NOTE: MIL-STD-1605 has been redesignated as a Standard Practice. The cover page has been changed for Administrative reasons. There are no other changes to this Document.

MIL-STD-1605(SHIPS)
20 April 1973

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

PROCEDURES FOR CONDUCTING A SHIPBOARD ELECTROMAGNETIC INTERFERENCE (EMI) SURVEY (SURFACE SHIPS)

AMSC N/A

AREA EMCS

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

DEPARTMENT OF THE NAVY

NAVAL SHIP SYSTEMS COMMAND

WASHINGTON, D.C. 20360

Procedures for Conducting a Shipboard Electromagnetic Interference (EMI) Survey (Surface Ships)

MIL-STD-1605(SHIPS)

1. This Military Standard is approved, 20 April 1973, for use by the Naval Ship Systems Command.

2. Recommended corrections, additions, or deletions should be addressed to Commander, Naval Ship Engineering Center, Department of the Navy, Center Building, Prince George's Center, Hyattsville, Maryland 20782.

FOREWORD

The procedures for conducting a shipboard electromagnetic interference survey, previously promulgated by Bureau of Ships Instruction 9671.25 of 15 January 1965, have been revised and updated and are now specified in this standard. These revised procedures have resulted from many EMI surveys and a review of resultant reports. Certain test requirements and test limits have been relaxed. Testing of electrical equipment has been limited to only those which could interfere with electronic systems. Electronic equipment testing has been detailed to the extent necessary to provide a comprehensive, yet simplified, EMI survey. An improved format for reporting the results of an EMI survey is also provided. Upon issuance of this Standard, Bureau of Ships Instruction 9671.25 of 15 January 1965 will be canceled.

CONTENTS

TABLE

FIGURE

1. SCOPE

1.1 Scope. This standard provides detailed procedures for conducting an electromagnetic interference (EMI) survey aboard surface ships. An EMI survey is required for new construction ships and ships receiving overhauls or other major repair work that changes the electromagnetic configuration.

2. REFERENCED DOCUMENTS

2.1 The issues of the following documents in effect on date of invitation for bids form a part of this standard to the extent specified herein:

GOVERNMENTAL

STANDARD

MILITARY
MIL-STD-1310 - Shipboard Bonding, Grounding and Other Techniques for Electromagnetic Compatibility and Safety.

PUBLICATIONS

MILITARY
NAVSHIPS 0900-005-8000 - Technical Manual for Radio-Frequency Radiation Hazards.
NAVSHIPS 0967-317-7010 - Radio Frequency Burn Hazards Reduction.
NAVSHIPS 0967-477-3010 - Shipborne Systems Certification Requirements Manual (Non Nuclear).

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

3. DEFINITIONS

3.1 Electromagnetic compatibility (EMC). The ability of electronic equipments or systems to operate in a fixed environment within design levels of performance without degradation due to electromagnetic interference (EMI).

3.2 Electromagnetic interference (EMI). Electromagnetic energy which interferes with the detection and analysis of a desired signal or causes a malfunction in an equipment.

3.2.1 Narrowband EMI. An electromagnetic interference that has the principal spectral energy lying within the bandpass of the equipment receiving the interference. Narrowband interference is sharply tunable and is similar to the tuning of a radio station signal. Examples of narrowband interference are radio transmissions, hull-generated intermodulation signals, and oscillator type signals.

3.2.2 Broadband EMI. An electromagnetic interference that has the spectral energy distributed over a wide frequency in relation to the frequency bandwidth of the equipment receiving the interference. Broadband interference is broadly tunable and will exist over all or a portion of the tuning range of an affected receiver. Examples of broadband interference are atmospheric disturbances, arcing static discharges and short duration pulses.

3.3 Equipment, electrical. An equipment, other than electronic equipment, designed to generate, convert, distribute, control, or utilize electrical energy. Examples are generators, power switchboards, motor controls, motors, lighting fixtures, and electrical appliances.

3.4 Equipment, electronic. An equipment designed to generate, transmit, convey, receive, store, process, or otherwise use electronic signals. Examples are oscillator equipments, transmitters (sonar, radio and radar), amplifiers, sensing devices, receivers, computers, underwater detection equipment, fire control equipment, drone control equipment, and associated test equipment.

3.5 Intermodulation. The production in a nonlinear element of frequencies equal to the sums and differences of integral multiples of two or more frequency sources.

3.6 Phase I tests. That part of the EMI survey, specified herein, that is conducted at dockside for the purpose of keeping the phase II (underway) test time to a minimum. Phase I tests are measurements of the electromagnetic emissions from installed electrical equipments to determine whether these equipments are a potential source of interference to electronic equipments.

3.7 Phase II tests. That part of the EMI survey, specified herein, that determines the electromagnetic compatibility of the ships electronic systems. Phase II tests are conducted while the ship is underway and in a typical operating configuration.

3.8 Receiver overload. A radio frequency (RF) voltage present at the antenna input of an electronic receiver in excess of that which the receiver was designed to process. As a result, receiver tuning and detection are impaired.

3.9 Space, electrical. A space used primarily to contain installed units of electrical equipment. Examples are 60 and 400 Hertz (Hz) motor generator spaces, and power switchboard distribution spaces. (Spaces containing both electrical and electronic equipments shall be considered as electronic spaces).

3.10 Space, electronic. A space used primarily to contain installed units of electronic equipment. Examples are radar rooms, sonar rooms, electronic counter measures (ECM) rooms, communication center, transmitter rooms, crypto rooms, and missile control rooms.

3.11 Topside areas. All shipboard areas exposed to the weather, such as main deck and above. Topside areas for ships with flight decks or antenna decks are all areas, including the gallery deck and above, that are exposed to the weather. Hangar decks and sponsor deck areas are not considered to be topside areas.

4. GENERAL REQUIREMENTS

4.1 The electromagnetic interference (EMI) survey shall be well planned and coordinated with all participating personnel to insure optimum utilization of dock-side and underway test time. A test agenda or test plan shall be prepared listing the specific equipments, by nomenclature and location, that are required to be tested (see table I). The number of equipments and monitor positions can then be determined and a required test time can be affixed to the total survey. At the conclusion of the EMI survey, a report shall be prepared detailing the survey results (see 5.3). The report shall provide sufficient information to determine the following

(a) The cause and severity of any interference detected.
(b) Methods for reducing or eliminating the interference.
(c) Estimated manpower and materials required for any changes recommended and any effects on ship scheduling.
(d) The responsibility for any additional work or material required (see 5.2.7).

Based on the information provided, Naval Ship Systems Command will determine the responsibility for and the priority and extent of additional or corrective work to be performed.

5. DETAILED REQUIREMENTS

5.1 Phase I tests. Phase I tests shall consist of measuring the electromagnetic emission from certain installed (non-portable) electrical equipments within certain specified shipboard areas (see 5.1.1) to determine whether these emissions are potential sources of interference to the ship's electronic systems. Phase I tests shall be performed at a time when local man-made electrical noise is below the equipment emission limits of figure 1. Portions of the phase I tests may be scheduled to coincide with load testing or other check-out tests of deck machinery, providing the phase I test results are not impaired. Phase I tests shall be conducted in accordance with 5.1.2.

5.1.1 Electrical equipments requiring testing.

5.1.1.1 Nonmetallic hull ships. Except as specified in 5.1.1.3, all electrical equipments located in both topside and non-topside areas of nonmetallic hull ships shall be tested for electromagnetic emissions.

5.1.1.2 Metallic hull ships. Except as specified in 5.1.1.3, electrical equipment located in metallic hull ships shall be tested for electromagnetic emissions only under one or more of the following conditions

(a) When located in topside area.

(b) When located in a compartment having a door opening onto a weatherdeck or when located in a compartment which is separated from a weatherdeck by a nonmetallic bulkhead(s) or deck(s).
(c) When located in a compartment designated as an electronic space.
(d) When located in a compartment adjacent to (including above and below) compartments specified in (c), or when located in a compartment which is separated from the compartment specified in (c) by a nonmetallic bulkhead(s) or deck(s).

5.1.1.3 Exceptions. Electrical equipments such as alternating current (ac) motors which do not contain commutators, slip rings, or variable speed controllers are inherently free of interference and do not require testing. In addition, portable electrical equipments, transformers, heat-element types of equipment, ac outlets, connection boxes, and switch boxes do not require testing.

5.1.2 Test procedures. Electromagnetic (EM) emissions from electrical equipments shall be measured as follows:

(a) Select an interference measuring equipment that has the frequency capability of 150 kilohertz (kHz) to 25 megahertz (MHz), such as the radio test set AN/PRM-1 (Stoddart NM-20), or Stoddart NM-25T.
(b) Set the function selector to Quasi-Peak (QP) (Use the Peak position if the measuring equipment selected does not have a QP capability). Tune the measuring equipment to 150 kHz and calibrate. Attach the E-field pick-up antenna (rod or whip) to the measuring equipment and extend the antenna to the maximum height.
(c) Locate the pickup antenna 3 feet from that part of the electrical equipment which is most likely to be the source of electromagnetic emissions.
(d) Energize the electrical equipment and observe the measuring equipment for any indication of electromagnetic emissions. These emissions can be expected to be broadband and therefore will exist over a wide frequency range. Disregard any quick meter indications which may occur when the electrical equipment is initially energized or de-energized. If necessary, tune the measuring equipment slightly to avoid signals from sources other than the equipment under test. Investigation of any narrowband signal(s) during phase I tests is not required. If an electromagnetic emission is not detectable from the electrical equipment at 150 kHz, further testing of that equipment is not required.
(e) If an electromagnetic emission is detectable, record the level of the emission. Verify that the source of this emission is the electrical equipment under test by de-energizing the equipment or by moving the measuring equipment antenna away from the electrical equipment and noting a decrease in the meter indication. Determine the severity of the emission by the following steps:
    (1) If the electromagnetic emission recorded at 150 kHz is below 50 microvolts/meter/5kHz for topside installed equipment (or 500 microvolts/meter/5 kHz for non-topside installed equipment) tune the measuring equipment to 2 MHz, recalibrate and take another emission measurement.
    (2) If the emission level at 2 MHz is below 15 microvolts/meter/5 kHz for topside installed equipment (or 150 microvolts/meter/5 kHz for non-topside installed equipment) then the electrical equipment under test is not considered a potential interference source to electronic equipments and further investigation of that equipment is not required.
    (3) If the level at either frequency exceeds the levels specified in steps (1) and (2), make two additional measurements within each band of the measuring equipment at points where the emission level is highest.
    (4) Compare these emission levels with emission limits on figure 1. If the levels measured do not exceed the limits of figure 1, the electrical equipment under test is not considered a potential interference source to electronic equipments and further investigation of that equipment is not required.
    (5) If any of the levels measured exceed the limits of figure 1, re-schedule that equipment to be energized again during phase II tests (see table I) to determine whether that electrical equipment actually causes interference to electronic equipments or systems. To expedite the identification of these emission sources during phase II tests, pertinent characteristics of the emission such as frequency and audible characteristics shall be recorded.

5.2 Phase II tests. Phase II tests shall consist of operating active electronic equipments within a specified category (see table I) while receivers and other susceptible equipments in the same category are monitored for electromagnetic interference. Electrical equipments which exceeded the emission limits of figure 1 shall also be tested for compatibility with electronic systems.

5.2.1 Preliminary examination. A visual examination shall be made sufficiently in advance of phase II tests to permit correction of conditions that are likely to affect the test results adversely. The examination shall confirm that; (1) bonding, grounding, and other techniques for electromagnetic compatibility and safety have been accomplished in accordance with MIL-STD-1310 (if specified), (2) multicouplers, filters, and blankers, (where required) are installed and operating, (3) there are no missing or visibly defective electronic equipments or broken or missing antennas, (4) all loose metallic items that are not normally part of the ship have been removed from the topside areas. Deficiencies discovered during the examination shall be corrected prior to starting phase II interference tests.

5.2.1.1 Personnel safety. The safety precautions and operating procedures of Publications 0900-005-8000 and 0967-317-7010 relating to radio-frequency radiation hazards and radio-frequency burn hazards shall be observed while electronic antennas are energized.

5.2.2 Test area ambient. The ship shall be located in an area where the ambient electrical noise level and the off-ship transmitter signal levels do not exceed those specified in 5.2.2.1 and 5.2.2.2.

5.2.2.1 Below 25 MHz. Interference tests utilizing monitor receivers operating below 25 MHz shall be conducted in a test area where the ambient electrical noise level in the 2 to 25 MHz frequency range does not exceed 25 microvolts/meter/5 kHz (QP). This level shall be determined by making a series of measurements in steps of 2 MHz from 2 to 10 MHz and in steps of 5 MHz from 10 to 25 MHz. Measurements may be made using the same measuring equipment of phase I. The ambient measurements shall be taken in an open topside area and shall be repeated at least every 2 hours. Transmitters operating below 25 MHz, ultra high frequency (UHF) radars, and all electrical equipments that exceeded the emission limits of phase I tests shall be secured during the ambient measurements.

5.2.2.1.1 Exceptions. The following minor exceptions to the ambient limits specified in 5.2.2.1 are acceptable:

(a) If not more than two measurements exceed 25 microvolts, they can be disregarded and excluded from the overall ambient measurement results.
(b) Measurements in crowded portions of the frequency spectrum may be omitted when the crowding is so severe that ambient measurements cannot be obtained.
(c) During all ambient measurements, intermittent, random spaced noise pulses, (regardless of amplitude) are allowable exceptions, provided they do not occur more frequently than an average of one per 3-second period.

5.2.2.2 25 MHz and above. Tests using monitor receivers operating at 25 MHz, and above, shall be conducted in a test area where signals from off-ship transmitters are not great enough to overload or adversely affect the monitor receivers.

5.2.3 Monitor equipment (receiver) selection. Receiving equipments shall be selected and energized in accordance with table I. Equipments shall be selected not only to monitor each frequency category specified but shall also be selected to use at least one of each different type of receiving equipment within the same frequency category. In addition, each receiving antenna shall be used at least once during phase II testing.

5.2.3.1 HF receiver selection. Two high frequency (HF) receivers shall be selected to monitor the HF frequency range during HF transmitter tests. When possible, receivers shall be selected which are capable of continuous tuning in preference to step-tuning. One of the receivers shall be connected to a receiving antenna near the HF transmitting antennas, and the other receiver connected to an antenna remote from the transmitting antennas. The two receivers shall be tuned throughout the HF frequency range and a search made for interference in the form of overloading, arcing in the ship structure, or intermodulation. Other HF receivers shall be selected to be used as fixed-frequency monitors. The number of fixed frequency receivers shall, if possible, equal the number of HF transmitters energized. These receivers shall be tuned to fleet broadcast, WWV, or other signals that are steady and free of interference. The frequencies selected shall be representative of normal ship receiving frequencies and shall provide a good sampling of various types of modulation. The frequencies shall be spaced across the bands and shall meet the frequency

separation requirements of the equipments involved. If crowded band conditions make it impracticable to tune to interference-free signals, then less desirable frequencies, including those free of any transmissions, shall be selected.

5.2.3.2 Receiver sensitivity. Each receiver used shall be checked prior to phase II testing to insure the receiver sensitivity meets the applicable requirements of the Reference Standards Books, Maintenance Standards Books or Equipment Technical Manuals.

5.2.3.3 Receiver gain setting. The maximum practical sensitivity (maximum RF gain control setting that does not cuase receiver overload) shall be utilized. If interference is detected, the RF gain setting shall be reduced to ensure that receiver overload is not the cause of the interference.

5.2.3.4 Channelized UHF receiver tuning. When channelized UHF receivers are used as monitor receivers, the receivers shall be tuned to a minimum of 36 frequencies spaced not greater than 5 MHz apart. When the potential interference source is a scanning beam (mechanically or electronically), each frequency shall be monitored for a time exceeding the beam scan period.

5.2.3.5 Receiver protective devices. During each test, all receiver protective devices, such as bandpass filters, notch filters, multicouplers, and blankers that are installed and are normally specified for use with the receiver under test shall be used. In cases where the use of manually tuned filters and multicouplers makes it impossible to rapidly tune a wide frequency range, it is permissible to bypass the filter or multicoupler temporarily while an interference search is being made. If interference is encountered, the filter or multicoupler shall be reconnected to determine if it will reject the interference. If the signal(s) under investigation is rejected, it is not interference and does not require further investigation.

5.2.4 Active equipment (transmitter) selection. Transmitting equipment shall be selected and energized in accordance with table I. Equipments shall be selected, not only to transmit within each frequency category specified, but also shall be selected to use at least one of each different type of transmitting equipment within the same frequency category. In addition, each ship transmitting antenna shall be used at least once during phase II testing. All transmitters shall be operated at maximum rated power during tests.

5.2.4.1 Transmitter test frequencies. Transmitter test frequencies shall be selected that are typical of operating requirements for the ship being tested. Frequency separation requirements specified for transmitters, multicouplers, and antennas shall be complied with.

5.2.4.2 Transmitter modulation. To readily identify interference sources, transmitters shall be modulated with an easily recognized signal, such as multiplex, frequency shift keying (FSK), voice, teletype, or test tone.

5.2.4.3 Transceiver selection. If group transmitter tests involve primarily transceivers, then 75 percent of the transceivers shall be operated as transmitters and the remainder as monitor receivers.

5.2.4.4 Transmitter multicoupler test. A special test shall be conducted on each transmitter multicoupler. The test shall use the maximum number of transmitters connected to the multicoupler with each transmitter operating at maximum power. The test will determine the compatibility of the complete transmitter-multicoupler-antenna system.

5.2.5 Test procedures. The specified active equipments of table I shall be energized and radiated (as appropriate) while the susceptible equipments are energized and monitored for interference. If interference is detected, the active equipments shall be de-energized one at a time until the interfering source(s) is determined. The equipments shown in table I may be tested in any order of preference with the exception of category 7 which shall be accomplished as a conclusion of the phase II tests. Any extraneous signals generated by or caused by the active equipments or systems and detected by the monitoring equipments shall be termed interference. This interference shall be assigned a severity level based on the following:

Mild - A level of interference which, although detectable, does not hamper the detection and interpretation of a desired signal. This level of interference is mainly a background or nuisance type.

Medium - A level of interference which interferes with the detection and interpretation of a desired signal. This level of interference causes partial break-up or masking of the desired signal with some loss of signal content.

Severe - A level of interference which causes complete loss of a desired signal or interferes to the extent that desired signal information or message content cannot be interpreted.

5.2.6 Hull generated intermodulation interference test. A special test shall be performed on ships which have six or more HF communication transmitters installed. This test shall consist of operating two HF transmitters (at frequencies F_1 and F_2) and monitoring an HF receiver tuned to the 3rd order intermodulation frequency, $2F_1 \pm F_2$ or $2F_2 \pm F_1$. Transmit frequencies shall be selected so that the 3rd order intermodulation frequency falls within the HF frequency range, preferably in the lower half of the band. In addition, transmit frequencies shall be selected which are not harmonically related. Proper frequency separation shall be maintained between the transmit frequencies and the resultant 3rd order intermodulation frequency to prevent monitor receiver overload. The transmitters shall be operated at maximum power and shall be connected to separate antennas which will provide maximum deck radiation coverage. The receiver shall be coupled to an antenna centrally located on the ship. The level of 3rd order intermodulation interference shall be determined by observing the receiver signal level meter, then substituting a signal generator at the receiver antenna terminals and adjusting the generator for the same signal level. The generator signal level shall then be recorded in terms of microvolts or decibel (dB) above 1 microvolt. Information details relative to the intermodulation test shall be included in the EMI survey report. This information shall include:

(a) The frequency, power, and type of transmitters used.
(b) The type of receiver used.
(c) The description and location of all antennas used.
(d) The frequency and level of the 3rd order intermodulation interference.

5.2.7 Interference correction. Correction of interference, due to contractor-furnished equipment or workmanship, or due to workmanship in the installation or modification of government-furnished equipment, shall be in accordance with the terms of the contract. Interference due to government-furnished equipment shall be described in the interference survey report (see 5.3) in sufficient detail for the government to determine the feasibility of correcting the interference.

5.3 Interference report. At the conclusion of the interference survey, an interference report shall be prepared. The report shall be analytic and sufficiently detailed to permit its use as the basis for decisions concerning corrective action. The format desired for an interference report is detailed in the sample report contained herein. This sample shall be used as a guide, however, inclusion of any additional useful information shall have precedence over strict adherence to the format details. The information contained in the interference report shall include:

(a) The name, hull number, location of the ship and the date when each test phase was conducted.
(b) A brief description of the test procedures to indicate that the survey was adequate in scope and method. An explanation of any unusual circumstances concerning the test procedures or results.
(c) A list of phase I electrical equipments which exceeded the limits of figure 1.
(d) Results of the visual examination and whether all deficiencies noted were corrected prior to starting phase II tests.
(e) An interference summary sheet (see sample report in the appendix), listing all equipments tested and the interference condition of each.
(f) Interference details giving an analytic discussion of each case of interference recorded on the interference summary sheet and recommendations to eliminate the interference.
(g) Antenna identification giving antenna number, description, location, and terminating equipment.
(h) An EMI Test and Survey Certification to certify the EMI status of the ship under test.

5.3.1 Test data sheets. As part of the test agenda specified in 4.1, test data sheets shall be prepared to record the results of phase II tests. Each of the test monitor personnel assigned to monitor the specified equipments of phase II shall use the test data sheets to record the equipments monitored and all incidents of interference. At the conclusion of the tests, the data sheets shall be used to prepare the Interference Summary sheet and the Interference Details.

5.3.2 Interference summary sheet. An interference summary sheet (as shown in the sample report herein) shall be completed to give a composite view of the ship's overall interference condition. The summary sheet shall be prepared from information recorded on the test data sheets and shall list all electronic equipments tested and the level of interference relative to each. The severity of the interference shall be entered opposite the equipment causing the interference and under the equipment receiving the interference. This level of interference will then determine the urgency of the corrective action necessary. Active equipments, such as transmitters, which malfunctioned due to energy received from other transmitting equipments shall be listed also under Monitored Equipments.

5.3.3 Interference details. The incidents of interference entered on the Interference Summary Sheet shall be fully discussed under a section of the report entitled Interference Details. Information relative to the following shall be given in the discussion of each interference condition:

(a) Each interference condition identified by the active equipment row number and the monitored equipment column number.
(b) The active and monitored equipments by nomenclature involved in each interference condition.
(c) The frequency, frequencies, or frequency range of the interference and whether the level of interference changes with a change in frequency.
(d) The operational mode of each equipment such as amplitude modulation (AM), continuous wave (CW), FSK, and single sideband (SSB) or other (describe), and whether interference varies with a change in the operational mode.
(e) Characteristics of the interference such as broadband, narrowband, static discharges, radar PRF, spoking, buzzing, hash, overloading, intermodulation, or other (describe).
(f) Effects of the interference such as, causes complete loss or partial loss of signal information, presents noise on video display, causes voltage standing wave ratio (VSWR) relay to trip.
(g) The cause of the interference such as, coupling between antennas, radar illumination, of susceptible cables, arcing in standing rigging, insufficient separation between transmitting and receiving frequencies, or case penetration.
(h) Whether the monitored equipments are equipped with filters, blankers, or multicouplers and the operational condition of each.
(i) Recommendations to eliminate or reduce the interference. Corrective action shall be based upon technical considerations, physical constraints and economical factors. Recommendations that are technically correct but totally impractical shall be avoided. If relocation of an equipment is recommended, a location shall be specified.

5.4 EMI test and survey certification. An EMI test and survey certification (see sample report) shall be included as part of the EMI survey report. The certification form shall be duplicated and each blank shall be filled in relating to the ship under test. The certification form shall then be signed by personnel conducting the survey or by a cognizant supervisor. The certification will satisfy the EMI Test requirement of Publication 0967-477-3010 and will provide information as to the EMI status of each ship.

5.5 Report distribution. Copies of the EMI survey report shall be distributed to the following.

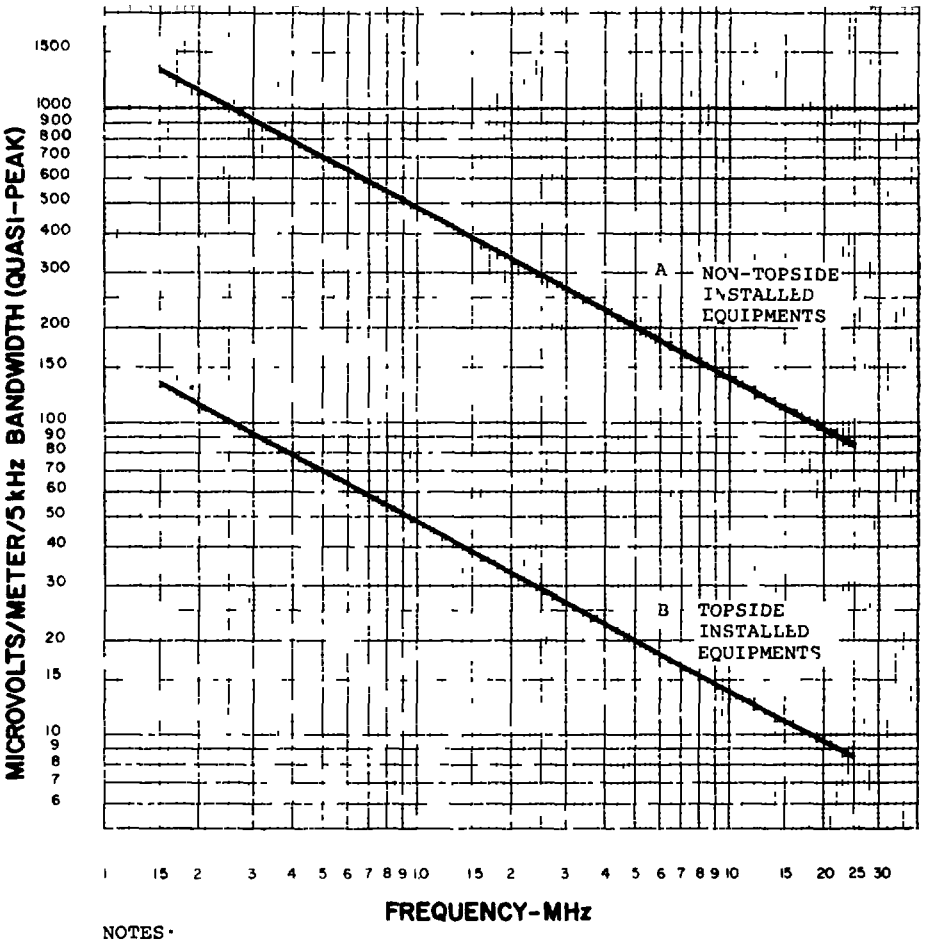
(a) Ship's Commanding Officer or Prospective Commanding Officer
(b) Shipyard Commander or Supervisor of Shipbuilding
(c) Type Commander
(d) Cognizant NAVSHIPS Ship Logistic Managers (SLM's) or Ship Acquisition Project Managers (SHAPM)
(e) NAVSEC 6179C (2 copies)

Preparing activity:
Navy - SH
(Project EMCS-N046)

Table I - Phase II electronic equipment test categories.

Category	Active equipments	Monitoring equipments
1	-Electrical equipments which exceeded the allowable limits of Phase I	-Receivers, VLF thru HF
2	-Transmitters, VLF thru HF	-Receivers, VLF thru HF
3	-Transmitters, VHF and above (excluding radar)	-Receivers, VHF and above -Amplifier type announcing systems
4	-Radar transmitters	-Receivers, HF and above -Amplifier type announcing systems -Closed circuit TV
5	-Sonar transmitters -Degaussing system	-Receivers, sonar, LF, underwater telephones, fathometers
6	-Miscellaneous active equipments not specified above	-Receivers, as applicable
7 (Final)	-All active equipments utilized in above tests	-All monitor equipments utilized in above tests

NOTE VLF - 3kHz-30kHz
LF - 30kHz-300kHz
MF - 300kHz-3000kHz
HF - 3MHz-30MHz
VHF - 30MHz-300MHz
UHF - 300MHz-3000MHz
SHF - 3000MHz-30,000MHz



NOTES:

(1) Microvolts/Meter/5 kHz = Meter Reading Times Attenuator Setting Times Antenna Correction Factor

(2) If the instrument readout is in Microvolts/Meter/MHz, divide by 200 to obtain Microvolts/Meter/5 kHz.

(3) Use limit curve "B" for topside and non-topside installed equipments on nonmetallic hull ships

Figure 1 EMISSION LIMITS FOR PHASE I EQUIPMENTS

APPENDIX

SAMPLE EMI SURVEY REPORT

10. SCOPE

10.1 Scope. This appendix covers a sample EMI survey report, (EMI test and survey certification and survey report).

SAMPLE

EMI TEST

AND

SURVEY CERTIFICATION

SHIP USS JOHN DOE (DDG 000)

I certify that the ship specified has been tested in accordance with the requirements of MIL-STD-1605 and has the electromagnetic interference conditions and equipments as recorded herein.

Certifying Authority Dwight R. Roman

Title or position EMI Engineer Code 191.5

Shipyard or Facility Twin City Naval Shipyard

Address Washington, D. C.

Date 29 May 1971

The required information shall be provided in the appropriate blanks to provide a certification that the ship specified has been EMI tested and presents the EMI conditions as recorded herein and in the EMI report.

I. Test Authority

(a) EMI test conducted as a result of X overhaul

shipalt new construction other (describe)

_____

_____

II. Bonding and Grounding

(a) Does this ship have six or more hf transmitters installed?

X yes ___ no

(b) Has MIL-STD-1310 been invoked on this ship? X yes ___ no

If yes, give brief description of work accomplished
All equipments within the ship and those located in topside areas have been bonded in accordance with MIL-STD-1310. Several items in topside areas have been fabricated from non-metallic material.

_____

_____

_____

(c) Is there a copy of NAVSHIPS 0967-266-1010, "Hull Generated Intermodulation Interference Reduction Techniques for Forces Afloat", in ships files?

X yes ___ no

III. Blankers

(a) Are AN/SLA-10 blankers installed? X yes ___ no

How many? 1

(b) Equipments blanked by AN/SLA-10 blanker(s)

AN/WLR-1 _____ _____

_____ _____

(c) Are all blanker(s) programmed correctly? X yes ___ no

Remarks _____

_____

_____

IV. Filters

(a) Equipments utilizing transmission line filters. (Filters which are not part of the original equipment).

R-1051 _____ AN/UPN-12 _____ _____

R-390A _____ _____ _____

(b) Are all filters connected and utilized? X yes ___ no

Remarks _____

_____

_____

V. Multicouplers

(a) Are multicouplers installed on this ship? X yes ___ no

(b) If yes, what type are installed and with what equipments are the multicouplers used.

AN/SRA-33 used with AN/SRC-20 equipments.

_____

_____

(c) Are all multicouplers connected and utilized?

X
yes no

Remarks _____

VI. EMI

(a) Abstract of EMI report

The Phase I tests revealed four electrical equipments exceeded the emission limits specified Two were corrected prior to Phase II tests. The remaining two were energized again during Phase II tests with no effects on ships electronic systems. Four deficiencies were noted during the visual examination and were corrected prior to Phase II tests. During Phase II tests, mild to severe interference was encountered on one HF reciever (R-390A) from an HF transmitter due to insufficient spacing between the respective antennas. Mild interference was observed on HF receivers during simultaneous operation of HF transmitters. Severe interference was also noted on band 8 of the WLR-1 from the AN/SPS-10 radar due to improper programming of the AN/SLA-10 blanker. Medium interference from the AN/SPS-43A radar was observed on the AN/SRC-20 UHF receiver. The installation of an AN/SRA-49 antenna coupler group and an AN/SRA-33 multicoupler and the correct programming of the AN/SLA-10 blanker should reduce all medium and severe interference to an acceptable level.

SAMPLE EMI REPORT

ELECTROMAGNETIC INTERFERENCE SURVEY REPORT

USS JOHN DOE (DDG-000)

Ref: (a) MIL-STD-1605(SHIPS) - Procedures for Conducting a Shipboard Electromagnetic Interference Survey.
(b) MIL-STD-1310 - Shipboard Bonding, Grounding and Other Techniques for Electromagnetic Compatibility and Safety.

1. INTRODUCTION

1.1 This report presents the results of an electromagnetic interference (EMI) survey conducted aboard USS JOHN DOE (DDG-000) to determine the effect of self-generated electromagnetic energy upon the performance of the ship's electronic systems. The EMI survey was conducted in accordance with reference (a).

2. SURVEY TESTS

2.1 Test agenda. A test agenda was prepared in accordance with the requirements of reference (a) listing the electrical and electronic equipments installed in USS JOHN DOE. All equipments scheduled for testing were recorded by nomenclature, location, and category number. Test data sheets were prepared and monitor positions were assigned.

2.2 Phase I. Phase I tests were conducted on 20 May 1971 while the ship was docked at the Twin City Naval Shipyard. Each electrical equipment scheduled for testing was energized one at a time and tested for electromagnetic emission by making measurements 3 feet from each equipment. A Stoddart NM-25T Field Intensity Meter was utilized for these measurements.

2.3 Visual examination. The ship was examined for loose metallic items in topside areas and for missing or visibly defective equipments, antennas, and the like, that could adversely affect the test results of phase II. In addition, the ship was examined for compliance with reference (b).

2.4 Phase II. Phase II tests were conducted on 23 May 1971 while the ship was underway in OP Areas 38-22 and 23. The ambient limits specified by reference (a) were met. The electronic equipments specified by the test agenda were energized by categories in accordance with table I of reference (a) while the specified monitor equipments were tuned and observed for any indications of interference. As a conclusion to the survey, all active equipments were energized simultaneously and all susceptible equipments were monitored for interference.

3. TEST RESULTS

3.1 Phase I. The following electrical equipments exceeded the emission limits specified for phase I requirements

(a) Crane hoist motor, 01 level, frame 131.
(b) Windshield wiper motor, bridge.
(c) Boat launching winch motor, main deck, frame 96.
(d) Motor-generator, main deck, frame 119.

Items (a) and (b) were examined and no reason for excessive electromagnetic emission could be determined. These equipments were then scheduled for testing during phase II. Item (c) was examined and a loose connector was found. The connector was repaired and the item was retested. The electromagnetic emission was then below the specified limits. Item (d) was examined and it was found that the item was not properly grounded. Two bond straps were installed in accordance with reference (b) and the item was retested. Emission was then below the specified limits

3.2 Visual examination. The following conditions were noted as a result of the visual examination:

(a) Ladders ascending the mast were not bonded to ground potential as required by reference (b).
(b) A broken bond strap was found on one weather deck door, 03 level, frame 128, port side.
(c) Miscellaneous pipe and other loose metal items were located in topside areas.
(d) A cracked antenna insulator bowl was noted on antenna 2-2.

All of the above conditions were corrected prior to ship departure for phase II tests.

3.3 Phase II. The active monitor equipments utilized and the interference detected during phase II testing are recorded on the Interference Summary Sheet. The interference recorded on the Interference Summary Sheet is described on the Interference Details (see Appendix).

INTERFERENCE SUMMARY SHEET

	MONITORED EQUIPMENTS / ACTIVE EQUIPMENTS	1 AN/SRR-11 NO.1	2 AN/SRR-11 NO.2	3 R-390A NO.2	4 R-390A NO.3	5 R-1051 NO.5	6 R-1051 NO.1	7 AN/UPN-12	8 AN/URR-35	9 AN/SRC-20 NO.4	10 AN/WLR-1	11 AN/SPS-10	12 AN/SPS-43A	13 AN/SPG-53	14 AN/SPG-55	15	16	17	18	19	20	21	22	23	24	25	26	27
A	PHASE 1 EQPTS.																											
B	EQPTS. C-G*	1	1	1	3	3	1																					
C	AN/WRT-1 NO.1		1																									
D	AN/WRT-2 NO.1				3																							
E	AN/WRT-2 NO.2					3																						
F	AN/URC-32 NO.1																											
G	AN/WRT-2 NO 3																											
H	EQPTS. I-L*																											
I	AN/SRC-20 NO.1																											
J	AN/SRC-20 NO.2																											
K	AN/SRC-20 NO.3																											
L	AN/URT-7																											
M	EQPTS. N-R*									2	3																	
N	AN/SPS-10										3																	
O	AN/SPS-43A									2																		
P	AN/SPG-53																											
Q	AN/SPG-55																											
R	AN/URN-20																											
S	ALL EQPT.*		1	1	3	3	1			2	3																	
T																												

* SIMULTANEOUSLY

Interference Severity: 1 mild, 2 medium, 3 severe

INTERFERENCE DETAILS

Row Number/Column Number
(from Interference Summary Sheet)

Discussion

B-1,3,6 — Interference from simultaneous operation of all HF transmitters to HF receivers
Interference in the form of hull generated intermodulation was detected on all HF receivers at various frequencies across the tuning range of each receiver. The interference was mild and did not interfere with desired signal detection.

Recommendation. No corrective action needed since receiver operation was not impaired.

C-2 — Interference from AN/WRT-1 No. 1 to AN/SPR-11 No 2
Interference received by the AN/SRR-11 was mild and occurred only at 440 kHz. This interference was traced to a spurious radiation which was coupled from the AN/WRT-1 antenna to the AN/SRR-11 receiving antenna.

Recommendation. Since receiver operation was not impaired, no corrective action is recommended.

D-4 — Interference from AN/WRT-2 No. 1 to R-390A No 3
Mild to severe interference to the R-390A No. 3 from the WRT-2 No. 1 was detectable across the entire tuning range of the R-390A and was the result of overloading caused by insufficient separation between the transmit and receive antennas. The transmitter was operated CW and the receiver AM.

Recommendation. Relocation of any of the antennas involved is impractical. Recommend the installation of an AN/SRA-49 Antenna Coupler Group.

E-5 — Interference from AN/WRT-2 No.2 to R-1051 No. 5

Same as D-4

M-9,10 — Interference from simultaneous operation of all radars
(See individual interference entries)

N-10 — Interference from AN/SPS-10 to AN/WLR-1
Severe interference from the AN/SPS-10 radar was detectable on band 8 of the AN/WLR-1 and was a result of improper programming of the AN/SLA-10 blanker.

Recommendation: Program the AN/SLA-10 so that the AN/SPS-10 pretrigger will blank band 8 of the AN/WLR-1.

O-9 — Interference from AN/SPS-43A to AN/SRC-20 No. 4
Medium interference to the AN/SRC-20 UHF receiver was detected over the frequency range of 225 to 400 MHz from the AN/SPS-43A radar.

Recommendation Install an AN/SRA-33 multicoupler between the AN/SRC-20 and associated antenna. Properly adjust the squelch control on the AN/SRC-20 receiver.

S-2,3
4,5,6
9,10 — Interference from simultaneous operation of all active equipments
(See individual interference entries)

MISCELLANEOUS TESTS

Transmitter Multicoupler Test

The transmitter multicoupler test as required by reference (a) was conducted utilizing two AN/WRT-2 transmitters multicoupled to antenna 2-3. Each transmitter was operated at maximum power of 500 watts. No degradation in performance was noted.

Hull Generated Intermodulation Interference Test

The topside intermodulation test as required by reference (a) was conducted utilizing two AN/WRT-2 transmitters connected to antennas 2-4 and 2-5. The transmitters were operated at maximum power of 500 watts at frequencies of 5.759 MHz (F_1) and 7.304 MHz (F_2). An R-390A receiver (No. 3) was utilized as a monitor. The receiver was connected to antenna 1-2 and tuned to the indermodulation frequency of 4.214 MHz ($2F_1 - F_2$). The intermodulation level varied slightly with ship movement but averaged approximately 28 dB above 1 microvolt.

ANTENNA IDENTIFICATION

No.	Description and Location	Used with
1-1	35' whip, FR 122, port side, 01 level	Spare
1-2	35' whip, FR 60, port side, main deck	R-390A No. 3
1-3	35' whip FR 60, stbd side, main deck	AN/SRR-11 No. 1 R-1051 No. 5
2-1	6 wire fan, aft mast to aft stack	AN/WRT-1 No. 1
2-2	35' whip, FR 122, stbd side, 01 level	AN/URC-32 No. 1
2-3	Cage, FR 23 C/L, 01 level	AN/WRT-2 No. 1 & 2
2-4	35' whip, FR 86, port side, 03 level	AN/WRT-2 No. 3
2-5	35' whip, FR 86, stbd side, 03 level	AN/WRT-2 No. 4
3-1	AS-390A, main mast, yard arm, port side	AN/SRC-20 No. 1
3-2	AS-390A, UHF outrigger, frame 95	AN/SRC-20 No. 2
3-3	AS-390A, main mast, yard arm, stbd side	AN/SRC-20 No. 3
3-6	NT-66095, dipole, FR 38, top of pilot house	AN/URT-7
3-9	AT-150, platform, aft stack	AN/URR-35
6-1	Main mast, platform	AN/WLR-1
10-1	AN/SPG-53	AN/SPG-53
10-2	AN/SPG-55	AN/SPG-55
11-1	AN/SPS-10	AN/SPS-10
11-3	AN/SPS-43A, frame 79, main mast	AN/SPS-43A

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No 22-R255

INSTRUCTIONS The purpose of this form is to solicit beneficial comments which will help achieve procurement of suitable products at reasonable cost and minimum delay, or will otherwise enhance use of the document DoD contractors, government activities, or manufacturers/ vendors who are prospective suppliers of the product are invited to submit comments to the government Fold on lines on reverse side, staple in corner, and send to preparing activity Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements Attach any pertinent data which may be of use in improving this document. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity.

DOCUMENT IDENTIFIER AND TITLE

NAME OF ORGANIZATION AND ADDRESS

CONTRACT NUMBER

MATERIAL PROCURED UNDER A

☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1 HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?

A GIVE PARAGRAPH NUMBER AND WORDING

B RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY DOCUMENT REQUIREMENT CONSIDERED TOO RIGID

3 IS THE DOCUMENT RESTRICTIVE?

☐ YES ☐ NO *(If "Yes", in what way?)*

4 REMARKS

SUBMITTED BY *(Printed or typed name and address - Optional)*

TELEPHONE NO

DATE

DD FORM 1 JAN 72 **1426**

REPLACES EDITION OF 1 JAN 66 WHICH MAY BE USED

S/N 0102-014-1802