \qquad (110\text{-}18)$$

$$\Theta = \cos^{-1}\left(\frac{P}{S}\right) \qquad \Theta_x = \cos^{-1}\left(\frac{P_x}{S_x}\right), \qquad (110\text{-}19)$$

or

$$\Theta = \tan^{-1}\left(\frac{Q}{P}\right) \qquad \Theta_x = \tan^{-1}\left(\frac{Q_x}{P_x}\right), \qquad (11\text{-}20)$$

Θ_x is positive if Q_x is positive.

Θ_x is greater than 90° if P_x is negative.

Recall the general voltage drop equation for three-phase lighting systems derived in section 100:

$$D\% = I_x L \left(\frac{z\cos(\alpha_x)}{E_x}\right) * 100, \qquad (100\text{-}17)$$

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Since,

$$P_x = I_x V\cos(\Theta_x)$$

The current I_x is then:

$$I_x = \left(\frac{P_x}{V\cos(\Theta_x)}\right) \qquad (110\text{-}21)$$

Substitution of I_x in equation (100-17) gives:

$$D\% = P_x L\left(\frac{1}{V\cos(\Theta_x)}\right)\left(\frac{z\cos(\alpha_x)}{E_x}\right) * 100, \qquad (110\text{-}22)$$

From equation (110-22), a new drop factor is defined as:

$$DF' = \left(\frac{1}{V\cos(\Theta_x)}\right)\left(\frac{z\cos(\alpha_x)}{E_x}\right) * 100, \qquad (110\text{-}23)$$

Finally,

$$D\% = P_x L(DF) \qquad (110\text{-}24)$$

For single-phase circuits, in equation (110-22), the parameters E_x, P_x, α_x, and Θ_x become E, P, α, and Θ respectively. The percent voltage drop for a single-phase circuit is then:

$$D\% = 2PL(DF) \qquad (110\text{-}25)$$

With,

$$DF' = \left(\frac{1}{V\cos(\Theta)}\right)\left(\frac{z\cos(\alpha)}{E}\right) * 100, \qquad (110\text{-}26)$$

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The computed drop factors for LSTSGU cables from equations (110-23) or (110-26) are shown in table XVII. Now, let derive equation for D% in function of watts (P) and vars (Q). Equation (110-18) can be written as:

$$P_x = S_x \cos(\Theta_x), \qquad (110\text{-}27)$$

Substitution of P_x in equation (110-22) gives:

$$D\% = \left(\frac{S_x L z \cos(\Theta_x)\cos(\alpha_x)}{E_x V \cos(\Theta_x)}\right) * 100, \qquad (110\text{-}28)$$

$$D\% = \left(\frac{S_x L z \cos(\alpha_x)}{E_x V}\right) * 100, \qquad (110\text{-}28)$$

Rewrite equation (110-28) as:

$$D\% = \left(\frac{S_x L z \cos(\beta \pm \Theta_x)}{E_x V}\right) * 100, \qquad (110\text{-}29)$$

$$D\% = \left(\frac{S_x L z[\cos(\beta)\cos(\Theta_x) \pm \sin(\beta)\sin(\Theta_x)]}{E_x V}\right) * 100, \qquad (110\text{-}30)$$

Recall:

$$P_x = S_x \cos(\Theta_x), \qquad Q_x = S_x \sin(\Theta_x),$$

$$R = z\cos(\beta), \qquad X = z\sin(\beta)$$

After the substitution, equation (110-30) becomes:

$$D\% = \left(\frac{L(RP_x \pm XQ_x)}{E_x V}\right) * 100, \qquad (110\text{-}31)$$

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For lighting systems, let assume:

$$E_x = 120V, \qquad V = 115V$$

Equation (110-31) can be written as:

$$D\% = (7.25)(10^{-5})L(RP_x \pm XQ_x) * 100, \qquad (110\text{-}32)$$

For a single phase system, equation (110-31) becomes:

$$D\% = 2\left(\frac{L(RP \pm XQ)}{EV}\right) * 100, \qquad (110\text{-}33)$$

The signs " + " and " − " are for inductive and capacitive loads respectively. The values of R and X for different types of cables can be found from Tables XI through XVII.

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120. DERIVATION OF VOLTAGE DROP EQUATIONS FOR THREE-PHASE FOUR-WIRE SYSTEMS

Consider a three-phase four-wire (Wye) system as shown below:

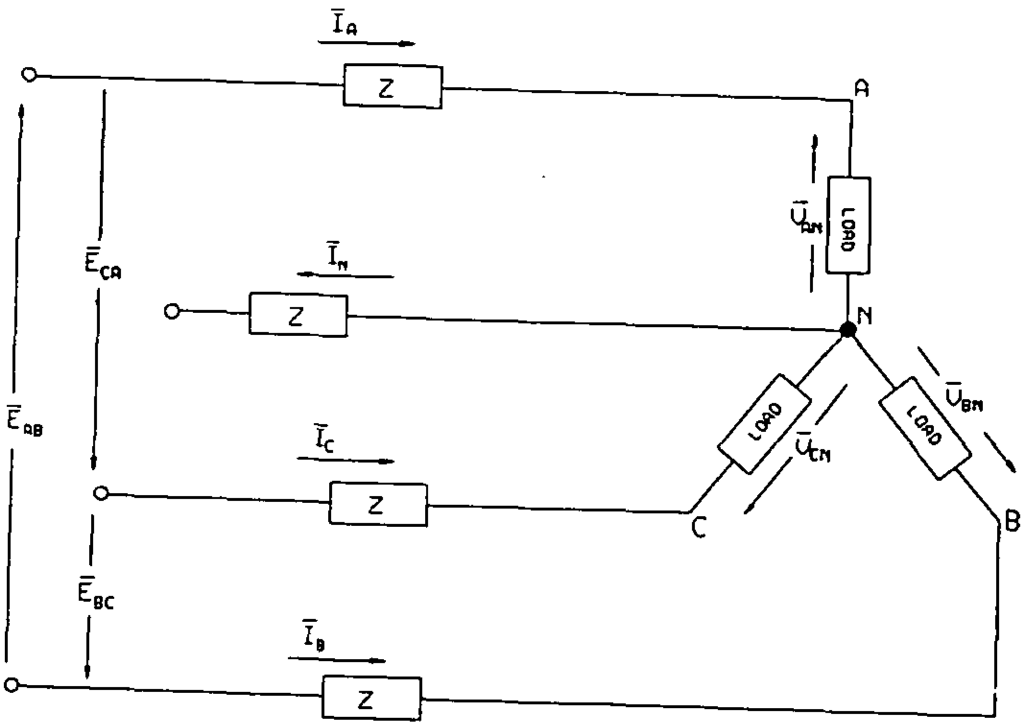

Figure 6. Three-phase Four-wire System.

If the system is balanced, the voltage drops for all lines are the same. For example, in line A, the percent drop is:

$$D_A\% = \left(\frac{E_{AN} - V_{AN}}{E_{AN}}\right) * 100, \qquad (120\text{-}1)$$

Or

$$D_A\% = IL\left(\frac{z\cos(\alpha_A)}{E_{AN}}\right) * 100, \qquad (120\text{-}2)$$

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Where:
$$I = I_A = \frac{V_{AN}}{Z_{AN}}, \quad (120\text{-}3)$$

$$\alpha = -\theta_A + \beta, \quad (100\text{-}7)$$

With, $E_{AN} = (E_{AB}/\sqrt{3}) = E$, equation (120-2) becomes:

$$D_A\% = IL\left(\frac{z\cos(\alpha_A)}{E}\right) * 100, \quad (120\text{-}4)$$

Or

$$D_A\% = IL(DF), \quad (120\text{-}5)$$

With,

$$DF = \left(\frac{z\cos(\alpha_A)}{E}\right) * 100$$

Now, let derive equations for the drop in each phase (the drop in phase A plus the drop in phase B). From figure 6, the source voltage in line A to line B is:

$$\bar{E}_{AB} = \bar{V}_{AN} - \bar{V}_{BN} + \bar{Z}(\bar{I}_A - \bar{I}_B), \quad (120\text{-}5)$$

For $\bar{V}_{BN} = \bar{V}_{AN}(1\underline{/-120°})$,

$$\bar{E}_{AB} = \bar{V}_{AN} - \bar{V}_{AN}(1\underline{/-120°}) + \bar{Z}(\bar{I}_A - \bar{I}_B)$$
$$= \bar{V}_{AN}(1.5 + j0.866) + \bar{Z}(\bar{I}_A - \bar{I}_B)$$
$$= \bar{V}_{AN}(\sqrt{3}\underline{/30°}) + \bar{Z}(\bar{I}_A - \bar{I}_B)$$

Since $\bar{V}_{AB} = \bar{V}_{AN}(\sqrt{3}\underline{/30°})$, equation (120-5) becomes:

$$\bar{E}_{AB} = \bar{V}_{AB} + \bar{Z}(\bar{I}_A - \bar{I}_B), \quad (120\text{-}6)$$

Similarly:

$$\bar{E}_{BC} = \bar{V}_{BC} + \bar{Z}(\bar{I}_B - \bar{I}_C), \quad (120\text{-}7)$$

and

$$\bar{E}_{CA} = \bar{V}_{CA} + \tilde{Z}(\bar{I}_C - \bar{I}_A), \qquad (120\text{-}8)$$

Note that equations (120-6),(120-7), and (120-8) are similar to equations (100-4), (100-5), and (100-6) in section 100. After the line currents I are computed from equation (120-3), the currents I_x and the associated angles Θ_x and α_x can be determined in accordance with the following equations as derived in section 100 :

$$\bar{I}_{x(AB)} = \bar{I}_A - \bar{I}_B, \qquad (100\text{-}12)$$

$$\Theta_{x(AB)} = 0° - \underline{/I}_{x(AB)},$$

$$\alpha_{x(AB)} = -\Theta_{x(AB)} + \beta$$

$$\bar{I}_{x(BC)} = \bar{I}_B - \bar{I}_C, \qquad (100\text{-}13)$$

$$\Theta_{x(BC)} = -120° - \underline{/I}_{x(BC)},$$

$$\alpha_{x(BC)} = -\Theta_{x(BC)} + \beta$$

$$\bar{I}_{x(CA)} = \bar{I}_C - \bar{I}_A, \qquad (100\text{-}14)$$

$$\Theta_{x(CA)} = 120° - \underline{/I}_{x(CA)},$$

$$\alpha_{x(CA)} = -\Theta_{x(CA)} + \beta$$

The percent drop in each phase is calculated from equation (100-17) as derived in section 100:

$$D\% = I_x L \left(\frac{z\cos(\alpha_x)}{E_x} \right) * 100, \qquad (100\text{-}17)$$

With,

$$DF = \left(\frac{z\cos(\alpha_x)}{E_x} \right) * 100$$

Equation (100-17) reduces to:

$$D\% = I_x L(DF)$$

130. DERIVATION OF VOLTAGE DROP EQUATIONS FOR UNBALANCED SYSTEMS BY SYMMETRICAL COMPONENT METHOD

For analyzing unbalanced circuit, all loads are assumed unequal. Therefore, the currents in all phase loads are different. The symmetrical component method is preferred here to analyze the network. To use this method, it is convenient to keep the voltages, currents, and impedances in phasor forms. The following figures represent a three-phase unbalanced system and a three-phase unbalanced currents.

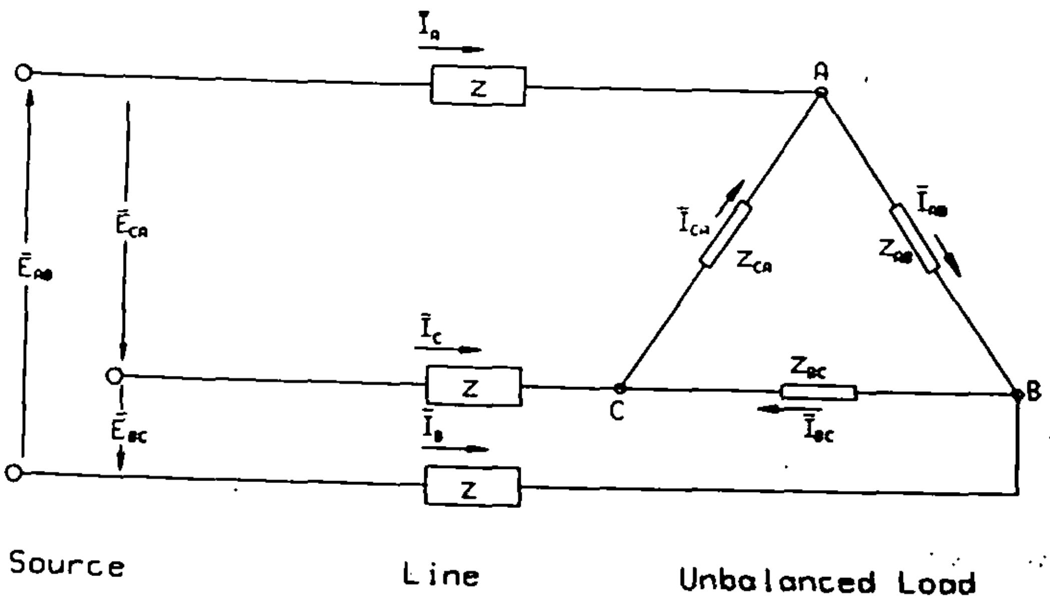

Figure 7. Three-phase unbalanced system.

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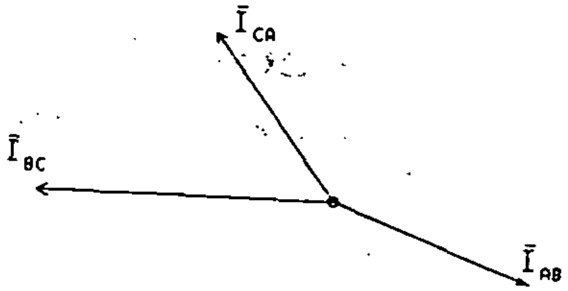

Figure 8. Three-phase unbalanced currents.

Assume all three loads are unbalanced. The load currents are:

$$|\bar{I}_{AB}| \neq |\bar{I}_{BC}| \neq |\bar{I}_{CA}|$$

and

$$\Theta_{AB} \neq \Theta_{BC} \neq \Theta_{CA}$$

The line currents, as functions of load currents at nodes A, B, and C of figure 7, are determined from equations derived in section 100 as follows:

$$\bar{I}_A = \bar{I}_{AB} - \bar{I}_{CA}, \qquad (100\text{-}7)$$

$$\bar{I}_B = \bar{I}_{BC} - \bar{I}_{AB}, \qquad (100\text{-}8)$$

$$\bar{I}_C = \bar{I}_{CA} - \bar{I}_{BC}, \qquad (100\text{-}9)$$

Rearranging equation (100-7) as follows:

$$\bar{I}_A + \bar{I}_{CA} - \bar{I}_{AB} = 0, \qquad (130\text{-}1)$$

Substitution of equation (100-9) into equation (130-1) yields:

$$\bar{I}_A + \bar{I}_C + \bar{I}_{BC} - \bar{I}_{AB} = 0, \qquad (130\text{-}2)$$

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Substitution of equation (100-8) into equation (130-2) yields:

$$\bar{I}_A + \bar{I}_B + \bar{I}_C = 0, \tag{130-3}$$

Consider the zero sequence component of $\bar{I}_A$:

$$\bar{I}_{A0} = (1/3)(\bar{I}_A + \bar{I}_B + \bar{I}_C), \tag{130-4}$$

Substitution from equation (130-4) gives:

$$\bar{I}_{A0} = (1/3)(0) = 0,$$

By similar derivation:

$$\bar{I}_{A0} = \bar{I}_{B0} = \bar{I}_{C0} = 0, \tag{130-5}$$

Thus, in a three-phase delta system the zero sequence currents are zero.

Now, let calculate the positive and negative sequence components of the line currents in term of current in phase AB.

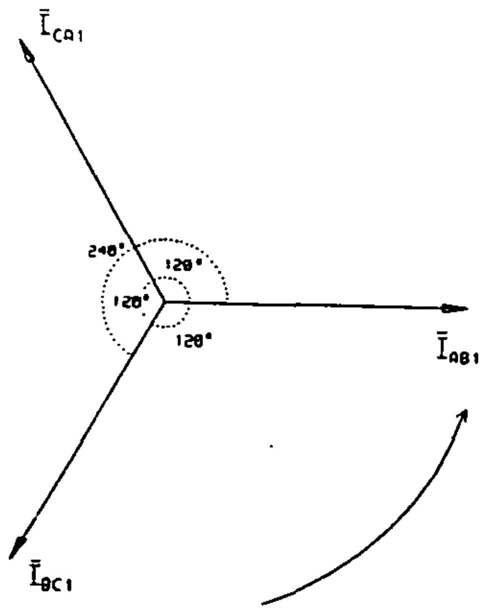

Figure 9. Positive sequence currents.

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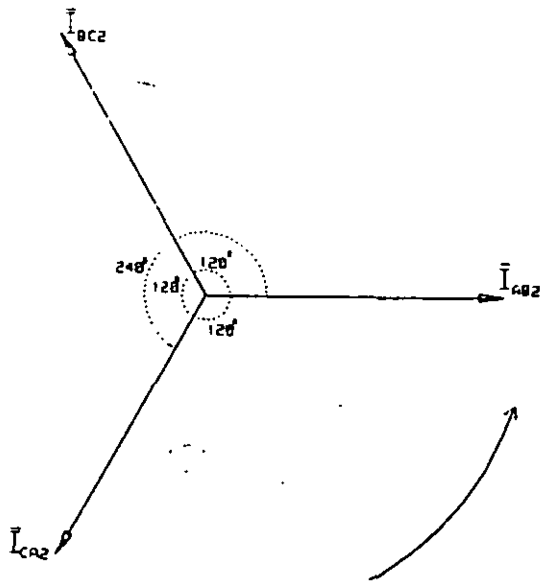

Figure 10. Negative sequence currents.

Components of $\bar{I}_A$

From equation (306), the positive sequence current is:

$$\bar{I}_{A1} = \bar{I}_{AB1} - \bar{I}_{CA1}, \qquad (130\text{-}6)$$

From figure 9:

$$\bar{I}_{CA1} = \bar{I}_{AB1} \underline{/120°}, \qquad (130\text{-}7)$$

Substitution equation (130-7) into equation (130-6) yields:

$$\begin{aligned} \bar{I}_{A1} &= \bar{I}_{AB1} - \bar{I}_{AB1}\underline{/120°}, \\ &= \bar{I}_{AB1}(1\underline{/0°} - 1\underline{/120°}) \\ &= \bar{I}_{AB1}(1 + 0.5 - j0.866) \\ &= \bar{I}_{AB1}(\sqrt{3}\underline{/-30°}), \qquad (130\text{-}8) \end{aligned}$$

From equation (130-7), the negative sequence current is:

$$\bar{I}_{A2} = \bar{I}_{AB2} - \bar{I}_{CA2}, \qquad (130\text{-}9)$$

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From figure 10:

$$\overline{I}_{CA2} = \overline{I}_{AB2}\underline{/240°}, \qquad (130\text{-}10)$$

Substitution of equation (130-10) into equation (130-9) gives:

$$\begin{aligned}\overline{I}_{A2} &= \overline{I}_{AB2} - \overline{I}_{AB2}\underline{/240°} \\ &= \overline{I}_{AB2}(1\underline{/0°} - 1\underline{/240°}) \\ &= \overline{I}_{AB2}(1 + 0.5 + j0.866) \\ &= \overline{I}_{AB2}(\sqrt{3}\underline{/30°}), \qquad (130\text{-}11)\end{aligned}$$

Components of $\overline{I}_B$

From equation (100-8), the positive sequence current is:

$$\overline{I}_{B1} = \overline{I}_{BC1} - \overline{I}_{AB1}, \qquad (130\text{-}12)$$

From figure 9:

$$\overline{I}_{BC1} = \overline{I}_{AB1}\underline{/240°}, \qquad (130\text{-}13)$$

Substitution of equation (13-13) into equation (130-12) yields:

$$\begin{aligned}\overline{I}_{B1} &= \overline{I}_{AB1}/240° - \overline{I}_{AB1} \\ &= \overline{I}_{AB1}(1\underline{/240°} - 1\underline{/0°}) \\ &= \overline{I}_{AB1}(-1 - 0.5 - j.866) \\ &= \overline{I}_{AB1}(\sqrt{3}\underline{/-150°}), \qquad (130\text{-}14)\end{aligned}$$

From equation (100-8), the negative sequence current is:

$$\overline{I}_{B2} = \overline{I}_{BC2} - \overline{I}_{AB2}, \qquad (130\text{-}15)$$

From figure 10:

$$\overline{I}_{BC2} = \overline{I}_{AB2}\underline{/120°}, \qquad (130\text{-}16)$$

Substitution of equation (130-16) into equation (130-15) yields:

$$\bar{I}_{B2} = \bar{I}_{AB2}\underline{/120°} - \bar{I}_{AB2}$$

$$= \bar{I}_{AB2}(1\underline{/120°} - 1\underline{/0°})$$

$$\bar{I}_{B2} = \bar{I}_{AB2}(-1 - 0.5 + j.866)$$

$$= \bar{I}_{AB2}(\sqrt{3}\underline{/150°}), \qquad (130\text{-}17)$$

Components of $\bar{I}_C$

From equation (100-9), the positive sequence current is:

$$\bar{I}_{C1} = \bar{I}_{CA1} - \bar{I}_{BC1}, \qquad (130\text{-}18)$$

From figure 9:

$$\bar{I}_{CA1} = \bar{I}_{AB1}\underline{/120°}, \qquad (130\text{-}19)$$

$$\bar{I}_{BC1} = \bar{I}_{AB1}\underline{/240°}, \qquad (130\text{-}20)$$

Substitution of equations (130-19) and (130-20) into equation (130-18) gives:

$$\bar{I}_{C1} = \bar{I}_{AB1}\underline{/120°} - \bar{I}_{AB1}\underline{/240°}$$

$$= \bar{I}_{AB1}(1\underline{/120°} - 1\underline{/240°})$$

$$= \bar{I}_{AB1}(0 + j1.732)$$

$$= \bar{I}_{AB1}(\sqrt{3}\underline{/90°}), \qquad (130\text{-}21)$$

From equation (100-9), the negative sequence current is:

$$\bar{I}_{C2} = \bar{I}_{CA2} - \bar{I}_{BC2}, \qquad (130\text{-}22)$$

From figure 9:

$$\bar{I}_{CA2} = \bar{I}_{AB2}\underline{/240°}, \qquad (130\text{-}23)$$

$$\bar{I}_{BC2} = \bar{I}_{AB2}\underline{/120°}, \qquad (130\text{-}24)$$

Substitution of equations (130-23) and (130-24) into equation (130-22) gives:

$$\begin{aligned}\bar{I}_{C2} &= \bar{I}_{AB2}\underline{/240°} - \bar{I}_{AB2}\underline{/120°}\\ &= \bar{I}_{AB2}(1\underline{/240°} - 1\underline{/120°})\\ &= \bar{I}_{AB2}(0 - j1.732)\\ &= \bar{I}_{AB2}(\sqrt{3}\underline{/-90°}),\end{aligned} \qquad (130\text{-}25)$$

Take phase AB as the reference, the line currents can be written in terms of the sequence currents as follows:

$$\begin{aligned}\bar{I}_{A} &= \bar{I}_{A0} + \bar{I}_{A1} + \bar{I}_{A2}\\ &= \bar{I}_{AB1}(\sqrt{3}\underline{/-30°}) + \bar{I}_{AB2}(\sqrt{3}\underline{/30°}),\end{aligned} \qquad (130\text{-}26)$$

$$\begin{aligned}\bar{I}_{B} &= \bar{I}_{B0} + \bar{I}_{B1} + \bar{I}_{B2}\\ &= \bar{I}_{AB1}(\sqrt{3}\underline{/-150°}) + \bar{I}_{AB2}(\sqrt{3}\underline{/150°}),\end{aligned} \qquad (130\text{-}27)$$

$$\begin{aligned}\bar{I}_{C} &= \bar{I}_{C0} + \bar{I}_{C1} + \bar{I}_{C2}\\ &= \bar{I}_{AB1}(\sqrt{3}\underline{/90°}) + \bar{I}_{AB2}(\sqrt{3}\underline{/-90°}),\end{aligned} \qquad (130\text{-}28)$$

To complete the above equations, the positive and negative sequence currents of phase AB must be calculated. From figure 9, it can be shown that:

$$\bar{I}_{AB1} = (1/3)(\bar{I}_{AB} + a\bar{I}_{BC} + a^{2}\bar{I}_{CA}), \qquad (130\text{-}29)$$

$$\bar{I}_{AB2} = (1/3)(\bar{I}_{AB} + a^{2}\bar{I}_{BC} + a\bar{I}_{CA}), \qquad (130\text{-}30)$$

Where:

$$a = 1\underline{/120°}, \qquad a^{2} = 1\underline{/240°}$$

Finally, to determine $\bar{I}_{AB}$, $\bar{I}_{BC}$, and $\bar{I}_{CA}$, the information supplied by the systems must be used. This information must consist of at least one of the following sets:

Set 1:

- Power (P) in kW of each phase load with pf = cos(Θ).

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- Terminal load voltage (V) of each phase.

Then,

$$\bar{I}_{AB} = [P_{AB}/V_{AB}\cos(\Theta_{AB})] \underline{/0° - \Theta_{AB}}, \qquad (130\text{-}31)$$

$$\bar{I}_{BC} = [P_{BC}/V_{BC}\cos(\Theta_{BC})] \underline{/-120° - \Theta_{BC}}, \qquad (130\text{-}32)$$

$$\bar{I}_{CA} = [P_{CA}/V_{CA}\cos(\Theta_{CA})] \underline{/120° - \Theta_{CA}}, \qquad (130\text{-}33)$$

<u>Set 2</u>:

- *Load impedance (Z_{LO}) of each phase.*
- Load terminal voltage (V) of each phase.

Then,

$$\bar{I}_{AB} = \bar{V}_{AB}/\bar{Z}_{AB}, \qquad (130\text{-}34)$$

$$\bar{I}_{BC} = \bar{V}_{BC}/\bar{Z}_{BC}, \qquad (130\text{-}35)$$

$$\bar{I}_{CA} = \bar{V}_{CA}/\bar{Z}_{CA}, \qquad (130\text{-}36)$$

Once the line currents $\bar{I}$ have been determined, the percent voltage drop for each line can be calculated from equation (100-10) as derived in section 100:

$$D\% = IL\left(\frac{z\cos(\alpha)}{E}\right) * 100, \qquad (100\text{-}10)$$

Where:

L : Cable length.
z : Conductor impedance per phase per foot.
E : Line-to-neutral source voltage.

$$\alpha = -\Theta + \beta, \qquad (90\text{-}2)$$

In the above equation, Θ is the angle by which the line current I lags the terminal load voltage, and it is calculated from equations (100-7), (100-8), or (100-9) as derived in section 100.

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140. DERIVATION OF CABLE RESISTANCES AND REACTANCES

This section contains the derivation of cable resistances and reactances used in tables XI through XVII. These cables reflect conductor diameters of standard American Wire Gage (AWG) in accordance with MIL-C-24643.

140.1 Calculations of cable resistance. the ideal method of obtaining accurate cable resistance and reactance is by test measurements. In the absence of test data,these parameters can also be determined mathematically.

The method used in this handbook is based upon the one specified in the ASTM B 258 and ASTM B 8. This method may be used to calculate with reasonable accuracy the resistances of any cables of concentric-lay-stranded conductors. The overall approach is as follows:

- Calculate dc resistance at 20° Celsius for solid conductor using ASTM B 258.
- Adjust for concentric-lay-stranded conductors using ASTM B 8.
- Adjust for temperature for which cable service will be designed.
- Adjust for ac resistance by multiplying the dc resistance by the (ac/dc) resistance conversion ratio at any desired frequencies (60/400 Hz).

From the ASTM B 258, dc resistance at 20°C of conductor in ohm per 1000 feet is given by:

$$R_{dc} = 105.35\left(\frac{\rho_o}{\delta d^2}\right) \qquad (140\text{-}1)$$

Where:

ρ_o = resistivity of conductor (copper) at 20°C

= 875.20 Ω lb/mile^2

δ = conductor (copper) density at 20°C

= 8.89g/cm^3

d = conductor diameter in mil.

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Equation (140-1) becomes:

$$R_{dc} = 10371.46\left(\frac{1}{d^2}\right)\ \Omega/1000\text{ft}, \qquad (140\text{-}2)$$

From equation (140-2), R_{dc} resistances for type SG equivalent solid conductors are computed and shown in table XVIII below.

TABLE XVIII. Dc Conductor Resistances at 20°C.

Designation	Conductor Diameter (mil)	R_{dc} ($\Omega/10^3$ft)
SG-3	50.79	4.021
SG-4	64.11	2.523
SG-9	101.88	0.999
SG-14	114.41	0.792
SG-23	144.29	0.498
SG-50	229.39	0.197
SG-75	289.29	0.124
SG-100	324.96	0.098
SG-150	409.63	0.062
SG-200	460.00	0.049
SG-300	547.72	0.035
SG-400	643.12	0.025

The data for these solid conductors must be adjusted for concentric-lay-stranded SG conductors. Due to the lay stranded conductors, the resistance per unit length of a stranded conductor will be slightly greater than that for an equivalent diameter solid conductor. ASTM B 8 provides a mathematical method for deriving the multiplying factor that is used to modify dc resistance of a solid conductor for an equivalent concentric-lay-stranded conductor. A lay factor (m_{ind}) is determined for each wire in a concentric-lay-stranded conductor from:

$$m_{ind} = \sqrt{1 + (9.8696/n^2)}, \qquad (140\text{-}3)$$

Where:

n = length of lay/diameter of wire helical path.

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The lay factor (m) for the complete stranded conductor is the numerical average of the lay factors (m_{ind}) of the individual wires in the conductor. Finally, the increment factor K is calculated from:

$$K = (m-1) * 100, \qquad (140-4)$$

K is the percentage increase in resistance of a solid conductor for an equivalent concentric-lay-stranded conductor. In lieu of performing many calculations based upon detailed conductor geometry, which would be required by the above method, an increment factor of 2 percent will be used in accordance with table 3 of ASTM B 8. Therefore, the concentric-lay-stranding of a solid conductor results in a nominal increase in electrical resistance of 2 percent. The previous tables for dc resistance of solid conductors can be used to generate a table for concentric-lay-stranded conductors by applying this increment factor.

TABLE XIX. Dc Stranded Conductor Resistances at 20°C

Designation	Number of Strands	R_{dc} ($\Omega/10^3$ ft)
SG-3	7	4.101
SG-4	7	2.573
SG-9	7	1.019
SG-14	7	0.808
SG-23	7	0.508
SG-50	19	0.201
SG-75	37	0.126
SG-100	61	0.100
SG-150	61	0.063
SG-200	61	0.050
SG-300	91	0.036
SG-400	127	0.026

Next, R_{dc} must be adjusted to the designed temperature of cable service. Resistance (R_t) at a selected temperature (t) can be calculated from the following equation:

$$R_t = R_{to}[1 + 0.00393(t - 20)], \qquad (140-5)$$

Where:

R_{to} = wire resistance at 20°C.

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t = temperature at which resistance is required.

(0.00393) = temperature coefficient of resistance at 20°C.

At t = 65°C:

$$\frac{R_t}{R_{to}} = [1 + 0.00393(65 - 20)] = 1.177$$

Therefore, resistances in the preceding table must be multiplied by the above ratio to yield the dc resistances at 65°C. The following results are obtained:

TABLE XX. **Dc stranded conductor resistances at 65°C**

Designation	R_{dc} ($\Omega/10^3$ft)
SG-3	4.827
SG-4	3.028
SG-9	1.199
SG-14	0.951
SG-23	0.598
SG-50	0.237
SG-75	0.148
SG-100	0.118
SG-150	0.074
SG-200	0.059
SG-300	0.042
SG-400	0.031

Similarly, the (R_t/R_{to}) ratio at 45°C is as follows:

$$\frac{R_t}{R_{to}} = [1 + 0.00393(45 - 20)] = 1.098$$

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The dc stranded-conductor resistances at 45°C for various cables are tabulated below:

TABLE XXI. Dc stranded conductor resistances at 45°C

Designation	R_{dc} ($\Omega/10^3$ft)
SG-3	4.503
SG-4	2.825
SG-9	1.119
SG-14	0.887
SG-23	0.558
SG-50	0.221
SG-75	0.138
SG-100	0.110
SG-150	0.069
SG-200	0.055
SG-300	0.040
SG-400	0.029

The dc resistances must be converted to ac resistances. The converting factor known as the skin effect ratio (SER) is determined as follows:

Determine the factor F:

$$F = 0.0635598\sqrt{(f\mu/R)}, \qquad (140\text{-}6)$$

Where,

f = System frequency.
μ = Wire permeability.
R = Dc resistance in Ω/mile.

Equation (140-6) can be rewritten as:

$$F = 0.027677\sqrt{f/R}, \qquad (140\text{-}7)$$

Where the wire permeability u is assumed equal to 1.0000 and the dc resistance R is in ohm per 1000 feet. Then, from the table below, the skin effect ratios are determined.

TABLE XXII. Skin effect ratio

F	SER	F	SER	F	SER
0.0	1.00000	1.3	1.01470	2.6	1.20056
0.1	1.00000	1.4	1.01969	2.7	1.22753
0.2	1.00000	1.5	1.02582	2.8	1.25620
0.3	1.00004	1.6	1.03323	2.9	1.28644
0.4	1.00013	1.7	1.04205	3.0	1.31809
0.5	1.00032	1.8	1.05240	3.1	1.35102
0.6	1.00067	1.9	1.06440	3.2	1.38504
0.7	1.00124	2.0	1.07816	3.3	1.41999
0.8	1.00212	2.1	1.09375	3.4	1.45570
0.9	1.00340	2.2	1.11126	3.5	1.49202
1.0	1.00519	2.3	1.13069	3.6	1.52879
1.1	1.00758	2.4	1.15207	3.7	1.56587
1.2	1.01071	2.5	1.17538	3.8	1.60314

With R_{dc} given in the previous tables, the ac resistance at 60 Hz and 400 Hz can be determined using the ac to dc resistance ratios in the following table:

TABLE XXIII. Dc to ac resistance conversion ratios

Designation	Ac/dc Ratio at 60 Hz	Ac/dc Ratio at 400 Hz
SG-3	1.000	1.000
SG-4	1.000	1.000
SG-9	1.000	1.000
SG-14	1.000	1.000
SG-23	1.000	1.000
SG-50	1.000	1.000
SG-75	1.000	1.033
SG-100	1.000	1.052
SG-150	1.000	1.111
SG-200	1.000	1.175
SG-300	1.007	1.286
SG-400	1.015	1.456

Therefore, ac resistance of conductors at 60/400 Hz and at any temperatures can be calculated by multiplying the appropriate (ac/dc) resistance conversion factors by the R_{dc} of concentric-lay-stranded conductors in the previous tables.

TABLES XXIV. Ac resistance for SG conductors at 65°C

Designation	R_{ac} at 60 Hz ($\Omega/10^3$ft)	R_{ac} at 400 Hz ($\Omega/10^3$ft)
SG-3	4.827	4.827
SG-4	3.028	3.028
SG-9	1.199	1.199
SG-14	0.951	0.951
SG-23	0.598	0.598
SG-50	0.237	0.237
SG-75	0.148	0.153
SG-100	0.118	0.124
SG-150	0.074	0.082
SG-200	0.059	0.069
SG-300	0.042	0.054
SG-400	0.031	0.045

TABLES XXV. Ac resistance for SG conductors at 45°C

Designation	R_{ac} at 60 Hz ($\Omega/10^3$ft)	R_{ac} at 400 Hz ($\Omega/10^3$ft)
SG-3	4.503	4.503
SG-4	2.825	2.825
SG-9	1.199	1.199
SG-14	0.887	0.887
SG-23	0.558	0.558
SG-50	0.221	0.221
SG-75	0.138	0.143
SG-100	0.110	0.116
SG-150	0.069	0.077
SG-200	0.055	0.065
SG-300	0.040	0.051
SG-400	0.029	0.042

These resistance values are used in tables XI through XIV, and XVI through XVII. For type 6SG cables in table XV, two conductors are in parallel for each phase. Therefore, the resistance per phase is half of the ac resistance (400 Hz) calculated earlier at the required designed temperature of 65°C. The resulting resistances are shown in table XXVI.

TABLE XXVI. Ac resistance for 6SG conductors at 65°C

Designation	R_{ac} at 400 Hz ($\Omega/10^3$ft)
6SG-100	0.062
6SG-125	0.049
6SG-150	0.041
6SG-200	0.035

140.2 Calculations of cable reactances. The determination of cable reactances is relatively complicated since the reactances are not only dependent upon the geometry of conductors in the cable, but also on the external environment of the cable, e.g., conducting armor material and closeness to surrounding steel. Below are the step-by-step calculations for cable reactances per phase. These calculations give a reasonable estimate of the total cable reactances. The actual reactances will differ slightly when all magnetic effect are considered, and only for larger cables at high frequencies.

Step 1.

Determine the conductor geometric mean radius (GMR) as follows:

$$GMR = 0.779(d/2), \qquad (140\text{-}8)$$

Where d is the conductor diameter.

Step 2.

Determine the conductor geometric mean distance (GMD) as follows:

$$GDM = \sqrt[3]{D_{AB}D_{BC}D_{CA}} \qquad (140\text{-}9)$$

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Where,

D_{AB} : Distance between centers of conductors A and B.

D_{BC} : Distance between centers of conductors B and C.

D_{CA} : Distance between centers of conductors C and A.

Step 3.

Determine the reactance per phase as follows:

$$X = 0.05292(f/60)\log_{10}(GMD/GMR)\ \Omega/1000ft, \qquad (140\text{-}10)$$

Where f is the frequency at which the reactance is calculated.

From equation (140-10) with conductor characteristics listed in MIL-C-24643 the following tables for reactances can be generated.

TABLE XXVII. Reactances for SG conductors

Designation	GMR	GMD	X at 60 Hz ($\Omega/10^3$ft)	X at 400 Hz ($\Omega/10^3$ft)
SG-3	0.0198	0.1300	0.0432	0.2883
SG-4	0.0250	0.1430	0.0401	0.2672
SG-9	0.0397	0.1870	0.0356	0.2374
SG-14	0.0446	0.2620	0.0407	0.2713
SG-23	0.0562	0.3100	0.0392	0.2616
SG-50	0.0893	0.3340	0.0303	0.2021
SG-75	0.1127	0.4070	0.0295	0.1967
SG-100	0.1266	0.4530	0.0293	0.1953
SG-150	0.1596	0.5570	0.0287	0.1915
SG-200	0.1792	0.6340	0.0290	0.1936
SG-300	0.2133	0.7480	0.0288	0.1922
SG-400	0.2463	0.8620	0.0288	0.1919

Again, the reactances for 6SG conductors are equal to half of the SG conductor reactances as shown in Table XXVIII.

TABLE XXVIII. Reactances for 6SG conductors at 65°C

Designation	X at 400 Hz ($\Omega/10^3$ft)
6SG-100	0.0977
6SG-125	0.0974
6SG-150	0.0958
6SG-200	0.0968