

**METRIC**  
DOD-STD-2133(SH)  
NOTICE 1  
22 August 1988

**MILITARY STANDARD**

**CABLE ARRANGEMENT FOR MINIMUM  
STRAY MAGNETIC FIELD (METRIC)**

TO ALL HOLDERS OF DOD-STD-2133(SH):

1. THE FOLLOWING PAGES OF DOD-STD-2133(SH) HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

<u>NEW PAGE</u>	<u>DATE</u>	<u>SUPERSEDED PAGE</u>	<u>DATE</u>
1	22 August 1988	1	3 August 1981
2	3 August 1981	REPRINTED WITHOUT CHANGE	
3	3 August 1981	REPRINTED WITHOUT CHANGE	
4	22 August 1988	4	3 August 1981

2. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

3. Holders of DOD-STD-2133(SH) will verify that page changes and additions indicated above have been entered. This notice page will be retained as a check sheet. This issuance, together with appendix pages, is a separate publication. Each notice is to be retained by stocking points until the Military standard is completely revised or cancelled.

Preparing activity:  
Navy - SH  
(Project 6145-N333)

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## 1. SCOPE

1.1 Scope. This standard covers the arrangement of power cables in a manner that will reduce to a minimum the stray magnetic field produced by the current in these cables.

1.2 Application. Requirements specified herein are applicable to shipboard installation of direct current (d.c.) and alternating current (a.c.) power cables aboard minesweepers and other special installations where stray magnetic fields must be reduced to a minimum.

## 2. REFERENCED DOCUMENTS

2.1 Issues of documents. The following other Government publication forms a part of this standard to the extent specified herein.

### PUBLICATION

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

S9300-AW-EDG-010/EPISM - Electric Plant Installation Standard  
Methods.

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

## 3. DEFINITIONS

3.1 Crossways cable run terminal approach. A cable run approaches its connecting terminals in a crossways direction when it approaches at a vertical angle of 90 degrees from the plane common to all terminals (see figure 1).

3.2 Current loop. A current loop is a closed electric conductor. It may have one or more turns of any size or shape conductor and may be arranged in any way. A simple current loop is a closed conductor making one turn in a single plane, or alternatively, making a number of turns which are in the same plane or in parallel planes and so close together that, to a first approximation, they can be considered to be physically coincident in space. More complicated current loops can be resolved into a combination of simple current loops.

3.3 Edgewise terminals. Edgewise terminals are oriented such that their widths lie in parallel vertical planes (see figure 1).

3.4 Endways cable run terminal approach. A cable run approaches its connecting terminals in an endways direction when it approaches the forward edges of the terminals at an angle of zero degrees (see figure 1).

3.5 Flat terminals. Flat terminals are oriented such that their widths lie in the same horizontal plane (see figure 1).

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3.6 Flux density. Flux density is that magnetic flux per unit area normal to the direction of flux. It is also known as magnetic induction. The usual symbol for flux density is  $b$ . The unit of flux density is telsa (T). One tesla equals one weber per square meter ( $\text{Wb}/\text{m}^2$ ).

3.7 Magnetic minesweep cable. The magnetic minesweep cable is the interconnecting cable between the magnetic minesweep generator(s) and the minesweep cable terminal box.

3.8 Magnetic minesweep terminal box. The magnetic minesweep terminal box is the device which enables the magnetic minesweep cable to be connected to the sweep tail cable.

3.9 Sideways cable run terminal approach. A cable run approaches its connecting terminals in a sideways direction when it approaches the forward edges of the terminals at a horizontal angle of 90 degrees (see figure 1).

3.10 Stray magnetic field. A stray magnetic field is a magnetic field produced by an electric circuit or equipment which is undesirable and external to the electric circuit or equipment causing it.

3.11 Sweep tail cable. The sweep tail cable is the cable aft of the magnetic minesweep terminal box. When this cable is not in use, it is stored on the magnetic minesweep cable reel.

#### 4. GENERAL REQUIREMENTS

##### 4.1 Direct current (d.c.) power cables.

4.1.1 Four-conductor, quadded cables. Four-conductor, quadded cables shall be utilized for d.c. power cables, whenever practicable.

4.1.2 Utilization of double-conductor cables. Where four-conductor, quadded cable is unavailable or not practicable, one double-conductor cable may be utilized in a d.c. cable run if it is twisted such that the cable's conductors are transposed at regular intervals by the twist of the conductors to form the lay of the cable or the conductors are concentric and the size of the cable is small enough to handle conveniently for the selected application. Two or more double-conductor cables connected in parallel shall not be utilized in d.c. cable runs since unequal division of current between conductors connected in parallel can give rise to a magnetic field of objectionable magnitude.

4.1.3 Utilization of single-conductor cables. An even multiple of parallel, single-conductor cables in the positive and negative branches of a d.c. cable run shall be utilized. The cables shall be arranged in accordance with section 5. Cable runs consisting of only one or an odd multiple of single-conductor cables in the positive and negative branches of a d.c. circuit shall not be utilized since an odd number of current loops makes magnetic field compensation by arrangement impracticable and results in large magnetic fields (see figure 2).

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#### 4.2 Alternating current (a.c.) power cables.

4.2.1 Phase conductors in a common cable. Special cable arrangement is not necessary when all phase conductors of an a.c. circuit are in the same cable.

4.2.2 Phase conductors in separate cables. Where it is necessary to install a.c. phase conductors in separate cables, these cables shall not be grouped on the same cable hangers with cables carrying d.c. and shall be as close together as practicable throughout the entire length of the cable run. Closed loops of magnetic material around a phase conductor cable and the placement of any magnetic material between the phase conductor cables shall be avoided.

### 5. DETAILED REQUIREMENTS

#### 5.1 Cable arrangements.

5.1.1 Arrangement of cables for opposing current loops. Parallel, single-conductor cables in the positive and negative branches of a d.c. cable run shall be arranged in a manner that will result in opposing (nonadditive) current loops, so that their magnetic fields are opposed and self-compensating. Figure 2 illustrates typical cable arrangements which are preferred and nonpreferred and their relative resulting magnetic flux density values.

5.1.2 Equal current division among cables connected in parallel. Parallel, single-conductor cables in the positive and negative branches of a d.c. cable run shall be selected and installed in a manner to ensure that the resistance of each branch circuit in parallel is as nearly equal as possible so that circuit current divides equally among all of the conductors connected in parallel. Figure 3 illustrates the effects of unequal current division in cables connected in parallel.

5.1.3 Spiraling the cable run to minimize the effects of unequal current division. A d.c. circuit cable run array consisting of multiple, single-conductor cables shall be spiraled (twisted) on itself from one cable hanger to the next so that any magnetic field created by an unequal current division in parallel conductors of the circuit is compensated for. Cable runs less than 1.5 meters long need not be spiraled; spiraling will aid in minimizing the separation between adjacent conductors of the cable. Figure 4 illustrates a typical spiraling arrangement for a d.c. circuit cable array composed of four cables in a quad array and eight cables in a circular array.

5.1.4 Cable spacing. Multiple, single-conductor d.c. cables in a cable run shall be spaced equally to each other along their entire run so that the opposing current loops created by the cable arrangements will result in a net magnetic moment as close to zero as possible. Cables in a quad arrangement shall be pressed tightly together all along the cable run with their centers at the corners of a square. Figure 5 illustrates the

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typical effects of excessive cable separation in a quad arrangement. Equal spacing of the cables in a circular array arranged about a central core shall be accomplished by utilizing cables of the same diameter, selecting a central core of the proper diameter, and by tightly clamping the cables against the core.

## 5.2 Magnetic minesweep cable arrangements.

5.2.1 Four-cable arrangements. Magnetic minesweeping cable arrangements consisting of two parallel, single-conductor cables in both the positive and negative branches of the cable run, for a total of four cables, shall be arranged to form a quad array. The cable centers of the quad shall form a square with alternate positive and negative polarity (see figure 2A). The arrangement and installation of the cables shall be in accordance with 5.1 with the additional requirement that the spiraling of the quad shall be a right hand lay of 360 degrees every 1.0 to 3.0 meters (see figure 4A). With the exception of terminal connections and hull penetrations, the separation, if any, of the outer sheath of adjacent conductors of the quad should be less than 12.5 mm.

5.2.1.1 Bulkhead penetrations. Where space permits, a single community type stuffing tube shall be used for the cables of a quad when penetrating a watertight bulkhead. Details of the arrangement shall be in accordance with the standard method for community stuffing tubes penetrating watertight wood bulkheads on minesweepers as shown on NAVSEA S9300-AW-EDG-010/EPISM. Where the cables of the quad penetrate a bulkhead through individual stuffing tubes, the separation of the outer sheath of adjacent cables shall not exceed 75 mm at the bulkhead and 12.5 mm at a distance of 450 mm from the bulkhead. The cables shall be tightly bound together just prior to entering and after leaving the stuffing tubes.

5.2.2 Eight-cable arrangements. Magnetic minesweeping cable arrangements consisting of four parallel, single-conductor cables in both the positive and negative branches of the cable run, for a total of eight cables, shall be arranged around a central core as shown on figure 6. The arrangement, installation and spiraling of the cables shall be in accordance with 5.1.

5.2.3 Cable arrangements with other than four or eight cables. When the magnetic minesweep cable installation design is such that an even multiple of parallel, single-conductor cables other than two (four total) or four (eight total) is required in both the positive and negative branches of the cable run, the cables shall be arranged about a central core with the cable alternating positive and negative. For convenient connection to three-terminal equipment, the preferred total number of cables is an integral multiple of four.

5.2.4 Sweep tail cable. In order to prevent the formation of excessive current loops, when connecting the sweep tail cable to the magnetic minesweep terminal box, the sweep tail conductors shall have a separation of not more than 12.5 mm at a distance of 300 mm from the terminal connection. After the cable is connected to the terminal box, the conductors shall be tightly bound in order to prevent further separation between conductors of the cable during the sweep operation.

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