

RECORD OF CHANGES

Correction or Change No.	Date of Change	Date Entered	By Whom Entered

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REFERENCES, DEFINITIONS, FORMULAS AND COURSE OUTLINE

REFERENCES

1. NAVSEA S9086-KC-STM-00/CH-300 RI, Technical Manual Electrical Plant, Section 2, Safety
2. NAVSEA 0901-LP-400-0000/CH-400, Technical Manual Electronics, Section 2, Safety
3. NAVSEA 0967-0100, EIBM General Handbook, Section 3
4. NAVSEA S5475-AF-GTP-010/INT HIST MSIL, Introduction and History of Magnetic Silencing
5. NAVSEA S5475-AD-MMD-010/MAG FAC, Magnetic Silencing Facilities Description and Installation of Permanent and Portable Equipment
6. NAVSEA 0981-LP-063-8012, Maintenance Manual for Degaussing Range System, Type 2
7. (C) NAVSEA S5475-AC-MMM-010/(C) MAG-RNG-PROC, Magnetic Ranging and Calibration of Degaussing Systems Degaussing Performance Criteria
8. (C) NAVSEA 0981-LP-056-7010/(C), Magnetic Ranging and Calibration of Non-Magnetic Minesweepers
9. (C) NAVSEA S5475-AL-PRO-010/(C), Principles and Procedures for Magnetic Treatment of Ships
10. NAVSEA 8950/1B(M/S), Degaussing Folder (Minesweepers)
11. NAVSEA S5475-AN-PRO-010/EMR FAC, The Electromagnetic Roll (EMR) and Stray Field Facility
12. NAVSEA S9475-AC-PRO-010, Degaussing Forms, Records, and Reporting Procedures
13. TSN 8T-5251-01 through TSN 107-5251-07, Degaussing Range System, Requirements for Installation of

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14. NAVSEA S5475-AK-MMA-010, Systems Manual for the Type II Magnetic Treatment Measurement System (MTMS)
15. NAVSEA S5475-AB-MMA-010, Magnetic Treatment Measurement Systems (MTMS) Type 1
16. NAVSEA 0981-LP-056-4010, Magnetometer Control System MK6 MOD 2
17. NAVSEA S5475-AM-MMA-010, Operation and Maintenance Instructions, Deperming Power Plant Control System (Type II)
18. NAVSEA 0988-LP-052-8380, Minimizing Stray Magnetic Fields of Wooden Hull Mine Warfare Vessels
19. NAVSEA 0981-LP-064-0010, The Dual Electromagnetic Roll System MK1 MOD1
20. NAVSEA S9086-QN-STM-004, Naval Ship's Technical Manual, Chapter 475, Magnetic Silencing
21. NAVSEA 0981-LP-052-8130, Degaussing Manual
22. (C) OPNAVINST 08950.2 Series, U.S. Naval Degaussing Policy
23. NAVSEA S9475-E3-MMA-010/SSM-3, Technical Manual for SSM3 Automatic Degaussing Control Equipment
24. NAVSEA 0981-LP-070-7010, Operating and Maintenance Instructions, Automatic Degaussing Control Equipment Type MCD-1
25. NAVSEA 8950/1B(OM/S), Degaussing Folder (Other than Minesweepers)
26. OPNAVINST 5510.1 (Series), Department of the Navy Information Security Program Regulation
27. OPNAVINST 5513.7 (Series), Department of the Navy Information Security Program Regulation

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28. NAVSEA S9475-D4-MMA-010/EMS-4, Automatic Degaussing Control System Type EMS-4

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DEFINITIONS

AM - The symbol for athwartship magnetization.

A/m - The standard SI symbol for ampere-turn per meter.

Ampere-turn - For shipboard degaussing coil loops, the unit of amperes in a loop times the number of effective turns in the loop.

Ampere-turns per meter, A/m - The SI unit of magnetic field strength (magnetizing force).

Autodeg - The acronym for automatic degaussing and refers to shipboard automatic degaussing control equipment.

Background field - The magnetic field existing at a sensor (probe or detector) against which degaussing procedures are measured. Earth's field and nearby magnetic material are normal background fields. This field is compensated by calibration of sensor readings prior to ship's arrival.

Bias - The current required in a deperming solenoid (or X solenoid) to compensate the magnitude of earth's field component aligned with the ship's longitudinal axis. See "Perm bias" for another use of the term.

CM - The standard symbol for the term cyclically magnetized condition.

Coil effect - The magnetic field produced by current in a shipboard degaussing coil as measured at a degaussing facility.

Coil misfit - The magnetic field residual between a ship axial component magnetization and the calibrated coil effect which compensates that component as measured at a degaussing facility.

Contour - A graphic representation of a ship magnetic field consisting of isomagnetic lines that outline a sequence of graduated magnetic magnitudes. The contour normally is used for display of a ship's total field or component fields at a depth used by degaussing facilities.

Cycle - A term applied to the top shots beginning a deperm ME and a deperm R. A cycle consists of two shots given in sequence of opposite polarities with

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both shots of equal magnetic intensity including the effect of the Earth's field on the shots. (See cycling.)

Cyclically magnetized condition (CM) - A magnetic material is in CM condition when, after having been subjected to a sufficient number of identical cycles of magnetizing force, it follows identical hysteresis or flux-current loops on successive cycles which are not symmetrical with respect to the origin of the axes.

Cycling - A term used in deperming when the X solenoid is cycled more than once. Cycling is used to establish SCM, to change a ship's VM either with a Z loop energized or following the use of a Z loop, and to establish EVM.

Decay - A term which is applied to the gradual change in ship permanent magnetization either from an abnormal status towards a normal status or from a "soft" perm status towards a "hard" perm status. The term normally applies to the change in VM from an abnormal status towards EVM and to the change in VM after a magnetic treatment when a ship's magnetization was left with a certain amount of soft perm.

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

Degaussing calibration - The procedure of adjusting current and ampere turns of each shipboard degaussing coil to neutralize the ship component magnetization for which each coil is designed.

Deperm ME - A standard procedure authorized for the magnetic treatment of deperming. The procedure uses a monitored control of X solenoid applied field measured while the solenoid is energized; hence, the letters M for monitored, and E for energized, are used.

Deperm R - A deperming procedure consisting of a series of X solenoid shots of alternating polarity given in a fixed schedule having a constant decrement of specified magnitude between shots. Deperm R is an alternate procedure to deperm ME.

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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.

Deperming solenoid - A solenoid formed by electrical conductors encircling the ship abeam in turns and spaced along the ship's entire length. Each turn is placed in a vertical plane perpendicular to the longitudinal axis. The number of turns is based on ampere-turns per meter required, the current capacity of the cable within heating limitations, and the current and voltage capacity of the facility.

Detector - The sensing unit, probe, or sensor used with a magnetic field measuring system.

Domains, ferromagnetic - Magnetized regions, either macroscopic or microscopic in size, within ferromagnetic materials. Each domain, per se, is magnetized to intrinsic saturation at all times, and this saturation induction is unidirectional within the domain.

Earth's magnetic equator - The locus circumscribing the Earth where the vertical component, Z , of the Earth's magnetic field is zero and the angle of dip of the Earth's magnetic field is zero.

Earth's north magnetic pole - The location of the Earth's north magnetic poles is near the Earth's geographic south pole. Location is very near latitude $65^{\circ} 30'S$ and longitude $139^{\circ} 30'E$ (year 1980).

Earth's south magnetic pole - The location of the Earth's south magnetic pole is near the Earth's geographic north pole. Location is very near latitude $78^{\circ} 12'N$ and longitude $102^{\circ} 54'W$ (year 1980).

Eddy current - The electric current generated in electrically conductive materials when either the materials have rotational motion within a stationary ambient field or the ambient field has a rotational motion within stationary electrically conductive materials.

Eddy current field - The magnetic field from eddy currents in electrically conductive materials.

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Effective turns - The algebraic sum of plus and minus ampere turns in the energized conductors of a ship degaussing coil loop divided by the total current in the loop.

Electromagnetic field - The magnetic field from electric current, generally applicable to electric current in the effective turns of a circuit formed into a loop. The term is used in degaussing to refer to shipboard degaussing coils and facility magnetic treatments or magnetic treatment loops.

Electromagnetic polarity - The direction of field from electric current in a conductor or electric circuit loop.

Electromagnetic roll (EMR) - The motion of magnetic fields acting upon a ship and due to alternating electromagnetic fields in facility Y and Z loops when the Y and Z loop fields are made to simulate the alternations of the Earth's magnetic field upon a ship when the ship is rolling.

Equilibrium vertical magnetization (EVM) - A magnetic condition of ship vertical component magnetization wherein the vertical permanent magnetization is in equilibrium with the Earth's Z component.

Ferrous field - The magnetic field, induced or permanent, associated with iron and steel materials. In degaussing, ferrous fields include all static magnetic fields associated with magnetic materials.

Flash Deperming - A magnetic treatment of a ship, particularly landing craft and submarines, which alters the ship's PVM according to a specified procedure which results in a value required for compensation of a specified value of IVM. Along with alteration of the PVM, a normal deperming is performed. The flash deperming procedure is applied to ships without degaussing coil compensation and as specified by U.S Navy criteria.

Flux density, magnetic - The strength of a magnetic field, expressed in flux lines per unit area. (See also magnetic induction.)

Gamma - The cgs unit of a magnetic flux density equal to 10^{-5} gauss. One gamma equals the SI unit of one nanotesla.

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Gauss - The unit of magnetic induction in the cgs electromagnetic system. The gauss is equal to one maxwell per square centimeter or 10^{-4} tesla.

Intrinsic induction - The vector difference between the magnetic induction in a magnetic material and the magnetic induction that would exist in a vacuum under the influence of the same magnetizing force.

Magnetic flux - The product of the magnetic induction and the area of a surface (or cross section) when the magnetic induction is uniformly distributed and normal to the plane of the surface. The concept that the magnetic field is flowing along the lines of force suggests that these lines are therefore "flux" lines, and they are called magnetic flux.

Magnetic history - A general term covering a chronological record of occurrences that affect the magnetic status of a ship. A ship's magnetic history begins with its magnetic status upon completion of construction and includes the magnetic status at significant events throughout the life of the ship.

Magnetic hysteresis - The property of a ferromagnetic material exhibited by the lack of correspondence between the changed induction resulting from increasing magnetizing force and from decreasing magnetizing force.

Magnetic induction (flux density), B - That magnetic vector quantity which at any point in a magnetic field is measured either by the mechanical force experienced by an element of electric current at that point or by the electromotive force induced in an elementary loop during any change in flux linkages with the loop at that point. (See flux density.)

Magnetic permeability - Permeability is a general term used to express relationships between magnetic induction, B, and magnetizing force, H, under various conditions of magnetic excitation. These relationships are either (1) absolute permeability, which, in general, is the quotient of a change in magnetic induction divided by the corresponding change in magnetizing force or (2) relative permeability, which is the ratio of the absolute permeability to the magnetic constant.

Magnetic retentivity - That property of a magnetic material which is measured by its maximum value of the residual induction.

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Magnetic saturation - The total magnetization produced in a ferromagnetic material, at which point the incremental permeability has progressively decreased to approach unity.

Magnetic treatment - A deperming, flash deperming, and any similar method of altering a ship's permanent magnetization.

Magnetizing force (magnetic field strength), H - That magnetic vector quantity at a point in a magnetic field which measures the ability of electric currents or magnetized bodies to produce magnetic induction at the given point.

Magnetometer - An instrument for measuring a magnetic field. It is distinguished from a fluxmeter by its ability to measure static magnetic fields.

Magnetometer garden - The underwater installation of magnetometer detectors (sensors or probes) installed at facilities for measurement of magnetic fields or moored ships. Magnetometer gardens are installed for deperming facilities, electromagnetic roll facilities, and stray field facilities.

Microtesla - The SI unit of flux density nearest to the common cgs unit of milligauss. One microtesla is 10^{-6} tesla and equals 10 milligauss.

Milligauss - The cgs unit of flux density commonly used for magnetic measurements of steel hull ships. The SI measurement equal to one milligauss is 0.1 microtesla.

Nanotesla - The SI unit of flux density equal to the common cgs unit gamma. One nanotesla is 10^{-9} tesla and equals 10^{-5} gauss.

Perm - An abbreviation of permanent magnetization. The term may be used in magnetic treatments to indicate the action of creating permanent magnetization as distinguished from "deperming."

Perm bias - A term applied to a shipboard degaussing control. It refers to the portion of a total current in a degaussing coil which compensates permanent magnetization. The degaussing control is designed to maintain a constant perm bias setting while current for induced magnetization is changing automatically.

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Probe - A term synonymous with "sensor" and "detector." The term probe is more often used, however, for the sensing unit of a portable magnetometer.

Pulsing - A term used in magnetic minesweeping to refer to the current flow in the minesweeping tails. The common terms are "forward pulse," "reverse pulse," and "pulse patterns" such as square wave and sine wave current cycles.

Minesweepers operating in groups of two or more must synchronize their pulsing. Measurements of magnetic fields from magnetic minesweeping generators are made by pulsing current from the generators.

Quad - A term used to indicate the arrangement of four single conductor cables with two plus polarity cables and two minus polarity cables. The two cables of like polarity are placed in an X relationship so as to neutralize the electromagnetic fields from the cables to the maximum extent possible. The field from a "quadded" cable is essentially zero at a distance critical to minesweeper safety.

Ranging - A term applicable to measurement of a ship's magnetic field at a degaussing range facility. The measurement by ranging is distinguished from measurements at facilities for moored ships by the method of continuous measurement while the ship is underway and crossing a single row of sensors spaced perpendicularly to the ship's course.

Roll effect - A term applicable to the behavior of a ship's vertical and athwartship component magnetic fields when a ship rolls in the Earth's magnetic field. The same roll effect can be simulated at an electromagnetic roll facility.

Sensor - The sensing device of an influence mine. Also, the "detector" or "probe" used with a magnetic measurement system to respond to magnetic fields at the point of measurement.

Sensor tube - The pipe or tube installed at a degaussing facility for housing a sensor, detector, or probe of a magnetic measuring system. The tube is nonmagnetic and is normally installed vertically into the Earth at the sea bottom of a waterway for a range or the sea bottom at degaussing facilities used for moored ship measurements.

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Shot - A term which applies to current applications of a deperming solenoid during a deperming series.

Signature - A term used in magnetic silencing to refer to the status of magnetic/electric effects existing at distances critical to ship or submarine safety. Only the term magnetic is used at degaussing facilities, and the term generally refers to the graphic display of ship magnetic fields as measured at normal depths and usually refers to profile displays as distinguished from contour displays. Onboard minesweepers, the term refers to the ship's maximum magnetic field existing at a specified depth and is used with reference to responsibilities and procedures for maintaining low magnetic fields from various sources.

Symmetrically cyclically magnetized (SCM) condition - A magnetic material is in a SCM condition when, under the influence of a magnetizing force that varies cyclically between two equal positive and negative limits, its successive hysteresis loops or flux-current loops are both identical and symmetrical with respect to the origin of the axes.

Tesla - The unit of magnetic induction equal to 1 weber per square meter.

Triaxial magnetometer - A magnetometer system that measures magnetic fields from a detector with three sensing elements whose axes are mutually perpendicular to each other. Each axis may be used for axial measurements or all three may be used for measurement of a total field.

Weber - The unit of magnetic flux whose decrease to zero, when linked with a single turn, induces in the turn a voltage whose time integral is one volt-second. One weber equals 10^8 maxwells. (See magnetic flux.)

X-monitor - A term applicable to an X oriented monitor used during a deperm ME treatment. The monitor is a detector placed horizontally at a suitable distance away from the ship and aligned with the ship's longitudinal axis.

X-solenoid - A term frequently used for a ship deperming solenoid, since the axis of the solenoid corresponds to the ship's longitudinal axis.

Y loop - A loop in a vertical plane with its axial alignment in a direction corresponding to a ship's athwartship axis, or with its axial alignment in a

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direction perpendicular to the Earth's horizontal magnetic field. A Y loop may be in a plane other than vertical, but it is used to establish a magnetic field in a ship's athwartship axis; therefore, loops at a roll facility that are placed in horizontal planes on either side of a ship and designed to create an athwartship field through the ship are called Y loops.

Z loop - A loop in a horizontal plane with its axial alignment in a direction that corresponds to the Earth's vertical magnetic field (Z). The most common uses of a Z loop are at magnetic treatment facilities performing flash deperming and at an EMR facility.

Z-monitor - A term applicable to a Z oriented monitor used during a deperming ME treatment. The monitor is a vertical detector at a position suitable to measure X solenoid fields during the deperm ME treatment. Usually, detectors in the keel row of the magnetometer garden are selected.

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FORMULAS

A. M coil chart setting calculation

$$M_{ZR} = M_R + MS \frac{(Z_z - Z_R)}{.110}$$

where:

- M_{ZR} = M setting for chart zone of range site
- M_R = M best setting at range site
- MS = M step in amperes
- Z_z = value in gauss for chart zone of range site
- Z_R = value in gauss for range site
- .110 = value in gauss between zones

B. Mstep calculation

$$MS = .110 \frac{mb}{NM}$$

where:

- MS = M step in amperes
- .110 = value in gauss between zones
- m = statistical constant for a class of ship (unclassified table of values provided by Ranging Technical Manual)
- b = maximum beam of the ship in meters
- NM = effective number of turns of M coil at midships

C. FP-QP coil chart settings

$$P_{REG} = P_{RVM} + \frac{(M_R + AM (Z_{REG} - Z_R))}{M_R} + P_{FLM}$$

where:

- P_{REG} = FP-QP current setting in the elected region
- P_{RVM} = FP-QP current value for VM compensation at the range
- M_R = best M setting at range
- Z_{REG} = value of Z in gauss for the regions:

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Northern Region = .440 gauss
Middle Region = .055 gauss
Southern Region = -.330 gauss

Z_R = value of Z in gauss at the range site
 AM = $\frac{M_step}{.110}$ in amperes per gauss
 P_{PLM} = FP-QP current value for PLM compensation

D. FI-QI coil chart settings

$$I_{HZ} = \frac{I_R}{H \cos^2} \times H_z$$

where:

I_{HZ} = FI-QI current for H_z value in gauss of the selected zone
 I_R = FI-QI current for full compensation of $H \cos^2$ at the range
 $H \cos^2$ = component of H in gauss on the range course angle 2
 H_z = value in gauss of H in the selected zone

E. Local Coil Settings for Degaussing Chart No. 1

1. M coil settings

Formula:

$$M \text{ Setting} = M (\text{zone}.00) + MS \left(\frac{\text{Local } Z}{.110G} \right)$$

2. FP-QP (or P) setting

Formula: (for Chart P settings dependent on M coil settings)

Facility Best P Setting

$$= \text{Chart Region P setting} \left(\frac{\text{Facility M setting}}{\text{Region M setting}} \right)$$

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F. Local coil settings for Degaussing Chart No. 2-S

1. FI-QI (or I) coil settings

Formula:

$$\text{FI-QI Zone H Chart Setting} = \text{IJ} \frac{(\text{Local H Zone})}{(.400\text{G})}$$

$$\begin{aligned} \text{FI-QI Zone H Course Setting} \\ = \text{IJ} \frac{(\text{Local H Zone})}{(.400\text{G})} \cos (\text{course magnetic heading } ^\circ) \end{aligned}$$

2. A Coil Setting

Formulas:

$$\text{AI Zone H Setting} = \text{AJ} \frac{(\text{Local H Zone})}{(.400)}$$

$$\begin{aligned} \text{AI Zone H Course Setting} \\ = \text{AJ} \frac{(\text{Local H Zone})}{(.400)} \sin (\text{course magnetic heading } ^\circ) \end{aligned}$$

AI Facility Best Setting

$$= \text{AJ} \frac{(\text{Facility H})}{(.400)} \sin (\text{course magnetic heading } ^\circ)$$

G. M Setting for Z Zone of Range Site

$$M_z = \frac{(Z_z - Z_R)}{.110} \times MS + M_R$$

where:

Z_z	=	chart Z zone value in gauss for range site
Z_R	=	Z value in gauss at range site
MS	=	M step
.110	=	gauss per chart zone step
M_R	=	best M setting for range site
M_z	=	chart M setting for range Z zone

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H. The formula for calculating variable FP-QP coil settings is:

$$P_{CR} = P_{PLM} + P_{VMR} \frac{(M_{RZ})}{(M_R)}$$

where:

P_{CR}	=	FP-QP setting for selected chart region
P_{PLM}	=	FP-QP setting for ship's PLM
P_{VMR}	=	FP-QP setting for ship's VM at range site
M_{RZ}	=	M setting for selected Region Z
M_R	=	best M setting for the range site

I. DGI Calculations

$$DGI = D_{eff} \left(\frac{\text{Max Fld mG}}{15mG} \right)^{1/2}$$

J. Maximum Amperes (X Solenoid Cable)

$$Tr = .505 \left(\frac{I}{M^2} \right)^2 \times 10^{-14} \times t$$

Tr	=	85 - T_a (limit of temperature rise, degrees Celsius)
T_a	=	ambient temperature (Degrees Celsius)
t	=	shot duration time in seconds
M^2	=	area of copper conductor in meters ²
I	=	current in amperes

K. X-Solenoid Cable Resistance

R_{t_2}	=	$R_{t_1} (1 + k_{t_1} (t_2 - t_1))$ ohms/1000' at 85 °C
R_{t_2}	=	cable resistance at 85 °C
R_{t_1}	=	cable resistance at 20 °C
k_{t_1}	=	temperature coefficient of resistance (97% conductivity) at t_1 temperature
t_2	=	85°
t_1	=	20°

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L. ME deperming to following:

$$B_o = B_e + (1-G) B_s + B_v + B_{mf} + B_z + B_a + B_y$$

B_e = Earth's H field at facility

B_s = Solenoid bias current effect

G = Normally 0.75. See Reference No. 9 for calculation of G

B_v = Ship's VM effect. Derived from M coil effect to compensate ship's VM

B_{mf} = Misfit factor

B_z = Z loop effect for Z loop current during treatment

B_a = Ship's AM effect. Derive from A coil effect set for AM compensation

B_y = Y loop effect for Y loop current during treatment

M. EMR

Formulas for continuous roll values

1. $Z' = Z \cos^2 \theta - H_y \sin^2 \theta$

Z = Earth's vertical field component

H_y = Earth's horizontal field component in ship's athwartship axis at $\theta = 0^\circ$

Z' = value of Earth's field in ship's vertical axis

2. $H' = H_y \cos^2 \theta + Z \sin^2 \theta$

H' = value of Earth's field in ship's athwartship axis

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1. Introduction to Course.

Purpose, listing of SSWBs, general procedures, description of format, role of instructors, safety precautions.

2. Introduction to Magnetic Silencing.

a. Basic Information

Mines, impact of mines, units of measurements.

b. Fundamentals of Magnetism

Theory, properties, materials, characteristics, electromagnetism, analysis, Earth's field.

3. Basics of Magnetic Silencing.

a. Magnetics of Ships

Magnetic environment, magnetizations, measurements.

b. Magnetic Silencing Techniques

Compensation, degaussing coils, magnetic treatments, signature control of minesweepers.

c. Magnetic Measurements of Ships

Background, basis of measurements, measurement equipment.

4. Facilities.

a. General Site Requirements

Headings, access, magnetic survey.

b. Ranging Facilities

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- Criteria, underwater equipment, installations, ship positioning.
- c. Treatment Facilities
Requirements, installations, equipment.
 - d. Stray Field Facility
 - e. EMR Facilities
5. Instrumentation.
- a. Measurement Sensors
Theory, connections, installations.
 - b. Range Control System
Components, operation.
 - c. Treatment Control System
Components, operation.
 - d. Stray Field System
Components, operation.
 - e. Electromagnetic Roll System
Components, operation.
 - f. Special Installation
Off-field measurements, monitors.
6. Shipboard Degaussing Installations: Coils, Loops.

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- a. Basics of Installation
Compensation, coils, loops, design, misfit.
 - b. Steel Hull Ships
Coils, loops, location, misfit, calibration.
 - c. Wood Hull Ships
Coils, loops, location, misfit, calibration.
7. Shipboard Degaussing Installations: Controls, Compass.
- a. Control Systems
Manual, heading control, magnetometer control.
 - b. Magnetic Compasses
Treatment effect, compensating coils.
8. Steel Hull Ship Ranging: Magnetics, Compensation.
- a. Magnetics of Ships
Components, type steel, cruise effect, overhaul.
 - b. Degaussing Compensation
Induced/permanent compensation, heading, latitude.
9. Steel Hull Ship Ranging: Magnetic Signature Analysis.
Characteristics, scaling, side traces, mean ordinates, heading data, coil effects, computations.
10. Steel Hull Ship Ranging: Magnetic Calibration Standards.

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Definitions, class values, formulas, calibrations.

11. Magnetic Treatments: Magnetics.

Magnetic properties, steels, theory.

12. Magnetic Treatments: Deperming.

Principles, facility preparations, data, safety precautions.

13. Magnetic Treatments: Flash Deperming.

Principles, preparations, data, safety precautions.

14. Minesweeper Ranging: Magnetics and Shipboard Compensation.

Wood hull characteristics, coils/loop effects, ferrous materials, conductive materials, compensation, automatic compensation, phase lag.

15. Minesweeper Ranging: Ranging Procedures.

Check ranging, calibrations, loop effects, coil setting, material control, signature analysis.

16. Minesweeper Measurements: Stray Field, Eddy Current Fields.

- a. Stray Fields

Causes, minesweeping generators, ship service equipment, dc wiring/cabbling, method of measurements.

- b. Eddy Current Fields

Causes, minesweeping generator flywheel, methods of correction, shipboard inspections, method of measurements.

17. Minesweeper Ranging: Magnetic Materials

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Permeability, ferrous items, authorized/excess material, magnetic orientation, magnetic inspections, records, importance of measurements to minesweeper safety, shipboard control of ferrous materials.

18. Degaussing Forms, Records, and Reporting Procedures.

a. Degaussing Instructions for Minesweepers

Degaussing folder instructions, records, lists, charts.

b. Degaussing Instructions for Ships other than Minesweepers

Degaussing folder forms and instructions, charts, logs.

c. Degaussing Activity Reports and Records

Facility logs, watch list recommendations, degaussing summaries, range records, treatment report, instructions for preparation of logs.

19. References, Definitions, Formulas, and Course Outline.