S9086-QN-STM-010/CH-475

FIRST REVISION

NAVAL SHIPS' TECHNICAL MANUAL

S9086-QN-STM-010
CHAPTER 475
MAGNETIC SILENCING

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CHAPTER 475
MAGNETIC SILENCING

SECTION 1. GENERAL

475-1.1 SCOPE

Magnetic silencing is the science of reducing the magnetic/electric signature of a ship or submarine. Reduction of the static magnetic signature is accomplished by: degaussing, constructing ships of nonmagnetic materials, and controlling eddy current fields and controlling stray fields caused by various items of the ship's equipment. This chapter covers degaussing and magnetic treatment. Control of eddy current fields and stray fields are covered by fleet instructions issued to nonmagnetic minesweepers. This chapter is divided into eight sections. Section 1 provides general introductory information and safety. Section 2 covers shipboard degaussing principles and includes the fundamental magnetization relations. Section 3 covers all aspects of degaussing coils, including function, numbering and required current. Section 4 covers current degaussing control equipment, and section 5 follows immediately with maintenance of degaussing control equipment. Section 6 is a discussion of magnetic ranges and ranging, and section 7 discusses magnetic treatment and the requirements for its implementation. The final entry, section 8, discusses compass compensation techniques of newly installed or repaired compasses, as well as maintenance and operation data.

475-1.2 SAFETY PRECAUTIONS

475-1.2.1 SAFETY, DETAILED PROCEDURES AND PRECAUTIONS. Safety precautions must be observed when working around electrical equipment to avoid injury to personnel and equipment. NSTM Chapter 300, **Electric Plant General**, provides detailed procedures and precautions. Also refer to OPNAVINST 5100.19, **Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat.**

475-1.2.2 FIRE HAZARD DURING DEPERMING. A magnetic treatment operation presents a considerable fire hazard to any ship being treated since the deperming cables carry currents greatly in excess of their continuous rating, and the handling and immersion of the cables in seawater makes it difficult to maintain adequate insulation of the cables over an extended period. Extreme care in every detail must be exercised by all persons engaged in the operation. If the ship is carrying or has recently carried combustible liquid of any kind, or is loaded with explosives, the hazards are greatly increased and, under certain circumstances described in 475-7.4.13, magnetic treatment must not be carried out.

475-1.2.2.1 Precautions for the Prevention of Fire. The specific precautions given in the remainder of this section should be observed by all ships and facility personnel.

475-1.2.2.2 Fire Watch. During magnetic treatment, a fire watch should be placed so that all connections can be kept in view during each shot and so that the entire solenoid (coils of wire around the ship) above water can be viewed at least once per shot. Make sure that the members of this watch are able to communicate rapidly with the deperming control room.

475-1.2.2.3 Cable and Solenoid Testing. The cables used in the magnetic treatment solenoid must be tested electrically at frequent intervals (in the case of hazardous ships, just before rigging) - see paragraphs 475-7.4.11 through 475-7.4.13 to identify flaws in the insulation. Defective cable should be rejected and not used until it is repaired and satisfactorily passes the electrical test. After rigging, the resistance to ground of the entire solenoid should be measured. Faults shall be rectified before any shot is applied.

475-1.2.2.4 Type of Connections. Burndy Hypress or other similar types of connections should be used, rather than lugs that are held to the cables only by solder.

475-1.2.2.5 Care in Rigging. Use care in rigging to prevent damage to the cable insulation and the lugs or connectors. Rollers should be used where it is necessary to pull the cables over the edges of hull plating, piers, gunwales of work boats or other sharp edges. Chafing gear should be provided wherever the rigged cable rests across sharp edges above water such as the edge of hull plating and hatch combings. Particular care should be exercised in pulling cables over bilge keels.

475-1.2.2.6 Protection and Location of Connections. Connections between lengths of cable should be housed in insulating boots extending at least 0.1 meter beyond live parts on each side. The connection should be placed on an insulating surface. There should be no appreciable axial tension between the cables through the connections. Connections should be placed so that each one can be kept in view by the Fire Watch.

475-1.2.2.7 Electrical Loading of Cables. To prevent deterioration of the cable insulation with its consequent fire hazard and to reduce the direct fire hazard from overheated cables, the maximum currents and current durations (shot) shall not be exceeded. To prevent the possibility of insulation puncture by voltage surges, the current should not be switched off from full value with a circuit breaker. The current should be switched off by adequate rectifier control circuits.

475-1.2.2.8 Additional Special Precautions. It is desirable to use an electrical device to sound an alarm or trip the circuit breaker if the resistance of the solenoid to ground falls below a predetermined value at any time during the magnetic treatment. A signal system such as a buzzer or bell that sounds only when a magnetic treatment shot is on shall be used during the treatment operation.

475-1.2.3 HEALTH THREAT. Unnecessary exposure to high magnetic fields should be avoided. The dc magnetic field generated during the deperming process is well within the normally considered safe limit for personnel.

SECTION 2. DEGAUSSING PRINCIPLES

475-2.1 MAGNETIC FIELD OF EARTH

The earth's magnetic field primarily induces magnetization in ships. Like any magnetic field, the earth's can be broken down into lines of force and units of field strength that can be resolved into components.

475-2.1.1 LINES OF FORCE. The magnetic field of earth can be represented by lines of force as indicated in figure 475-2-1. By convention, the external direction of the magnetic field of a bar magnet is from its north pole to its south pole. Lines of force for the earth's field, however, leave the earth in the Antarctic regions and reenter in the Arctic regions. For this reason, it is necessary to think of the polar region in the Arctic as the geographic-north, magnetic-south pole of a magnet. The direction of the field at any point is tangent to the line of force through the point. The field is strong where the lines of force are close together and weak where they are far apart.

475-2.1.2 MAGNETIC UNITS. Units of magnetism are concerned with the magnetizing force (H), with magnetic flux (ϕ), and with flux density (B).

a. Magnetizing force (H) - The magnetic intensity at a point in a magnetic field. A magnetizing force may be produced by the alignment of magnetic domains in a magnetic substance (magnet) or by an electrical current in a conductor of a coil.

b. Magnetic flux (ϕ) - Magnetic flux is the number of lines of magnetic force set up in a magnetic substance.

c. Magnetic flux density (B) - Flux density is the flux per unit area normal to the direction of flux.

The magnetizing force and the magnetic flux density are related in free space, or approximately in air as:

$$B = \mu_o H$$

,

where μ_o is the permeability of free space. For purpose of this publication, free space can be considered vacuum, air, seawater, or freshwater.

In any material, the magnetizing force and the magnetic flux density are related as:

$$B = \mu_r \mu_o H = \mu H$$

,

where μ_r is the relative permeability of the material or μ/μ_o, and μ is the absolute permeability of the material, which may change with flux density. (In free space, $\mu = \mu_o$ and $\mu_r = 1$.) Mu (μ) of a magnetic material may be 2,000 times higher than μ_o, so higher flux densities may be obtained in a magnetic material than in free space or air for the same magnetizing force.

The units of magnetic phenomena have been standardized to those that originate with mks (meter-kilogram-second) derived units instead of the units originating from the previously derived cgs (centimeter-gram-second) units. Table 475-2-1 lists the older cgs units and the newer, preferred, mks units, with some benchmark magnetic fields and relations.

The preferred unit for magnetic fields is the tesla (traditionally called the gauss). The gauss is so firmly embedded in degaussing terminology, however, that it is not uncommon to speak of magnetic fields as being measured in gauss. One tesla is equal to 10,000 gauss.

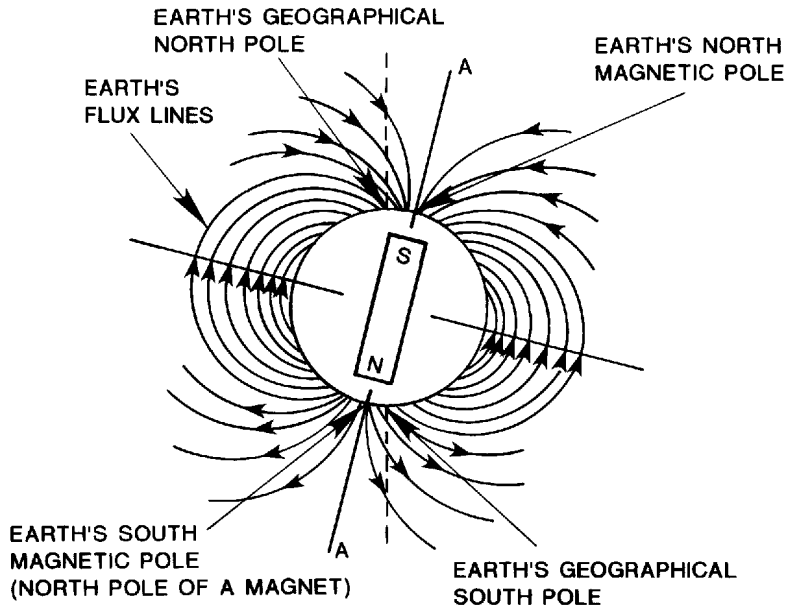


Figure 475-2-1. Earth's Magnetic Field.

TABLE 475-2-1. MAGNETIC UNITS

	Magnetic field intensity	**Magnetic flux**	**Flux density**	**Relations**
Symbol	H	ϕ	B	
CGS unit non-preferred	Oersted or ampere-turn/meter	Maxwell or line of force	Gauss or maxwell/cm^2	$B = \mu H$ $\varphi = BA\ (m^2)$
SI (MKS) unit preferred	Ampere/ meter	Weber	Tesla or weber/m^2	$\mu_o = 4\pi \times 10^{-7}$ $\mu = \mu_r \mu_o$
Earth's magnetic field	40 ampere/ meter or 0.5 oersted	********** ********** ********** **********	50 microtesla or 0.5 gauss	In free space: $B = \mu_o H$ ($\mu_r = 1$)
Deperming magnetic field (In air)	1600 ampere/ meter or 20 oersted	********** ********** ********** **********	2 millitesla or 20 gauss	In a material: $B = \mu_r \mu_o H$ (incremental)

475-2.1.3 RESOLUTION INTO COMPONENTS. At any point on the surface of the earth, the magnetic field can be resolved into a horizontal and a vertical component (see figure 475-2-2).

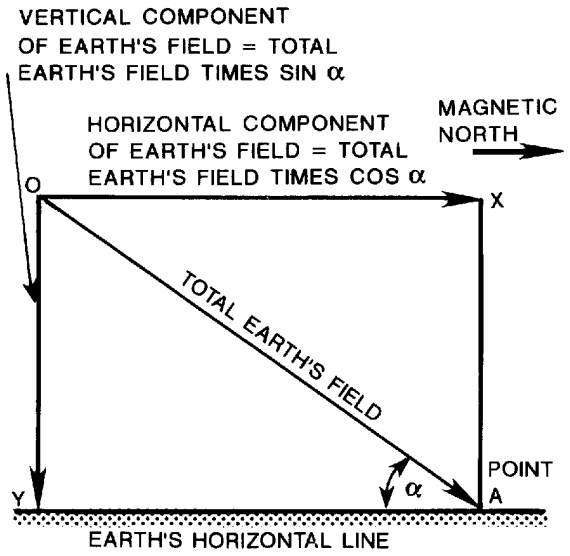


Figure 475-2-2. Horizontal and Vertical Components of the Earth's Magnetic Field.

475-2.1.3.1 Horizontal Component - Earth's Field. The horizontal component of the earth's magnetic field:

a. Is always directed from the earth's south magnetic pole to the earth's north magnetic pole. (See figure 475-2-1.)

b. Is zero at the magnetic poles.

c. Is a maximum at the magnetic equator.

d. Is always positive.

e. Is referred to as the H (for horizontal) field (not to be confused with magnetic field intensity, H).

475-2.1.3.2 Vertical Component - Earth's Field. The vertical component of the earth's magnetic field:

a. Is directed radially outward (upward), south of the magnetic equator.

b. Is directed radially inward (downward), north of the magnetic equator.

c. Is zero at the magnetic equator.

d. Is a maximum at the magnetic poles.

e. Is positive in the northern hemisphere and negative in the southern hemisphere.

f. Is referred to as the Z-field.

475-2.2 MINE SENSING OF A SHIP'S MAGNETIC FIELD

A ship is a magnet because it has magnetic material (steel) in its hull, machinery, and cargo. Like any other magnet, the ship is surrounded by a magnetic field that is strong near the ship but decreases greatly with distance from the ship. It is this magnetic field that actuates magnetic influence devices that can be used to detect the presence of the ship. The magnetic influence devices may form part of a magnetic detector whose function is merely to detect the presence of a ship, or they may form part of the firing mechanism of a magnetic mine and cause it to explode when a ship is near. Physical contact is not necessary to actuate magnetic influence devices.

475-2.3 REASONS FOR DEGAUSSING

Degaussing is done to counteract the ship's magnetic field so that it seems, as nearly as possible, as if the ship were not there magnetically. If this condition could be perfectly achieved, a magnetic influence device could not detect the presence of the ship. Even though the ship's magnetic field cannot be completely eliminated, degaussing

decreases the danger to ships from magnetic weapons.

475-2.4 DEGAUSSING METHODS

A ship can be degaussed either by magnetic treatment or by providing a shipboard degaussing installation or by both.

475-2.5 MAGNETIC TREATMENT

Ships that require degaussing by magnetic treatment called flash-D are periodically treated at degaussing facilities to provide some measure of protection against magnetic mines and magnetic anomaly detection (MAD). These ships do not have equipment permanently installed and, therefore, nothing concerning degaussing has to be operated and maintained by the ships' forces. Ships that do not have permanently installed degaussing equipment require deperming to reduce and stabilize permanent magnetizations.

475-2.6 MAGNETIC TREATMENT EFFECTIVENESS

Degaussing by magnetic treatment does not protect against magnetic mines as effectively as a shipboard degaussing system and this treatment is used only to a limited extent. Magnetic treatment is further described in section 7.

475-2.7 SHIP'S MAGNETIZATION

A ship's magnetic field is caused in part by the ship's permanent magnetization and in part by the ship's induced magnetization.

475-2.7.1 SHIP'S PERMANENT MAGNETIZATION. Ships are built under the influence of the magnetic field of the earth and as a result become permanently magnetized. A ship's permanent magnetization depends on the magnetic field at the place where the ship was built, the orientation of the ship with respect to the magnetic field of earth, the material the ship was constructed of, and a number of other factors.

475-2.7.1.1 Reduction of Permanent Magnetization by Magnetic Treatment (Deperming). All ships that have a degaussing installation, and some that do not require degaussing installations, are magnetically treated. This treatment is essentially a large-scale version of demagnetizing a mechanical watch. Its purpose is to reduce permanent magnetization and bring all ships of the same class into a standard condition in which the permanent magnetization that remains after treatment is approximately the same for all ships of that class.

475-2.7.1.2 Components of Permanent Magnetization. Components of a ship's permanent magnetization are:

a. Permanent vertical magnetization.

b. Permanent longitudinal magnetization.

c. Permanent athwartship magnetization.

475-2.7.1.3 Permanent Magnetization - Effects of Heading or Latitude. The three above components are constant (except for slow change with time) and are unaffected by changes in heading or magnetic latitude.

475-2.7.2 SHIP'S INDUCED MAGNETIZATION. Magnetization is induced in a body of magnetic material when it is brought into a magnetic field. The induced magnetization depends on the strength of the magnetic field and the orientation of the body of magnetic material

with respect to the inducing field. The induced magnetization is divided into three components: longitudinal, athwartship and vertical.

475-2.7.2.1 Longitudinal Component Effects of Latitude. Longitudinal components are affected by magnetic latitude. For example, consider a ship headed magnetic north: the horizontal component of the magnetic field of earth induces a north pole in the bow and a south pole in the stern (see figure 475-2-3) or induces a longitudinal (fore and aft) component of magnetization. The stronger the horizontal component of the magnetic field, the greater the longitudinal component of magnetization. If the ship starts at the earth's south magnetic pole and heads north, the longitudinal component of the induced magnetization starts at zero at the earth's south magnetic pole, increases to a maximum at the magnetic equator, and decreases to zero at the earth's north magnetic pole. Thus, for a constant heading, the longitudinal component changes when the ship moves to a position where the horizontal component of the magnetic field is different, or as it is commonly expressed, when the ship changes its magnetic latitude.

475-2.7.2.2 Longitudinal Component Effects of Heading. If, at a given magnetic latitude, the ship changes its heading from north to east, the longitudinal component of the induced magnetization changes from a maximum on the north heading to zero on the east heading. When the ship changes its heading from east to south, the longitudinal component increases from zero on the east heading to a maximum on the south heading. On southerly headings, a north pole is induced at the stern and a south pole at the bow, just the reverse of the conditions on northerly headings.

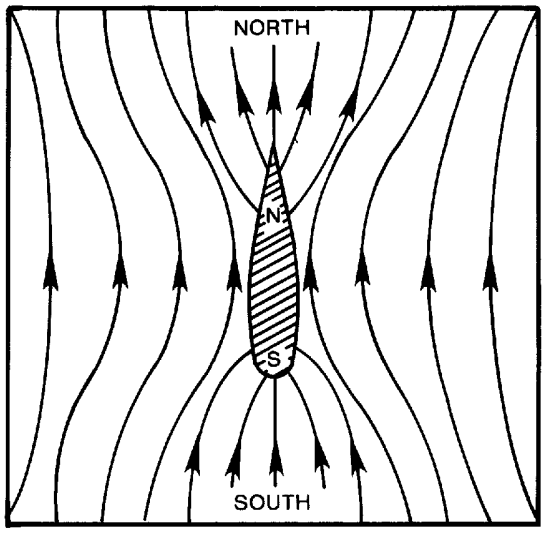


Figure 475-2-3. Longitudinal Magnetization.

475-2.7.2.3 Longitudinal Component Effects of Pitch. The longitudinal component of induced magnetization also changes, to some extent, as the ship pitches.

475-2.7.2.4 Athwartship Component. The earth's field induces an arthwartship component of a north pole on the port side and a south pole on the starboard side when a ship is on an east heading (figure 475-2-4). This is the athwartship component of induced magnetization. Its magnitude depends on the strength of the longitudinal component of the magnetic field of the earth where the magnetic field is at a maximum at the magnetic equator and zero at the magnetic poles.

475-2.7.2.5 Athwartship Component Effects of Heading. The athwartship component also changes when the heading changes. Its strongest magnitude is when the ship is headed magnetic east or

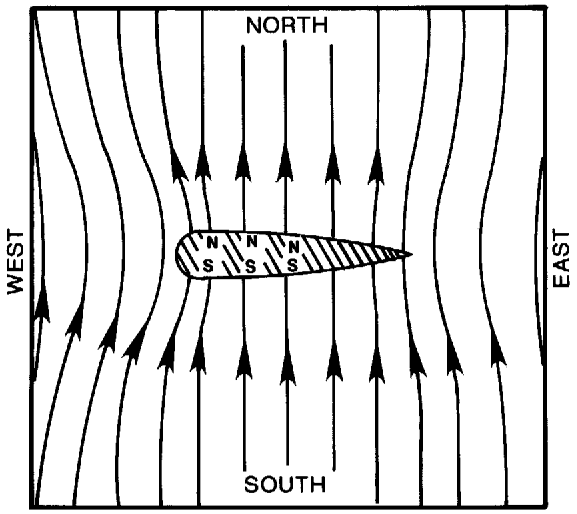


Figure 475-2-4. Athwartship Magnetization.

west, and zero magnitude is present when the ship is headed magnetic north or south.

475-2.7.2.6 Athwartship Component Effects of Roll. The athwartship component of induced magnetization also changes, to some extent, as the ship rolls.

475-2.7.2.7 Vertical Component. Vertical components of the magnetic field of earth are directed down when a ship is north of the magnetic equator. It induces a vertical component of induced magnetization that is also directed down, with the north pole below and south pole above. The magnitude of the vertical induced magnetization depends on the magnetic latitude. The magnitude is maximum at the magnetic poles and zero at the magnetic equator. The vertical induced magnetization is directed down when the ship is north of the magnetic equator and up when the ship is south of the magnetic equator. The vertical induced magnetization thus changes with magnetic latitude.

475-2.7.2.8 Vertical Component Effects of Heading. Unlike longitudinal and athwartship induced magnetization, vertical induced magnetization does not change with heading, since a change of heading does not change the orientation of the ship with respect to the vertical component of the magnetic field of earth.

475-2.7.2.9 Vertical Component Effects of Pitch and Roll. The vertical induced magnetization changes, to some extent, when the ship rolls or pitches.

475-2.7.2.10 Summary of Field Changes. The three components of induced magnetization change as follows:

a. Longitudinal induced magnetization changes when either the magnetic latitude or the heading changes, and when the ship pitches.

b. Athwartship induced magnetization changes when either the magnetic latitude or the heading changes, and when the ship rolls.

c. Vertical induced magnetization changes when the magnetic latitude changes or when the ship rolls or pitches, but not when the heading changes.

475-2.8 SHIPBOARD DEGAUSSING SYSTEM

A shipboard degaussing system consists of the following items:

a. Degaussing coils

b. A means to control coil current and strength of magnetic field caused by coil current

c. The ship's degaussing folder to provide information on current and turn settings

d. A power source to supply dc for the coils

e. Compass compensating equipment to prevent the disturbance of magnetic compasses by the magnetic field of the degaussing coils.

SECTION 3. DEGAUSSING COILS

475-3.1 COIL FUNCTION

Each of the components of the ship's magnetization produces a magnetic field in the vicinity of the ship. The function of the degaussing coils is to produce magnetic fields that are, as nearly as possible, equal and opposite to the magnetic fields produced by the components of the ship's magnetization. The result of the ship's field and the field produced by the degaussing coils is made as close to zero as possible so that detection of the ship's magnetic field by magnetic influence devices is reduced.

475-3.2 MAGNETIC FIELD FROM CURRENT-COIL CONVENTIONS

A straight conductor is surrounded by a magnetic field with lines of force as indicated in figure 475-3-1. When the conductor is wound into the form of a coil, the lines of force will be as indicated in figure 475-3-2. The convention used throughout this chapter is that current direction in a conductor connected to the terminals of a battery is from the positive terminal to the negative terminal and known as positive current. The relation between the direction of the current and the direction of the lines of magnetic force is as shown in figures 475-3-1 and 475-3-2.

475-3.3 M-COIL

The M- or main coil encircles the ship in a horizontal plane that is usually near the water level (see figure 475-3-3).

475-3.3.1 M-COIL PURPOSE. The M-coil produces a magnetic field that counteracts the magnetic field produced by the permanent vertical and the induced vertical magnetization of the ship.

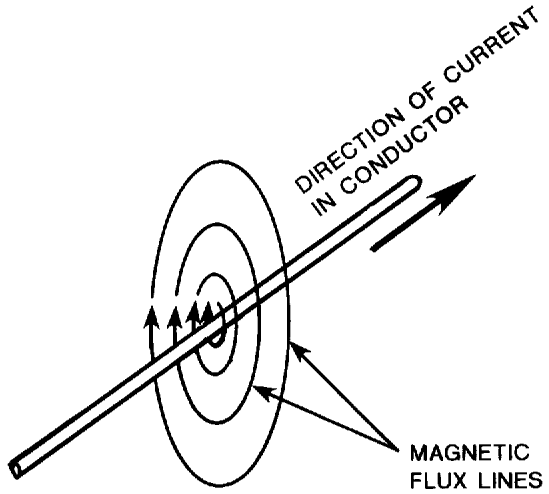


Figure 475-3-1. Magnetic Field Around a Conductor Carrying Current.

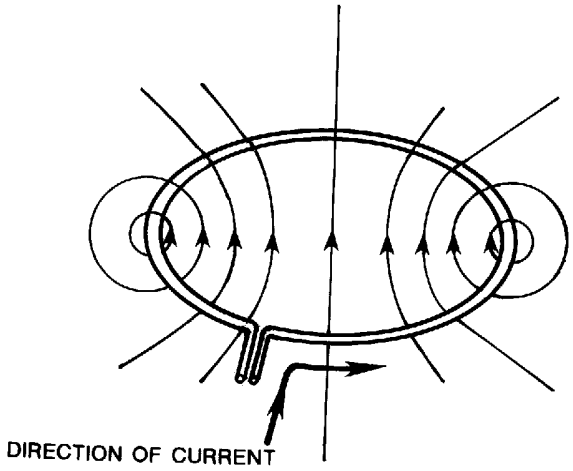


Figure 475-3-2. Magnetic Field of Coil Carrying Current.

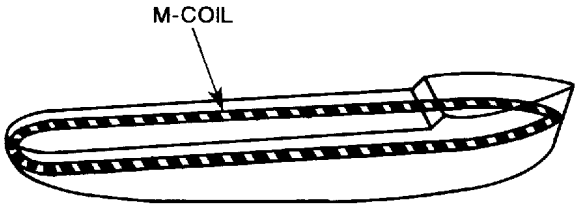


Figure 475-3-3. M- or Main Coil.

475-3.3.2 VERTICAL MAGNETIZATION AND M-COIL FIELD. Figure 475-3-4 illustrates the magnetic field produced by the vertical magnetization of a ship in the northern hemisphere near the magnetic pole. Figure 475-3-5 illustrates the magnetic field produced by the M-coil. This is opposed to the magnetic field produced by the vertical magnetization of the ship. If the M-coil field were everywhere exactly equal and opposite the field produced by vertical magnetization, the result of the two magnetic fIelds would be equal to zero. Although it is not possible to attain such a perfect match, the result is considerably less than the field produced by the vertical magnetization of the ship.

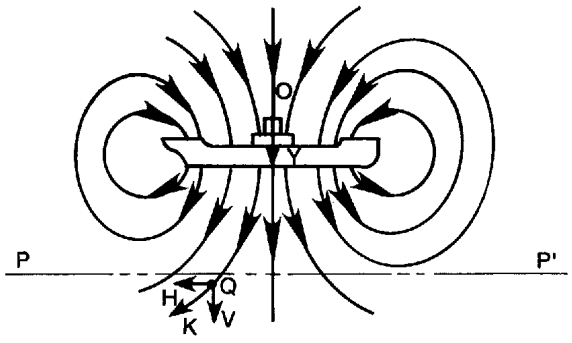


Figure 475-3-4. Magnetic Field due to Vertical Magnetization of Ship.

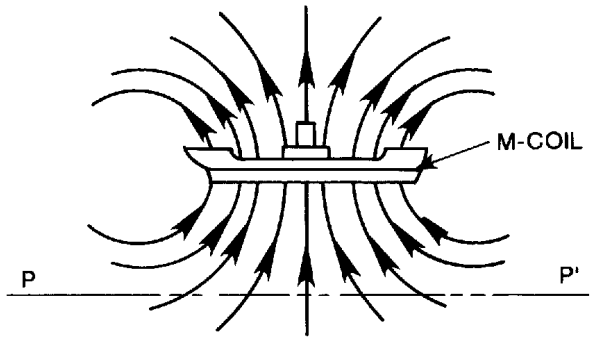


Figure 475-3-5. Magnetic Field due to M-Coil.

475-3.3.2.1 M-Coil Field Variability. The permanent vertical magnetization of a ship is constant whereas the vertical induced magnetization varies with the magnetic latitude and with the roll and pitch of the ship, but not with the heading. The combined result of the permanent and induced vertical magnetization will also vary with the magnetic latitude and with the roll and pitch of the ship. Consequently, the M-coil field strength must be changed when the ship changes magnetic latitude in order to keep the M-coil field as nearly equal as possible and opposite to the field produced by the ship's vertical magnetization.

475-3.3.2.2 M-Coil Field Variability with Pitch and Roll. The change in vertical magnetization caused by the roll and pitch of the ship is relatively small, and only in special cases is it necessary to change the M-coil field strength to compensate for this. The methods used to control degaussing coil field strengths are discussed in paragraphs 475-3.11 and 475-3.11.1.

475-3.4 F- AND Q-COILS

The F- or forecastle coil encircles the forward one-quarter to one-third of the ship and is usually just below the forecastle or other uppermost deck. The Q- or quarterdeck coil encircles the after one-quarter to one-third of the ship and is usually just beneath the quarterdeck or other uppermost deck. These locations are shown in figure 475-3-6.

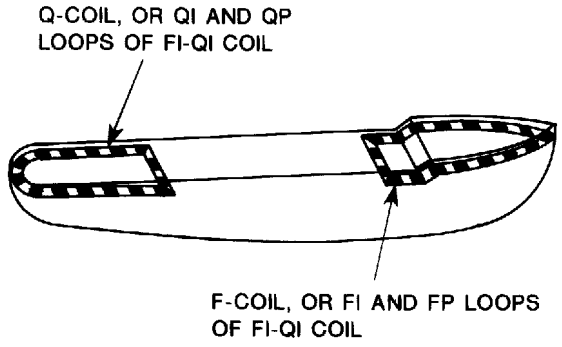


Figure 475-3-6. F- and Q-Coils.

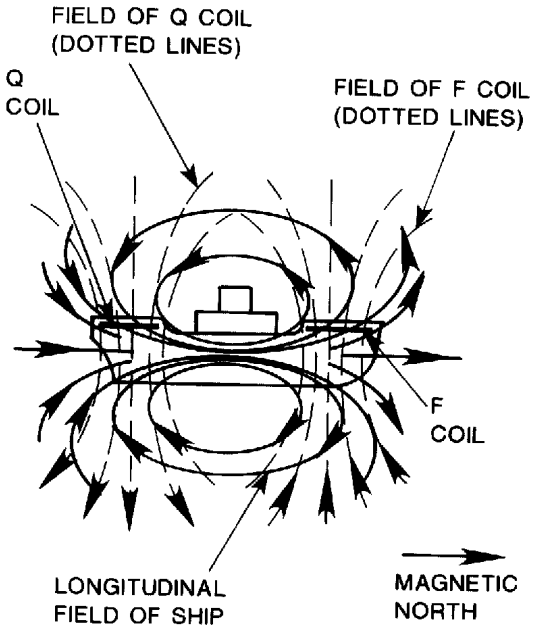


Figure 475-3-7. Longitudinal Field of Ship on North Heading and Neutralizing Fields of F- and Q-Coils.

475-3.4.1 LONGITUDINAL MAGNETIZATION AND THE F-AND Q-COILS.

The F- and Q-coils counteract the lower portion of the magnetic field produced by the ship's permanent and induced longitudinal magnetization. Although the shape of the magnetic field produced by the F- and Q-coils differs from the field produced by the ship's longitudinal magnetization, the two fields are, in general, oppositely directed below the bow and stern of the ship (see figure 475-3-7).

475-3.4.2 F- AND Q-COIL FIELD VARIABILITY.

The ship's permanent longitudinal magnetization is constant, but the induced longitudinal magnetization changes with the heading and magnetic latitude. The F- and Q-coil field strengths must both be changed whenever the ship changes either its heading or its magnetic latitude, otherwise the coil field strengths would lack the right values to counteract the changed induced longitudinal magnetization. Two adjustments must be made, one to change the F-coil field strength and one to change the Q-coil field strength.

475-3.5 FI-QI AND FP-QP COILS

In most installations the conductors of the F and Q coil loops are connected to form two separate circuits, designated FI-QI coil and FP-QP coil. The FI-QI coil consists of FI loops connected in series with QI loops so that the same current is in both. The FP-QP coil is similar. Installations with FI-QI and FP-QP coils are known as split-coil installations because the F- and Q-coil loops are each split into two coils.

475-3.5.1 FI-QI AND FP-QP FIELD VARIABILITY. The coil field strength depends on several factors:

a. The FI-QI coil is used to counteract the magnetic field produced by the ship's longitudinal induced magnetization. Since the longitudinal induced magnetization changes when the ship changes heading or magnetic latitude, the strength of the FI-QI coil must be changed accordingly.

b. The FP-QP coil is used primarily to counteract the magnetic field produced by the ship's longitudinal permanent magnetization. It is sometimes used to provide some compensation for vertical induced magnetization to supplement the M-coil compensation.

c. Since the longitudinal permanent magnetization remains unchanged when the ship changes heading or magnetic latitude, no change in FP-QP coil field strength is needed.

d. When an FP-QP coil is used to supplement the M-coil compensation, its coil field strength must be changed when the ship changes magnetic latitude.

As compared to F- and Q-coils in paragraph 475-3.4.2, FI-QI and FP-QP coils usually require only one adjustment of coil field strength, instead of two, when the ship changes heading or magnetic latitude.

475-3.6 L-COIL

The L- or longitudinal coil resembles a solenoid. It has loops in vertical planes parallel to the frames of the ship (see figure 475-3-8).

475-3.6.1 L-COIL PURPOSE. The purpose of the L-coil is to counteract the magnetic field produced by the ship's longitudinal permanent and induced magnetization. It does this better than F- and Q-coils, or FI-QI and FP-QP coils. For this reason, an L-coil is often used in mine warfare vessels.

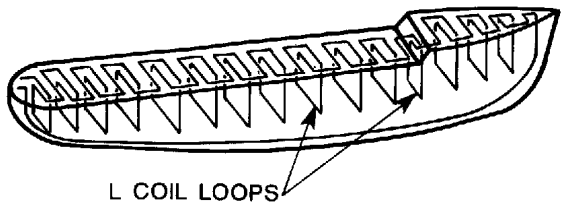


Figure 475-3-8. L- or Longitudinal Coil.

475-3.6.1.1 L-Coil Field Variability with Pitch. An L-coil is always used when compensation for pitch of the ship is required.

475-3.6.1.2 L-Coil Field Variability with Heading or Magnetic Latitude. Since the longitudinal induced magnetization changes when the ship changes its heading or magnetic latitude, the L-coil field strength must be changed accordingly. When compensation for pitch is required, the L-coil field strength must also be changed as the ship pitches.

475-3.7 A-COIL

The A- or athwartship coil has loops in vertical fore-and-aft planes (see figure 475-3-9).

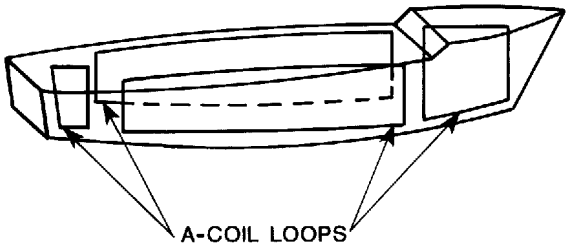


Figure 475-3-9. A- or Athwartship Coil.

475-3.7.1 A-COIL PURPOSE. The purpose of the A-coil is to produce a magnetic field that will counteract the magnetic field produced by the permanent and induced athwartship magnetization. Since the induced athwartship magnetization changes when the ship changes its heading or magnetic latitude, the A-coil field strength must be changed accordingly. When compensation for roll is required, the A-coil field strength must also be changed as the ship rolls.

475-3.8 P-COIL

The P- or permanent coil, used on mine warfare vessels, consists of conductors in the M-, A-, and L-coil cables connected in series to form the P-coil. The P-coil compensates for the permanent vertical, athwartship, and longitudinal magnetization. Since the permanent magnetization does not change when the ship changes its heading or latitude, no change in P-coil field strength is needed.

475-3.9 AUXILIARY COILS (MX, AX, LX, PX)

Auxiliary coils are used on some nonmagnetic minesweepers to provide greater adjustment capability during calibration of coil installations at a magnetic range (see section 6).

475-3.10 NUMBER OF COILS USED

Different combinations of the degaussing coils are installed aboard different ships. The combination selected for a particular ship will depend on the ship's size and intended service. The most common combinations used are:

M, FI-QI, FP-QP
M, FI-QI, FP-QP, A
M, L, A, P
M, L, A, P, MX, LX, AX, PX.

475-3.11 COIL FIELD STRENGTH

The magnetic field produced by a degaussing coil is proportional to ampere turns, designated as NI (the product of the number of turns in the coil times the coil current in amperes). A specified number of ampere turns can be obtained by using one turn and a current numerically equal to the required ampere turns, or by using more turns and a correspondingly smaller current. The magnetic field near degaussing cables can be estimated using the following formula:

$$H = 0.00667NI \div D$$

where:

H = the magnetic field intensity in oersteds

NI = the total ampere-turns of the degaussing cables

D = the distance in feet from the cable to the point

475-3.11.1 METHODS TO CHANGE COIL FIELD STRENGTH. Field strengths of all degaussing coils, except the permanent coils, must be changed when the ship changes its magnetic latitude. In addition, coil field strengths of the F-, Q-, FI-QI, L- and A-coils must be changed when the ship changes its heading. When compensation for pitch and roll is required: the M-coil field strength must be changed when the ship pitches or rolls; the L-, F-, Q- or FI-QI coil field strength must be changed when the ship pitches; and the A-coil field strength must be changed when the ship rolls. Coil field strength is changed by changing the ampere turns. This can be done by changing the current while keeping the turns constant, changing the turns while maintaining the current constant or, changing both the current and the turns. Changing the coil current is the only

method now used for new construction. In some previous installations still in use, the second and third methods are used.

475-3.12 SINGLE CONDUCTOR AND MULTICONDUCTOR COILS

Degaussing coils may be made with either single conductor or multiconductor cables.

475-3.12.1 SINGLE-CONDUCTOR COILS. Coils with single conductor cables have only one turn or a small number of turns. They can carry a current on the order of hundreds of amperes at low voltages, about 10 to 65 volts. Single conductor cables or a combination of some single conductor and some multiconductor cables are usually specified for the M-, F-, Q-, and A-coils used on large ships.

475-3.12.2 MULTICONDUCTOR COILS. When multiconductor cables are used for degaussing coils, the conductors in one or more cables are connected in series to give a considerable number of turns. The current in each conductor can be on the order of tens of amperes at voltages of about 120 to 250 volts. Multiconductor cables for degaussing coils are usually specified for the high-voltage, low-current systems employed on smaller ships or for the FI-QI and FP-QP coils used on large ships.

475-3.13 DEGAUSSING COIL POLARITY, MARKING AND DESIGNATION

475-3.13.1 DIRECTION OF ELECTRIC CURRENT. The direction of electric current in a conductor loop connected to a battery is from the positive terminal to the negative terminal. The relation between the direction of the current and the direction of the magnetic lines of force around the conductor is shown in figures 475-3-1 and 475-3-2.

475-3.13.1.1 Degaussing Polarity Indicators. The direction of current in a degaussing coil can be checked by using either a degaussing polarity indicator (such as H6625-00-314-4162) or a small hand compass. The polarity indicator dial is marked to show the direction of current. Compass deflections that correspond to positive degaussing coil currents are given in paragraphs 475-3.13.2 through 475-3.13.2.5.

475-3.13.1.2 Polarity Indicator Precautions. To avoid reversing the needle in the polarity indicator or compass, neither one should be brought too close to degaussing cables. Whichever one is used should be moved toward the cables only until a good deflection is obtained, and no closer. In addition, the indicator or compass should be checked after each test to make sure the needle has not reversed.

475-3.13.2 COIL POLARITY. In M-, F-, Q-, FI-, FP-, QI-, and QP-coils, the direction of positive current is forward on the starboard side (counterclockwise as viewed from above the coil). A small compass held above the degaussing cable will point outboard for a positive current in the coil.

475-3.13.2.1 A Coil Polarity Convention. In the A-coil, the direction of the positive current is aft in the upper run (counterclockwise as viewed from the starboard side). A small compass held below the upper run of the A-coil will point to starboard for positive current in the coil.

475-3.13.2.2 L-Coil Polarity Convention. In the L-coil, the direction of positive current is upward on the starboard side (counterclockwise as viewed from the after side of the coil). A small compass held below the upper run where it crosses athwartships will point aft for positive current in the coil.

475-3.13.2.3 FI and QI Coil Loop Polarity Convention. The FI and QI loops of an FI-QI coil are connected in series so that when the current is positive in the FI loops it is negative in the QI loops. The polarity of the FI-QI coil is the same as the polarity of the FI loops; that is, the ammeter for the FI-QI coil indicates positive current when the FI loops are positive.

475-3.13.2.4 FP and QP Coil Loop Polarity Conventions. The FP and QP loops of an FP-QP coil on a new installation are connected in series, so that when current is positive in the FP loops, it is negative in the QP loops. If ranging the ship (section 6) shows that it is desirable to have the FP and QP loops connected to produce fields in the same direction, they should then be reconnected. The polarity of the FP-QP coil is the same as the polarity of the FP loops; that is, the ammeter for the FP-QP coil indicates positive current when the FP loops are positive.

475-3.13.2.5 Ammeter Deflection Convention. The pointer of a zero center ammeter will deflect to the right for positive current in the coil with which the ammeter is used.

475-3.13.3 MARKING. The letters to be used for designating and marking degaussing installations and their meanings are shown in table 475-3-1.

475-3.13.4 LOOP DESIGNATION. Each degaussing coil may consist of one or more loops. Each loop may consist of one or more turns of cable.

a. The number 1, when used with the M-, F- or Q-coil (M1, F1, Q1); or the FI, FP, QI, or QP loops of the FI-QI or FP-QP coils, designates the longest loop. Other loops in each coil shall be numbered in sequence 2, 3, 4, and so on from bow to stern (see figures 475-3-10 and 475-3-11).

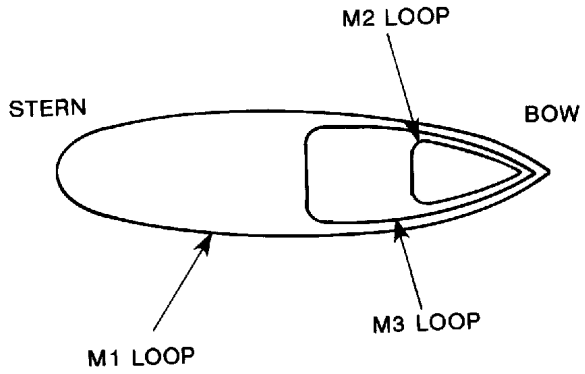


Figure 475-3-10. Numbering M-Coil Loops.

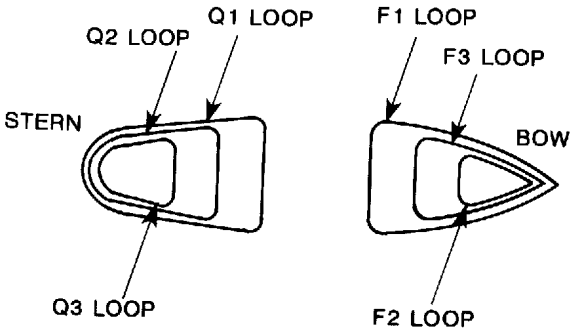


Figure 475-3-11. Numbering F- and Q-Coil Loops.

b. The number 1, when used with the L-coil (L1), designates the forward loop. Other loops are designated L2, L3, L4, and so on, in sequence, from bow to stern.

c. When used with the A-coil (A1, A2), the numbers 1 and 2 designate the starboard and port longest loops, respectively, with other loops following in sequence from bow to stern.

d. For minesweepers, the M1 loop does not go around the ship. All loops (M, A and L) are numbered consecutively from bow to stern except for loop pairs at the same distance from the bow. Loop pairs are numbered as follows:

1. Odd loop numbers are used for upper or starboard loops.

2. Even loop numbers are used for lower or port loops.

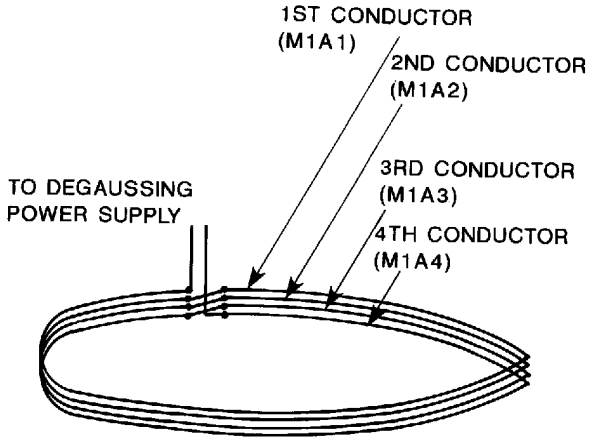


Figure 475-3-12. M-Coil With a Single Circuit.

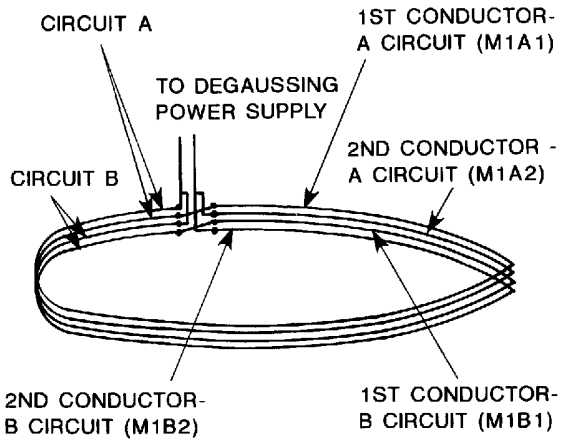


Figure 475-3-13. M-Coil With Two Parallel Circuits.

475-3.13.5 CIRCUIT DESIGNATION. Consider a degaussing coil loop consisting of one turn of four-conductor cable. Although degaussing cables have either only one conductor or more than four, a four-conductor cable serves to illustrate the meaning to be attached to circuits.

475-3.13.5.1 Circuits of Four-turn Loops. The four conductors in the cable may be connected as shown in figure 475-3-12. In this case there is only one circuit. Alternatively, the four conductors in the cable may be connected as shown in figure 475-3-13. In this case there are two circuits. The first and second turns in series are in parallel with the third and fourth turns in series.

475-3.13.5.2 Conductor Circuit Designation. The letters A, B, C, and so on are used as indicated in paragraph 475-3.13.9.1 to designate the circuit in which a particular conductor is connected.

475-3.13.6 COIL CABLE DESIGNATION. Degaussing coil cables are marked with: a D for degaussing, a dash, a number (1, 2, 3) to indicate the particular cable in a coil, the appropriate letter for the degaussing coil designation (M, F, Q, FI, FP, QI, QP), a second dash, and a number to indicate the particular section of the cable. Thus, D-2M-1 stands for the number 1 section of the number 2 cable of the M-coil. A section of a degaussing coil cable is the length of cable between two successive connections or through boxes. The number designation for a cable is to be retained throughout one

TABLE 475-3-1. DEGAUSSING INSTALLATION MARKING

A	Athwartships coil
AMM	Ammeter
AP	A coil to correct for permanent magnetism
AX	A-auxiliary coil
CC	Compass compensating coil
D	Degaussing system
F	Forecastle coil to correct for both permanent and induced magnetism
FDR	Feeder
FI	F-coil to correct for induced magnetism
FP	F-coil to correct for permanent magnetism
I	FI-QI coil - used in conjunction with feeders, compass compensating coil, and indicator light leads
IL	Indicator light
L	Longitudinal coil
LP	L-coil to correct for permanent magnetism
LX	L-auxiliary coil
M	Main coil
MP	M-coil to correct for permanent magnetism
MX	M-auxiliary coil
P	Used in conjunction with feeders for AP, FP-QP, LP and MP coils
PX	P-auxiliary coil
Q	Quarterdeck coil to correct for both permanent and induced magnetism
QI	Q-coil to correct for induced magnetism
QP	Q-coil to correct for permanent magnetism
SPR	Spare conductor

complete turn in a coil or loop if the cable makes a complete turn, or for as far as the cable goes if it does not make a complete turn. Therefore, while the number designation for a cable does not change when the cable goes through an intermediate connection or through box, the number designation for a section does. Section numbers are assigned as follows:

a. For a cable in a horizontal coil, section number 1 is assigned to the section that is farthest forward. The remaining sections are marked in sequence going around the coil counterclockwise as viewed from above.

b. For a cable in the A-coil, section 1 is assigned to the section that is highest and farthest forward. The remaining sections are numbered in sequence going around the coil counterclockwise as viewed from the starboard side.

c. For a cable in the L-coil, section 1 is assigned to the section that is highest and farthest forward. The remaining cable sections are numbered in sequence going around each loop counterclockwise as viewed from the after side of the loop and going from loop to loop fore to aft.

475-3.13.6.1 Degaussing Coil Cable Section Number. The section number should always be included in a degaussing coil cable designation even if the cable has only one section. See figure 475-3-14 for examples of degaussing coil cable designations.

475-3.13.7 FEEDER CABLE DESIGNATION. Cable designations vary with cable use.

475-3.13.7.1 Power Supply Cables. Degaussing power supply feeder cables are marked with a D for degaussing, a dash, FDR for feeder, a letter to indicate the coil to which the feeder carries current, a second dash, and a section number. A section in a feeder cable is the length of cable between two successive items of equipment. Sections should be numbered in sequence starting from the degaussing panel, as D-FDRI-1, D-FDRI-2, and so on, if there are several sections, or D-FDRI-1 if there is only a single section. When two or more feeder cables run to a coil, they should be numbered as indicated for degaussing coils. For example, D-1FDRM-1 and D-2FDRM-1 for two feeder cables to the M-coil (figure 475-3-16). When single-conductor cables are used as feeder cables, the cable with the positive conductor should be numbered 1; the cable with the negative conductor should be numbered 2. If more than two single-conductor cables are used for the feeders to one coil, odd numbers should be used for the feeders with positive conductors.

475-3.13.7.2 Interconnecting Cables. Interconnecting cables between FI and QI loops or FP and QP loops are considered feeder cables and bear the designation of the loop to which they carry power. For example, the feeder cable that carries power from the degaussing panel to the FI-QI coil is designated D-FDRI-1, D-FDRI-2, and so on, regardless of whether it connects to the FI loop or the QI loop. If the feeder cable for the FI-QI coil connects to the FI loop, the interconnecting cable between the FI and QI loops carries power from the FI to QI loop and is designated D-FDRQI-1 as illustrated in figure 475-3-14. If, on the other hand, the feeder from the degaussing panel connects to the QI loop, the interconnecting cable between the FI and QI loops carries power from the QI to the FI loop and is designated D-FDRFI-1.

475-3.13.7.3 Compass Compensating Coil and Indicator Light Cables. Feeder cables for compass compensating coils, ammeters, or indicator lights should be designated D-FDR followed by a dash and letters to indicate the equipment to which they are connected: for example, D-FDRM-CC for an M-coil compass coil feeder. Section numbers are omitted (see figure 475-3-16 for examples).

475-3.13.8 OTHER CABLE DESIGNATION. All feeders, mains, and other cables supplying power to degaussing switchboards, power supplies, and control panels shall be designated and marked as specified for power and lighting circuits in accordance with NSTM Chapter 300, **Electric Plant General**.

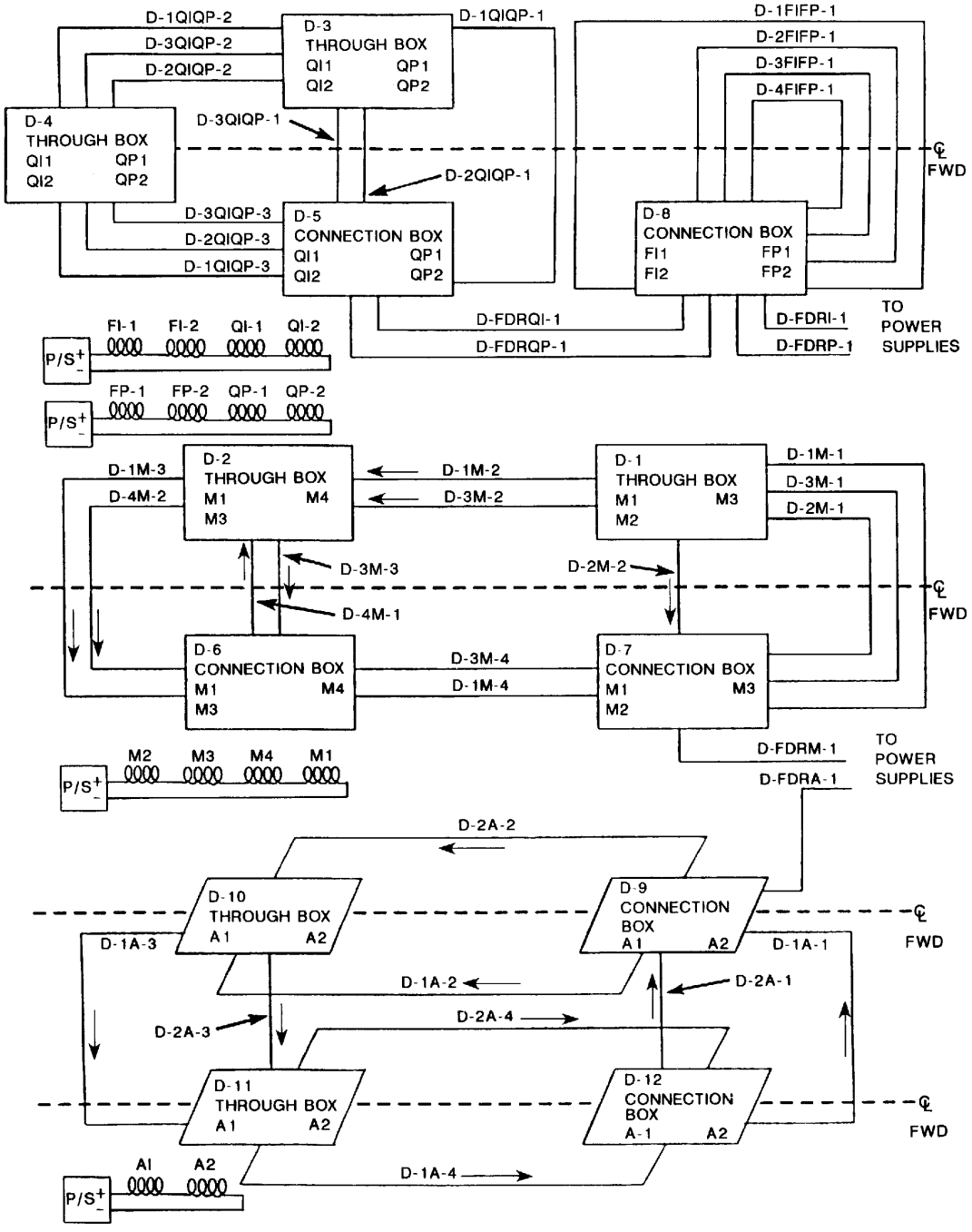


Figure 475-3-14. Degaussing Coil Cable Designations, Typical.

475-3.13.9 CONDUCTOR DESIGNATION. Both the cable designation given in paragraphs 475-3.13.6 through 475-3.13.8, and the conductor designation given in paragraphs 475-3.13.9.1 and 475-3.13.9.4, should be used even when the cable has only one conductor. This is because the conductor designation gives some information that the cable designation does not.

475-3.13.9.1 Single Conductors. Single conductors are to be marked by hot stamping (branding) the insulating sleeving, MIL-I-631, type F, grade A, form U (white) of appropriate size. The conductor marking shall conform with that of the terminal to which it connects. The following symbols, as applicable, should be used, arranged in the order given:

a. M, F, Q, FI, FP, QI, QP, A, and so on - degaussing coil.

b. 1, 2, 3, and so on - degaussing coil loop number (see paragraph 475-3.13.4). Omit the number if the coil has only one loop.

c. A, B, C, and so on - first, second, third parallel circuit in the coil (see paragraph 475-3.13.5). Use A if there is only one circuit.

d. 1, 2, 3, and so on - first, second, third series conductor in a circuit. A conductor that is connected in a degaussing coil or loop makes a complete turn and retains the same number designation throughout the entire turn.

e. Plus (+) or minus (-), shown on the conductor, as indicated in paragraph 475-3.13.9.4.

475-3.13.9.2 Spare Conductors. Spare conductors are marked with hot stamped plastic insulating sleeving with the same designations as the other conductors, except as follows:

a. For a spare conductor that is available for a complete turn, omit the circuit designation A, B, C, and so on, and substitute SPR in its place.

b. For a spare conductor that is not available for a complete turn, use the designation of the cable in which the spare conductor is contained, including the cable section number, and follow the cable designation with SPR, a number to identify the spare conductor, and + or - to indicate geometric polarity (for example, D-3M-1SPR2+).

475-3.13.9.3 Parallel Conductors. Conductors paralleled together within a portion of a particular series or parallel circuit and not constituting regular full-length circuits, receive the same conductor designation that equivalent single conductors would receive (see figure 475-3-15 for example).

475-3.13.9.4 Positive and Negative Geometric Polarity. Positive and negative geometric polarity is as follows:

a. The ends of M, F, Q, FI, FP, QI and QP coil conductors approaching a box (paragraphs 475-3.13.13 through 475-3.13.15) in the counterclockwise direction, as observed from above the coil (for example, from aft for a box on the starboard side), will be positive.

b. The ends of A-coil conductors approaching a box counterclockwise, as viewed from the starboard side of the coil (for example, from aft for a box in the lower run of the coil), will be positive.

c. The ends of L-coil conductors approaching a box counterclockwise, as seen from the after side of the coil (for example, from below a box on the starboard side), will be positive.

d. The conventions used for geometric polarity, positive direction of current

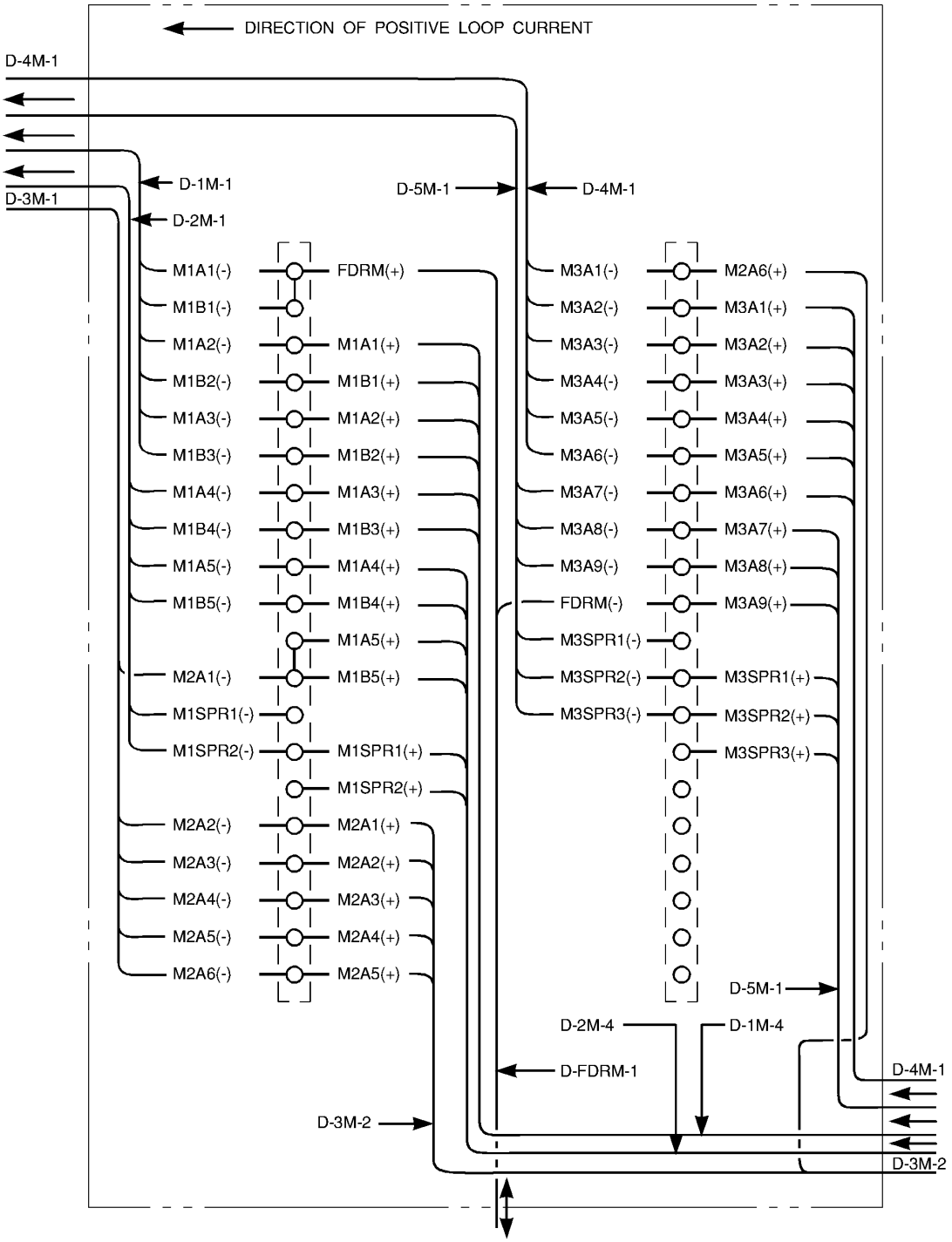


Figure 475-3-15. Typical M-Coil Connection Box.

(paragraphs 475-3.13.1 through 475-3.13.1.2) and positive direction of currents in degaussing coils (paragraphs 475-3.13.2 through 475-3.13.2.5), are so related that when the current in a degaussing coil and ammeter is negative, the electrical and the geometric polarities of loop conductor ends are the same.

475-3.13.10 FEEDER CABLE CONDUCTOR DESIGNATION. Feeder cable conductors are designated in a different manner than the degaussing coil type. There are two types of feeder cable conductors.

475-3.13.10.1 Power Supply Cables. Conductors to degaussing coils are designated by the following symbols, as applicable, in the order given:

a. FDR: feeder.

b. M, F, Q, FI, and so on: degaussing coil.

c. 1, 2, 3, and so on: coil loop number. The loop number is omitted if the coil has only one loop.

d. A, B, C: circuit designation. Used only when individual parallel circuits are fed separately. For example, where multicircuit rheostats are used.

e. Plus (+) and minus (-): positive and negative electric polarity when the controls are in the position for positive current (see paragraph 475-3.13.2 through 475-3.13.2.5). Feeder cable conductors carry the same polarity designation for the entire length of the conductor.

475-3.13.10.2 Compass Compensation and Indicator Light Cables. Conductors in compass compensating and indicator light feeder cables are designated with the following symbols in the order given:

a. M, F, Q, I, P, A, L, and so on: degaussing coil.

b. CC: for compass compensating coil conductors; or, IL: indicator light conductors.

c. Plus (+) and minus (-): electric polarity when the current in the coil is positive (see figure 475-3-16 for examples).

475-3.13.11 CABLE AND CONDUCTOR TAGS, NAVAL SHIPS. Cable and conductor tags on Naval ships should conform to NSTM Chapter 300, **Electric Plant General**, and paragraphs 475-3.13.9.1 through 475-3.13.9.3. Tags and marking are to be rigidly attached to the cable or conductor so that the tag marking is parallel to the axis of the cable or the conductor.

475-3.13.12 CABLE AND CONDUCTOR TAGS, MERCHANT SHIPS. Cable and conductor markings for merchant ships are the same as for Naval ships. In both Naval and merchant ships, a degaussing coil conductor marking is to be fastened to each end of a conductor inside the connection or through box.

475-3.13.13 CONNECTION AND THROUGH BOXES.

475-3.13.13.1 Definitions - Connection Box. A connection box is a watertight box used to connect loops together, to connect conductors in series, to reverse turns, etc. The power supply connection for a coil and all adjustments of ampere turn ratios between loops are made within connection boxes. The power supply cable and interconnecting cable for the FI-QI and FP-QP coils terminate at connection boxes.

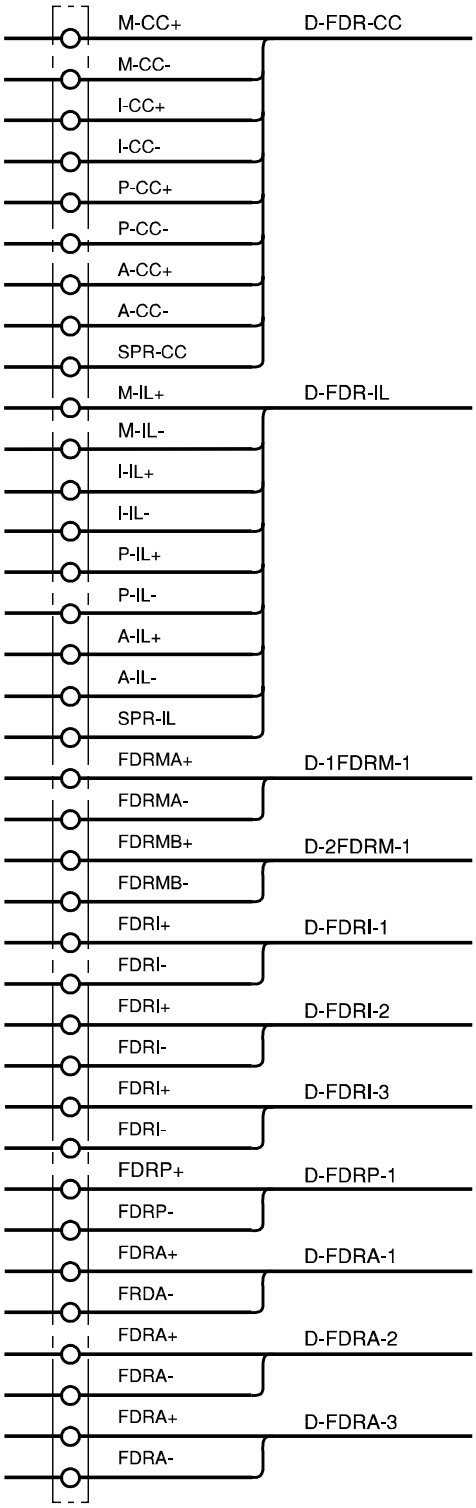


Figure 475-3-16. Feeder Cable Conductor Designation.

475-3.13.13.2 Definition - Through Box. A through box is a watertight box used to connect conductors together without changing the order of conductor connection. It is used when it is necessary to connect sections of cable together. In some cases splicing instead of through boxes is used.

475-3.13.13.3 Numbering. Connection and through boxes in the M, MX, F, Q, FI-QI and FP-QP coils are considered to be in one group. They are numbered D1, D2, D3, and so on, in sequence, starting at the bow and going around the ship counterclockwise as observed from above (figure 475-3-14).

475-3.13.13.4 A-Coil and Box Numbering. Boxes for the A-coil receive the next higher numbers after numbers for the M, F, FI, FP, QI and QP boxes have been assigned. Numbers for the A-coil boxes are in sequence starting with the highest forward box and continuing aft on the upper limbs of both the A1 and A2 loops, then down to the forward on the lower limbs, and then up (figure 475-3-14).

475-3.13.13.5 L-Coil and Box Numbering. Boxes for the L-coil receive the next higher numbers after numbers for the A-coil boxes have been assigned. Numbers for the L-coil boxes are assigned in sequence starting with the highest forward box on the port side and continuing around the ship in a counterclockwise direction as viewed from above. Boxes on the centerline are considered to be on the port side for number assignment.

475-3.13.14 IDENTIFICATION PLATES. Connection and through boxes should have identification plates marked as follows:

a. Degaussing box number - D1, D2, D3, and so on

b. Connection box or through box, as applicable

c. Coil and loop designation - M1, M2, FI1, QI1, and so on.

EXAMPLE:

D1

CONNECTION BOX	THROUGH BOX
M1	FI1
M2	

NOTE

This example identifies the No. 1 degaussing box serving as a connection box for the M1 and M2 loops and as a through box for the FI1 loop.

475-3.13.15 WIRING DIAGRAM. A wiring diagram of the connection within a box should be pasted on the inside of the box cover and coated with varnish or shellac. The wiring diagram for connection boxes should designate the conductors that may be reversed without reversing other loops, should indicate the arrangement of parallel circuits so that equal changes can be made in all parallel circuits when such changes are required, and should also show spare conductors. Spare conductors shall be secured to connection terminals in the connection boxes and shall not form a closed-loop circuit. All conductors within a connection box shall be cut to allow 1-1/2 times the length required to reach the farthest terminal within the box. The wiring diagram should show the direction of positive loop current and should include the following warning note:

WARNING

Important for magnetic defense: To maintain the ship's magnetic signature ensure that the connected turns for each loop in this box are in accordance with the turns specified in the ship's degaussing folder. Use this original connection wiring diagram (inside cover) for general guidance only.

475-3.14 REQUIRED COIL CURRENT ALGORITHM

Degaussing coils are installed so that they produce compensating fields parallel to each of the ship's three axes to counteract the permanent and induced magnetization along each of these axes (see paragraphs 475-3.1 through 475-3.2). Coil field strength is a function of coil current (see paragraph 475-3.11), and required coil field strength is a function of the inducing field and the permanent magnetization. Required coil current is therefore a function of the magnitude and polarity of the earth's magnetic field and the component of permanent magnetization, along the axis of the ship. This is illustrated by the following formula:

$$I = K\phi + Ip$$

where:

I = required coil current

ϕ = component of earth's magnetic field along ship's axis

Ip = current required to compensate for permanent magnetization

K = gain constant determined during calibration.

The first term in the equation, $K\phi$, represents the current component for compensating the ship's induced field (induced field current) and the second term, Ip, represents the current component for compensating the ship's permanent field (perm field current). The magnitude and polarity of Ip is constant and the same values are used until the ship is recalibrated. The magnitude and polarity of ϕ is obtained by one of two methods:

a. Measuring ϕ with a magnetometer.

b. Calculating ϕ as a function of the following parameters:

$$\phi = f(H, Z, a, r, p)$$

where:

H = the horizontal component of the earth's magnetic field (see paragraphs 475-2.1 through 475-2.1.3.2)

Z = the vertical component of the earth's magnetic field (see paragraphs 475-2.1 through 475-2.1.3.2)

a = ship's magnetic heading

r = ship's roll angle

p = ship's pitch angle.

SECTION 4. DEGAUSSING CONTROL EQUIPMENT

475-4.1 OPERATOR CURRENT CONTROL - PRIOR TO MID-1950S EQUIPMENT

Many of the older (prior to the mid-1950s) three-coil degaussing installations and all installations with only an M-coil, have operator current control. These installations were fabricated and installed by the shipbuilders. They were never assigned type designations. Manual or operator control is necessary because an operator must adjust the degaussing coil currents when they have to be changed because of a change in the ship's heading or magnetic latitude, or both. In such installations, roll and pitch compensation is not provided.

475-4.2 MANUAL CURRENT ADJUSTMENT EQUIPMENT

This equipment controls power obtained from constant voltage dc generators in some installations and from degaussing motor generators in other installations. Coil currents are set by adjusting rheostats. The rheostats are in series with the degaussing coils when the power is obtained from a constant voltage source, and in series with the generator field when motor-generators are used for the power source. Both manually operated and motor-driven rheostats are used. The required coil currents for each of the ship's degaussing coils, the various magnetic latitudes, and the major ship's headings are obtained from the degaussing charts in the ship's degaussing folder. These current values are determined for one latitude and calculated for other latitudes during calibration ranging. The current values given in the degaussing folder for the various zones of operation represent the sum of the induced field and perm field currents.

475-4.3 AUTOMATIC CURRENT CONTROL EQUIPMENT

Automatic degaussing (AUTODEG) control equipment is equipment that adjusts some or all the coil currents automatically with changes in the ship's attitude (heading, roll, pitch, trim, list) or with changes in both the attitude and location. This type of control equipment is provided on all ships with degaussing coils installed in more than one plane. The two basic types of AUTODEG control equipment currently provided are:

a. Magnetometer-controlled equipment

b. Gyro-controlled equipment.

475-4.3.1 MAGNETOMETER CONTROL. Signals to control the induced field currents are obtained from a three-axis magnetometer. The magnetometer measures the components of the earth's field along the axes of the ship and automatically adjusts the coil currents in a manner that will compensate for changes in the induced magnetization caused by the ship's roll and pitch and by changes in the ship's heading and geographical location. The perm field current is obtained by biasing the magnetometer output with a perm bias component or by providing a P-coil with a separate regulated current source (see paragraph 475-3.8) or a combination of both methods.

475-4.3.1.1 Magnetometer Control on Nonmagnetic Minesweepers. Magnetometer control is used on nonmagnetic minesweepers because roll and pitch compensation and smooth or stepless zone control (magnetic latitude variations) are needed for these ships. It is also used on minesweepers because the magnetometer can be readily located so that it measures the earth's field rather than a combination

of the earth's field, ship's field and other interference fields.

475-4.3.1.2 Magnetometer Control on Special Steel Hull Ships. Magnetometer control is also used on some steel hull ships with aluminum superstructures where the effect of the ship's field on the magnetometer can be cancelled by compensation techniques. Magnetometer control is used on these ships to eliminate the operator inputs (H, Z, and magnetic variation) required with gyro-controlled equipment.

475-4.3.2 GYRO CONTROL. Signals to control the induced field are obtained from the ship's gyro compass and gyro stabilizer systems.

475-4.3.2.1 Gyro Control - Induced Field. Signals are modified by operator inputs for magnetic latitude and heading (operator sets the H-zone, Z-zone and magnetic variation controls), and processed by an analog computer to provide induced field compensation currents proportional to the calculated values of ϕ.

475-4.3.2.2 Gyro Control - Perm Field. The perm field current is obtained by biasing computer output, or with a separate P-coil, or with a combination of both methods. Gyro control is currently used on ships that do not require roll and pitch compensation. On these ships the control signal is obtained from the ship's gyro compass, and the coil currents are adjusted automatically to compensate only for the change in the induced magnetization caused by a change in the ship's heading.

475-4.3.3 EMERGENCY MANUAL CONTROL. All types of AUTODEG control equipment are equipped with emergency manual controls for use if the automatic controls become inoperative. This equipment is manually operated by setting currents to values obtained from the ship's degaussing folder for the various magnetic latitudes and adjusting the eight-course heading switch as the ship's heading varies.

475-4.4 EQUIPMENT DESCRIPTION

Brief descriptions of the different types of automatic degaussing equipment are given in table 475-4-1. Detailed descriptions for specific equipment are given in the technical manuals for each type of equipment. The first three types - MDG, SSM and MCD - are the only types being installed on new ships. These types are further described in paragraphs 475-4.4.1 through 475-4.4.3.

475-4.4.1 TYPE MDG. Type MDG degaussing equipment is installed on nonmagnetic minesweepers. This equipment consists of a fluxgate-type triaxial magnetometer probe installed on the ship's mast and a control unit, containing all control and power circuits, installed in Command Information Center (CIC) or the pilot house (figure 475-4-1). The magnetometer probe is located and aligned so that it measures the earth's local magnetic field components along each of the ship's three axes. These field components are biased and amplified by the degaussing equipment to produce the required degaussing coil currents (figure 475-4-2). The probe location must be free of interference produced by the ship's magnetic field, degaussing coils and other installed equipment. The equipment is unique in that ninety separate power amplifiers are available to supply the ship's degaussing loops.

475-4.4.2 TYPE SSM EQUIPMENT. Type SSM degaussing equipment is the standard degaussing equipment installed on all ships that re-

TABLE 475-4-1. AUTODEG EQUIPMENT

Equipment type codes	Description
MDG	Control signals from three-axis magnetometer. Solid-state control circuits with as many as ninety power amplifiers available to supply the degaussing loops.
SSM	Control signal from heading gyro. Solid-state control circuits. Silicon-controlled rectifier-type power supplies.
MCD	Control signals from magnetometer. Solid-state control circuits. Silicon-controlled rectified-type power supplies.
GEM	Control signal from three-axis magnetometer. Combination of solid-state and magnetic amplifier control circuits. Controls field of degaussing motor generator. This equipment is type GM equipment that has been converted to magnetometer control.
SEM	Control signal from three-axis magnetometer. Combination of solid-state and magnetic amplifier-type power supplies.
GM	Control signal from heading gyro or from heading gyro and gyro stabilizer. Magnetic amplifier control circuits. Controls field of generator of degaussing motor generator. Note: All type GM equipment with roll and pitch signals from the gyro stabilizer have been converted to type GEM equipment.
FM	Control signal from heading gyro. Magnetic amplifier control circuits. Controls field of exciter of degaussing motor generator.
RM	Control signal from heading gyro. Magnetic amplifier control circuits. Controls motor of motor-driven rheostat. Rheostat is in series with degaussing coil connected to constant voltage dc power supply.
EMS	Control signals from three-axis magnetometer. Solid-state control circuits. Power transistors or silicon-controlled rectifiers for power control.

quire degaussing except nonmagnetic minesweepers and patrol frigates (FFG 7 class). This equipment consists of a control switchboard, remote control unit and a power supply for each installed degaussing coil (figure 475-4-3).

475-4.4.2.1 SSM Control Equipment Description. The switchboard contains all operator controls, control circuits and status indicators for all coils. The switchboard is functionally divided to facilitate operation and maintenance. The remote control unit provides status indicators and a heading switch for emer-

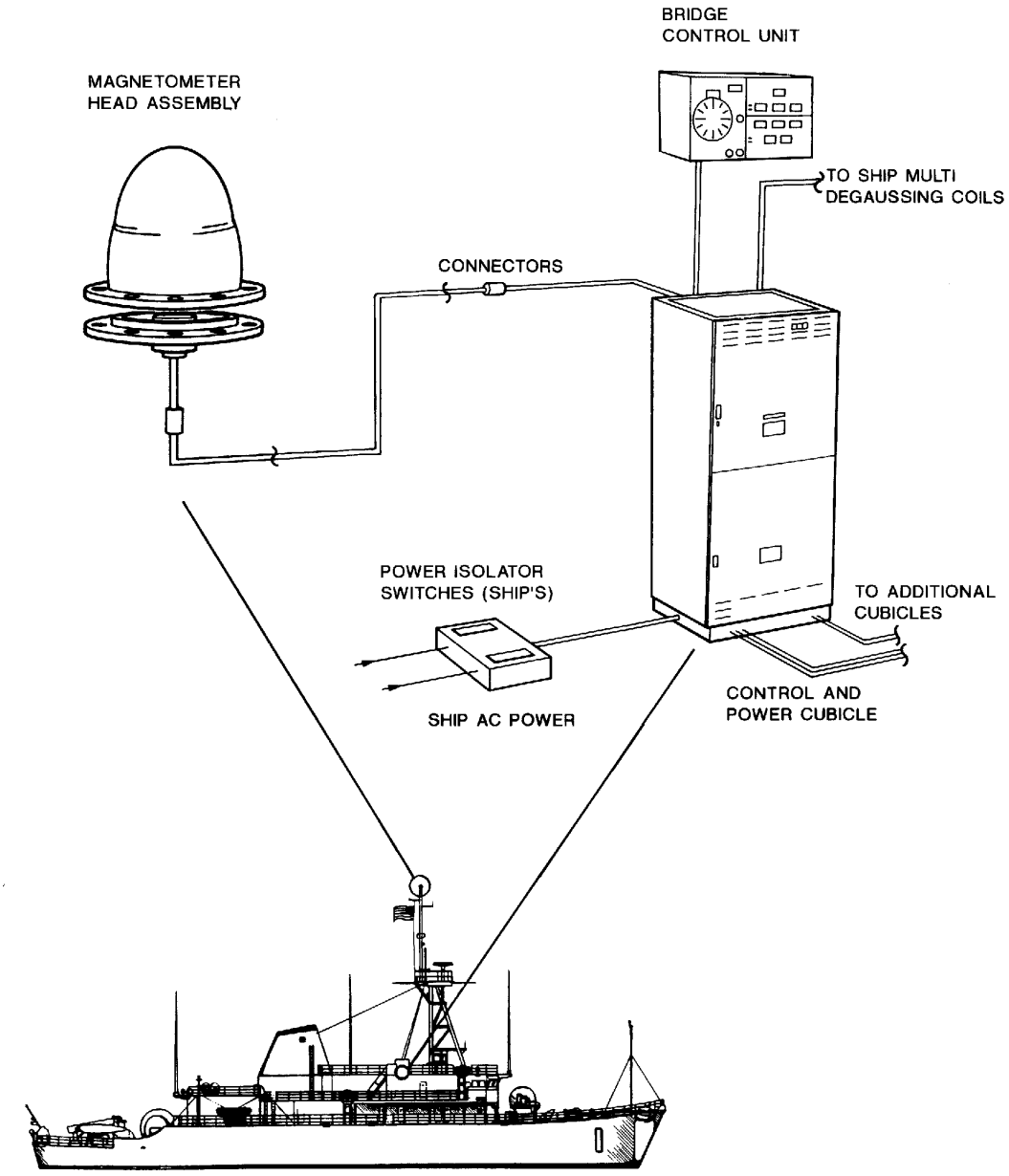


Figure 475-4-1. Type MDG Automatic Degaussing Equipment.

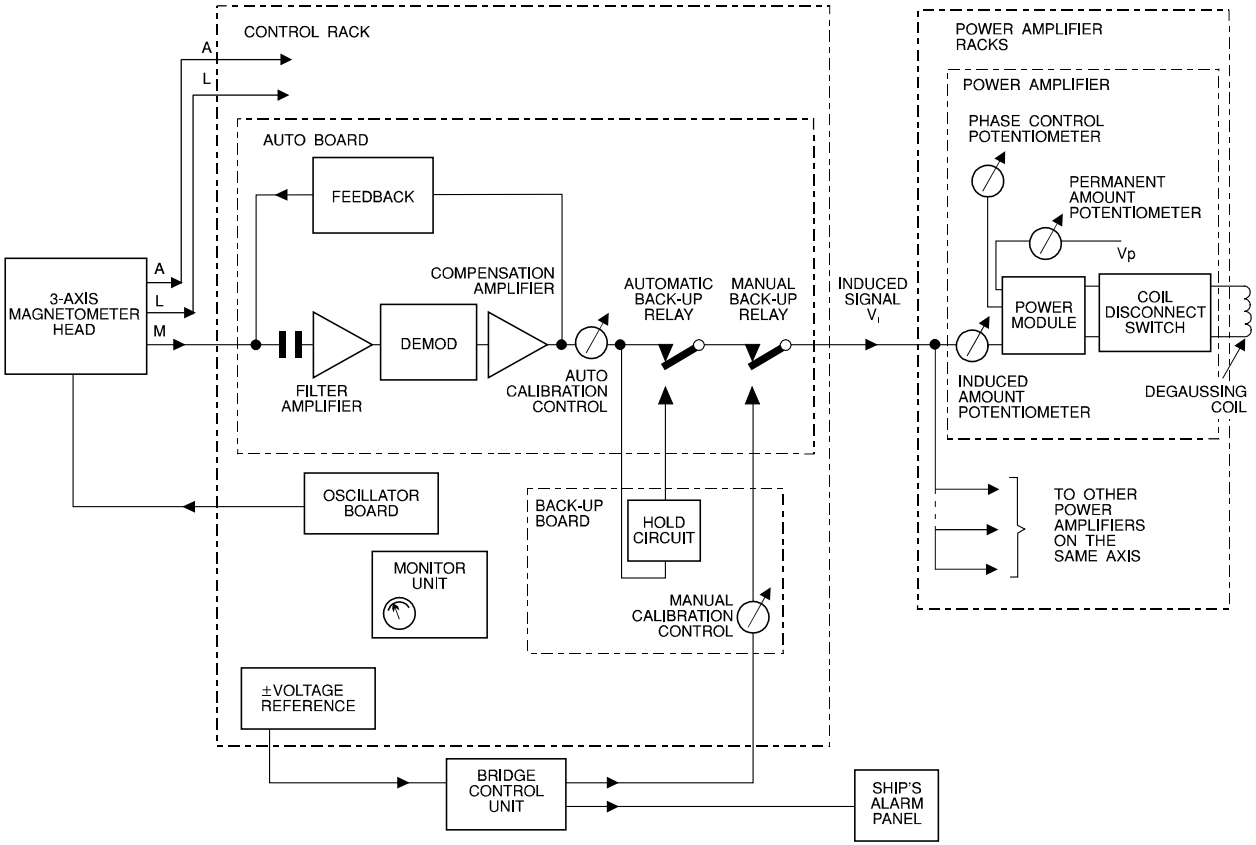


Figure 475-4-2. Block Diagram for Type MDG Degaussing System.

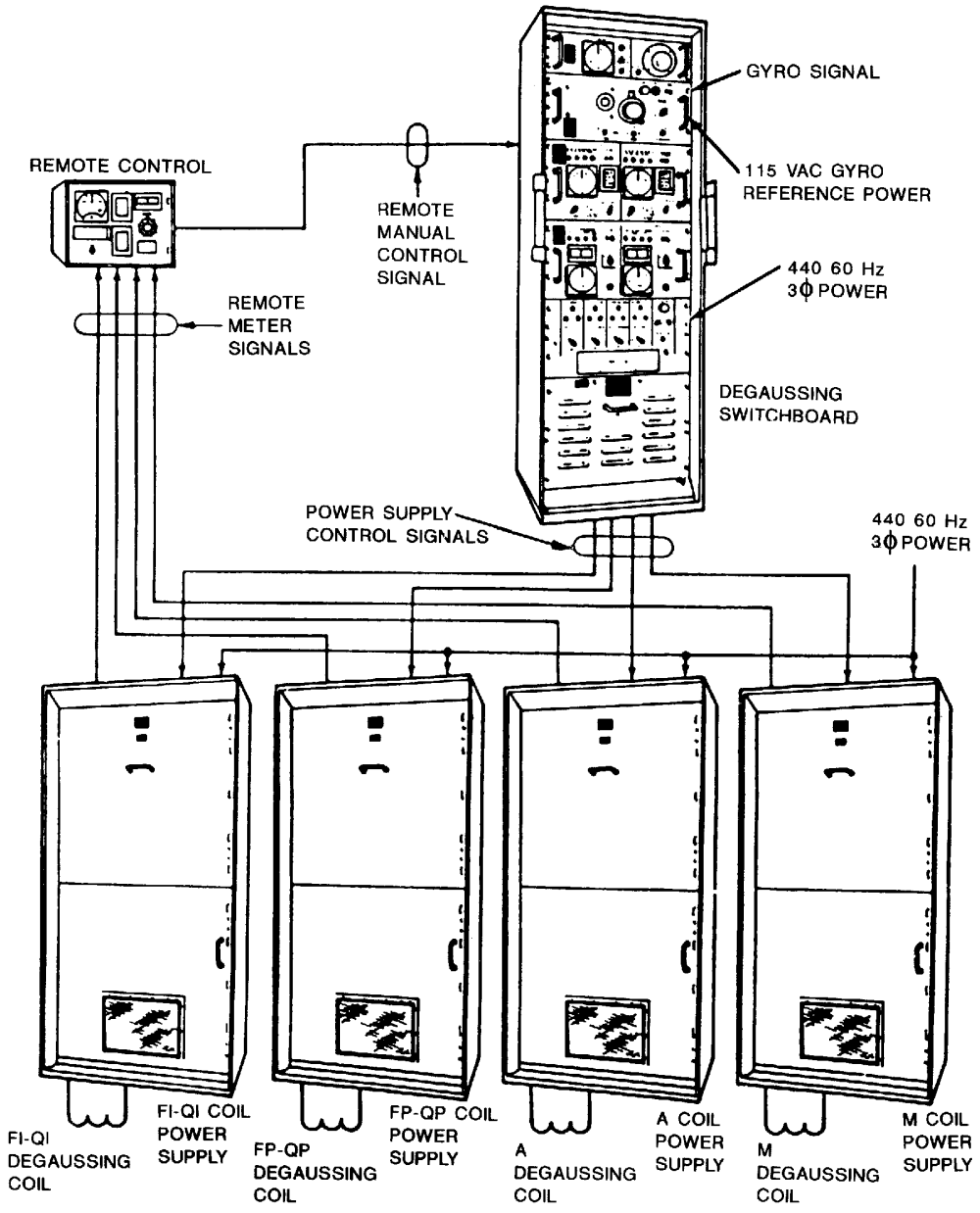


Figure 475-4-3. Type SSM Automatic Degaussing Equipment.

gency manual operation in a remote location (usually the pilot house). The computer drawer contains an electromechanical computer and the controls necessary to provide induced FI-QI and A-coil current magnitudes derived from the ship's heading and location (figure 475-4-4). The automatic and manual drawers contain current controls, meters and status indicators for the automatic coils (FI-QI and A) and the manual coils (M and FP-QP). The ground detector, temperature alarm bell, power-supply blown fuse indicators, and power switches are located on the front panels.

475-4.4.2.2 SSM Power Control Equipment. The power supplies amplify the control signals from the switchboard. The power supplies are supplied in standard power ratings and differ only in their output current ratings. All are functionally identical (figure 475-4-5).

475-4.4.3 TYPE MCD. Type MCD degaussing equipment is installed on FFG 7 class ships. This equipment consists of a fluxgate-type triaxial magnetometer, control unit, remote control unit, and power supply unit for each installed degaussing coil. It is essentially a combination of type EMS equipment and type SSM equipment. The magnetometer and control unit are functionally similar to the type EMS magnetometer and control unit. The main differences are that additional compensation features are provided to minimize the effect of the ship's magnetic field at the magnetometer and the control unit outputs are current signals to the power supplies instead of currents to the degaussing coils. The remote control unit and the power supplies are similar to the type SSM remote control unit and power supplies.

475-4.5 DEGAUSSING EQUIPMENT OPERATION, GENERAL

General information on operating automatic degaussing equipment is given in paragraphs 475-4.5.2 through 475-4.5.3.5. However, technical manuals are furnished with all AUTODEG control equipment and these manuals should be consulted for detailed operation information. Technical manuals were not furnished with older, operator control-type equipment. Information on operating this equipment is provided in the ship's degaussing folder and paragraph 475-4.5.3.5.

475-4.5.1 ESSENTIAL POINTS. The essential points in degaussing equipment operation are:

a. Energize the degaussing equipment in accordance with the instructions furnished with the equipment.

b. Set and maintain the coil currents to the values specified in the ship's degaussing folder.

c. Periodically monitor the trouble indicators and coil currents for indications of equipment malfunctions.

475-4.5.2 MAGNETOMETER-CONTROLLED AUTODEG EQUIPMENT OPERATION. Two modes of operation are used for magnetometer-controlled AUTODEG equipment.

475-4.5.2.1 Automatic Operation. Magnetometer-controlled equipment, when set up for automatic operation, will control the currents in the ship's degaussing coils in a manner that will compensate for the ship's permanent and induced magnetism regardless of the ship's heading, roll, pitch or geographic location. Automatic operation is the normal mode and consists primarily of turning the equipment on and periodically monitoring the front panel in-

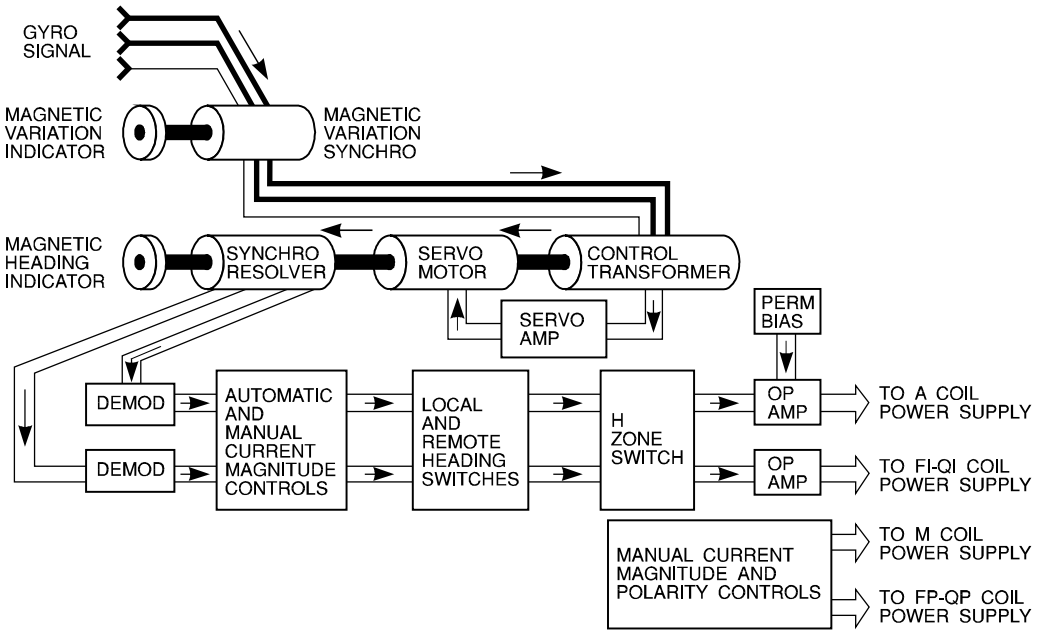


Figure 475-4-4. Block Diagram for Type SSM Degaussing Switchboard.

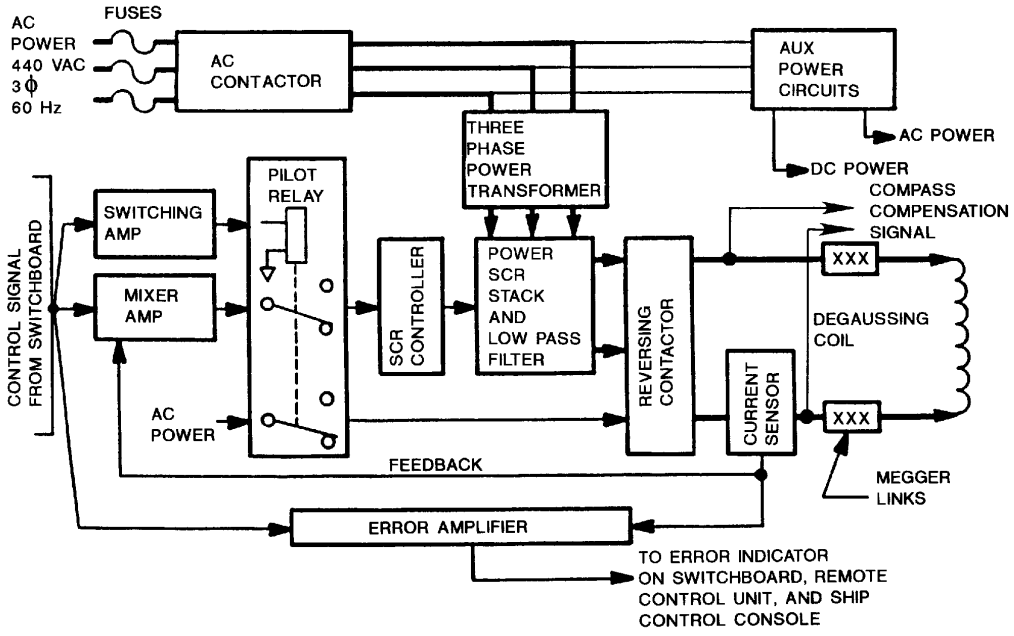


Figure 475-4-5. Block Diagram for Type SSM Degaussing Power Supply.

dicators and current outputs for indications of equipment malfunction.

475-4.5.2.2 Automatic Performance Checks. During calibration of the degaussing system at a degaussing range, the coil turns, current magnitude and current polarities are established. When

calibration is completed, the coils are connected for proper turns, the equipment is adjusted for automatic operation, and all pertinent information is recorded in the ship's degaussing folder. During normal (automatic) operation, none of the controls are adjusted or reset. Trouble indicators should be monitored periodically. Current outputs should be checked as follows:

a. The magnitude and polarity of permanent coil (FP-QP and P-coils) currents should be measured and compared with the values specified in the ship's degaussing folder.

b. Magnetometer outputs should be checked by comparing the indicated field strength for each axis with the values given in the ship's degaussing folder for the ship's position. Measurements should be made with the ship on cardinal magnetic headings with little roll and pitch. This procedure will provide, at best, a rough check of the magnetometer outputs because the indicated field strengths are affected by the roll, pitch, trim, and list of the ship. Also, only approximate values of the earth's local field can be obtained from charts in the degaussing folder.

c. The coil (M, A, L, FI-QI coils) currents for induced magnetic compensation should be measured and compared with the indicated field strengths. The magnitude of these currents should be directly proportional to the field strength indicated, the induced magnitude control setting, and the perm current setting (paragraph 475-3.14). Charts in the degaussing folder provide coil currents versus indicated field strengths for induced compensation coils on cardinal headings. The adjustment of induced magnitude and perm current control settings can be checked by comparing the current versus field strength values specified on the chart with the current versus field strength values measured.

475-4.5.2.3 Manual Operation.

Magnetometer-controlled equipment provides for operator control of degaussing coil currents when a fault exists in the magnetometer group circuits. Adjustments associated with the ship's heading and the earth's local field (H- and Z-zone of operation) are made during manual operation. Since the operator-set heading and the earth's field inputs only approximate optimum inputs, and since no roll or pitch inputs are provided, compensation of the ship's induced magnetism with manual operation is not as good as the compensation obtained with automatic operation. For this reason, when automatic operation is not possible, only the affected coil or coils should be operated manually. The general procedure for manual operation is:

a. Set the eight-course heading switch for the ship's magnetic heading (not required for manual operation of M-coil).

b. Set the M-coil polarity switch for the polarity specified in the ship's degaussing folder (positive for northern latitudes).

c. Set the operational mode switch for manual operation.

d. Check the coil current magnitude and adjust the manual current control, if required (see CAUTION below), for the current specified in the degaussing folder for the ship's zone of operation.

e. Keep the heading switch set to the position corresponding to the ship's magnetic heading and the coil current magnitude adjusted for proper H- or Z-zone of operation.

CAUTION

Setting the heading switch to positions other than the positions corresponding to the ship's magnetic heading can result in degaussing coil currents with the wrong magnitude or wrong polarity, which can be dangerous in a magnetic mine danger area. Current magnitudes should be adjusted in mine danger areas without changing the heading switch position. The procedure follows:

f. Adjust the manual induced magnitude controls as follows:

1. M-COIL. Adjust the control to obtain the current specified for the new location on the degaussing chart (see the ship's degaussing folder).

2. A-COIL. If the heading switch is set in the E or W position, adjust the control to obtain the current specified for the new location on the degaussing chart. If the switch is set for an intercardinal heading, set the control to obtain 70 percent of the current specified for the new location. If the heading switch is set in the N or S position, do not adjust the control until the ship's heading changes so that the heading switch is set to a new position.

3. L-COIL and FI-QI COIL. Magnitude control for this coil is adjusted in the same manner as for the A-coil, except that adjustments are made with the heading switch in the N, S, and intercardinal heading positions. Current should not be adjusted when the switch is set to the E or W headings.

475-4.5.2.4 Technical Manual Consultation for Exact Procedures.

Exact procedures vary with the equipment installed. Some types of equipment have separate manual current controls which should be preset so that they do not have to be adjusted when coils are switched to manual operation. On equipment with common current controls for automatic and manual operation, the controls should be adjusted for zero current (maximum CCW) before switching to manual operation. The technical manual furnished with the equipment should be consulted for detailed information on adjusting the currents and operating equipment.

475-4.5.3 GYRO-CONTROLLED AUTODEG EQUIPMENT OPERATION.

As with magnetometer-controlled equipment, gyro-controlled AUTODEG equipment has two modes of operation.

475-4.5.3.1 Automatic Operation.

Gyro-controlled equipment, when set up for automatic operation, will automatically make changes in coil currents required because of changes in the ship's heading. Gyro-controlled equipment will not automatically make changes in the coil currents necessary when the ship changes its magnetic latitude (H-zones).

NOTE

Some equipment would automatically change coil currents for changes in the ship's roll and pitch, thus providing roll and pitch compensation. The following description does not pertain to this type of equipment, which is now obsolete and has been converted to magnetometer control or removed from service.

475-4.5.3.2 Automatic Operation Setup. Automatic operation is the normal mode of operation and consists primarily of energizing the equipment, periodic monitoring for indications of malfunction, and adjusting the current controls as a ship moves from one H- or Z-zone to another. Gyro-controlled equipment, like magnetometer-controlled equipment, is completely set up and adjusted in accordance with ship's Degaussing Folder, appendix A, when the ship's degaussing system is initially calibrated at range. Some controls on this equipment, however, must be set each time the equipment is energized. The general procedure for automatic operation is:

a. Set the magnetic variation, H-zone, M-coil polarity, and FP-QP coil polarity controls to the settings corresponding to the ship's geographic location as obtained from the ship's degaussing folder.

b. Set the FI-QI and A-coil operation mode switches and test switches for automatic operation. Energize the equipment by turning on all the coil power switches.

c. Adjust the M- and FP-QP current magnitude controls for the current specified in the degaussing folder for the ship's position.

d. Keep the magnetic variation, H-zone, M-, and FP-QP current polarities and magnitudes set for the ship's geographic location.

e. Periodically monitor the trouble indicators for any indication of malfunction.

475-4.5.3.3 Automatic Operation Performance Checks. Periodically monitor the currents and compare them with the values specified in the degaussing folder for the ship's location. (Refer to the coil current tables in the ship's Degaussing Folder.) The magnitude and polarity of FI-QI and A-coil currents will vary with the ship's heading. These should be monitored on cardinal headings or calculated. The FI-QI current should be equal to the value specified for the ship's location, multiplied by the cosine of the ship's magnetic heading angle. The A-coil current should be equal to the value specified for the location, multiplied by the sine of the magnetic heading angle.

475-4.5.3.4 Manual Operation of Gyro-controlled Equipment. Gyro-controlled equipment has a provision for operator control of the FI-QI and A-coil currents with a loss of gyro signal or a fault in the control computer. Manual operation consists of keeping the heading switch set for the ship's magnetic heading and the H-zone switch set for the ship's position. Since step inputs from the heading switch only approximate the heading signals from the gyro and control computer, the ship's induced magnetism compensation during manual operation is not as good as that provided by automatic operation. Consequently, the equipment should be operated manually only when normal operation is impossible.

475-4.5.3.5 Manual Operation

Setup. The equipment should be set up for manual operation (the manual induced magnitude current controls should be adjusted and locked) at the same time it is set up for automatic operation. This will enable the operator to switch from automatic to manual operation without having to adjust the current magnitude because incorrect current or changes in current magnitudes and polarities can be dangerous in a mine danger area. If the reason for switching to manual operation is defective automatic operation, see "Operating with Defective Equipment" in the instructions appendix section of the ship's Degaussing Folder. The general procedure for manual operation of the FI-QI or A-coil is:

a. Set the local-remote transfer switch for local operation, the H-zone switch for the ship's position and the eight-course heading switch for the ship's magnetic heading.

b. Set the operational mode switch for manual operation and the power switch to on.

c. Keep the H-zone set for position and the heading switch set for magnetic heading.

d. Periodically monitor the trouble indicators and currents for indications of malfunction. The current magnitude and polarity will depend on the heading switch position. The magnitude should be zero, 70 or 100 percent of the value specified in the degaussing folder for the ship's position. Currents should be monitored without switching the heading switch. Indiscriminately switching the heading switch will result in currents with incorrect magnitude and polarity. Current magnitudes can be adjusted, if necessary, for 70 percent on intercardinal headings and for 100 percent on cardinal headings (adjust the FI-QI on north-south headings and the A-coil on east-west headings).

e. The heading switch at a remote location can be used for manual operation by first setting the heading switch at the remote location to the ship's magnetic heading and then setting the local-remote transfer switch for remote operation. Indiscriminately switching the local-remote transfer switch will result in currents with the incorrect magnitude and polarity.

475-4.5.4 OPERATOR CURRENT CONTROL EQUIPMENT.

Coil currents in the older, manual degaussing installations (paragraph 475-4.1) should be controlled as follows:

475-4.5.4.1 General Procedures.

For each ship, the degaussing folder gives the current needed for each coil for all positions on the earth's surface and for all headings. One or more of the coil currents must be changed when one of the following occurs:

a. When the ship passes from one Z-zone into another (see degaussing chart 1 in degaussing folder).

b. When the ship passes from one H-zone into another (see degaussing chart 2 in degaussing folder).

c. When the ship's heading changes from one sector to another. The entire range of headings from 0 to 360 degrees is divided into a number of sectors, each covering a part of the whole range of courses. See the course correction setting, diagram 1 or 2; or course correction setting, table 1, 2 or 3, in the degaussing folder. None of the degaussing coil currents is changed as long as the course remains in one sector; some of the coil currents must be changed when the course changes from one sector to another.

475-4.5.4.2 Detailed Adjustments. Changes required are as follows:

a. The FP-QP coil current is not changed no matter how the heading of the ship's position changes.

b. The M-coil current must be changed when the ship moves from one Z-zone to another. It is not changed when the ship moves from one H-zone to another, or when the heading changes from one sector to another.

c. The F, Q, FI-QI, L-, and A-coil currents are not changed when the ship moves from one Z-zone to another, but must be changed if the ship moves to a different H-zone, or the heading changes to a different sector. In a few ships, exceptional conditions may require a departure from the foregoing schedule of changes. In all cases, the degaussing folder will show the currents to be used.

SECTION 5. DEGAUSSING SYSTEM MAINTENANCE

475-5.1 PREVENTIVE MAINTENANCE

Preventive maintenance shall be performed in accordance with the appropriate Planned Maintenance System (PMS) documentation.

475-5.2 CORRECTIVE MAINTENANCE

Degaussing system equipment requiring maintenance can be grouped in two general classes: degaussing coils (cable, cable fittings, connection boxes), and control and power equipment (control units, switchboards, power supplies, magnetometers, generators). Maintenance information for each class is available from various sources.

475-5.2.1 DEGAUSSING COILS.

See the ship's detail drawings on degaussing for information on installed coils, their location, connections, marking, and so forth. NSTM Chapter 300, **Electric Plant General**, has instructions on the maintenance of this class of equipment.

475-5.2.2 CONTROL AND POWER EQUIPMENT.

Applicable technical manuals on control and power equipment cover specific information for installed equipment. NSTM Chapter 300, **Electric Plant General**, outlines the general instructions on the maintenance of most of this equipment (motors, generators, switchboards, circuit breakers, contactors, relays). See NAVSEA 0967-LP-000-0160, **Electronics Installation and Maintenance Book**, for general instructions on the maintenance of solid state equipment.

475-5.3 TECHNICAL INFORMATION SOURCES, DEGAUSSING EQUIPMENT AND SYSTEMS

Further information on degaussing equipment is available from:

a. Technical manuals for the operation and maintenance of degaussing power and control equipment

b. Ship's detail drawings for degaussing coil installation

c. Ship's degaussing folder on coil installations, types of control and power equipment installed, and coil turns and current settings.

d. NAVSEA S9475-AF-OMI-011, **Degaussing Manual**, covers detailed information on design, installation, and maintenance requirements of shipboard degaussing systems and equipment.

Personnel responsible for the operation, care and maintenance of degaussing systems should be thoroughly acquainted with these documents and should refer to them during equipment maintenance.

SECTION 6. MAGNETIC RANGES AND RANGING

475-6.1 RANGE DESCRIPTION

A magnetic range is a station equipped to measure and record the magnetic field of ships that pass over measuring equipment located at or near the bottom of the channel in which the ships travel. A ship is said to be **ranged** when its magnetic field is measured at a magnetic range.

475-6.2 PURPOSE OF RANGING-CHECK RANGING

Check ranging determines that the ship's degaussing installation is operating satisfactorily. The following operating conditions are checked:

a. Adequacy of current settings in degaussing coils.

b. Performance of degaussing equipment and personnel.

475-6.3 PURPOSE OF RANGING - CALIBRATION

Calibration ranging serves the following functions:

a. Determines initial degaussing coil current settings.

b. Provides information for degaussing charts.

c. Indicates when changes or modifications are required to the degaussing installation. Maintenance and updating of degaussing forms is presented in NAVSEA S9475-AC-PR-010, **Degaussing Forms, Records, and Reporting Procedures**.

475-6.4 FREQUENCY OF RANGING

All ships that have degaussing coils or are magnetically treated by Flash-D (paragraph 475-7.1.2) are required by CNO to perform a satisfactory check ranging in accordance with OPNAVINST C8950.2, **Magnetic Silencing**. Any ship that exceeds the satisfactory check range limits must undergo calibration ranging or magnetic treatment as soon as possible.

475-6.5 SHIP'S RESPONSIBILITIES FOR ACCURATE RANGING

All ships must proceed as follows:

a. The ship must pass directly over the range at a constant speed and heading.

b. The degaussing coils must be set correctly.

c. The Range Officer must be notified of the coil settings.

d. The Range Officer must be notified of the ship's draft, forward and aft, to the nearest 6 inches, for depth correction.

e. The Range Officer must be notified of the ship's magnetic heading at the time the ship crosses the degaussing range.

f. Ships with magnetometer-controlled degaussing equipment, (e.g., type MCD), should report their millioersted readings as well as the coil currents at time of crossing range.

475-6.6 MINESWEEPER OFF-LOAD PROCEDURES

Minesweepers shall off-load all unauthorized magnetic material and ensure that all authorized magnetic material is stowed in its proper location before ranging. The Magnetic Material Control Officer is responsible (check applicable minewarfare instructions).

475-6.7 SHIP'S DEGAUSSING FOLDER

475-6.7.1 DEGAUSSING FOLDER CONTENT.

The degaussing folder is an official ship log. It contains information on the magnetic treatment of the ship, instructions for the operation of the shipboard degaussing system, degaussing charts, values for the coil current and loop turn settings, installation information forms, compass compensating forms, and a log section showing all pertinent details of magnetic treatment and action taken on the ship's degaussing system.

475-6.7.2 DEGAUSSING FOLDER PREPARATION BY DEGAUSSING RANGE PERSONNEL.

The folder is prepared and issued to a ship by the Magnetic Silencing Facility that renders the initial magnetic treatment and degaussing system calibration. During calibration ranging, induced field and perm field current magnitudes and polarities are established for each coil, and loop turns are established for all loops. Current setting charts are prepared to provide the ship's personnel with up-to-date magnitudes and polarities to be used for any position on the earth's surface and any heading of the ship.

SECTION 7. MAGNETIC TREATMENT

475-7.1 TYPES

The two types of magnetic treatment commonly used are deperming and flash-D. Deperming is used only for ships that are degaussed by coils. Flash-D is used for ships that are degaussed by magnetic treatment alone and are not equipped with degaussing coils.

475-7.1.1 DEPERMING. Deperming is a large-scale way of demagnetizing a watch. Its purpose is to reduce permanent longitudinal and athwarthship magnetization and stabilize permanent vertical magnetization. When the permanent magnetism becomes excessive, to the point where the degaussing coils cannot provide adequate compensation, the permanent magnetism must be reduced. The process of removing permanent magnetism is called "deperming." Ships are usually depermed when then are first commissioned, and then again later, as determined necessary by a degaussing range.

475-7.1.2 FLASH-D. Flash-D is a magnetizing process that eliminates permanent longitudinal and athwartship magnetization. It produces a permanent vertical magnetic field that is equal to and opposite the induced vertical magnetic field for a specific geographic operating area.

475-7.2 EFFECTIVENESS

Induced vertical magnetization changes with a ship's location on the earth; permanent vertical magnetization does not. Therefore, the cancellation of the vertical magnetization by flash-D is complete only for a particular value of the earth's magnetic field. When the ship moves to a place where the earth's magnetic field is different, the cancellation is not as good and the ship is not as well degaussed. Since induced athwartship and longitudinal magnetization change with the heading, magnetic treatment is not used to reduce these fields. For this reason, degaussing by magnetic treatment alone is not extensively used on ships having other than limited operating areas.

475-7.3 FREQUENCY

All new ships required to be degaussed must be depermed or have a flash-D magnetic treatment. Ships exceeding the magnetic field limits (with onboard degaussing systems optimally adjusted) of NAVSEA S5475-AC-MMM-010/(C), **Magnetic Ranging and Calibration of Degaussing Systems - Degaussing Performance Criteria**, must undergo calibration ranging, be depermed, or have a flash-D magnetic treatment.

475-7.4 SHIP'S RESPONSIBILITY

The nearest magnetic treatment facility should be contacted and the ship scheduled for magnetic treatment when the ship has been notified that magnetic treatment is required. The ship will be issued instructions by the magnetic treatment facility as to the ship requirements and responsibilities while using the magnetic treatment facility.

475-7.4.1 SPECIAL PRECAUTIONS DURING MAGNETIC TREATMENT. During deperming of surface ships and submarines, as well as during flash-D treatment, high magnetic field intensity on the order of 1,600 amp/meter can be measured in and near the ship. Some local fields may be greater and various individual components as well as operating equipment may be altered by this magnetic field strength.

Equipment that may be affected is described in the following paragraphs along with special precaution procedures to be observed to avoid difficulties.

475-7.4.2 EQUIPMENT AND ORDNANCE PRECAUTIONS.

Special precautions concerning guided missiles, missile guidance and control sections, rocket motors and missile boosters, electric bomb fuses, nuclear weapons, and ship's equipment must be adhered to before and after arrival at the magnetic treatment facility.

475-7.4.3 SUBMARINE GENERIC EQUIPMENT PRECAUTIONS.

Equipment aboard submarines has components that may be influenced by the magnetic treatment field. Although this equipment may not be addressed specifically, the following considerations give guidance on whether to pursue offloading procedures.

475-7.4.3.1 Effects on Computers.

Computer elements such as logic components (transistor transistor logic [TTL], complementary metal oxide semiconductors [CMOS], emitter coupled logic [ECL], resistor transistor logic [RTL], medium-scale integration [MSI], and large-scale integration [LSI] circuits, read-only memories [ROMS], programmable read-only memories [PROMS], erasable programmable read-only memories [EPROMS], electronically erasable programmable read-only memories [EEPROMS], and random access memories [RAM]) are not affected by the demagnetizing magnetic treatment field. A variety of computer magnetic storage items, however, should be protected by offloading or storage in shielded lockers before magnetic treatment. These items are:

a. Computer floppy disks.

b. Personal and mainframe computer hard drives.

c. All magnetic memory elements for weapons systems.

NOTE

Although mainframe computer tape backups can be removed easily, mainframe and personal computer hard drives require considerable effort to remove and can be protected best by removing the computer with the hard drive installed. (To do so, position the hard drives of personal computers to the move-protected position.)

475-7.4.3.2 Effects of Other Magnetic Elements.

All magnetic elements dependent upon magnetization for operation may be affected by the magnetic treatment field. Examples of items that could be affected are:

a. Video- and audiotapes

b. Credit cards such as are used for bank deposit or withdrawal.

475-7.4.3.3 Effects on Cathode Ray Tube (CRT) Displays.

Displays (now in use for radar presentations) aboard ship are devices that function by electrostatic or electromagnetic deflection. Those that function by electrostatic deflection (such as the type 25G raster scanned deflection system) would not be influenced by electromagnetic deperming or degaussing. It is possible that magnetic fields caused by deperming may influence the electromagnetic deflection display types. After deperming is complete and magnetic field levels aboard ship are normal, the magnetic history of some display devices, including television sets, can be reset by turning the

display on and off and then on again. Other electromagnetic displays, such as the type 25A and 25D types, have been designed to the requirements of MIL-STD-2036, **General Requirements for Electronic Equipment Specifications**, and are immune to electromagnetic interference due to internal magnetic shielding. Any residual interference with a display due to deperming should be reported to the respective equipment program manager for resolution after the on-off-on procedure has been implemented.

475-7.4.4 SPECIFIC SUBMARINE WEAPONS PROTECTION PROCEDURES.

475-7.4.4.1 Strategic Weapons Protection.

Precautions for protection of submarine strategic weapons are described in SSPINST 8950.2, Subj: "**Procedures for Protection of Fleet Ballistic Missile (FBM) Strategic Weapon System Components During Flash Deperm Treatment of an SSBN 598, 608, 616, (616-659 including the C-4 Backfit configurations), and 726 Class (TRIDENT) Submarines.**"

475-7.4.4.2 MK48 ADCAP Torpedo Procedures During Deperming/ Flash Magnetic Treatment.

Current protection procedures for the MK48 ADCAP Torpedo are as follows:

a. No torpedoes in firing tubes during magnetic treatment.

b. Torpedo room secured with all hatches closed.

c. Deperm cables shall not pass within 0.66 meter of torpedoes in storage racks.

475-7.4.4.3 TOMAHAWK Missile Offload and Protection Procedures During Deperming/Flash Magnetic Treatment.

Current protection procedures for the Tomahawk missile aboard submarines requires that the missiles be offloaded during the magnetic treatment process.

475-7.4.5 SPECIFIC SUBMARINE EQUIPMENT PROTECTION PROCEDURES DURING DEPERMING/ FLASH MAGNETIC TREATMENT.

Precautions for the protection of the ship's installed equipment are as follows:

a. **Radio Navigation and Communication Equipment: AN/BLD-1, AN/WLQ-4, AN/WLR-8, AN/WRN-5, AN/SRN-19 and OMEGA Set AN/BRN-7**. The magnetic tapes used to load the computer portion of the AN/WRN-5 and the AN/BRN-7, and the cassette tapes used for recording with the AN/SRN-19, shall be removed and stored off the ship in a clean, dry area away from deperming fields. The magnetic tape cartridge assembly should be stored in a clean plastic bag after it is removed from the unit. The magnetic tape itself should not be touched or scraped. The two AN/WRN-5 magnetic core memory modules, MFR-12813 and MPN 625521-801, and the AN/BRN-7 core memory unit, MU-6O1URN, shall be removed from the ship and stored in a clean, dry area away from all deperming fields during flash-deperm. The AN/SRN-19 radio receiver should be turned off during flash-deperm. The AN/BLD-1, AN/WLQ-4, AN/WLR-8 and WLR-8 Augmentation systems should be de-energized in accordance with the applicable technical manuals. All magnetic tapes shall be stored in appropriate magnetic tape cases and removed from the ship.

AN/WRR-7 VERDIN - Remove the RD-350 Magnetic Tape Unit (MTU) from the processor (CP-1071) and the spare RD-350 and

remove them from the ship to a clean, dry area away from the deperming fields.

b. **Infrared Viewers and Infrared Metascopes**. Infrared viewers or infrared metascopes, if aboard, shall be removed during flash-deperm, as a precautionary measure.

c. **Fire Control Equipment, including MK 113 MOD 9, MK 117, MK 118, CCS MK1 (all mods), CCS MK2 (all mods), and AN/BSY-1.** All fire control equipment, including MK 113 MOD 9, MK 117, MK 118, CCS MK1 (all mods), CCS MK2 (all mods), and AN/BSY-1 shall be de-energized in accordance with the applicable technical manuals.

d. **Magnetic Tape System UNIVAC 1840 (RD-358) and 0J-172 (DEAC)**. Remove the magnetic tapes from the tape transports, insert them in shipping containers, and place them in the assigned storage cabinet.

e. **Ships Inertial Navigation System (SINS) MK 2 MOD 1 Equipment**. The following special precautions are required for the SINS components of the navigational subsystem installed on SSN 594 class (614-615).

1. The SINS shall be turned off in the normal manner. If desired, the SINS may be left in the **PRIMARY POWER MODE STANDBY** to keep heat on the gyros and thus reduce startup time slightly.

2. Remove the VERDAN computer drawer from the navigation console and from the auxiliary control console. Remove the spare VERDAN magnetic memory, P/N 55370-304. Store this equipment off the ship in a clean, dry area away from the deperming fields.

3. Inertial components may be left installed during deperming operations. Spare inertial components may be left onboard if they are not stored within 2 meters of the hull structure. Spare inertial components may be moved temporarily within the submarine to meet the distance limitation.

4. Once the SINS has been shut down for deperming, adequate time for temperature stabilization should be allowed after restarting and before any scheduled operations involving the SINS. Sufficient time should be allowed for normal startup, temperature stabilization and calibration procedures necessary to attain a stable, well-settled system.

5. Following deperming, scale factors and gyro bias runs shall be conducted before use of the system for navigation.

NOTE

Detailed procedures for removal and replacement of the SINS computers and for the SINS operation and calibration are covered in: NAVSEA 0324-LP-047-7010 through 7120, Technical Manual for SINS MK 2 MOD 1.

f. **SINS MK 3 MOD 4 and MOD 6 Equipment**. The following special precautions are required for the SINS components of the navigation subsystem installed on SSN 637 class and SSN 671 submarines.

1. Preferably keep the SINS in the NAVIGATE mode with the monitor closed loop. Any other mode, including OFF, however, is acceptable.

2. Service the SINS, if ON, from the static inverter (primary) or a ship service generator (secondary).

3. All the operating SINS components shall be left installed during the deperming operations. The following spare components may be left on board if they are not stored within 2 meters of the hull structure. These components may be moved temporarily within the submarine to meet this distance limitation:

(a) Spare gyros (2), P/N 1686038-2 or -4.

(b) Spare PIPAs (2), P/N 1685291-2.

(c) Spare magnetic drum memory (1), P/N 1601871 on MOD 4, P/N 633083 on MOD 6.

(d) Spare magnetic core memory (1), P/N 1602144 on MOD 4, P/N 753141 on MOD 6.

(e) Module test set on MOD 6 only.

(f) Spare magnetic tape assembly (1), P/N 2686585-1 for module test set on MOD 6 only.

4. Following deperming, reset the SINS, using 8 hours of data, and then perform the gyro scale factor calibration using the Theta "D" procedure.

NOTE

Detailed procedures for operation and calibration of the SINS are covered in: NAVSEA 0324-LP-064-5000 series, Technical Manual for SINS MK 3 MOD 4 and NAVSEA 0924-LP-022-1000 Technical Manual for SINS MK 3 MOD 6.

g. **Dual Miniature Inertial Navigation System (DMINS), AN/WSN-1(V)2**. The following special precautions are required for the DMINS components of the navigation system installed on SSN 594 class, SSN 637 class, and SSN 688 class submarines.

1. Turn off the DMINS in the normal manner.

2. Leave all components of the DMINS, including the spare IMU, installed during the deperming operations.

3. Following deperming, perform VM and gyro calibration.

NOTE

Once the DMINS has been shut down for deperming, adequate time should be allowed after restarting for normal startup and calibration procedures to attain a stable, well-settled system. Detailed procedures for the DMINS shutdown, turn-on, and calibration for these ships are included in the applicable navigation operating procedures and in the SSN 688 Class Ship Systems Manual, volume 6, part 3, chapter 1, section 4.

h. **Recorder/Reproducer.** Special precautions are required for the AN/UYH-2 and AN/BYH-1 SUBRASS installed on SSN 637 class and SSN 688 class submarines equipped with MK 117, MK 118, CCS MK1, (all mods), CCS MK2 (all mods), and AN/BSY-1.

AN/BSY-1, and Combat Control System Magnetic Storage Media. Blank/spare disks and tapes, as well as those with information recorded on them, need protection from the deperm fields. The following magnetic data/program storage media shall be removed before beginning the flash deperm procedure:

1. SUBRASS (Submarine Random Access Storage Set) DTD's (Data transfer devices): CC-3, Acoustic-3, OTH (Over the Horizon), TLAM (Tomahawk Land Attack Missile) mission.

2. AN/ASH-34 tape cartridges.

3. Work tape recorder (Studer-Revox) cassettes.

4. Tactical Support Device (TDS) hard and floppy disks.

The magnetic disk packs used in the recorder/reproducer shall be stored in the carrying case or in the equipment.

NOTE

Some SSN 688 class submarines may have provided for the storage of the disk packs in a stowage locker designed to protect them against strong magnetic fields.

i. **AN/BQQ-5 Sonar**. Special precautions are required for the AN/BQQ-5 sonar installed on SSN 637 class and SSN 688 (pre-SSN 751) class submarines. Remove all backup program tapes and store them off the ship in a clean, dry area away from the deperming fields.

j. **SSBN 726 (TRIDENT) Class Submarines CCS Subsystems (MK 118 FCS) and AN/BQQ-6 Sonar System**.

1. In accordance with existing operating procedures, turn off the electrical power to all equipment except the cesium beam frequency standard.

2. Securely fasten the equipment drawers and doors in the closed position.

3. Remove the magnetic tapes and disc packs, including the spares not housed in a protective environment, and store them off the ship in a clean, dry area away from the deperming fields.

4. Upon completion of the deperming, return the tapes and discs to their locations and power up the equipment in accordance with the existing operating procedures.

k. **AN/WSN-2 and AN/WSN-2A, Stabilized Gyrocompasses**. The following special precautions are required for the AN/WSN-2 installed on SSN 688 class submarines (716-725 and 750) and the AN/WSN-2A installed on SSN 688 class submarines (751-773).

1. Turn off AN/WSN-2 or 2A in normal.

2. The spare inertial measuring unit (IMU) should be installed in the storage container, and the navigation control group (NCG) door should remain closed during deperming operations.

l. **AN/WSN-3, Electrically Suspended Gyro Navigator (ESGN)**. The following general precautions are required for the AN/WSN-3 installed on SSN 688 and SSN 637 class submarines:

1. The ESGNs may be in any mode (cage, stabilized, or off). The spare IMU should be installed in the storage container, and the NCG doors should remain closed during the operation. Any spare modules normally stored within 1.2 meters of the outer hull should be removed to a more central location within the ship.

m. **Other Equipment**.

1. Remove the magnetic tapes from the tape transports. Place all the magnetic tapes in magnetic tape stowage lockers.

2. Remove the following equipment from the ship before magnetic treatment:

(a) Chronometers and navigation watches.

(b) Magnesyn compass transmitters and soft iron compass correctors (flinders bars).

NOTE

If specific equipment is not listed and it is suspected that magnetic treatment or degaussing could affect it, contact the respective equipment program manager.

(c) Cesium Beam Clocks for IMA storage.

NOTE

The equipment must be plugged into a power source immediately. It has a battery supply capable of maintaining the equipment for 1/2 to 2 hours. If kept without external power for longer periods, the clocks must be sent back to a laboratory for recalibration.

475-7.4.6 SURFACE SHIP GENERIC EQUIPMENT PRECAUTIONS. Equipment aboard surface ships possesses components that may be influenced by the magnetic treatment field. Although this equipment may not be addressed specifically, the following considerations give guidance on whether to pursue offloading procedures.

475-7.4.6.1 Effects on Computers. Computer elements such as logic components (TTL, CMOS, ECL, RTL, MSI and LSI circuits, ROMS, PROMS, EPROMS, EEPROMS, and RAMS) are not affected by the demagnetizing magnetic treatment field. However, a variety of computer magnetic storage items should be protected by offloading or storage in shielded lockers before magnetic treatment. These items are:

a. Computer floppy disks

b. Personal and mainframe computer hard drives

c. All magnetic memory elements for weapons systems.

NOTE

Although mainframe computer tape backups can be removed easily, mainframe and personal computer hard drives require considerable effort to remove and can be best protected by removing the computer with the hard drive installed. (To do so, position the hard drives of personal computers to the move-protected position.)

475-7.4.6.2 Effects on Other Magnetic Elements. All magnetic elements dependent upon magnetization for operation may be affected by the magnetic treatment field. Examples of items that could be affected are:

a. Video- and audiotapes

b. Credit cards such as are used for bank deposit or withdrawal.

475-7.4.6.3 Effects on Cathode Ray Tube (CRT) Displays. Displays (now in use for radar presentations) aboard ship are devices that function by electrostatic or electromagnetic deflection. Those that function by electrostatic deflection (such as the type 25G raster scanned deflection system) would not be influenced by electromagnetic deperming or degaussing. It is possible that magnetic fields caused by deperming may influence the electromagnetic deflection display types. After deperming is complete and magnetic field levels aboard a ship are normal, the magnetic history of some display devices, including television sets, may be reset by turning the display on and off and then on again. Other electromagnetic displays, such as the type 25A and 25D types, have

been designed to the requirements of MIL-STD-2036, **General Requirements for Electronic Equipment Specifications**, and are immune to electromagnetic interference due to internal magnetic shielding. This is more likely to happen to a color display, where the color presentations are extremely sensitive to an interfering magnetic field. Such interference may be remedied by providing separation between the degaussing coil and the display. (This would be more likely to happen to displays mounted below deck, in close proximity to the degaussing coils. Where no degaussing coils exist, there is no potential for this influence.) Any potential interference with a display by a degaussing coil or any residual interference with a display due to deperming should be reported to the respective equipment program manager for resolution after the above on-off-on procedure has been implemented.

475-7.4.7 SPECIFIC SURFACE SHIP WEAPONS PROTECTION PROCEDURES DURING DEPERMING MAGNETIC TREATMENT.

Precautions for the protection of the guided missiles, missile sections, and the ship's installed equipment are as follows:

a. **Guided Missiles, Missile Sections, and Torpedoes**. During ship magnetic treatment missiles must be stored only in the shipboard locations listed below. The precautions outlined for each location must be observed. No missile checkout operations should be conducted during the magnetic treatment.

1. **Missiles inside a closed steel hull or a closed regular steel stowage magazine**. The doors and hatches of the stowage compartment or magazine must be closed.

2. **Missiles inside a closed aluminum stowage magazine**. The doors and hatches must be closed. Deperm cables must be supported away from the side or overhead of magazine so as not to pass within 0.66 meter of a missile.

3. **For ASROC missiles wholly within a launcher**. Missiles must not project from the launcher, and deperm cables must not pass over the launcher.

4. **Missiles other than ASROC**. Such missiles must not be stowed on exposed launchers or inside box launchers outside the hull during the ship magnetic treatment.

5. **NATO SEASPARROW Missile System (NSSMS)** - In addition to the missile procedures covered in (a), the following procedures are to be observed for the SEASPARROW Missile.

(a) All spare programmable read only memory (PROM) circuit cards should also be stored in appropriate magnetic stowage containers/lockers and those installed in equipment be left installed with all cabinet doors closed throughout the deperming procedure.

(b) As a further precaution, all doors and hatches to all NSSMS equipment should be closed and secured during the deperming procedure.

6. **All Missile Systems** - Remove magnetic tapes from tape transports. Place all magnetic tapes in magnetic tape storage lockers.

7. Torpedoes shall not be stored in MK 32 torpedo tubes during magnetic treatment.

8. Torpedoes stored in magazine shall be treated as missiles. Paragraphs 1 and 2 preceding apply.

b. **Close-in Weapons System (CIWS) MK 15 ALL MODS**.

1. **Before magnetic treatment.**

(a) Store all MK 15 CIWS Operational Program tapes, diskettes, and tape cartridges inside the CIWS Local Control room or remove from the ship.

(b) Remove the motion transducer and its bracket (P/N 5191128) as a unit from the M61A1 20MM gun per OP 4154 Series (Block 0) and SW221 Series (Block 1). Store motion transducer and its bracket in the CIWS local control room or remove from ship.

2. **Following magnetic treatment**:

(a) Replace the motion transducer and bracket.

(b) Reload CIWS Operational Program.

475-7.4.8 SPECIFIC SURFACE SHIP INSTALLED EQUIPMENT PROTECTION PROCEDURES DURING DEPERMING MAGNETIC TREATMENT.

Precautions for the protection of ship installed equipment are as follows: Field and laboratory tests, to date, have indicated that magnetic treatment produces no adverse effects on many magnetically sensitive devices found aboard ship except for compasses and chronometers and that, excepting these, no special precaution need to be taken. These tests have been made on aircraft instruments, fuses, depth charges with magnetic pistols, and torpedoes with magnetic exploders. Special precautions may, however, be required with the advent of new devices.

a. **Protection of magnetic tapes.**

1. Remove the magnetic tapes from the tape transports. Place all the magnetic tapes in magnetic tape stowage lockers.

b. **Chronometers, navigation watches, and magnetic compasses.** Remove the following equipment from the ship before magnetic treatment:

1. Chronometers and navigation watches - Chronometers are to be removed from the ship before magnetic treatment while the degaussing coils are secured and placed where the field due to the treatment will not exceed 100 microtesla. (The magnetic field of the earth is approximately 50 microtesla.) Replacement on the ship must be done while the degaussing coils are secured. It is generally unnecessary to remove ordinary clocks and watches during magnetic treatment, although this may be done if desired.

2. Remove magnetic compasses and soft iron compass correctors under the following conditions:

Deperming cables should not be rigged closer than 4.5 meters to any magnetic compass on the ship, including the steering, standard, Magnesyn master, and life boat compasses. If this precaution cannot be observed, the compass systems, remote indicating devices, permanent magnet correctors, and transmitters should be removed.

Soft iron correctors must be removed from the ship during all magnetic treatments. The quadrantal spheres may also be removed if local experience has shown it to be desirable, although it is not usually considered necessary. Compensating magnets need not be removed. All magnetic compasses, including standard, steering, and lifeboat compasses, must be put in the free operating position unless they are removed from the ship. Magnetic treatment cables should not be rigged nearer than 2.0 meters to a vacated compass position.

c. **Protection of the Ship's Inertial and Compass Navigation Systems.**

1. **Clearance or removal of the compass** - Deperming cables should not be rigged closer than 4.5 meters to any magnetic compass on the ship, including steering, standard, and Magnesyn master compasses. If this precaution cannot be observed, the compass systems, remote indicating devices, permanent magnet correctors and transmitters should be removed. The compass clearance distance for submarines may be taken as 3 meters instead of 4.5 meters.

Soft iron correctors must be removed from the ship during all magnetic treatments. The quadrantal spheres may also be removed if local experience has shown it to be desirable, although it is not usually considered necessary. Compensating magnets need not be removed. All magnetic compasses, including standard and steering compasses, must be put in the free operating position unless they are removed from the ship. Magnetic treatment cables should not be rigged nearer than 2.0 meters to a vacated compass position.

After a ship has been given a magnetic treatment, it should be swung for adjustment of the magnetic compasses before sailing. When practicable, this should not take place the same day as the treatment. If absolutely necessary, the magnetic compasses may be adjusted on the same day, but in no circumstances should a ship be swung until 5 hours have elapsed since the treatment.

2. **The ship's inertial navigation system (SINS).**

Precautions for protection of the ship's inertial navigation system (SINS) MK 3, MOD 4, MOD 5, MOD 6, MOD 7, and MOD 8 during flash-deperm of surface ships are as follows:

(a) Preferably keep the SINS in the NAVIGATE mode with the monitor in closed loop. Any other mode, including OFF, however, is acceptable.

(b) Service the SINS, if ON, from the static inverter (primary) or a ship service generator (secondary).

(c) All operating SINS components shall be left installed during the deperming operations. The following spare components may be left on board if they are not stored within 2 meters of the hull structure. These components may be moved temporarily within the ship to meet this distance limitation:

- Spare gyros
- Spare PIPAs
- Spare magnetic drum memory on MOD 4, MOD 5, MOD 6, and MOD 8
- Spare magnetic core memory on MOD 4, MOD 5, MOD 6, and MOD 8
- CP-642B computer spare core memory chassis and control memory chassis on MOD 7
- Module test set on MOD 6 and MOD 7
- Spare magnetic tape cartridge for module test set on MOD 6 and MOD 7.

(d) Detailed procedures for removal and replacement of the SINS components and the operation of the SINS are covered in the applicable technical manuals listed below:

- NAVSEA 0324-LP-064-5110 through 5620, **Technical Manual for SINS MK 3 MOD 4**
- NAVSEA 0924-LP-001-2010 through 2120, **Technical Manual for SINS MK 3 MOD 5**
- NAVSEA 0924-LP-022-1010 through 1100, **Technical Manual for SINS MK 3 MOD 6**
- NAVSEA 0924-LP-038-8010 through 8120, **Technical Manual for SINS MK 3 MOD 7**
- NAVSEA 0924-LP-045-5010 through 5160, **Technical Manual for SINS MK 3 MOD 8.**

(e) Following deperming, reset the SINS using 8 hours of data; then perform the gyro scale factor calibration using the Theta D procedure.

d. **Other Surface Ship Equipment**.

1. Remove magnetic tapes from the tape transports. Place all magnetic tapes in magnetic tape stowage lockers.

2. Remove the following equipment from the ship before magnetic treatment:

(a) Chronometers and navigation watches

(b) Magnesyn compass transmitters and soft iron compass correctors (flinders bars).

NOTE

If specific equipment is not listed and it is suspected that magnetic treatment or degaussing could affect it, contact the respective equipment program manager.

475-7.4.9 CLEARANCE OF AMMUNITION, PYROTECHNICS, EXPLOSIVES, AND INFLAMMABLE MATERIALS.

All munitions, explosives, or flammable material forming part of the ship's regular equipment, except depth charges and torpedoes, shall be properly stowed below decks in magazines or topside in ready-service lockers. Cables shall clear ready-service lockers, depth charges, and torpedoes by at least 0.6 meter, and wooden boxes containing pyrotechnics or other flammables by at least 1.2 meters. All tanks, fuel oil bunkers, cofferdams, dry cargo spaces, and ullage plates are to be closed. Deperming cables are to be kept at least 1.2 meters away from the vents of such spaces.

475-7.4.10 CLEARANCE OF FUEL OIL BUNKERS.

In the case of ships other than tankers, it is desirable that turns be placed so that they do not lie over a fuel oil bunker and are at least 1 meter from any bunker bulkhead when its location is known.

475-7.4.11 RESTRICTIONS ON THE MAGNETIC TREATMENT OF TANKERS.

Tankers ordinarily used to carry combustible liquids of any kind must not be magnetically treated unless they meet one of the following conditions:

a. The ship shall be cleaned out and certified to be "gas free for personnel and fire."

b. The ship shall be cleaned out and certified to be "gas free for personnel only" not more than 24 hours before the magnetic treatment.

c. All cargo tanks, adjacent compartments, and other spaces suspected of containing explosive gases shall be cleaned out and proven free of explosive gases by the method prescribed in NSTM Chapter 074, **Welding and Allied Processes** and NSTM Chapter 541, **Petroleum Fuel Stowage, Use and Testing,** not more than 24 hours before treatment.

475-7.4.12 RESTRICTION ON DEPERMING OF SHIPS (OTHER THAN TANKERS) THAT CARRY COMBUSTIBLE LIQUIDS WITH A FLASH POINT BELOW 66 DEGREES C.

Ships, other than tankers, that carry gasoline, kerosene or any other liquid with a flash point below 66 degrees C in built-in structures just below the weather deck, just within the hull plating or in separate containers stowed just below the weather deck or near the hull plating, may be depermed under any one of the conditions below:

a. After discharge of the combustible liquid, provided that the precautions, exactly as specified for tankers in the preceding paragraphs, are observed.

b. Tanks or containers are at least 95 percent full. Compartments adjacent to these tanks or storage spaces containing the combustible liquid in separate containers shall be cleaned and proven gas free by the method prescribed in NSTM Chapter 074, **Welding and Allied Processes** and NSTM Chapter 541, **Petroleum Fuel Stowage, Use and Testing**, or certified "gas free for personnel" not more than 24 hours before the magnetic treatment.

475-7.4.13 RESTRICTIONS ON MAGNETIC TREATMENT OF SHIPS CARRYING EXPLOSIVES AS CARGO.

Ships whose cargo contains explosives or incendiary material may be magnetically treated only if:

a. The explosives are properly stowed below decks in accordance with applicable regulations for such stowage, and no such material is loaded just below the weather deck or near the hull plating.

b. Regulations governing the docking of such ships are complied with.

c. The precautions to prevent fire given in paragraphs 475-1.2.2 through 475-1.2.2.8 are rigidly observed.

Ships carrying a waiver permitting loading of the ammunition in a manner not in accordance with normal regulations or ships not conforming to the restrictions above shall not be magnetically treated. This paragraph does not apply in the case of ammunition and explosive weapons carried by the ship for its own use.

475-7.5 DEGAUSSING FOLDER FOR DEPERMED SHIPS

A ship's degaussing folder is also prepared for ships that are degaussed by magnetic treatment. These folders are prepared by the Magnetic Silencing Facility that renders the initial magnetic treatment. A log section shows details of the magnetic treatment and action taken on the ship as well as directions on preparing the degaussing charts that show the areas of operation in which the ship is satisfactorily degaussed. If the degaussing folder is lost, a replacement can be obtained by application to the nearest Magnetic Silencing Facility.

SECTION 8. COMPASS COMPENSATING INSTALLATION

475-8.1 PURPOSE/DESCRIPTION

Degaussing coils must produce large magnetic fields in order to provide satisfactory degaussing. Unless neutralized in the vicinity of the magnetic compass, these fields may be of sufficient magnitude to make the compass useless for navigation. Compass compensating coils are used to set up a compensating magnetic field that is equal and opposite to the degaussing coil field in the immediate vicinity of the compass.

475-8.1.1 VERTICAL COMPONENT. Almost all degaussing coils create a vertical component of a magnetic field at the compass. A vertical component at the compass causes the compass to deviate when the ship heels, even though it will usually cause no deviation when the ship is on an even keel. A compass compensating coil, called the heeling coil, is used to compensate for the vertical component of a magnetic field caused by the degaussing coils. The heeling coil is placed in a horizontal plane around the binnacle, usually at the level of the compass needle, with its vertical axis passing through the center of the compass. A heeling coil, hereafter referred as the compensation element for the "H" component, is used in all types of compass compensating coil assemblies. The heeling (H) coil compensates by canceling the total effect of vertical degaussing, which when the ship heels, contains a horizontal magnetic field component that would deflect the compass.

475-8.1.2 HORIZONTAL COMPONENT. The horizontal component of a magnetic field at the compass causes compass deviations whether or not the ship is on an even keel. Deviation due to degaussing on any heading can be obtained by subtracting the magnetic compass reading with degaussing OFF from the magnetic compass reading with degaussing ON. The horizontal component of a magnetic field is compensated by two perpendicular vertical coils or pairs of coils.

475-8.1.2.1 Horizontal Component Error. In figure 475-8-1, E represents the horizontal component of the magnetic field of earth, D the horizontal component of the magnetic field produced by a degaussing coil and R the resultant field. The magnetic compass will point in the direction of R and will therefore be in error by the angle θ. When the ship changes heading, D will move with it and θ, the compass error or deviation caused by degaussing, will change with the heading. This error can be eliminated by installing compass compensating coils to produce a magnetic field equal to -D at the compass. The result is to cancel the component D produced by the degaussing coil so that the compass will point in the direction of the magnetic field of earth.

475-8.1.2.2 Horizontal Component Error Compensation. A horizontal component of a magnetic field equal to -D can be produced by two intercardinally mounted coils that produce NE and NW components of a magnetic field (figure 475-8-2).

475-8.1.3 INTERCARDINAL COIL COMPENSATION. The NE and NW coils are known as intercardinal coils because they produce magnetic fields that are in the intercardinal directions when the ship is headed north. A single NE coil can be used as illustrated in figure 475-8-2, or alternatively, a pair of NE coils, one at each end of a diameter passing through the axis of the compass. The same is true of NW coils.

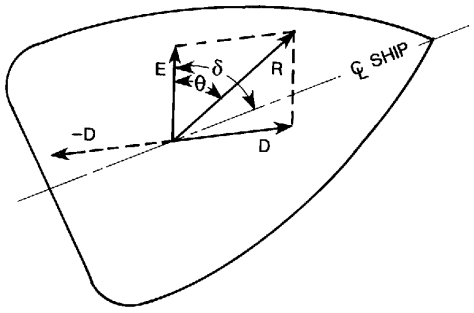


Figure 475-8-1. Degaussing Coil Magnetic Field Effect.

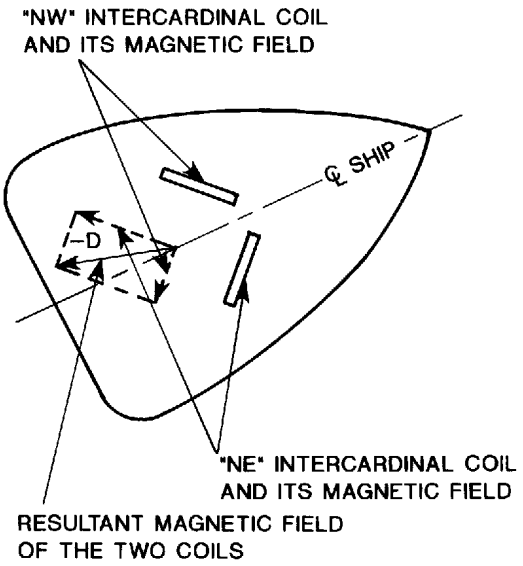


Figure 475-8-2. Compensation of Intercardinal Components of Degaussing Coil Magnetic Field.

475-8.1.4 COMPENSATION CURRENT RELATIONSHIP TO THE DEGAUSSING CURRENT. The magnitude of the magnetic field produced at the compass by a degaussing coil varies with the degaussing coil current. The magnetic field produced by the compass compensating coils must also vary in the same way to compensate for this field. This is arranged by connecting the equipment so that the compass compensating coil current is always the same fraction of the degaussing coil current. When this fraction is adjusted so that the magnetic fields produced by the degaussing coil and the compass compensating coil are equal and opposite, the balance between them is maintained no matter how the degaussing coil current varies. Doubling the degaussing coil current, for example, would double the magnetic field produced at the compass by the degaussing coil and would also double the field produced by the compass compensating coils used to compensate the degaussing coil.

475-8.1.5 COMPENSATING COIL CONSTRUCTION. Most of the standard types of compass compensating coils are furnished as a coil assembly that consists of enclosures to protect the coils from damage, a single heeling coil to compensate the vertical component, and two coils, or two pairs of coils, to compensate the intercardinal components. Each coil consists of a number of windings, one winding for each degaussing coil that produces a magnetic field at the compass.

475-8.1.6 TYPES OF COILS. A considerable number of compass compensating coils have been developed. Some of them are now obsolete and have been replaced by standard types. Other types, if in good condition, shall be left in place where now installed. New installations shall use standard types only. Standard types of compass compensating coils utilize intercardinally mounted coils. These installations are more adaptable to a greater variety of binnacle arrangements and are less dependent upon quadrantal sphere and flinder bar conditions.

475-8.1.6.1 Acceptable Old-Style Compass Compensation Coils.

The following coils are to be left in place in installations where they now exist provided the coils are in good condition and there is no indication of approaching failure, but they are not to be used for new installations or replacements:

a. Type K

b. Type K-1

c. Type Filled K

d. Type R-1.

475-8.1.6.2 Standard Present Types of Compass Compensation Coils.

Present standard types of compass compensating coils and their uses are described in table 475-8-1. These are the coils to be used for new installations and replacements. The type K-2 coil is illustrated in figure 475-8-3.

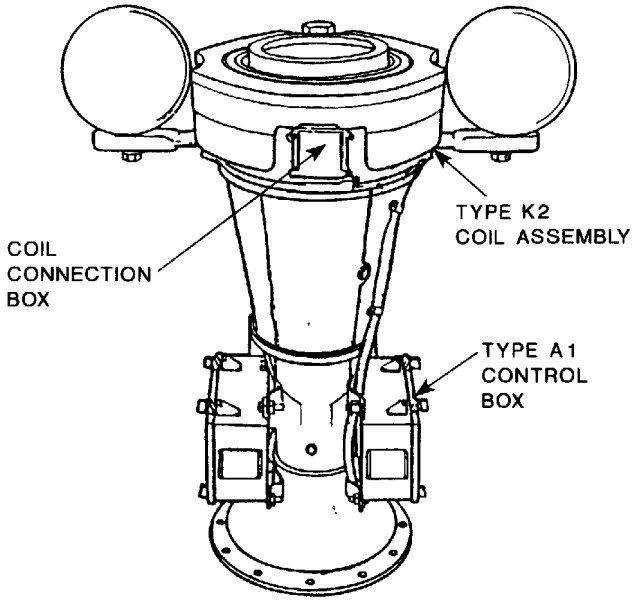


Figure 475-8-3. Type K-2 Compensating Coil Assembly and Type A-1 Control Box.

475-8.1.7 COIL POWER SUPPLY.

The power source used for the compass compensating coils is the voltage-drop across a fixed resistor connected in series with the degaussing coil or, for newer equipment, a voltage source from the respective coil degaussing power supply. This voltage and the current that the power supply sends through the compass compensating coils are proportional to the degaussing coil current. This is the condition which must be satisfied to ensure that the compass compensation will not be disturbed by a change in the degaussing coil current.

475-8.1.8 CONTROL BOXES. One type A or type A-1 control box is used for each degaussing coil that requires compass compensation. The control box consists of a watertight enclosure with a removable cover and contains three sets of resistors. One is used for compensating the H (Heeling) component and two for the horizontal components, NE and NW.

475-8.1.8.1 Type A and Type A-1 Control Box Wiring Diagrams.

Figures 475-8-4 and 475-8-5 show type A and type A-1 control box wiring diagrams, respectively. The current in a compass compensating coil winding is adjusted, when the compass is compensated for degaussing, by adjusting the variable resistors (shorting out one or more of the fixed resistors in the case of the type A box).

475-8.1.8.2 Type K-2 and Type R-2 Compass Coils Wiring Diagrams.

Wiring diagrams for type K-2 and type R-2 compass compensating coils are shown in figures 475-8-6 and 475-8-7, respectively. Similar diagrams are in the compass compensating coil manual. See NAVSEA 0924-LP-044-7010, **Compass Compensating Coil Type K-2,** or NAVSEA 0924-LP-044-9010, **Compass Compensating Coil Type R-2**.

TABLE 475-8-1. STANDARD TYPES OF COMPASS COMPENSATING COILS

Type	Use
K-2	This is the latest type of general purpose compass compensating assembly coil. This type should be used in new installations and for replacement of earlier type "K" coils that are removed because they are defective or show signs of impending failure. Type "K-2" fits USN Standard Mark VII binnacle, USN standard No. l shelf-type binnacle and all types of binnacles on merchant ships built for the U.S. Maritime Commission in World War II. The type "K-2" assembly is interchangeable with the "K-1" and "Filled K" types. See figure 475-8-3 for type "K-2" assembly and associated type "A-1" control boxes installed on a Navy Standard Mark VII binnacle.
R-2	The type R-2 compass compensating coil is used for compensation of the USN No. 5 boat compass, the USN No. 3 compass, the gyro fluxgate compass, and the modified Magnesyn compass. When used to compensate the No. 3 compass, the coil is supported by brackets or collars to accommodate special compass mounting, as installed in the FF's pilot house, for example.

475-8.2 INSTALLATION AND COMPASS COMPENSATION

475-8.2.1 INSTALLATION PERSONNEL. Compass compensating coils are usually installed by naval shipyard personnel or degaussing activity, not by the ship's force. If it is ever necessary for the ship's force to install the compass compensating coils, the installation should be made in accordance with the instruction manual furnished with the coils.

475-8.2.2 COMPASS COMPENSATION PERSONNEL. Compasses are usually compensated for degaussing by personnel at a naval shipyard or a degaussing activity. At times, however, the ship's force may have to compensate the compasses after repairs to the compass compensating coil installation. For this reason, instructions on compass compensation are included, beginning in paragraph 475-8.2.5.

475-8.2.3 DOCKSIDE COMPENSATION LOCATION. Dockside compensation is a preliminary compensation usually made soon after the degaussing system is installed and tested. Dockside compensation is made while the ship is moored. The compass is deflected with one degaussing coil at a time turned on, and the appropriate control resistor is adjusted so that the compass error caused by the degaussing coil is a minimum. (See paragraph 475-8.2.3.1 for further discussion of dockside compensation.)

475-8.2.3.1 DOCKSIDE COMPENSATION CONDITIONS. Certain conditions must be dealt with during dockside compensation. Local magnetic disturbances caused by moving cranes, moving ships alongside, arc welding, and other activities may impair the accuracy of dockside compensation. Dockside compensation should be made, if possible, when disturbances are at a minimum (during the noon hour or at changes of shifts). Maximum coil

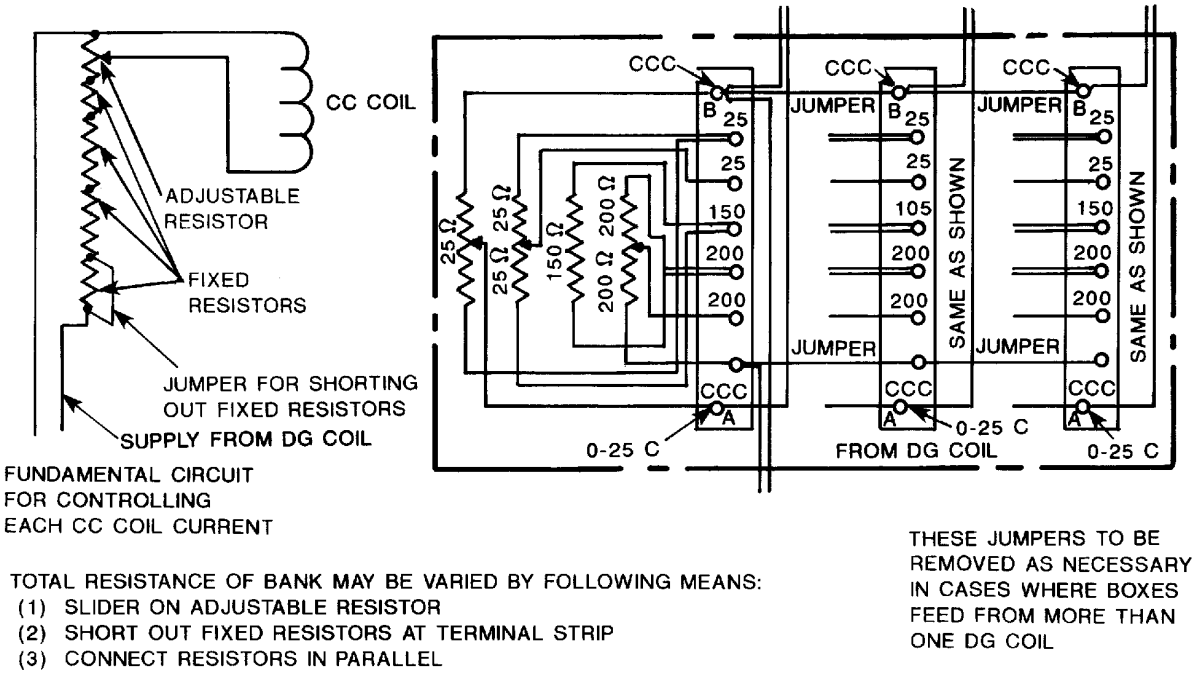


Figure 475-8-4. Type A Control Box Wiring Diagram.

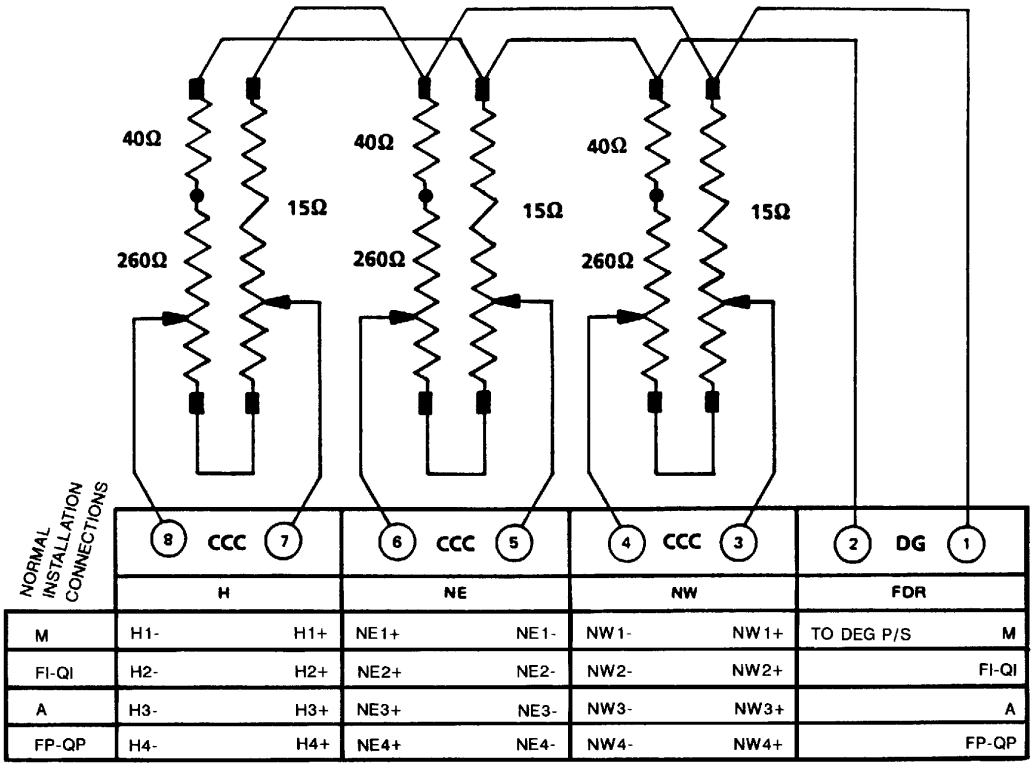
currents specified in the ship's degaussing folder should be used during dockside compensation.

475-8.2.3.2 Optimum Dockside Compensation. Better dockside compensation will result if the compass is in good normal adjustment. If the compass is not in good normal adjustment, normal adjustment should be approximated. If normal adjustment or a partial adjustment cannot be made, the dockside compensation should still be made, since even under poor conditions the dockside compensation gives a check on correct voltage supply, electrical connection and winding polarity. When dockside compensation is made under good conditions, only slight or no resetting of the control resistors will be required in the final compensation.

475-8.2.4 FINAL COMPENSATION LOCATION. Final compensation is made in the harbor or swinging area on completion of normal compass compensation (magnets, spheres) with the ship away from dockside disturbances. It is a refinement of the dockside compensation.

475-8.2.5 COMPASS COMPENSATION TECHNIQUE. Compass compensation for degaussing consists of adjusting resistors in the control boxes so that the compass points in the same direction regardless of whether the degaussing coils are turned on or off.

475-8.2.6 FINAL COMPENSATION TECHNIQUE. Final compensation is made by placing the ship on the desired heading and then, with one degaussing coil at a time turned on, adjusting the appropriate control resistor so that the compass error caused by degaussing is at a minimum. Both dockside and final compen-



	H		NE		NW		FDR	
M	H1-	H1+	NE1+	NE1-	NW1-	NW1+	TO DEG P/S	M
FI-QI	H2-	H2+	NE2+	NE2-	NW2-	NW2+		FI-QI
A	H3-	H3+	NE3+	NE3-	NW3-	NW3+		A
FP-QP	H4-	H4+	NE4+	NE4-	NW4-	NW4+		FP-QP

Figure 475-8-5. Type A-1 Control Box Wiring Diagram.

sation should be made only by qualified adjusters.

475-8.2.6.1 Swing for Deviation. Immediately following final compensation, the ship is swung to determine compass deviations.

475-8.2.6.2 Intercardinal Coil Compensation Headings. Intercardinally mounted compass coils are compensated on intercardinal headings; that is, with the compass reading NE or SW for compensating the NE component, and NW or SE for compensating the NW component. The headings used are positioned so that the compass needles are perpendicular to the component of the degaussing coil magnetic field being compensated. The heeling coil can be compensated on any heading.

475-8.2.6.3 Component Compensation. The H (heeling) component should be compensated first, then the horizontal components. The following procedure should be used for compensating the H (heeling) component for both cardinally and intercardinally mounted compass coils.

475-8.2.6.4 Reduction of Residual Magnetism by Reversals. Start with all the degaussing coil currents set at the maximum current specified in the degaussing folder. Then reduce all coil currents to zero by the method of reversals, as follows:

a. Reduce the current to zero and then increase it to the starting value in the reverse direction.

b. Reduce the current to zero and then increase it to 3/4 value in the original direction.

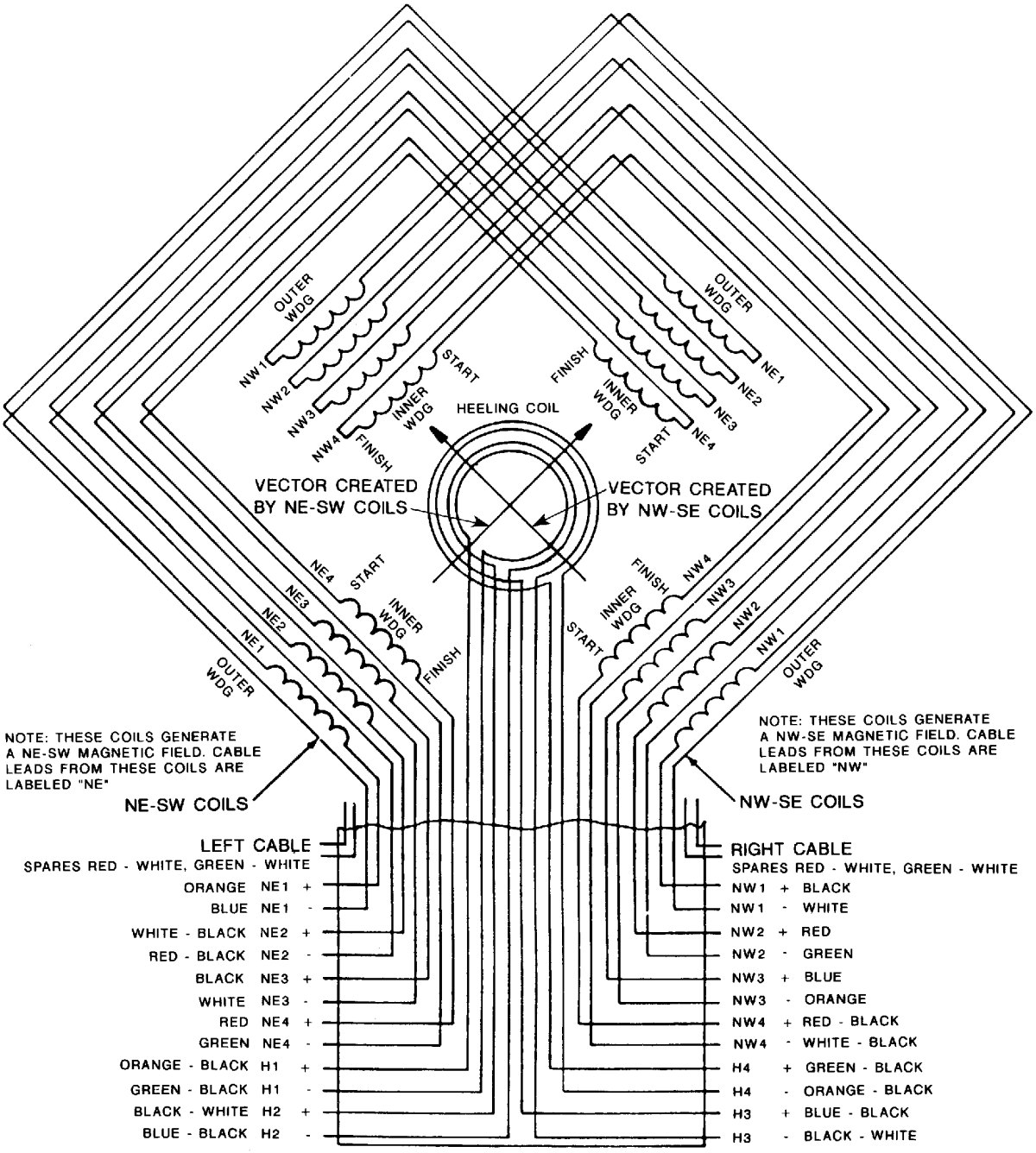


Figure 475-8-6. Type K-2 Coil Wiring Diagram.

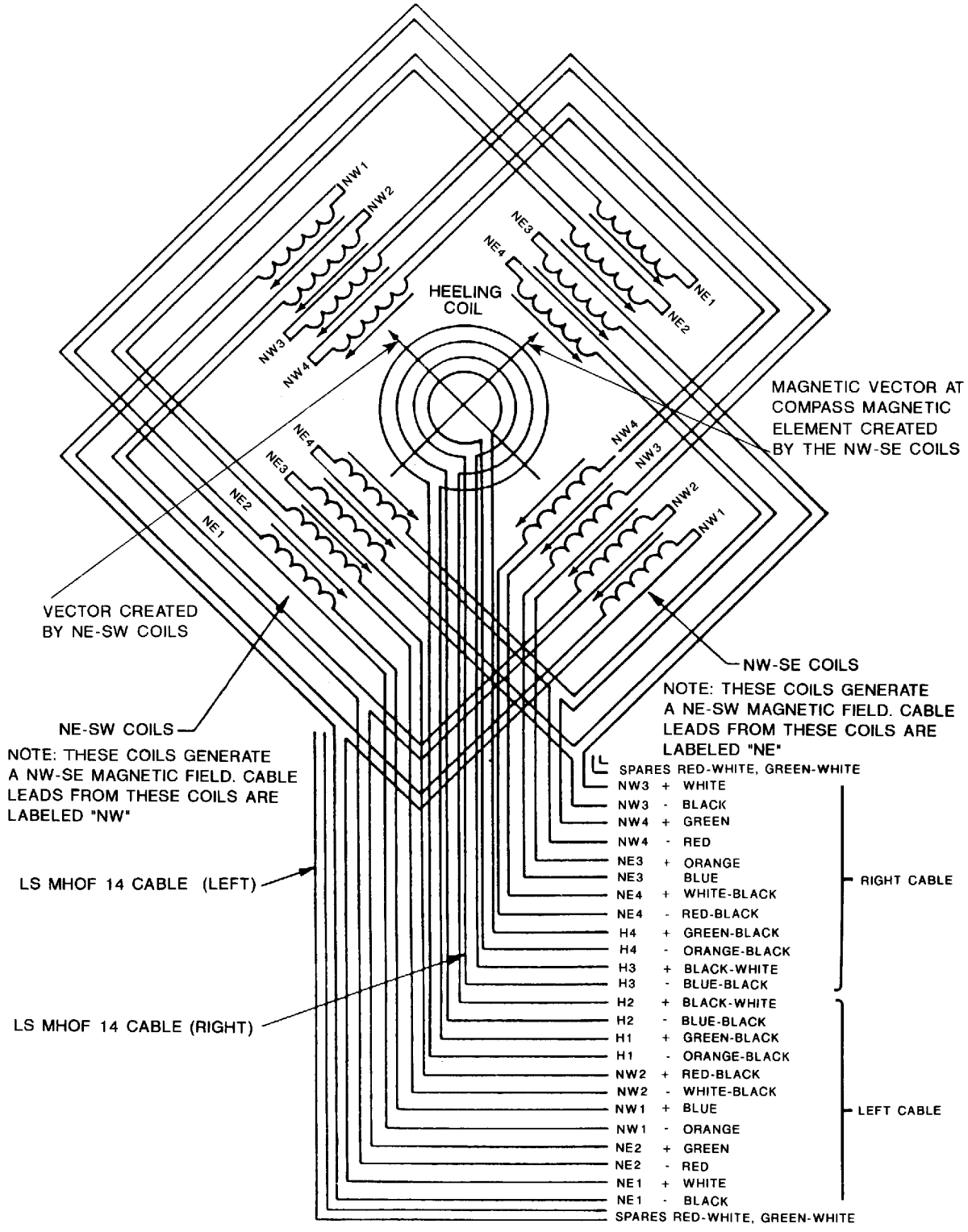


Figure 475-8-7. Type R-2 Coil Wiring Diagram.

c. Reduce the current to zero and then increase it to 1/2 value in the reverse direction.

d. Reduce the current to zero and then increase it to 1/4 value in the original direction.

e. Reduce the current to zero and then increase it to 1/8 value in the reverse direction.

f. Reduce the current to zero.

475-8.2.6.5 Compensation Adjustments. After reducing the coil currents to zero by the method of reversals, compensate the compass as follows:

a. Remove the compass and put in a calibrated dip needle in place of the compass. For model A Magnesyn transmitters, the dip needle pivot should be centered between 5/8 and 7/8 inch above the top of the compass coil. For model B Magnesyn transmitters, the distance should be between 2-7/8 and 3-1/8 inches. For other compasses, center the dip needle at the level of the compass card.

b. Adjust the weight on the dip needle to make the needle horizontal. If the weight on the dip needle was previously set for normal compass adjustment and it is desired to leave this setting undisturbed, level the needle by raising or lowering the heeling magnet. If the second method is used, make sure that the heeling magnet is restored to its correct position after compensating the H-component of the degaussing coil field. In certain cases, it may not be convenient to replace the compass with a dip needle. Under this condition, other provisions, such as placing the dip needle to one side of the compass compensating coil at a predetermined location, may be necessary.

c. Energize one degaussing coil with its maximum current and note any dip of the needle. If the needle does not dip, steps d and e are unnecessary.

d. Increase or decrease the current in the heeling coil circuit for the energized degaussing coil to make the dip needle return to its original position. This may necessitate shorting out or adding fixed resistance as well as adjusting the variable resistor, or it may require reversing the compensating coil leads. Note the dip with and without the heeling coil in the circuit to see whether the heeling coil leads need to be reversed. The heeling coil leads should be reversed if the needle dips more in the same direction when the heeling coil is in the circuit.

e. Check the current through the compass compensating coils and the variable and fixed resistors of the control box to make sure that the current in each circuit element does not exceed the current rating of the element.

f. Reduce the degaussing coil current to zero and then increase it to the maximum value in the opposite direction. Note any dip in the needle, other than a momentary dip, and make any further adjustments necessary.

g. Reduce the degaussing coil current to zero by the method of reversals (see paragraph 475-8.2.6.4).

h. Repeat steps c through g for each degaussing coil.

i. Record the compensation data, as it is taken, on NAVSEA Form 8950/40, **Compass Compensating Coil Data**, (figure 475-8-8).

475-8.2.6.6 Deflecting Compass for Horizontal Components. The heading of the ship is unchanged during dockside compensation. Instead, a suitable arrangement of deflector magnets is employed to deflect the compass to specified readings and to approximate the strength and direction of the magnetic field that would be present if the ship were placed on the heading that corresponds to the compass reading.

COMPASS COMPENSATING COIL DATA

U.S.S.	NO.	LOCATION (City)	DATE OF COMPENSATION
ARLEIGH BURKE	DDG–51	Bath, Maine	3–23–91

1. COMPASS: MAKE J. Hand, 5", Navy TYPE: ☐ #1 ☐ #2 ☒ #3 ☐ OTHER ☐ ST'D ☐ STR'G ☐ OTHER _____ (Indicator)
BINNACLE: MAKE Henschel Console (OR PEDESTAL) ☐ MARK VII ☐ SHELF ☐ OTHER ☒ PILOT HOUSE ☐ FLYING BRIDGE ☐ OTHER _____ (Location)
(commercial plywood stand etc.)
FLINDERS BAR ☒ FORWARD ☐ AFT SLEWED _____ (degrees) LENGTH _____ (mm)

2. DEGAUSSING: COILS M, FI–QI, FP–QP, A (M, I, P, F, W,, etc.) CONTROL Type SSM–6 (see remarks) (Manual, Rheo, REV. SW., M.G., etc.)

3. COMPASS COMPENSATING COILS: TYPE: R–2 INSTALLED BY Bath Iron Works DATE 3–23–91
VOLTAGE SUPPLY: ☐ FIXED RESISTOR ☐ ACROSS D.C. COILS ☒ OTHER Tap, Fixed Resistor (TAP OR D.C. COIL, ETC.)
CONTROL BOXES: TYPE: A–1 8 lug (4–lug, 6–lug, etc.) NO 4 (Quantity)
MOUNTED: ☐ IN WEATHER ☒ PROTECTED ☐ ON BINNACLE ☐ BULKHEAD ☐ OTHER See remarks (Mast, Stack)

4. OBSERVED DEGAUSSING EFFECTS (COMPASS COMPENSATING COILS DISCONNECTED) ☒ ROUGH ☐ ACCURATE

D.G. SETTING			NW/SE ☒ OR B ☐ EFFECT			NW/SE ☒ OR C ☐ EFFECT			HEELING EFFECT						
			COMPASS (OR MAGNETOMETER) READING			COMPASS (OR MAGNETOMETER) READING			CHECK ( ) ONE				OR BY MAGNETOMETER		
COIL	+ OR –	*AMP	D.G. OFF	D.G. ON	DIFF.	D.G. OFF	D.G. ON	DIFF.	NONE	SLIGHT	MED	GREAT	D.G. OFF	D.G. ON	DIFF.
M	+	73	135°	137.5°	+2.5°	45°	48°	+3°				X			
FI–QI	+	73	135°	137.5°	+2.5°	45°	42.5°	–2.5°			X				
FP–QP	+	36	135°	137°	+2°	45°	47°	+2°		X					
A	+	73	135°	132°	–3°	45°	49.5°	+4.5°	X						

*D.C. current in 4 or 5 should be maximum setting for each coil as specified in Degaussing Folder.

5. RECORD OF COMPENSATION ☒ DOCKSIDE ☐ FINAL

COMPONENT		VOLTAGE: ACROSS SUPPLY LEADS	VOLTAGE: ACROSS C.C. COIL	*CURRENT: IN SUPPLY LEADS	*CURRENT: IN C.C.C. WINDING	REMARKS ON COMPENSATION (Include information useful to Commanding Officer or adjustor, e.g., uncompensated deviations or hysteris.)
H			1.02		.270	
NW	M	9.66	1.265	.872	.336	
NE			1.025		.257	
H			1.137		.641	
NW	FI–QI	9.63	1.369	1.622	.488	
NE			1.522		.461	
H			0.116		.935	
NW	FP–QP	9.62	0.382	1.728	.169	
NE			1.348		.560	
H			0		0	Disconnected and taped open.
NW	A	9.01	1.479	1.728	.940	
NE			1.503		.838	

6. REMARKS ON INSTALLATION: (Include details of any special equipment such as Type "A" heeling.)
The A & FI–QI coils are automatic with M and FP–QP coils manual.

After compensation random hdg DG off 190 DG on 190 Need to secure by reversals ☐ YES ☒ NO
A–1 boxes located: Pilot House in console under compass.

SIGNATURE (Adjuster)	NAVAL SHIPYARD
Stephen Baughman	Bath Iron Works

NAVSEA 8950/40 (REV. 2–85) (NAVSEA 8950/40 (9–81) IS OBSOLETE. DESTROY STOCK)

Figure 475-8-8. Compass Compensating Coil Data, NAVSEA Form 8950/40.

475-8.2.6.7 Deflecting Magnet Placement. To deflect the compass by means of a permanent magnet (or a bundle of magnets), the deflecting magnet should be placed with the longitudinal axis perpendicular to the imaginary vertical plane that bisects the angle between the original direction of the compass needle and the desired direction. The magnet may be placed either above (preferred), to the side, or below the compass, provided that the axis of the magnet is perpendicular to the bisecting plane. The desired compass heading is obtained by moving the magnet closer to or farther away from the compass. Figure 475-8-9 illustrates this method of deflecting the compass.

475-8.2.6.8 NE and NW Component Compensation. The compensated horizontal components are the NE and the NW components for intercardinally mounted coils. The larger component should be compensated first.

475-8.2.6.9 NE Component. The following procedure should be used to compensate the NE component:

a. Replace the dip needle with the regular compass.

b. Deflect the compass to a reading of 045 or 225 (paragraph 475-8.2.6.7).

c. Energize one degaussing coil with its maximum current and note the compass deflection. If the compass does not deflect, steps d and e are unnecessary for this degaussing coil.

d. Increase or decrease the current in the labeled NE compensating coil winding for the degaussing coil being compensated to make the compass return to the heading obtained in step b. This may require shorting out or adding fixed resistors as well as adjusting the variable resistor in the control box. It may also require reversing the compass compensating coil leads. To see if the coil leads need to be reversed, note the compass deflection with and without the compensating coil in the circuit. Reverse the leads if the deviation with the coil in the circuit is in the same direction and larger than when the coil is not in the circuit.

e. Check the current through the coil and the variable and fixed resistors in the control box to make sure that the current in each circuit element is no greater than the current rating of the element.

f. Reduce the degaussing coil current to zero and then increase it to a maximum in the other direction. Note any deviation and make any refinement necessary.

g. Reduce the degaussing coil current to zero by reversals (paragraph 475-8.2.6.4).

h. Repeat steps c through g for each degaussing coil.

i. Record the compass compensation data, as it is taken, on NAVSEA Form 8950/40, **Compass Compensating Coil Data** (figure 475-8-8).

475-8.2.6.10 NW Component. The foregoing procedure for compensation of the NE component is repeated for compensation of the NW component, except that the compass is deflected in step b to a reading of 135 or 315 and the current adjusted in the labeled NW compensating coil winding.

475-8.2.6.11 Check for Resistor Settings. A major change of the current in one compass coil winding will change the voltage drop in the compass coil power supply leads and will change the voltage applied to the other compass coil windings. When one or more compasses are being compensated, all coils of all compasses should be approximately compensated before making the final resistor settings. If only one compass coil is installed aboard the ship, resistor settings may be made immediately after compensation be-

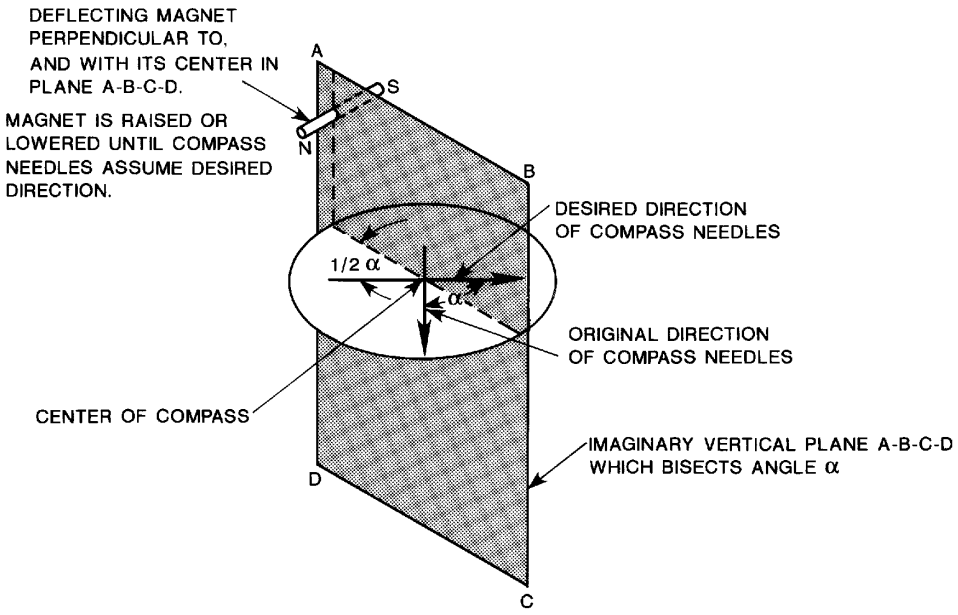


Figure 475-8-9. Deflecting Compass With Permanent Magnet.

cause there are no other coils to be adjusted and no possibility of disturbing the adjustment of the single coil.

475-8.2.6.12 Check for Residuals. With the compass deflected to a reading of about 090 or 270, energize a degaussing coil with its maximum positive value, then deenergize without reversals. If the compass fails to return to within 1 degree of its original reading, that particular degaussing coil should be secured by a series of reversals explained in paragraph 475-8.2.6.4. Each degaussing coil should be checked for residuals for both positive and negative coil current, and the results shall be indicated per paragraph 475-8.2.6.13.

475-8.2.6.13 Securing by Reversal Documentation. If a coil should require securing by reversals, this fact should be noted on NAVSEA Form 8950/40, **Compass Compensating Coil Data** (figure 475-8-8), by an entry under **Remarks** and on NAVSEA Form 3120/4, **Magnetic Compass Table** (figure 475-8-10), by inserting the designations of the coils that should be cycled (secured by reversals) (width of figure 475-8-10 is oversized for clarity).

475-8.2.6.14 Final Compensation. Final compensation is a refinement of dockside compensation and is made under actual operating conditions away from dockside magnetic disturbances and after a fairly accurate normal compass adjustment. Final compensation is made in the same way as dockside compensation except that a deflecting magnet is not used to deflect the compass needle to the desired reading. Instead, the ship itself is placed on the heading that gives the compass reading desired for compensation.

475-8.2.7 ACCURACY. Compensation should reduce compass deviations to as small a value as possible. The deviation shall be reduced to 2 degrees or less, and the heeling effect reduced to a degree so small that it will not cause oscillation in a heavy sea with the degaussing coils on. In some cases, however, where the initial horizontal deviations are large (30 to

MAGNETIC COMPASS TABLE NAVSEA RPT. 3530–2
NAVSEA 3120/4 (REV. 6–72) (FRONT) *(Formerly NAVSHIPS 1104)*
S/N 0105–C01–9521

U.S.S. CLEVELAND NO. LPD–7 *(BB, CL, DD, etc.)*

[X] PILOT HOUSE [ ] SECONDARY CONNING STATION [ ] OTHER

BINNACLE TYPE [X] NAVY ST'D [ ] OTHER

COMPASS 7–1/2" MAKE LIONEL SERIAL NO. 13613

TYPE CC COILS K DATE 19 SEP 1976

READ INSTRUCTIONS ON BACK BEFORE STARTING ADJUSTMENT

SHIPS HEAD MAGNETIC	DEVIATIONS		SHIPS HEAD MAGNETIC	DEVIATIONS	
	DG OFF	DG ON		DG OFF	DG ON
0	1.5W	0.0	180	0.0	0.5E
15	0.5W	0.5E	195	0.5E	1.5E
30	0.0	1.0E	210	1.5E	2.0E
45	0.0	0.5E	225	2.5E	2.5E
60	0.0	0.0	240	3.0E	3.0E
75	0.5W	0.5W	255	2.5E	2.5E
90	1.0W	1.5W	270	1.5E	1.0E
105	2.0W	2.0W	285	0.0	0.0
120	3.0W	1.5W	300	0.5W	1.0W
135	2.5W	0.5W	315	2.0W	1.5W
150	2.0W	0.5W	330	2.5W	1.0W
165	1.0W	0.0	345	2.0W	0.5W

DEVIATIONS DETERMINED BY: [ ] SUN'S AZIMUTH [X] GYRO [ ] SHORE BEARINGS

B 2–4" MAGNETS RED [X] FORE [ ] AFT AT 15" FROM COMPASS CARD

C 0 MAGNETS RED [ ] PORT [ ] STBD AT " FROM COMPASS CARD

D 2–5" [X] SPHERES [ ] CYLS AT 12" [ ] ATHWART–SHIP [ ] SLEWED 0° [ ] CLOCKWISE [ ] CTR. CLOCKWISE

REFLING MAGNET: [ ] RED UP [X] BLUE UP 13.6 FROM COMPASS CARD

FLINDERS BAR: [ ] FORE [ ] AFT 12"

[X] LAT 23" 24' North [ ] N

[X] LONG 130° 39' East [ ] Z

SIGNED (Adjuster or Navigator) R. E. FURGUSON

APPROVED (Commanding) J. B. RIDGE CAPT USN

Figure 475-8-10. Magnetic Compass Table, NAVSEA Form 3120/4. (Sheet 1 of 2) (shown oversize for clarity)

VERTICAL INDUCTION DATA

(Fill out completely before adjusting)

RECORD DEVIATION ON AT LEAST TWO ADJACENT CARDINAL HEADINGS

BEFORE re STATING/ADJUSTMENT: N _____ E _____ S _____ W _____

RECORD BELOW INFORMATION FROM LAST NAVSEA 3120/4 DEVIATION TABLE:

DATE: 6 AUG 1975 [X] LAT 32 20' N [X] LONG 118 00' W

[ ] M [ ] Z

12" FLINDERS BAR [X] FORWARD [ ] AFT

DEVIATIONS

N 2.5W E 0 S 0 W .5E

RECORD HERE DATA ON RECENT OVERHAULS, GUNFIRE, STRUCTURAL CHANGES, FLASHING, DEPERMING, WITH DATES AND EFFECT ON MAGNETIC COMPASSES

PERFORMANCE DATA

COMPASS AT SEA:	[ ] UNSTEADY	[X] STEADY
COMPASS ACTION:	[ ] SLOW	[X] SATISFACTORY
NORMAL DEVIATIONS:	[ ] CHANGE	[X] REMAIN RELIABLE
DEGAUSSED DEVIATIONS:	[ ] VARY	[X] DO NOT VARY

REMARKS

INSTRUCTIONS

1. This form shall be filled out by the Navigator for each magnetic compass as set forth in NSTM Chapters 252 and 475 of Naval Ships' Technical Manual.
2. When a swing for deviations is made, the deviations should be recorded both with degaussing coils off and with degaussing coils energized at the proper currents for heading and magnetic zone.
3. Each time this form is filled out after a swing for deviations, a copy shall be submitted to: Naval Sea Systems Command Washington, D.C. 20362. A letter of transmittal is not required.
4. When choice of box is given, check applicable box.
5. Before adjusting, fill in section on "Vertical Induction Data" above.

NAVSEA 3120/4 (REV. 6–72) (REVERSE) C–24055

Figure 475-8-10. Magnetic Compass Table, NAVSEA Form 3120/4. (Sheet 2 of 2) (shown oversize for clarity)

60 degrees), it may be impractical to reduce these deviations to the 2-degree value. In such cases, the deviations can always be reduced to less than 10 percent of the original deviation and normally can be reduced to less than 7 percent of the original deviation.

475-8.2.8 ASYMMETRICAL DEVIATIONS. Asymmetrical magnetic fields, due either to the compass magnets or to the compass coils, may, under unusual conditions, result in asymmetrical deviations that cannot be reduced to the limits specified above. Asymmetrical deviations occur on headings that differ from those used for the setting compass coil currents and therefore cannot be compensated by resetting these currents. In the case of cardinally mounted compass coils, unsymmetrical deviations are maximum on headings other than N/S or E/W and for intercardinally mounted coils, are maximum on headings other than NE/SW or NW/SE.

475-8.2.8.1 Asymmetrical Deviation Compensation Technique. Asymmetrical deviations may be reduced to the limits specified above by:

a. Replacing the compass coils with a modern assembly of known symmetry.

b. Replacing the magnetic compass with one of known symmetry.

c. Relocating the binnacle to a position farther from the degaussing cables.

d. Relocating the degaussing coil crossover to a position farther from the binnacle, if such relocation will maintain an equally satisfactory magnetic signature.

475-8.2.8.2 Binnacle Position Check. A check to determine whether the binnacle is too close to the degaussing cables can be made by using the following formula.

$$D = \frac{NI}{200}$$

where:

D = distance in feet

NI = total ampere turns in the degaussing cables

475-8.2.9 BINNACLE POSITION OUT OF TOLERANCE. If the separation between the compass and the degaussing cables is less than that obtained by the formula, the condition should be reported to the nearest Naval shipyard. See NSTM Chapter 252, **Ship Control Equipment**, for further data.

475-8.2.10 PRECAUTIONS. Care must be taken to see that the safe currents of the resistors and compensating coils are not exceeded in both dockside and final compensation.

475-8.2.10.1 Maximum Currents, Type A Control Box Resistors. Resistors in the type A control box may be connected in various parallel and series combinations provided that the maximum currents do not exceed:

a. 25-ohm variable resistor - 1.41 amperes.

b. 50-ohm fixed resistor - 1.00 ampere.

c. 150-ohm fixed resistor - 0.58 ampere.

d. 400-ohm fixed resistor - 0.35 ampere.

475-8.2.10.2 Maximum Currents, Type A-1 Control Box Resistors. Maximum currents in the type A-1 box resistors should not exceed:

a. 15-ohm variable resistor - 2.00 amperes.

b. 1-ohm variable resistor

260-ohm portion - 0.32 ampere

40-ohm portion - 1.25 amperes.

475-8.2.10.3 Maximum Coil Currents, Type K, K-1, K-2, R-1 and R-2 Coil Types. Maximum current in any one winding of a compensating coil should not exceed the value given in table 475-8-2.

TABLE 475-8-2. COIL MAXIMUM CURRENT IN ANY ONE WINDING

Type of Coil	Maximum Current (amperes)
K, K-1, K-2, and Filled K:	
NE and NW coils	1.4
Heeling coil	2.0
R-1	1.0
R-2	1.0

475-8.2.11 FORWARDING OF FORMS. For specific instructions regarding forwarding NAVSEA Form 3120/4, **Magnetic Compass Table**, refer to NSTM Chapter 252, **Ship Control Equipment**. A copy of NAVSEA Form 8950/40, **Compass Compensating Coil Data**, should be filed in the installation section of the degaussing folder. One copy of the form should be forwarded to NAVSEA at the time of the initial compensation and upon any subsequent compensation made as a result of adding additional compensating equipment or changing the type of equipment. In the case of changing or adding equipment, the form will normally be made out by the installing activity. The form should be submitted by the ship's force if it performs the compensation.

475-8.3 OPERATION

When the degaussing coils are energized, the compass compensating coils operate automatically. Operation should be checked at least once a week by noting whether any compass deviations, in excess of the allowable limits (paragraph 475-8.2.7), are caused when power to the degaussing coils is turned on or off.

475-8.4 MAINTENANCE

There are several common sources of trouble for the various components of the compass compensating system.

475-8.4.1 COMPASS COMPENSATING COILS. Care should be taken that the position of the coils on the binnacle is unchanged. Grounds and resultant burnouts of the windings may be caused when coil case seams are broken because of mechanical damage or improper installation. An insufficient number of shims used between the coil and the binnacle and subsequent tightening of the coil mounting bolts may distort the case and break the soldered seams. Leaky packing glands and gaskets may also allow moisture to enter the case with resulting grounds. An increase in degaussing deviation may be caused by a lack of recompensation of compass compensating coils after alterations to the degaussing coils or after changes in the ship's steel.

475-8.4.2 CONTROL BOXES. Grounds, poor electrical connections, corrosion of resistors, and burn-outs of windings and resistors may be caused by the entrance of moisture into type A or A-1 control boxes. This moisture is usually the result of loose covers or leaky gaskets or stuffing tubes. When grounds are isolated in the compass compensating system, the control box involved should be opened and, if wet, should be drained and dried out.

475-8.4.2.1 Control Box Maintenance Procedure. All corrosion should be cleaned from the resistor contacts and, if beyond repair, the entire resistor assembly should be replaced. Cable should enter exposed control boxes on the bottom or on the sides, not on the top. Where repeated grounds occur in a four-lug control box mounted in the weather, the entire unit should be replaced with a six-lug control box and in addition, where practical, mounted out of the weather.

475-8.4.2.2 Connecting Cables. Cable from the compass coils to the control boxes should be checked for possible cracks in the sheath or for mechanical damage. If cable is run through a deck, suitable protection should be afforded by kick pipes. It should be watertight where nipples enter the control boxes.

475-8.4.2.3 Reports. Report all equipment failures and replacements in accordance with the Planned Maintenance System.

475-8.4.2.4 Compass Coil Troubleshooting. The following steps should be followed when troubleshooting the compass coil electrical equipment:

a. Check each winding for short circuits and continuity. (Use an ohmmeter at the control box.)

b. Test each winding for magnetic effect and identity. (Use 1-1/2 volt flashlight battery across the winding leads in the control box. Explore, with a pocket compass, for effect of winding.) Make sure the windings in series aid in magnetic polarity. Make sure each winding is connected to the proper control circuit and tagged.

c. Test the insulation resistance between the compensating coil windings and from each winding to ground with a megger.

d. Make sure the control resistor contacts and terminals are not corroded. Inspect the cover and terminal tubes for leakage if corrosion exists.

e. Check the supply voltage to the control box; it should be proportional to the degaussing circuits. The best results are obtained when the supply voltage into the control box is between 6 and 10 volts with 3 amperes load current and the degaussing current set at the maximum value specified in the degaussing folder.

f. Make sure each compass compensating effect is strong enough to compensate the degaussing effect.

g. Make sure the winding current does not exceed the maximum current values given in table 475-8-2.

475-8.4.2.5 Locating Grounds. If a ground appears in the compass coil circuits:

a. Open the type A or type A-1 compass compensating coil control box for the degaussing coil circuit grounded.

b. Disconnect the compass compensating coil feeder from the degaussing circuit. Check both conductors of the feeder for grounds.

c. If a grounded reading is obtained here, disconnect the feeder at the other end to isolate the ground in either feeder conductor.

d. If the feeder to the type A control box is not grounded (see figure 475-8-4):

1. Isolate the circuits compensating the degaussing coil being checked by disconnecting the jumpers (if installed) paralleling the A terminals in the control box and also the jumper paralleling the B terminals.

2. Check the insulation resistance for each compass coil circuit to the ground by connecting a meter between terminal A or B and the ground.

3. After finding the grounded circuit, ascertain whether the ground is in the compass resistors or in the compass coil winding by disconnecting the compass coil winding at terminals CCC-B and CCC-O-25C in the control box.

4. In the event the winding is grounded and the coil is otherwise satisfactory, physically and electrically, substitute the spare winding of the same coil, if available. This substitution will require checking the compensation and recompensation as necessary.

5. If the ground is located in the resistor bank of the type A or type A-1 control box and is due to moisture, wipe the box clean and dry it by means of exposure to sunlight or the heat of an electric light bulb. Check for the entrance of moisture due to a distorted box cover, improperly seated gasket, or leaky terminal tubes.

e. If the feeder to the type A-1 control box is ungrounded, use figure 475-8-5 and a procedure similar to the item d list above.

APPENDIX A
REFERENCE PUBLICATIONS

The following technical publications are listed in the order in which they appear in the text:

Section 1

NSTM Chapter 300, **Electrical Plant General**

Section 2

OPNAVINST 5100.19, "**Navy Occupational Safety and Health (NAVOSH) Program Manual for Forces Afloat**"

Section 3

MIL-I-631, **Insulation, Electrical, Synthetic-Resin Composition, Non-rigid**

Section 5

NAVSEA 0967-LP-000-0160, **Electronics Installation and Maintenance Book**

NAVSEA S9475-AF-OMI-010, **Degaussing Manual**

Section 6

NAVSEA S9475-AC-PR-010, **Degaussing Forms, Records, and Reporting Procedures**

OPNAVINST C8950.2, **Magnetic Silencing**

Section 7

NAVSEA S5475-AC-MMM-010/(C), **Magnetic Ranging and Calibration of Degaussing Systems - Degaussing Performance Criteria**

MIL-STD-2036, **General Requirements for Electronic Equipment, Specifications**

SSP Instruction 8950.2, "**Procedures for Protection of FBM/Strategic Weapon System Components During Flash Deperm Treatment of SSBN 598, 608, 616, (616-659 including the C-4 Backfit Configurations), and 726 Class (TRIDENT) Submarines**"

NAVSEA 0324-LP-047-7010 through 7120, **Technical Manual for SINS MK 2 MOD 1**

NAVSEA 0324-LP-064-5101 through 5620, **Technical Manuals for SINS MK 3 MOD 5**

NAVSEA 0924-LP-001-2010 through 2120, **Technical Manuals for SINS MK 3 MOD 5**

NAVSEA 0924-LP-022-1010 through 1100, **Technical Manual for SINS MK 3 MOD 6**

NAVSEA 0924-LP-038-8010 through 8120, **Technical Manual for SINS MK 3 MOD 7**

NAVSEA 0924-LP-045-5010 through 5160, **Technical Manual for SINS MK 3 MOD 8**

NSTM Chapter 074, **Welding and Allied Processes**

NSTM Chapter 541, **Petroleum Fuel Stowage, Use and Testing**

Section 8

NAVSEA 0924-LP-044-7010, **Compass Compensating Coil, Type K-2**

NAVSEA 0924-LP-044-9010, **Compass Compensating Coil, Type R-2**

NAVSEA Form 8950/40, **Compass Compensating Coil Data**

NAVSEA Form 3120/4, **Magnetic Compass Table**

NSTM Chapter 252, **Ship Control Equipment**

GLOSSARY

Alternating electric (AE) fields - the electric field component of an electromagnetic field whose magnitude varies with time, whether periodically or aperiodically.

Alternating magnetic (AM) field - the magnetic field component of an electromagnetic field whose magnitude varies with time, whether periodically or aperiodically.

Ammeter calibration - Checking of remote control unit ammeters on steel-hulled ships to verify that they have been calibrated (see equipment manual for procedure).

Ampere turns - the product of the current in a coil or loop and the number of effective turns.

Beam - the extreme molded width of the ship hull at the widest part.

Calibration limit - the maximum acceptable value of the magnetic flux density after the onboard degaussing system has been calibrated or the ship/submarine has been flashed/depermed.

Check ranging - The action of a ship making reciprocal range runs for the purpose of satisfying the measurement of the component of the static magnetic (SM) field signature measurement requirements.

Check range limit - the maximum acceptable value of the magnetic signature. The magnetic signature is determined when the ship/submarine runs a magnetic silencing range.

Coil section - A section of a degaussing coil cable is the length of cable between two successive connections or through boxes.

Compass compensation coil assemblies - Coil assemblies that, when energized with direct current, create a magnetic field approximately equal and opposite to the degaussing field at the compass, thereby eliminating the undesirable effects of degaussing upon the compass.

Compass compensation coils check - The contractor shall demonstrate operation of the degaussing compass compensating circuits on steel hull ships by performing a dockside degaussing compass compensation, before builder's trial, of each magnetic compass equipped with a compass compensating coil. All data required for form, 8950/40 (Compass Compensating Coil Data), shall be noted and recorded on the form during this compensation.

Compass compensating control box - A watertight enclosure having a removable cover and containing sets of control resistors. By adjustment of the control resistors, the compass compensating coil currents are regulated to give the desired magnetic compass compensation.

Components of magnetism - magnetism, both permanent and induced, is composed of vertical, longitudinal, and athwartships components.

Conductor turn - One conductor encircling the loop area once.

Connection box - A watertight box with a removable cover used as a junction to connect loops together, to connect conductors in series, to reverse turns, and to perform similar functions. The power supply connection for a coil and adjustments of ampere turn ratios between loops are made within connection boxes.

Degaussing - The technology dealing with the methods and techniques of reducing a ship's static magnetic (SM) field with onboard coils.

Degaussing coil - One or more loops of degaussing cable where each loop encircles a different total area. A degaussing coil provides compensation for the ship's magnetization in either the vertical , longitudinal, or athwartship direction.

Degaussing control and power equipment - Equipment that produces the degaussing currents and contains electrical circuits, indicating devices, and controls to provide automatic and manual control of the polarity and magnitude of the degaussing coil currents. Automatic control is provided as a function of the earth's magnetic field along the ship's axes.

Degaussing folder - The degaussing folder, form NAVSEA 8950/1, is an official ship log. It contains instructions for operation of the degaussing system, degaussing charts, values for current and turn settings, installation forms, compass compensation forms, and a log section showing all pertinent details of magnetic treatment and of action taken on the ship's degaussing system for the information of degaussing authorities. The degaussing folder is issued to a ship by the Magnetic Silencing Facility that renders the initial magnetic treatment and system calibration.

Degaussing system - Consists of control and power equipment and one or more coils of electric cable installed at specific locations on board ship to reduce the ship's magnetic signature. In operation, these coils are energized with direct current so that the magnetic field produced is in opposition to, and reduces, the magnetic field of the ship. Equipment is provided to vary the current through the coils in both magnitude and polarity. The degaussing system also includes the compass compensation equipment.

Effective turns - The number of turns that are effective in producing a magnetic field under the ship. The difference between the number of series conductors in a loop in which the current is in a counterclockwise direction (called forward turns) and the number of series conductors in which the current direction is clockwise (called reverse turns), when viewed in accordance with polarity convention for each coil.

Induced magnetism - That component of the ship's magnetic field that results from the ship's position in an external magnetic field. This component varies as a function of the ship's location, heading, roll, and pitch in the earth's magnetic field.

Installation information forms - Installation information forms are official NAVSEA forms showing plan and profile views of degaussing coils (steel hull ships only), identification of equipment, schematic electrical diagrams, test results, and other pertinent information on the system as installed.

Just above a deck - Where cables are specified to run "just above a deck" the cable is installed, unless otherwise noted, to allow a 4-1/2 inch clearance between the deck and the bottom of the cables.

Just under or below a deck - Cable is strapped to supports mounted directly to the deck so that the cable will be flush with overhead. Where athwartship beams and brackets are encountered, the cable is routed around or through the beams or brackets. Cables running athwartship are strapped underneath deck plating or along the beams, depending on the specified location and interferences encountered for installation.

Just within the skin or shell - The cable is routed and strapped along the inboard side of the transverse frames to which the plates or planks forming the "skin" or shell of the ship are fastened. The cables are run through the webs of deep frames if ample strength compensation is made where the webs are pierced. Cables are not run more than 18 inches inboard of skin.

Loop - One or more turns of the conductors of a degaussing cable encircling a specific area. All loops that produce fields along a particular ship's axis for a coil. In steel-hulled ships different loops connected in series form a degaussing coil; for example: FI-1, FI-2, QI-1 loops are connected in series to form an FI-QI coil. To conserve cable, the conductors used for different loops encircling the same area may be contained in the same cable; for example: an FP and FI loop may both be contained in an FI-FP designated cable.

Magnetic silencing - Any method or procedure that will reduce the magnetic/electric signature of a ship or submarine.

Magnetic silencing methods - Magnetic Treatment

a. Deperming - The process whereby a ship's permanent longitudinal and athwartship magnetism is ideally removed and its vertical permanent magnetism is stabilized at a known level by exposing the platform to large magnetic fields of alternating polarities and decreasing magnitude.
b. Flashing - a deperming treatment used on ships and submarines with no shipboard degaussing coils. In this treatment, the vessel's permanent vertical magnetism is changed in such a way that the total magnetization will be at a minimum in its intended area of operation.

   Magnetic Types:

   1. Permanent - The magnetism resulting from a ship or submarine being built in the presence of the earth's magnetic field and other fields such as those produced by welding cables, electromagnetic positioners, magnaflux testers, engine starting

cables, etc. The magnitude is determined by the location of the building facility, the orientation of the hull with respect to the earth during construction and the material used for construction and its magnetic history. The permanent magnetism will change slowly through platform vibration, change in geographic location, extensive period on a single heading, etc.

2. Induced - Magnetism that results from a ship or submarine operating in the earth's magnetic field. The magnitude is determined by the ship/submarine geographic position and attitude (heading, roll, and pitch) with respect to the direction of the inducing field.

Magnetic/electric fields - For the purpose of this instruction and other definitions, the ship/submarine magnetic or electric field sources are stationary with respect to the magnetic or electric field measurement sensor.

Magnetometer interference tests - Tests performed if a magnetometer is installed. Magnetometer interference tests are performed to determine if various items of ship equipment might materially affect the magnetic field in the vicinity of the magnetometer probe. The magnetometer outputs are monitored to observe changes in readings caused by operation of other equipment. The Supervisor shall be notified of interferences greater than 0.2 microtesla. Notification shall include source and magnitude of the interference.

Magnetometer probe assembly - A unit that is a magnetometer or part of a magnetometer that is installed remote from the degaussing control unit.

Middle-fifth - The middle 1/5 of the length of the ship.

Modification forms - Modification forms are official NAVSEA forms describing all modifications to the degaussing system during calibration, repair or conversion.

Parallel circuit - An arrangement of conductors connected to provide two or more complete and independent electrical paths through a coil or loop and having a common source of supply.

Permanent magnetism - That component of the ship's magnetic field that is permanently fixed in the ship's ferrous structure. This component changes as a result of mechanical stress, vibration, or deperming and is likely to change during a major overhaul or conversion period.

Remote control unit - A unit that enables an operator to monitor coil currents and manually input heading changes during manual operation.

Run - The continuous route of the cable (including connection and through boxes) between specified elevations, distances, or frames.

Satisfactory check range - Two range runs on reciprocal headings within a six-week period that are determined to be magnetically satisfactory (i.e., meet the check range limits while ship-installed degaussing equipment is operating properly).

Static electric (SE) field - An electric field whose magnitude remains constant with time.

Static magnetic (SM) field - A magnetic field whose magnitude remains constant with time.

Tesla (T) - The Systeme Internationale (SI) unit used to denote the magnitude of magnetic flux density. It is the preferred unit and is to be used in all correspondence and publications on this subject. Nanotesla may be used when discussing magnetic signatures of ships; microtesla should be used when discussing the earth's magnetic field. The following conversion list is provided for convenience:

1 tesla (T)	=	10,000 gauss (G)
1 millitesla (mT)	=	10 gauss (G)
1 microtesla (μT)	=	0.01 gauss = 10 milligauss (mG)
100 nanotesla (nT)	=	0.001 gauss = 1 milligauss (mG)
1 nanotesla (nT)	=	0.01 milligauss = 1 gamma

Through box - A watertight box with a removable cover used to connect sections of cable without changing the order of conductor connections.

Turns - One complete lap around the perimeter of a specified area by a coil or loop. One turn consists of one conductor or two or more conductors connected in parallel.

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	A. EXCEL-LENT		B. GOOD		C. FAIR		D. POOR		E. COM-PLETE		F. INCOM-PLETE

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PAGE NO A.	PARA-GRAPH B.	LINE NO. C.	FIG. NO. D.	TABLE E.	F. RECOMMENDED CHANGES AND REASONS

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13. SIGNATURE OF WORK CENTER HEAD	14. SIGNATURE OF DEPARTMENT OFFICER	15. AUTOVON/COMM. NO.

16. SHIP HULL NO. AND/OR STATION ADDRESS (DO NOT ABBREVIATE)

17. THIS SPACE ONLY FOR NSDSA

A. CONTROL NO.	B. COG ISEA	C. DATE			D. PRIORITY	E. TRANSMITTED TO
		RECEIVED	FORWARDED	DUE		

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(REPLACES 4-84 EDITION & NAVSEA 4160/1 DESTROY STOCK)

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DEPARTMENT OF THE NAVY

Official Business
Penalty for Private Use $300

COMMANDING OFFICER
NAVAL SHIP WEAPON SYSTEMS ENGINEERING STATION
NAVAL SEA DATA SUPPORT ACTIVITY (Code 5H00)
PORT HUENEME, CA 93043-5007

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(Insert Classif. of TMDER Here and At Bottom of Page) **CLASSIFICATION:**

NAVSEA (USER) TECHNICAL MANUAL DEFICIENCY/EVALUATION REPORT (TMDER)
(NAVSEA S0005-AA-GYD-030/TMMP & NAVSEAINST 4160.3)

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1. NAVSEA NO. ★	2. VOL. PART ★	3. TITLE ★
S9086-QN-STM-010/CH-475		Magnetic Silencing

4. REV. DATE OR TM CH. DATE	5. SYSTEM/EQUIPMENT	6. IDENTIFICATION/NOMENCLATURE (MK/MOD/AN)

7. USER'S EVALUATION OF MANUAL (*Check Appropriate blocks*)

	A. EXCEL-LENT		B. GOOD		C. FAIR		D. POOR		E. COM-PLETE		F. INCOM-PLETE

8. GENERAL COMMENTS

9. RECOMMENDED CHANGES TO PUBLICATION

PAGE NO A.	PARA-GRAPH B.	LINE NO. C.	FIG. NO. D.	TABLE E.	F. RECOMMENDED CHANGES AND REASONS

10. ORIGINATOR AND WORK CENTER (PRINT)	11. ORIGINATOR'S RANK, RATE OR GRADE, AND TITLE	12. DATE SIGNED

13. SIGNATURE OF WORK CENTER HEAD	14. SIGNATURE OF DEPARTMENT OFFICER	15. AUTOVON/COMM. NO.

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