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NAVAL SEA SYSTEMS COMMAND
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From: Commander, Naval Sea Systems Command

Subj: SHIP POST DELIVERY TEST AND TRIALS GUIDANCE MANUAL

Ref: (a) NAVSEA Instruction 3960.5,Policy on Ship Testing
(b) Ship PDT&T Guidance Manual, NAVSEA 0900-LP-095-3010, Revision 1

Encl: (1) Surface Ship Post-Delivery Test and Trials Guidance Manual, NAVSEA S9094-AE-GYD-010 of Jan 01

1. Enclosure (1) provides guidance for Ship Program Managers (SPMs) of new construction surface ships in planning the events during the ship's Post Delivery Test and Trials period. Descriptions of the major test and trial events are provided to assist the SPM in coordinating and scheduling the appropriate events in an optimum manner. Enclosure (1) is published as part of NAVSEA's Total Ship Test Program, the purpose of which is to promote thorough systematic testing in support of the delivery and maintenance of fully operable and capable ships to the Fleet. Reference (a) applies.

2. Enclosure (1) supersedes reference (b). It is being provided in hardcopy to a limited number of users in the interest of reducing printing costs. The complete manual in PDF format is available for download to all users by accessing the NAVSEA Test & Evaluation Office's (SEA 91T) web site at:
http://www.navsea.navy.mil/navysea-te/index.htm.

3. Questions, comments or suggestions to improve the manual, should be referred to the NAVSEA Test and Evaluation Office, SEA 91T by e-mail at:
TestEvaluation@navsea.navy.mil

M. T. REYNOLDS
By direction

Subj: SHIP POST DELIVERY TEST AND TRIALS GUIDANCE MANUAL

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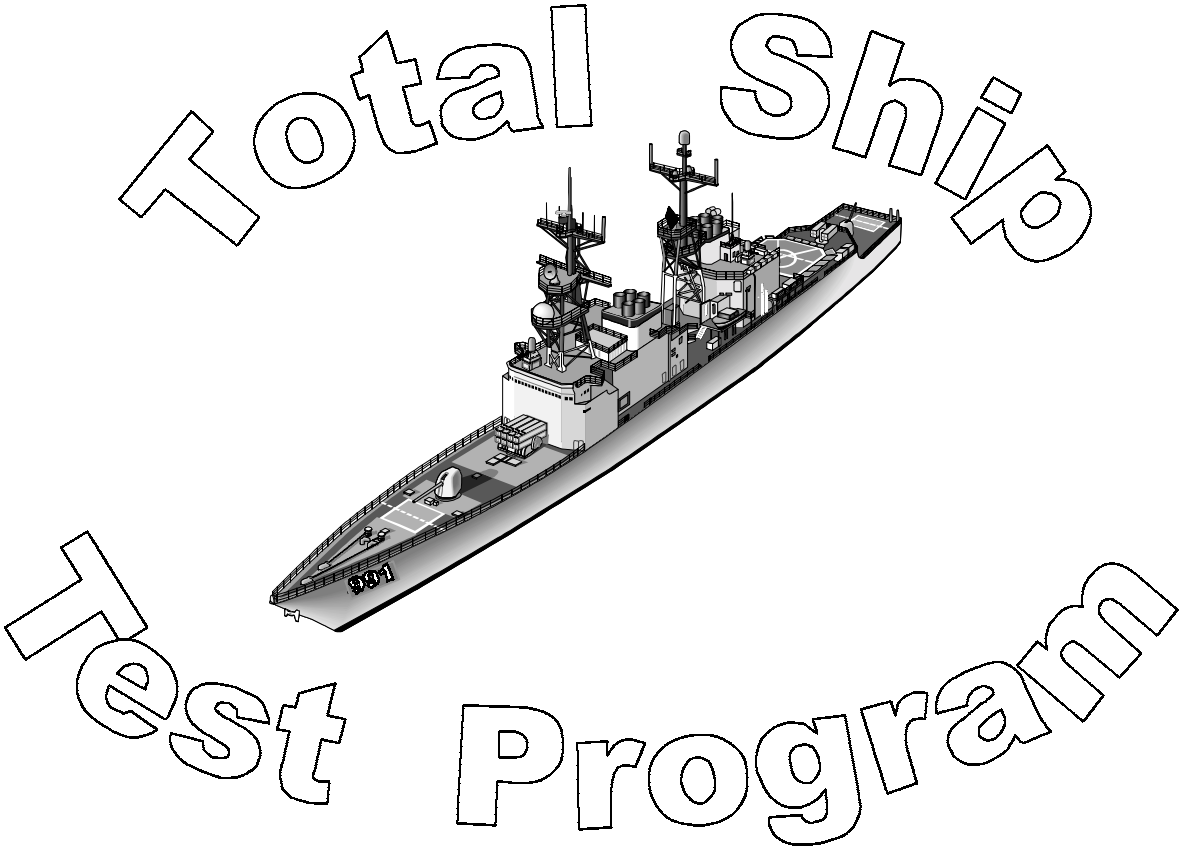

SURFACE SHIP POST-DELIVERY TESTS AND TRIALS GUIDANCE MANUAL

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DEPARTMENT OF THE NAVY
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1.0 INTRODUCTION

1.1 PURPOSE

This manual provides a guide for Ship Program Managers to the common test and trial events that occur during the Post-Delivery Tests and Trials (PDT&T) period after delivery of a new construction surface ship. This guide will help in planning the PDT&T period for a surface ship acquisition program by helping to identify which test and trial events may be applicable and which organizations are responsible for the event.

A well-planned, consolidated and cohesive PDT&T program will translate into a productive and effective test period that will bring the ship from a level of material completion at delivery to its maximum state of operational readiness prior to initial deployment as a Fleet unit.

The objectives of the tests and trial events conducted during PDT&T period are:

- To demonstrate the ship's operational capabilities and characteristics
- To verify the ship's material readiness in an at-sea environment
- To establish the ship's baseline characteristics necessary for Fleet planning
- To develop the proficiency of the ship's force in the operation of the ship and the combat, support, and mobility systems aboard the ship

1.2 BACKGROUND

A new ship undergoes extensive industrial testing during construction in the building yard. This testing is typically conducted, by a team of contractor and Navy representatives, as a Ship Production Acceptance Test and Evaluation program under the auspices of a Total Ship Test Program. These industrial tests are then followed by Acceptance Trials conducted at-sea by the President, Board of Inspection and Survey, prior to ship delivery by the shipbuilding contractor.

Despite all these tests and trials, there remain a certain number of tests and trials that are required to be conducted by the Navy after delivery. These tests and trials utilize specialized instrumentation, resources, ranges and facilities in order to demonstrate the ship’s performance and mission capabilities in an operational environment while using the ship’s crew. Partly because of the locations of these ranges and facilities, as well as the extensive planning, manpower and preparations

required, it would be prohibitive from a cost and scheduling aspect to attempt to accomplish these events as part of the industrial test program. Thus, these test and trial events are accomplished after ship delivery during what is known as the Post-Delivery Tests and Trials (PDT&T) period.

These events conducted during the PDT&T period also afford the Fleet Commander In Chief (CINC), Type Commander (TYCOM) and the Commanding Officer (CO) objective measures of the ship's material and operational readiness. Additionally during this PDT&T period, the CINC, TYCOM and CO can conduct training and accomplish crew certification that could not be accomplished in the building yard prior to delivery.

1.3 SCOPE

This manual provides an overview of those test and trial events most often conducted after delivery of a new construction surface ship to the Navy. Some of these events may also conducted after ship Modernization or ship Conversion programs. Submarine post-delivery test events are not included in this manual.

1.4 CHAPTER FORMAT

The individual chapters, beginning with Chapter 3, are arranged in sequential order of conduct as laid out in the notional PDT&T schedule provided in chapter 2.

Each individual chapter describes a single test or trial event and is formatted as follows:

X.1 Purpose
X.2 Source of Requirement
X.3. General Description
X.4 Organizations Involved
X.5 Schedule
X.6 Detailed Description

Sections X.1 through X.5 provide a short but comprehensive overview of the individual event. This overview provides information necessary to begin early planning. Section X.6 provides additional information about the event.

1.5 CHANGE PROCEDURE

Comments, omissions, inaccuracies, recommended changes and suggestions for improving this manual should be brought to the attention of the NAVSEA Test and Evaluation Office (SEA 91T) on e-mail at TestEvaluation@navsea.navy.mil or by mail:

Commander, Naval Sea Systems Command
NAVSEA Test and Evaluation Office (SEA 91T)
2531 Jefferson Davis Highway
Arlington, VA 22242-5160

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2.0 POST-DELIVERY PERIOD - PLANNING AND SCHEDULING

2.1 POST-DELIVERY TESTS AND TRIALS (PDT&T) PERIOD

The period of time between ship delivery on through to Post-Shakedown Availability is known as the Post-Delivery period. The total time available for the Post-Delivery period is typically 12 months (for a follow ship) to 18 months (for a lead ship) and is constrained by the Navy Comptroller's expiration date of the Ship Construction, Navy (SCN) funds used to procure, construct, outfit, test, and repair the ship. Also, both the ship acquisition strategy and the needs of the Fleet Commander In Chief or other cognizant higher authority influence and determine the actual Post-Delivery time available. Ship acquisition requirements have in the past necessitated extension of the SCN Obligation Work-Limiting Date (OWLD) especially for lead ship. Requests for extensions of the OWLD require the approval of the Navy Comptroller.

In the past, this Post-Delivery period has been divided into distinct phases. These phases are: Fitting Out; Readiness-For-Sea; Post-Delivery Tests and Trials, and; Shakedown. Each phase has its own set of events to be conducted. However, with the complexity of installed systems on recent ship classes, the events required to be run could not all be accomplished entirely during its designated phase, especially those events previously designated to be conducted during the Post-Delivery Tests and Trials phase and the Shakedown phase. In order to ensure that all these events are accomplished, while effectively managing time and resources, it has become necessary for the Ship Program Manager in conjunction with the Fleet Commander in Chief to schedule the all the events into a highly coordinated, cohesive and integrated single ship schedule utilizing the entire Post-Delivery period. This single ship schedule is called the Post-Delivery Tests and Trials schedule.

Thus, for purpose of this manual, the PDT&T period encompasses that entire Post-Delivery period of time from ship delivery to Post-Shakedown Availability.

2.1.1 Ship Delivery

For new construction ships, the delivery date is the date when the Navy assumes custody of the ship. This date follows the recommendation by the President, Board of Inspection and Survey (PRESINSURV) that the ship be accepted for fleet introduction.

2.1.2 Fitting-Out

Fitting-Out is that period of time necessary for placing on board the material specified in the ship's allowance lists. Any industrial work during Fitting-Out is limited to

those items generated by the Board of Inspection and Survey during Acceptance Trials that affect operational readiness or safety and those items specifically designated by the Chief of Naval Operations (CNO). The duration of Fitting-Out is typically less than 90 days.

2.1.3 Readiness-For-Sea

Readiness-For-Sea commences upon completion of Fitting Out and provides the time for the Commanding Officer to prepare the ship for Shakedown. The duration of Readiness-For-Sea is typically less than three weeks.

2.1.4 Post-Delivery Tests and Trials

Post-Delivery Tests and Trials is that period of time for the conduct of test and trials on selected systems. Historically, this was a variable duration period of 8-16 weeks as assigned by the Fleet Commander in Chief, for the conduct of events such as Combat Systems Ship Qualification Trials and Acoustic Trials.

2.1.5 Shakedown

Shakedown historically encompasses the period from completion of Post-Delivery Tests and Trials period (or the completion of the RFS period if no PDT&T period is required) to the commencement of the Post-Shakedown Availability. During this period various events such as Performance and Special Trials, Structural Test Firing, and at-sea operations were conducted to exercise the ship and its systems.

2.1.6 Post-Shakedown Availability

The Post-Shakedown Availability (PSA) is a shipyard availability period that occurs after Shakedown and prior to the expiration of Ship Construction, Navy (SCN) funds. The purpose of this availability is to correct shipbuilder responsible and government responsible deficiencies found during Shakedown including those found during Final Contract Trials, and to make other improvements as authorized.

2.2 PLANNING

2.2.1 General

The specific test and trial events to be conducted will depend on the ship’s mission and equipment installation. The lead ship of a class will usually require the

most extensive amount of testing. Unless otherwise directed by the CNO sponsor, follow-ships will usually conduct fewer events.

- The PDT&T periods for ship classes such as major combatants, carriers, and amphibious warfare helicopter carriers require the most planning and coordination because of the complexity of the systems and of the extensive resources involved,

- The PDT&T periods for ship classes such as auxiliaries, mine warfare, and patrol combatants (with a missile system or a gun system of 76mm or larger, or both) are less complex.

- Patrol boats, small boats, and auxiliary craft do not require a PDT&T phase as described in this manual. Individual events may be applicable, however, and should be conducted during the Shakedown period.

The Ship Program Manager (SPM) must ensure that adequate financial resources are budgeted early to ensure that all necessary PDT&T events to be conducted on the ship can be accomplished. The SPM should contact the organizations identified to determine estimated funding requirements.

The need for early planning is emphasized. This is to ensure that necessary resources, such as facilities and services, including personnel, ranges, instrumentation, aircraft service, other Fleet ships, and targets and expendable ordnance, have been addressed at applicable scheduling conferences or included in long range resource plans and are available when needed.

- If it is determined that a CSSQT will be conducted, planning for missile and target resources should commence at least three to five years in advance, as discussed in Chapter 8 on CSSQT.

- If it is determined that Shock Trials will be conducted, planning for environmental impacts should commence at least three years in advance, as discussed in Chapter 16 on Shock Trials.

- Detailed planning for post delivery events should commence at least two years prior to the date of delivery of the ship to the Navy. It may be possible to consolidate or coordinate test and trials events to conserve resources and to optimize test time.

2.2.2 Coordination and Liaison

An integrated or combined testing program requires considerable liaison, coordination, and cooperation between the activities responsible for the individual events.

The PDT&T period is a transition period for which both the SPM and the Fleet have inter-related responsibilities. During this period, the ship is brought from its state of contractual completion at delivery to an operational ship ready for unrestricted service.

Close coordination during both planning and implementation is essential between the SPM, TYCOM, CO, PRESINSURV. When Operational Test and Evaluation (OT&E) is required, the SPM must work closely with COMOPTEVFOR. The SPM has the responsibility to plan, coordinate and in most cases, fund the PDT&T events.

During the PDT&T period, the SPM must work closely with System Command organizations performing the PDT&T events as well as with TYCOM, CO, PRESINSURV and COMOPTEVFOR to assist in maintaining the schedule and plan in developing work- around alternatives, when necessary.

During the planning and especially during conduct of the PDT&T program, the SPM must work closely with organizations performing the PDT&T events as well as with the Type Commander and Ship's Commanding Officer to ensure that the PDT&T schedule can be executed or so that any changes to the schedule can be accommodated.

2.2.3 Scheduling Conferences

On behalf of the cognizant Fleet Commander, the TYCOM controls the ship movements during the PDT&T period. Through participation at Fleet scheduling conferences, TYCOM will identify the ship schedule and the Fleet support needed for PDT&T events.

2.3 PDT&T Scheduling

2.3.1 Scheduling concerns

A ship schedule for the post-delivery phase should be developed which accommodates the time required for each PDT&T event. Additional factors and allowances to be considered in developing the ship schedule include:

- Transit times between locations such as ranges and operating areas
- Crew workload and schedules
- Environmental restrictions
- Retest requirements when failures occur

Dockside periods are scheduled for preparation and preliminary testing. Many range facilities do not operate on weekends except when special arrangements are made (in which case the SPM must fund for additional costs to cover the overtime required). Government logistics facilities do not operate on weekends, thus requiring weekday dockside periods.

Benefits in the form of time and resource savings can arise when dockside periods can be used concurrently for dockside testing and training and for preparations for on-range testing for the various events, by reducing personnel travel costs, by minimizing idle time and by reducing the number of transits to operational areas and ranges.

By the time of ship delivery, the SPM should have a well-defined plan for the PDT&T events and an achievable schedule that has been fully coordinated with all the activities involved including cognizant Systems Commands, the Fleet CINC, the Type Commander and the Ship's Commanding Officer to ensure its viability.

2.3.2 Sample schedule

A sample ship’s PDT&T schedule is provided as Figure 2-1. This sample schedule includes all the tests and trials discussed in this manual that would be applicable for a notional lead surface combatant ship. There are some other tests or test related events shown on this schedule that must be accommodated, which are not the subject of a separate chapter in this manual but are discussed briefly herein (Para 2.4). A schedule for ship to be homeported on the East Coast would differ from that of a ship of the same class homeported on the West Coast due to locations of ranges, facilities and operating areas. An actual schedule would also show actual daily events and the in port and at-sea periods in more detail.

2.3.3 Summary Table of Events

To assist the planners of PDT&T events, a summary table of events is provided as Table 2-1. Some PDT&T events are normally applicable only to the first (lead) ship of a class are noted in the remarks. Programmatic requirements may cause a lead ship PDT&T event to be deferred to a follow-on ship, with the agreement of all activities involved and the approval of higher authority where necessary.

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FIGURE 2-1
SAMPLE SHIP"S PDT&T SCHEDULE

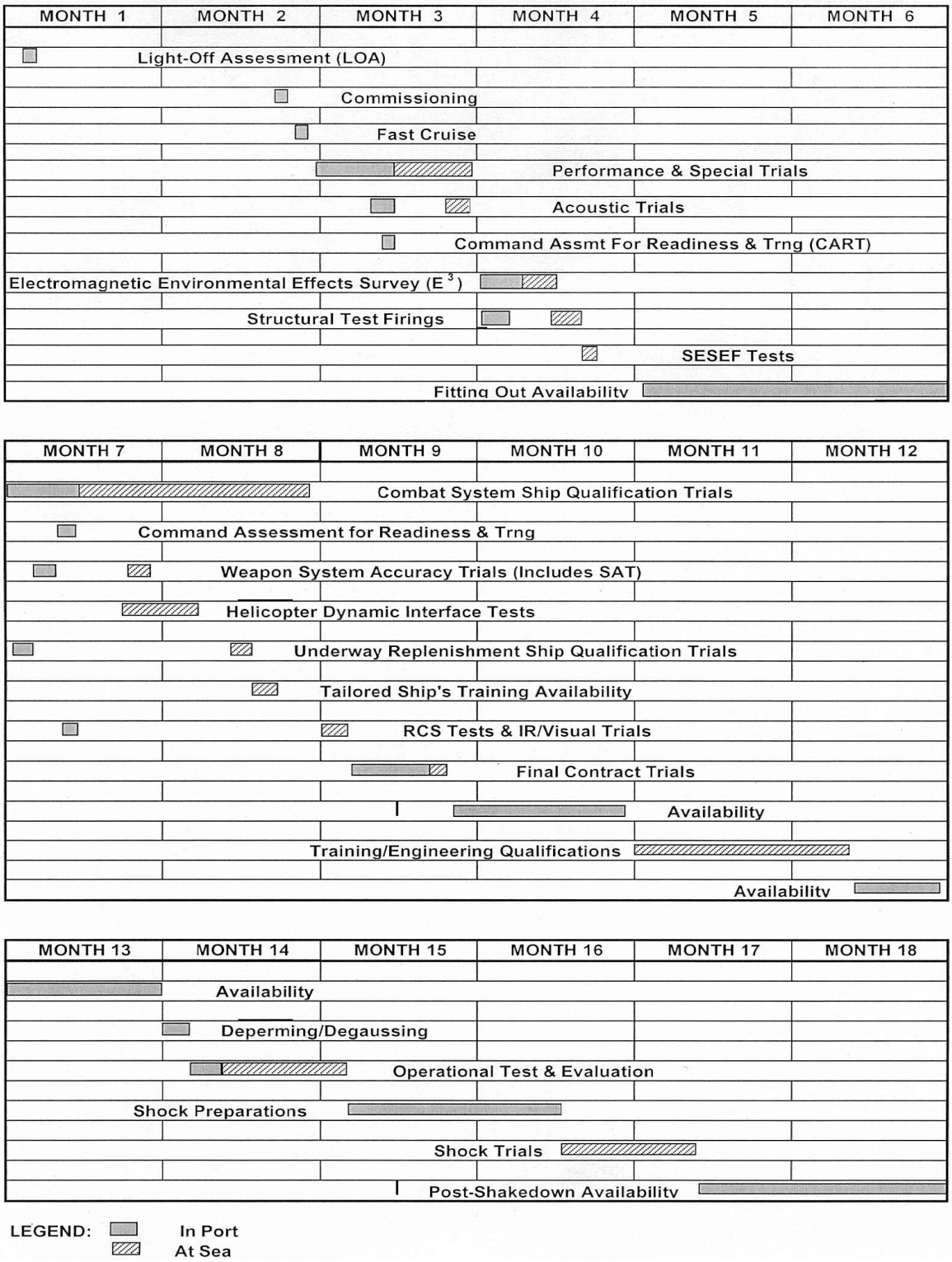

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TABLE 2-1

SUMMARY OF PDT&T EVENTS

Chapter	Event	Purpose	Typical Scheduling	Duration	Notes
3	Performance & Special Trials	Characterize the performance of hull, propulsion & control systems	Early in PDT&T Period	D/S: 1-2 Weeks A/S: 5-10 Days	Usually on the first ship of the class
4	Acoustic Trials	Validate acoustical operational requirements	Early in PDT&T Period	D/S: 1-3 Days A/S: 3-4 Days	Requires an acoustic range
5	Electromagnetic Environmental Effects Surveys	Determine effect of: EMI on equipment; RADHAZ on personnel and fuel; & HERO on ordnance	Early in PDT&T Period	D/S: 4-7 Days A/S: 4-7 Days	
6	Structural Test Firing	Test susceptibility of ship's structure to shock, vibration and blast of weapons firing	Normally combined with CSSQT	D/S: 4-7 Days A/S: 2-5 Days	
7	SESEF Tests	Test shipborne electromagnetic transmitting and receiving equipment in an operational environment	Early in the PDT&T period when in the vicinity of SESEF	A/S: 1-2 Days	Requires SESEF
8	CSSQT	Demonstrate system performance capability and material readiness of the overall combat system	Toward the middle or end of PDT&T	A/S: 3-12 Weeks	
9	Sensor Accuracy Tests	Measure accuracy of ASW, AAW, ASUW and navigation sensors on the ship	Prior to and in conjunction with WSAT	D/S: 1 Day A/S: 1 Day	FORACS range is required
10	WSAT	Demonstrate ability of ASW combat system to meet prescribed stands of performance	Normally combined with CSSQT	D/S: 3-5 Days A/S:3-5 Days	Weapons range is required
11	Aircraft Dynamic Interface Tests	Determine safe operating envelope for aircraft operating with ships	Normally prior to UNREP	A/S: 10-14 Days	Usually on the first ship of the class
12	UNREP SQT	Verify material readiness of the ship to safely conduct UNREP	Normally during CSSQT	D/S: 3-5 Days A/S: 2-5 Days	
13	RCS Tests & IR/Visual Trials	Determine ship signature through Radar Cross Section tests and Infrared & Visual Trials	When in vicinity of tests sites	D/S: 1-2 Days A/S: 2-4 Days	
14	Final Contract Trials	Determine shipbuilder responsible defects, failure, or deterioration which have not been corrected	Near PSA	D/S: 2 weeks A/S: 1-3 Days D/S: 2-3 Days	
15	Deperming & Degaussing	To alter & reduce ship's permanent magnetic field to an acceptable level	When in vicinity of degaussing facility	D/S: 3-5 Days	Delay deperming if major equipment is installed during PSA
16	Shock Trials	Demonstrate resistance of hull, machinery, & payload equipment to underwater shock	Immediately prior to PSA	D/S: 3-5 Weeks A/S: 3 Weeks D/S: 2-5 Days	Usually on the first ship of the class

Acronyms:
D/S = Dockside
A/S = At-Sea
AAW = Anti-Air Warfare
ASW = Anti-Submarine Warfare
EMI - Electromagnetic Interference
SESEF = Shipboard Electronic System Evaluation Facility
ASUW = Anti-Surface Warfare
CSSQT = Combat System Ship Qualification Trials
FORACS = Fleet Operational Readiness Accuracy Check Site
WSAT = Weapon System Accuracy Trial

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2.4 Other Test or Test-Related Events

a. Developmental, Operational and Follow-on Operational T&E

Developmental Test and Evaluation (DT&E) , Operational Test and Evaluation (OT&E) and Follow-on Operational Test and Evaluation (FOT&E), of new systems, as required by the ship acquisition program Test and Evaluation Master Plan (TEMP). Definitions of DT&E and OT&E and the format and content requirements of the TEMP are included in SECNAVINST 5000.2 series.

b. Deferred Ship Construction Tests

Some shipboard time may be required immediately following ship delivery to conduct testing normally scheduled during the ship construction tests and trials, but deferred through a prior CNO approval to deviate from OPNAVINST 4700.8 series. This so-called "phased-delivery approach" has been used in several surface combatant ship programs to allow some combat system level testing to be performed after delivery, when it has been determined that including such testing in the shipbuilding contract is not cost-effective.

c. Certifications

Certifications that may apply to the ship are listed in NAVSEA S9040-AA-GTP-010/SSCR, "Shipboard Systems Certification Requirements for Surface Ship Industrial Periods (Non-Nuclear)". They are normally conducted during the new construction industrial periods prior to delivery. If an applicable certification cannot be completed before ship delivery, it will be necessary to schedule them for conduct during PDT&T.

d. Nuclear Weapons Technical Inspection/Certification

All nuclear capable ships must be inspected and certified prior to receipt of nuclear weapons. A Nuclear Weapons Acceptance Inspection (NWAI) of a prospective nuclear capable ship will be conducted by navy inspectors to determine the ship's readiness to perform technical assembly operations, maintenance, storage functions, logistic movement, handling and safety, and security directly associated with those functions.

Further guidance for the conduct of NWAI may be found in OPNAVINST 5040.6 series, “DON Nuclear Weapons Technical Inspections (NWTIS) and Nuclear Weapon Readiness Certification”, and Special Weapons Operating Procedure (SWOP) 25-1.

e. Propulsion Examinations (Non-Nuclear)

There are two phases of propulsion examinations that are the responsibility of the Ship's Commanding Officer (CO) and the Immediate Superior In Command (ISIC) .

The first phase is the Light-Off Assessment (LOA) that, like the Fast Cruise, is required prior to the Navy crew operation of the ship. The LOA includes a material inspection and safety check of the propulsion system, evaluation of Engineering Department Administration, and written and oral examinations of the propulsion crew in the propulsion system operation procedures.

Approximately six months after the LOA, the second phase of the propulsion examination will be conducted. Engineering Qualification (ENGQUAL) is a procedure used by the ISIC to verify propulsion plants and associated auxiliaries are safe to operate. The LOA and the ENGQUAL each require approximately two to five days to accomplish.

Guidance on the assessment, training and qualification of conventionally powered ships can be found in the joint COMSURFLANT/COMSURFPAC Instruction 3540.12 series.

f. Propulsion Examinations (Nuclear)

Ship's force personnel are the only personnel authorized to operate the nuclear propulsion plant while a nuclear ship is under construction. Therefore, for nuclear powered ships the initial propulsion examinations will have occurred prior to delivery. Detailed requirements for examinations and inspections of the nuclear powered ships are contained in OPNAVINST 9080.3 series, “Procedures for Tests and Trials of Navy Nuclear Powered Ships Under Construction, Modernization, Conversion, Refueling and Overhaul”.

g. Fleet Sponsored Training Events

Fleet sponsored training events, such as Fast Cruise, Command Assessment for Readiness and Training (CART), and Tailored Ship’s Training Availability (TSTA), are conducted by ship’s force, the Type Commander and the Afloat Training Group. The SPM must make allowances in the PDT&T schedule for their accomplishment.

- A Fast Cruise precedes the ship’s underway time and routinely requires one to five days depending on the ship size. This time period is dedicated to the ship’s crew to allow them time to prepare for at-sea operations.

- CART is a performance based (demonstration) assessment of the ship's readiness in each mission area. A CART is a two phased process with each phase requiring about four days. The CART is scheduled early in the PDT&T period as the results are used as a basis for the TSTA that follows.

- The TSTA provides the ship with a set of progressively structured, increasingly complex training evolutions. The duration of a TSTA is variable based upon the extent of the training package developed for the ship.

Guidance on the accomplishment of these fleet training events can be found in the joint COMSURFLANT/COMSURFPAC Instruction 3502.2 series.

h. Additional events

Additional test or trial events may be developed by the SPM to provide tests and/or operational training for special conditions, new technology insertions, or unique configurations.

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3.0 PERFORMANCE AND SPECIAL TRIALS

3.1 PURPOSE

Performance and special trials are conducted to determine the hydrodynamic and operational characteristics of the hull, propulsion, and control systems of the ship and whether design specifications, performance requirements and operational requirements are met.

Results of these trials are furnished as operational information to each follow-on ship of the class and as data to be used in model correlation studies.

3.2 SOURCE OF REQUIREMENT

a. OPNAVINST 4700.8 series, “Trials, Acceptance, Commissioning, Fitting Out, Shakedown and Post-Shakedown Availability”, identifies standardization trials and tactical trials as desired trials if not previously conducted

b. NAVSEAINST 9094.5 series, “Ship Performance Trials”, establishes the policy and defines the requirements for performance and special trials.

3.3 GENERAL DESCRIPTION

The general policy is to nominate the first ship of a new class on which to conduct performance and special trials; however, a follow-on ship can also be nominated if there have been changes in either hull-design or in the propulsion and control systems. Additionally, these trials may also be conducted for major conversion ships or ships in previous service when new design equipment is installed that affects the propulsion and maneuvering capabilities of the ship.

Performance and special trials are a series of underway ship test events that may include:

- Standardization trials
- Tactical trials
- Maneuvering trials
- Acceleration and deceleration trials
- Trailed and locked shaft trials

- Underway vibration trials
- Fuel economy trials
- Seakeeping and seaworthiness trials
- Miscellaneous special trials for special characteristics or experimentation

Additional discussion of performance and special trials is included in Section 4 of Naval Ships Technical Manual, NAVSEA S9086-C4-STM-010, Chapter 094, "Trials".

3.4 ORGANIZATIONS INVOLVED

Naval Sea Systems Command, Surface Ship Propulsion/Power Systems Division (SEA 05Z1), and the Ship Program Manager (SPM) develop the initial planning for the performance and special trials.

Naval Surface Warfare Center, Carderock Division (NSWC CD), Resistance and Powering Department, Code 52, when tasked will develop the detailed trial agenda and instrumentation requirements and will conduct the trials.

3.5 SCHEDULE

The following is a summary of typical schedule requirements for planning and conduct of performance and special trials:

- Trial Agenda Letter - submitted 10-12 months prior to delivery
- Detailed Trial Agenda - submitted six months prior to delivery
- Installation criteria for instrumentation - prepared three months prior to trials
- Hull cleaning - accomplished less than 30 days prior to start of trials preferably and in no case greater that four months
- Installation of instrumentation - one or two weeks prior to trials
- Trials - five to ten days test time. The length of time required for conduct of the trials is a function of the:
    - Types and extent of trials conducted
    - Propulsion configuration of ship

- Operational speed range of ship
- Transit time from port to trial site

- Remove instrumentation - two days
- Trial reports - preliminary data within seven days, preliminary report 60 days and final report in six months
- Model correlation. Upon completion of the standardization trials, an additional series of model tests are conducted and a new resistance correlation is established. A report is provided within six months

3.6 DETAILED DESCRIPTION

3.6.1 Trial Agenda Letter

Approximately 10-12 months prior to delivery of the ship, a trial agenda letter is prepared by SEA 05Z1 and the SPM, and submitted to the Chief of Naval Operations (CNO) for approval. The trial agenda letter will nominate the ship, outline the scope of the performance and special trials to be conducted and provide an estimate of the time required to accomplish performance and special trials

3.6.2 Detailed Trial Agenda

NSWC CD Code 52, when tasked, will develop the detailed performance and special trials agenda. NSWC CD Code 52 will submit this detailed trial agenda for approval by the SPM approximately six months prior to ship delivery.

The detailed agenda will further define each trial:

- Description of trial
- Location of trial
  - Trial logistics
  - Run numbers
  - Conditions
- Approximate time required for trials

- Station bill of observers
  - NSWC CD observers
  - Ship's observers
  - Duties of trial observers
- Data to be recorded by
  - NSWC CD observers
  - Ship's observers
- Special instrumentation requirements

Similarly, Naval Surface Warfare Center, Carderock Division - Ship System Engineering Station (NSWC CD-SSES) when tasked will develop the detailed fuel economy trial agenda and support its conduct as part of the overall performance and special trials agenda.

Depending on trial complexity, six to twenty personnel are required aboard the test platform during performance and special trials. These include Trial Directors and support personnel from NSWC CD and NSWC CD-SSES and the program sponsors from NAVSEA.

In addition, ship's force may participate as observers and data recorders. Requirements for ship's force personnel, instrument operators, and trial engineers are included in the trial plan. Ship's force personnel are briefed on the responsibilities of the observers and data recorders prior to the trials.

3.6.3 Instrumentation Requirements

Three months prior to the trials, NSWC CD will further define instrumentation requirements and will prepare the necessary trial data sheets and books to be used for data collection by the observers during the conduct of the trials. Instrumentation requirements will differ with types of propulsion systems, control systems and configuration of the ship.

NSWC CD and NSWC CD-SSES will provide instrumentation, equipment and cabling, installation criteria, a trial director, instrument operators, and trial engineers as applicable. NSWC CD will coordinate delivery of instrumentation, equipment and cabling.

3.6.4 Clean Hull

Prime prerequisites are clean hull, rudder(s), and propeller(s) in order to obtain valid data during conduct of performance and special trials. The hull and rudder(s) below the heavy load line are cleaned, to assure a smooth hull surface free of marine growth. Propellers are also cleaned.

It is highly desirable to accomplish this hull cleaning in a dry-dock within 30 days of the start of the performance and special trials period. Special circumstances that would retard marine growth, such as the ship remaining dockside in brackish or fresh water, may allow a longer period between completion of cleaning and commencement of trials but, in any case, the period should be kept to not greater than four months.

Just prior to the trials, divers are used to conduct a final inspection and cleaning of the hull, the propeller(s) and rudder(s) for marine growth, and to take hull and propeller roughness measurements. If installed, the transducer for the Doppler Sonar Velocity Log should also be inspected for marine growth and cleaned as necessary.

3.6.5 Installation of Instrumentation

Prior to conducting performance and special trials at-sea, a period of one to two weeks is required to perform the industrial work aboard ship to install the instrumentation. This industrial work may be performed in a shipyard or at a dockside location where industrial facilities are available. NSWC CD provides detailed installation criteria and plans to the industrial activity. Industrial work may include the following items:

- Prepare a space for use as an instrument room and provide and install an instrument table or tables to provide approximately a 20-foot long table area. Furnish chairs and stools and provide additional power and lighting as required

- Provide manpower to load and install trial instrumentation

- Provide hardware to install torsionmeter equipment and Revolutions Per Minute (RPM) counters on each shaft. (Similar instrumentation is also used for Acceptance Trials and provision should be made to leave equipment or special machined mounting assemblies in place to reduce reinstallation effort)

- Install instrumented thrust shoes in main thrust bearings

- Install pressure transducers in rudder rams, steering gear system, steam system and Controllable Pitch (CP) propeller hydraulic system

- Install strain gages on rudderstocks

- Install potentiometers in linkages of throttles
- Install any specially required radio communication equipment
- Install a trial anemometer
- Provide and install a small table in the pilothouse for test instruments
- Install vibration transducers in specified locations
- Inspect and calibrate shipboard-installed instruments, gages, and thermometers used for data collection during trials
- Install calibrated fuel flow meters
- Install all cabling required between instrumentation locations and instrumentation room
- Provide and install sound-powered telephone outlets at instrumentation locations as required
- Install power outlets and additional lighting at instrumentation locations as required
- Survey and paint draft marks as necessary
- Assist in the calibration of the rudder
- Clean hull and propellers as necessary
- Assist in the calibration of propeller pitch

3.6.6 Trials

3.6.6.1 Prerequisites

A prerequisite to conducting the performance and special trials is that the propulsion, auxiliary, and steering systems of the ship be in a fully operational status. Marginal performance or failure in any of these systems could result in costly delays and the need to reschedule the remaining events.

Ships equipped with Controllable Pitch (CP) propellers are required to have an accurate calibration of propeller pitch in both the ahead and astern directions. Prior to

conducting vibration testing, ships with CP propellers must demonstrate that the pitch schedule is correctly set to produce full power at the rated design conditions. A preliminary calibration will be accomplished while dockside with the assistance of divers or while in a dry-dock. A final underway pitch calibration will be accomplished prior to conduct of performance and special trials.

3.6.6.2 Trial Conduct Underway

Typical time requirements for each trial for a two-shaft ship are as follows:

Standardization Trials (2 displacements)	10 hours per displacement
Tactical Trials	12 hours
Maneuvering Trials	
Zigzag Maneuvers	4 hours
Spiral Maneuvers	9 hours
Low-Speed Controllability Maneuvers	2 hours
Free Rudder Tests	2 hours
Low Speed Rudder Response Test	2 hours
Steering Comparison (Rough Weather)	4 hours
Acceleration and Deceleration Trials	8 hours
Trailed and Locked Shaft Trials	8 hours
Underway Vibration Trials	Concurrent with others plus 8 hrs
Fuel Economy Trials	16-20 hours
Seakeeping and Seaworthiness Trials	2-3 days
Miscellaneous Tests and Trials	As required

NSWC CD will schedule compatible tests concurrently in order to reduce total trials time requirements.

Expected weather conditions, during the time period trials are to be conducted, must be noted in the trial agenda and are a factor in the selection of the location of the tests.

With the advent of Global Positioning System (GPS) ships are no longer constrained to fixed ranges during these trials which may be conducted free-route in waters of adequate depth. Most high-performance combatant ships of medium range endurance require water depths of greater than 300 feet. Aircraft carriers require a water depth of greater than 400 feet.

3.6.6.2.1 Standardization Trials

Standardization trials are conducted to establish overall speed/power performance of the ship. Trial runs are repeated for two displacements for conventionally powered ships without compensating systems:

- Full-load displacement
- A specified lighter displacement, typically 10% less than full load

Unless otherwise required by the trial agenda, the ship will be loaded to as close to zero trim as possible. The purpose of the trials is to determine the ship's speed, shaft rpm, propeller pitch, shaft thrust shaft torque, and shaft horsepower characteristics. Standardization curves at the displacement conditions existing during the trials will be issued to all other ships of the same class.

A minimum of three consecutive runs is accomplished, alternating in direction over the course, at nearly the same rpm and propeller pitch as possible for each speed. Speed increments will be approximately 3 knots, from speeds of 8 knots to full power for most combatant ships, as specified in the trial agenda. Slow speed ships (like mine sweepers) may need to use smaller speed increments to obtain sufficient data points.

If the ship is equipped with an Electromagnetic (EM)-Log, it can be calibrated during the standardization trials to provide ship's speed through the water. The EM-Log output is usually recorded during subsequent trials to obtain a direct measure of ship speed through the water.

If a ship has a Doppler Sonar Velocity Log installed and it has been previously calibrated, it should not require re-calibration unless the transducer has been moved.

On ships with CP propellers, standardization trials are conducted in the program control mode and at, over, and under design pitch in the manual mode.

3.6.6.2.2 Tactical Trials

Tactical trials determine the turning characteristics of the ship. Each run consists of attaining a constant approach speed, then turning the rudder to a specified angle and proceeding through a specific turn of 540 degrees. Constant throttle and rudder settings

are maintained throughout the turn. Turns on ships equipped with CP propellers are conducted in the program control mode. Turns will be made at:

- Three or more approach speeds, including full power
- Three or more rudder angles, including full rudder
- Same rudder angles in both right and left, unless otherwise specified in the trial agenda
- Additional rudder angles if rudder stall or "breakdown" is noted

These trials are conducted with as close to a full-load displacement and zero trim as practicable.

3.6.6.2.3 Maneuvering Trials

The maneuvering trials include several tests to investigate the ship's directional stability characteristics, and the ship's response to changes in rudder position at various ship speeds. These trials are designated as:

- Zigzag maneuvers
- Spiral maneuvers
- Low-speed controllability maneuvers
- Free rudder tests
- Low-speed rudder response tests
- Steering comparison (rough weather)

a. Zigzag Maneuvers

Zigzag maneuvers are generally conducted at a minimum of two speeds (e.g., 8 and 16 knots) and at a minimum of two rudder angles (e.g., 10 and 20 degrees). For each speed and each rudder angle, two runs are accomplished by moving the rudder from left to right at specific changes in heading relative to the base course. These runs are conducted to determine how the ship responds to changes in ship heading.

b. Spiral Maneuvers

Spiral maneuvers are generally conducted free route and at a minimum of two forward speeds, usually the same speeds as zigzag maneuvers. In addition, and if

feasible, a 2/3 astern speed test is conducted. The runs are accomplished to determine the directional stability of the ship.

c. Low-Speed Controllability Maneuvers

The low-speed controllability maneuvers are begun with the ship dead in the water and with a minimum of two terminal speeds, or shaft rpm corresponding to approximately 1/3 and 2/3 speed. Rudder angles used are full rudder, or some other specified value.

d. Free Rudder Tests

The purpose of the free rudder tests is to obtain the trailing characteristics of the rudder in the event of hydraulic failure.

The tests are repeated for all combinations of initial rudder angles and terminal speeds as specified in the trial agenda.

e. Low-Speed Rudder Response Test

The low-speed rudder response test consists of several runs at low approach speeds (e.g., 6, 5, 4, 3 knots) and at various rudder angle maneuvers (e.g., 10 degrees, 35 degrees) to determine the speeds at which the ship no longer responds to the rudder.

f. Steering Comparison (Rough Weather)

The purpose of this test is to determine the amount of rudder required to hold a heading in a seaway. At the start of the test and with the ship heading into the sea, the throttle is set to the desired speed (e.g., 15 knots) and, if applicable, the power is balanced on the shafts. These settings are to remain constant until all runs are completed.

After 30 minutes the course is shifted starboard by 45 degrees so that the sea is on the port bow.

After 15 minutes the course is shifted to port by 90 degrees so that the sea is on the starboard bow.

The final run is of 15 minutes duration at a heading opposite to the original heading, and in a following sea.

3.6.6.2.4 Acceleration and Deceleration Trials

Acceleration and deceleration trials are accomplished to obtain the acceleration and deceleration characteristics of the ship.

A time history of the ship position versus time is required to determine instantaneous ship's speed and reach. These trials need to be interspersed with the tactical trials so those drift vectors obtained from the turning circles can be applied to the acceleration/deceleration runs.

3.6.6.2.5 Trailed and Locked Shaft Trials

These trials are conducted on multi-shaft propulsion systems. The purpose of the trials is to determine the limiting shaft rpm values for ships of a class when operating with a trailing, or a locked shaft. The limiting rpm values are needed to avoid exceeding design torque of the propulsion power train.

The ship should be loaded as near full load displacement as practicable. Trials are conducted with the locked shaft test conducted first, followed by the trailed shaft test. The same shaft is used as the driving shaft for both tests.

3.6.6.2.6 Underway Vibration Trials

The purpose of the underway vibration trials is to measure the vibration characteristic of the propulsion system and hull/structure of the ship. Vibration trials may include one or more of the following categories:

- Main propulsion system vibration tests to determine longitudinal and torsional vibration characteristics of the main propulsion system consisting of the main engine(s), gears, foundations, shafting, bearings and propeller combinations. For propulsion plants with multiple power sources, testing shall encompass the different configurations.

- Hull vibration tests to determine hull vibration response characteristics due to propeller, sea, and machinery excitation

- Structural vibration tests to determine the characteristics and sources of local vibration of specific structures and units

Vibration measurements are generally taken in free route, but many of the measurements may be obtained concurrently with the conduct of other performance and special trials, such as standardization trials, tactical trials, and acceleration and deceleration trials. However, specifically designed runs may be necessary to obtain some of the vibration measurement data.

A considerable number of vibration measurement transducers (accelerometers) are required at various locations aboard the ship. The number of transducers varies significantly with the nature of the tests and configuration of the ship. In addition, the

associated cabling and the required signal conditioning and recording equipment constitute a significant installation effort.

3.6.6.2.7 Fuel Economy Trials

The purpose of the fuel economy trials is to determine the fuel rates under various operating conditions. These trials provide for the preparation of Interim Fuel Performance Standards for the class of ships and for the computation of cruising radius over a range of speeds. Additionally, for steam propulsion systems, main turbine water rate and heat balance tests are accomplished during this period.

3.6.6.2.8 Seakeeping and Seaworthiness Trials

Seakeeping trials are essential to define the mission performance capability of the ships in seas that will be encountered during the life of the ship. Seakeeping trials are particularly important for combatants since their mission has to be accomplished with minimal performance degradation in a seaway. The ship with the better seakeeping ability has greater combat capability, especially in northern operational areas during winter.

In order for a ship to maintain speed in a seaway it must meet acceptable requirements to minimize slamming and ship motions. Minimizing ship motions is important so that the crew is able to perform their various tasks effectively.

Seakeeping trials consist of a series of trials performed in seas ranging from fully sheltered, calm seas, to open seas with high waves and winds. For the open sea portion of the seakeeping trials, because it is difficult to schedule trials with heavy seas, the ship's crew sometimes accomplishes data collection on a long term basis with an installed ship motion recorder once the ship is in normal service. NSWC CD later analyzes the recorded data and prepares a report.

3.6.6.2.9 Miscellaneous Special Test and Trials

Additional special test and trials may be accomplished for experimental purposes or may be dictated by special characteristics of the ship. Special trials may also be warranted to investigate problem areas. The following are examples of such special test and trials:

- Airborne noise surveys of specific areas of compartments to determine noise characteristics and the remedial action required to reduce noise to acceptable limits. The offending noise may be due to the propulsion system, the ventilation or air conditioning system, or any other source and

may have detrimental effects on general conversation, signal devices, announcing systems or telephones, or own ship's active sonar transmission

- Self-noise tests to determine interference of ships noise on other equipment, e.g., sonar equipment

- Special tests and trials to further test a new propulsion plant or a new-design propeller system

3.6.7 Model Correlation Tests and Analysis

After the first ship of a class completes standardization trials, follow-up model tests are conducted to validate the design predictions and establish the correlation between model and full scale. Follow-up model tests are fundamental to continuous process improvement in the design of hull forms. Data obtained from both standardization trials and model tests are vital to the process of validating the computer codes that underlie future efforts in hull design.

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4.0 ACOUSTIC TRIALS

4.1 PURPOSE

Acoustic trials are conducted to:

- Verify meeting ship design acoustic specifications
- Define the underwater radiated, sonar self and structureborne noise characteristics of the ship
- Define and identify the sources of noise which govern the operational capability of the ship
- Establish the optimum quiet machinery bills for various ship's operating modes
- Define acoustical detection capabilities of installed sensors
- Determine effects of systems and equipment on ship's acoustical characteristics and to form the basis for the correction of any acoustical deficiencies
- Provide technical background necessary to initiate development of design improvements to reduce noise
- Provide the acoustical data necessary to evaluate Anti-Submarine Warfare (ASW) tactics

4.2 SOURCE OF REQUIREMENT

OPNAVINST 9070.2 series, "Ship Signature Policy for Ships and Craft of the U.S. Navy", establishes policy for the design, installation and testing of ship signature controls.

4.3 GENERAL DESCRIPTION

Acoustic trials are conducted to validate acoustic operational requirements and to provide data for vulnerability studies.

Acoustic trials include an underwater radiated noise trial, a sonar self noise trial and a structureborne noise trial. Each trial requires the ship to be underway on a range facility that is equipped with tracking equipment, and a noise measurement system.

4.4 ORGANIZATIONS INVOLVED

Naval Sea Systems Command, Ship Signatures Group (SEA 05T), and Naval Surface Warfare Center, Carderock Division (NSWC CD) plan and conduct acoustic trials. NSWC CD will make arrangements with the ship and arrange for required range support.

4.5 SCHEDULE

Planning for acoustic trials begins six months prior to scheduled conduct.

Acoustic trials may be conducted separately or may be coordinated with the Combat System Ship Qualification Trials (CSSQT), discussed elsewhere in this manual, in order to minimize transits to the range and to make effective use of range time .

Conduct of acoustic trials should be scheduled no later than three months prior to the scheduled start of PSA. This will allow sufficient time to incorporate any work necessary to correct found deficiencies into the Post-Shakedown Availability (PSA) work package.

The following typical schedule requirements apply to acoustic trials:

• Briefing of ship's force	About one month prior to trials
• Dockside availability	4 days (less than 2 weeks prior to trials)
• Conduct acoustic trials	
- Transit Phase	3 days
- On-Range Phase	48 hours, continuous and dedicated
• Dockside, offload instruments	1 day
• Quicklook Message	Two weeks after trial
• Preliminary Report	Three months after trial
• Final Report	Five months after trial

The actual extent of testing will vary with ship complexity and the requirements for testing. The dockside availability prior to tests is used to install instrumentation, to perform an underwater inspection of the hull, and to inspect machinery and air systems.

4.6 DETAILED DESCRIPTION

4.6.1 Personnel

Ten to fourteen additional personnel, depending on complexity of the trials, are required aboard the ship during acoustic trials. These include Trial Directors, sonar self-noise and structureborne noise personnel.

4.6.2 Dockside Availability

A diver's inspection is required to assess the condition of the sonar dome, propeller(s) and Propulsor Air Ingestion and Emission (PRAIRIE)/Masker systems. The divers will also assist in the calibration of the PRAIRIE/Masker system flow rates.

A dockside hull sonar calibration is also conducted to determine the sensitivity of the installed sonar at various bearings.

Shipboard equipment will be installed, for the following purposes:

<u>Tracking</u>

For tracking surface ships, a radar transponder is installed on the ship, usually mounted above the pilothouse.

<u>Structureborne Noise</u>

A structureborne noise data acquisition system will be installed aboard the ship prior to conduct of the trial. This system will include tape recorders, signal-conditioning units, noise analysis equipment, and accelerometers mounted throughout the ship.

<u>Sonar Self-noise</u>

To obtain the required sonar self-noise data, special data acquisition, recording, and analysis equipment will be installed. The specific equipment required is dependent on the type of sonar and the test requirements.

Underwater Radiated Noise

An accelerometer is installed in order to determine when the propeller begins to cavitate.

4.6.3 Conduct Acoustic Trials

Approximately one month prior to the scheduled trials, an Acoustic Range Trial Director will brief the ship's force on the forthcoming operations. This briefing will include the purposes and descriptions of each of the trials, underwater radiated noise, sonar self-noise and structureborne noise, the required runs, and the manner of keeping log data of events, machinery operations, maneuvers, etc.

The Trial Director and trial party will rendezvous with the ship prior to the start of trials and provide additional briefing on details.

4.6.3.1 Transit Phase

Sonar self-noise runs are special runs specifically designed to collect ship's noise as it affects the sonar system. These runs are generally conducted in free route and remote from the acoustic array. In addition, sonar self-noise data is acquired by ship's force through use of quarterly MRC cards during at-sea periods prior to acoustic trials.

4.6.3.2 On-Range Phase

The tracking systems will be activated and a checkout performed.

Various data runs with respect to the in-water array are made to collect acoustic data. For each data run, the Trial Director will set the machinery bill (i.e., designate machinery to operate during the run), and designate the desired speed and heading to ship's force. The Trial Director will assist in obtaining the necessary run geometry during each data run. The ship's position and heading are vectored from tracking data at the data facility for the fixed array facility. While taking structureborne noise data, the ship must be dedicated to the evolution. Interfering operations will compromise and contaminate the data, and will invalidate the results of the trial. Sonar self-noise can also be measured during radiated noise runs for correlation with radiated and structure borne noise data.

The following describes the types of data runs that may typically be used on the acoustic range. Other runs may be designed and conducted to meet special needs or requirements.

(1) Bow-Stern Run - The bow-stern runs commence at approximately 1000 yards from the in-water array and terminate approximately 1000 yards beyond the array with the closest-point-of approach (CPA) about 50 yards from the array.

(2) Beam Run - The beam runs start and stop at approximately 1000 yards from the array with a CPA varying from 100 to 300 yards depending on the ship class.

4.6.4 Acoustic Range Facilities

An acoustic range is required to obtain and analyze radiated noise data. The acoustic range consists of two systems:

- A tracking system to track the vessel under test through the range on a desired pattern and to provide range data for the necessary attenuation corrections for noise measurements

- A noise measurement system consisting of in-water hydrophones, and data recording and processing equipment

At present, there are two fixed acoustic ranges and one mobile range that perform acoustic trials.

Fixed Ranges

The Atlantic area (East Coast) fixed acoustic range is located off St. Croix, U.S. Virgin Islands and the West Coast fixed acoustic range is located at the San Clemente Island Underwater Range (SCIUR).

For fixed acoustic ranges, the in-water array is linked to the shore based equipment by a submarine cable. A control building ashore houses the required data collection and processing equipment including signal conditioners, analog tape recorders, filters, analog-to-digital conversion equipment, digital computers, plotters, printers, control equipment, and communication equipment.

A shore based radar, optical trackers, or a radio navigation system is usually used to track surface ships on the range in addition to the acoustical tracking. Communication with surface ships is generally by Ultra High Frequency (UHF) radio link.

Mobile Range

Mobile acoustic range equipment is available that can be placed on any suitable ship to support acoustic trials at locations other than the fixed ranges or whenever the fixed ranges are unavailable.

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5.0 ELECTROMAGNETIC ENVIRONMENTAL EFFECTS SURVEYS

5.1 PURPOSE

Electromagnetic Environmental Effects (E^3) surveys are conducted to assess, determine and document the extent to which shipboard electronic and electrical equipment and systems can operate safely, within their intended operational environment and at their design levels of performance and safety, and without suffering or causing unacceptable degradation, due to intentional or unintentional electromagnetic radiation between equipment and systems.

Certifications of compliance with Electromagnetic Interference (EMI) and Radio Frequency Radiation (RFR) Hazards (RADHAZ) standards are based on E^3 surveys.

Prior to onloading ordnance, the ship's required Hazards of Electromagnetic Radiation to Ordnance (HERO) Emission Control (EMCON) Bill is developed based on the results of the E^3 surveys.

5.2 SOURCE OF REQUIREMENT

The following directives establish policy and requirements for the conduct of E^3 surveys:

a. DODINST 6055.11 series, "Protection of DOD Personnel from Exposure to Radio Frequency Radiation and Military Exempt Lasers"

b. OPNAVINST 4700.8 series, "Trials, Acceptance, Commissioning, Fitting Out, Shakedown and Post-Shakedown Availability"

c. OPNAVINST 5100.23 series, "Navy Industrial Occupational Safety Manual"

d. NAVSEAINST 9700.2 series, "Integrated Topside Safety and Certification Program for Ships"

e. OPNAVINST 2450.2 series, "Electromagnetic Compatibility Program within the Department of the Navy"

f. OPNAVINST 8020.14 series, "Department of the Navy Explosives Safety Policy"

5.3 GENERAL DESCRIPTION

E^3 surveys are a series of inspections and tests that are conducted dockside and underway to assess and document electromagnetic radiation effects:

- Electromagnetic Interference (EMI) - effects on equipment
- Radio Frequency Radiation (RFR) Hazards (RADHAZ) - effects on personnel or to fuel:
  - Hazards of Electromagnetic Radiation to Personnel (HERP)
  - Hazards of Electromagnetic Radiation to Fuels (HERF)
- Hazards of Electromagnetic Radiation to Ordnance (HERO) - effects on ordnance

5.4 ORGANIZATIONS INVOLVED

Naval Sea Systems Command (NAVSEA), Battle Force Electromagnetic Environmental Effects Office (SEA 53H3) is the coordinator of shipboard EMI and RADHAZ programs within NAVSEA.

Naval Ordnance Safety and Security Activity (NOSSA) Indian Head, Code N716, is the coordinator of the Shipboard HERO Program and acts as the Navy technical authority for HERO.

Several other Navy laboratories, field activities and contractors are tasked by SEA 53H3 to provide specialized support as required.

5.5 SCHEDULE

Upon ship delivery, baseline E^3 surveys will be conducted. After each major conversion or overhaul, reduced scope E^3 testing against the baseline should be conducted.

An E^3 Survey plan is prepared 12 weeks prior to conduct and provided to the Ship Program Manager (SPM) for approval.

Actual length of testing periods will vary with the extent of testing required based on the complexity of the ship's systems. Typical lengths are given below.

5.5.1 EMI Survey

- Briefing of ship's force — 2 to 4 weeks prior to tests
- EMI Phase I test — 4 to 7 days (dockside)
- Resolution of deficiencies — approx. 4 weeks
- EMI Phase II tests — 4 to 7 days (underway)

5.5.2 RADHAZ and HERO Surveys

- RADHAZ survey — 3 to 5 days
- HERO survey — 3 to 5 days

The HERO survey can be scheduled and conducted concurrently with the RADHAZ survey. However, neither can be conducted concurrently with the EMI survey.

5.6 DETAILED DESCRIPTION

5.6.1 General

The shipboard electromagnetic environment is affected by both oceanic environmental effects and by life cycle events such as individual equipment or system installation or repair.

- One source of EMI is corroded electrical contacts, caused by chemical reaction of seawater and metal. Electrical energy passing through a corroded contact may be transformed into unintended electromagnetic radiation.

- The installation or repair of equipment and systems that are then operated may be sources of EMI, RADHAZ or HERO either because of unintended electromagnetic interaction between nearby equipment or because of the high power levels of normally emitted electromagnetic radiation.

E^3 surveys document the EMI, RADHAZ and HERO status by determining the ship’s configuration and by tests of equipment and systems.

5.6.2 Definitions

EMI

Electromagnetic Interference (EMI) is any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronic/electrical equipment.

RADHAZ

Radio Frequency Radiation (RFR) Hazards (RADHAZ) is a dangerous situation created by electromagnetic energy at certain frequencies and of sufficient intensity to produce harmful biological effects in humans (HERP) or cause spark ignition of volatile combustibles (HERF).

HERO

Hazards of Electromagnetic Radiation to Ordnance (HERO) is the program concerned with prevention of accidental ignition of Electro-Explosive Devices (EEDs) in ordnance due to RF electromagnetic fields.

5.6.3 E^3 Survey Results

5.6.3.1 EMI Certification

EMI certification requires that:

- A ship has available EMI fixes installed to correct mission degrading EMI problems
- All uncorrected mission degrading EMI problems have been identified and reported to cognizant authority for resolution
- Intermodulation Interference (IMI) levels do not exceed 19th product order

EMI certification is required for all new construction ships. EMI certification is also required for ships undergoing industrial availability where major topside structural changes or changes to topside emitters or sensors are made by Ship Alteration (SHIPALT), Ordnance Alteration (ORDALT), Engineering Change Proposal (ECP), or other authorized procedures.

Optimum Electromagnetic Compatibility (EMC) by minimizing EMI must be attained and be sustained throughout the ship's life cycle.

5.6.3.2 RADHAZ Certification

RADHAZ certification verifies a ship's compliance with DOD policy to identify, attenuate, or control by engineering design, protective equipment, administrative action, or a combination thereof, hazardous Radio Frequency (RF) Electromagnetic Fields (EMF), and other dangers associated with non-ionizing radiation from electronic equipment.

RADHAZ certification is required for all new construction ships. RADHAZ certification is also required for ships undergoing industrial availability where changes to topside emitters or surrounding superstructure that might impact the electromagnetic environment are made by SHIPALT, ORDALT, ECP, or other authorized procedure.

RADHAZ certification is based on instrumented RADHAZ testing on lead ships and visual inspection of topside EM control measures on follow-on ships.

5.6.3.3 HERO Emissions Control Bill

A ship’s HERO Emissions Control (EMCON) Bill is prepared and finalized as a result of the HERO Survey. Each ship is required to have an EMCON Bill prior to onloading ordnance.

The EMCON Bill is a set of directions for implementing HERO restrictions on board ship. Its purpose is to prescribe, through advance planning, the easiest and most efficient method of managing the conflict between the electromagnetic environment (EME) created by high power transmitting equipment and HERO classified ordnance. The degree of relief from HERO EMCON restrictions that can be obtained by following a HERO EMCON bill is dependent upon two factors:

- The amount and type of ordnance that is involved
- Knowledge of the ambient radio frequency (RF) environment at locations where ordnance exposure occurs during handling, loading, storage, assembly, and transportation operations

5.6.4 Prerequisites to Conduct of E^3 Surveys

5.6.4.1 Documentation

Electromagnetic Control Topside Arrangement Drawing

Topside electromagnetic interference control items are identified in Electromagnetic Control Topside Arrangement Drawings. A ship-specific or ship-class drawing is available for most ships. The ship-specific and ship-class drawings include:

- List of antennas
- List of bonding requirements
- List of EM control measures
- List of EMI PMS
- List of RADHAZ control measures

For those ships not covered by a class or ship-specific drawing a generic drawing is available. The Generic Electromagnetic Control Topside Arrangement Drawing contains a list of bonding requirements associated with specific equipment, systems, or items.

5.6.4.2 System Readiness Tests

Any prerequisite test required for EMI testing is included with the individual test instructions provided in NAVSEA STD 407-5291780.

Conduct of the specified system readiness tests demonstrate that the system under test meets established installation and performance requirements prior to subsequent E^3 system-to-system testing.

5.6.5 E^3 Surveys

MIL-STD-1605A delineates the lifecycle E^3 performance requirement for surface ship EMC and RADHAZ safety. It specifies the E^3 inspection and testing requirements to demonstrate that optimum EMC and RADHAZ safe performance has been attained. Compliance with MIL-STD-1605A satisfies the requirements described in the following subparagraphs.

Operational testing of primary sensors and communications systems should be coordinated to use the services of the Shipboard Electronic Systems Evaluation Facility (SESEF) to the maximum extent possible. SESEF is described elsewhere in this manual.

5.6.5.1 EMI Survey

EMI problem demonstration and EMI Certification testing of known system-to-system E^3 problems are in accordance with the visual inspections and EMI recognition tests of NAVSEA STD 407-5291780. The results of the EMI survey are entered into the SEMCIP Technical Assistance Network (STAN) database maintained by the NAVSEA Shipboard Electromagnetic Compatibility Improvement Program (SEMCIP). The STAN is an electromagnetic environmental effects information system that contains information from which the ship's EMI certification requirements are developed. A more detailed discussion of STAN is provided later in this chapter.

Any changes to the delivery configuration may impact the ship's certification status. During the Post-Delivery Test and Trials period the ship's configuration must be monitored. Should the ship's configuration be changed, the impact of the change on the ship's certification must be determined. NAVSEA reviews SHIPALTs, ORDALTs and ECPs to evaluate their impact on the ship's certification. If an alteration has an electromagnetic impact, a requirement for certification must be included in the alteration.

Visual Inspections

Visual inspections of specific system configurations and topside conditions confirm that EM control measures and system EMI fixes are installed or that deficiencies are documented.

- Topside EM control measures. The topside EM control measures inspection shall confirm the required EM control measures are in conformance with the applicable EM Control Topside Arrangement Drawing in STAN. Deviation from the EM Control Topside Arrangement Drawing shall be reported to cognizant authority.

- Equipment EMI fix installation status. The visual inspections applicable to installed equipment shall determine whether each required EMI fix is properly installed, partially or improperly installed or missing entirely.

EMI Recognition/Validation Tests

Generic and system specific recognition tests:

(1) Verify whether a known system to system problem is present and determine its severity;

(2) Validate that, once installed, a fix for a known problem is effective

Discovery Testing

Discovery testing is conducted to demonstrate EMC for systems that have not been previously installed in the ship class. Discovery testing is conducted when compliance with production materials, fabrication practices or installation procedure requirements of MIL-STD 1605A are required. Discovery testing is also required to demonstrate system-to-system EMC of government furnished material (GFM) and contractor furnished material (CFM) not tested in accordance with visual inspections and recognition tests. Discovery testing on new systems is conducted in accordance with NAVSEA STD 407-5291780.

5.6.5.2 RADHAZ Survey

RADHAZ surveys are required to ensure the safety of personnel and fuel during operation of equipment and systems in the complex EME aboard ships. RADHAZ Certification is obtained following instrumented RADHAZ testing or successful completion of the specified topside EM control measures visual inspection.

Instrumented RADHAZ Testing

Usually, on the first ship of a class in each construction yard, instrumented RADHAZ testing will be scheduled and executed by a government-designated test team. The government test team will identify areas where Permissible Exposure Limits (PELs) are exceeded in accordance with Institute of Electrical and Electronics Engineers (IEEE) C95.1, DODINST 6055.11 and NAVSEA OP-3565, and identify required RADHAZ avoidance measures and locations.

Topside EM Control Measures Visual Inspection

The topside EM control measures visual inspection is conducted to confirm that all RADHAZ avoidance requirements are installed in accordance with the EM Control Topside Arrangement Drawing. In the event of a conflict between the EM Control Topside Arrangement Drawing and a more recent RADHAZ instrumented survey report by a government-designated test team, the test team report will take precedence in determining appropriate control measures. A deviation report will be submitted to the Naval Supervising

Authority and SEA 53H3 documenting any changes from the EM Control Topside Arrangement Drawing.

5.6.5.3 HERO SURVEY

HERO surveys are conducted to develop procedures to ensure safe handling of HERO susceptible ordnance. HERO surveys may either be instrumented or accomplished by analysis based on a number of factors such as: (1) ship's topside configuration, (2) ordnance load-out, (3) assigned aircraft, (4) ship's mission, and (5) whether instrumented EME data is available from a similar ship configuration. Follow-on ships of a class, with identical topside configuration, will be evaluated by analyzing the existing EME data from earlier ships of the class relative to the follow-on ship's planned ordnance load-out, mission, embarked personnel and/or aircraft data.

HERO instrumented surveys are conducted by taking measurements at various weapon stations, and ordnance handling, loading and transporting areas. An analysis of the data is conducted and a report is submitted detailing the findings of the HERO conditions aboard the ship. Included in the report are:

- Recommendations to correct hazardous conditions
- Restrictions on ordnance handling and/or control of Electromagnetic Radiation (EMR) during ordnance handling and launching
- Procedures to minimize risk in emergencies when operational requirements preclude control of EMR

The HERO Survey is the basis for the ship's HERO Emissions Control (EMCON) Bill. The HERO EMCON Bill should be checked after a major availability or accomplishment of a SHIPALT or ECP that either installs, removes, or relocates an RF emitter or a new type of ordnance.

5.6.6 Test Standards and Performance Requirements

a. MIL-STD-1605A, "Standard Practice for Surface Ship Electromagnetic Environmental Effects (E^3) System-to-System Compatibility and Non-Ionizing Radiation Safety"

b. NAVSEA STD 407-5291780, "Standard Electromagnetic Interference (EMI) Survey Procedures"

c . IEEE C95.1-1991, "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz"

d. NAVSEA OP 3565/NAVAIR 16-2-529/SPAWAR 0967-LP-624-6010, “Electromagnetic Radiation Hazards”

e. MIL-STD-464 “Electromagnetic Environmental Effects Requirements for Systems”

5.6.7 Shipboard Electromagnetic Compatibility Improvement Program (SEMCIP) Technical Assistance Network (STAN)

The results of the EMI survey are entered into the SEMCIP Technical Assistance Network (STAN) database maintained by the NAVSEA Shipboard Electromagnetic Compatibility Improvement Program (SEMCIP). The STAN is an electromagnetic environmental effects information system that contains information from which the ship’s EMI certification requirements are developed.

The ship’s EMI survey data is updated following ship overhaul, repair availabilities and when new equipment/systems are installed.

STAN is the only SEA 53H3 authorized tool for determining applicable EMI problems in support of ship EMI Certification. STAN is password accessible via standard computer software at a toll-free 800 number or via the World Wide Web at: https://www.stan-smits.com/. The toll-free number and password required for access to STAN data may be requested from SEA 53H3. Through STAN, users have access to listings of ship and system EMI problems, EMI fix status, EMI test procedures, automated report generators for EMI survey, EM Control Topside Arrangement Drawings, EMI references, and points-of-contact.

6.0 STRUCTURAL TEST FIRINGS

6.1 PURPOSE

Structural Test Firings (STF) are conducted to:

- Confirm that the ship's ordnance installation and the ship's structure are of adequate strength, rigidity, tightness and heat resistance to withstand the shock, vibration, and blast of the weapons firing
- Determine if any hazardous exhaust products such as flame, smoke, or toxic agents enter the interior of the ship during gun firing or weapons launching operations
- Determine if any personnel hazards exist due to improper construction or installation of the weapon systems
- Gather additional empirical data for current and future ship modification and designs

These tests are designed to place the maximum realistic stress and strain on the weapon assemblies, the foundations, and the surrounding ship's structure by actual weapons firing.

6.2 SOURCE OF REQUIREMENT

a. OPNAVINST 4700.8 series, “Trials, Acceptance, Commissioning, Fitting Out, Shakedown and Post-Shakedown Availability”, identifies structural test firings as an event to be accomplished during the shakedown period.

b. NAVSEAINST 9700.2 series, “Integrated Topside Safety and Certification Program for Surface Ships”, details the requirements for structural test firing of all weapons systems on lead and follow-on ships.

6.3 GENERAL DESCRIPTION

Structural test firings (STF) will be accomplished on each weapon installed on lead ships, on new or modified weapons systems installations to verify the safety and integrity of the weapons systems installations and of surrounding ship structure, or when blast sensitive equipment is installed in close proximity to a blast zone.

After each gun, missile or weapons salvo, burst or launch, inspections for damage to ship structure and equipment will be conducted. Test instrumentation and photographic equipment will measure and record temperatures, ingress of gas, smoke or flame to ship's interior, toxic gas concentrations, blast pressures, sound pressures and blast effects. Observation for vibrations during firing bursts, missile ejecta and exhaust residue deposits will be conducted.

6.4 ORGANIZATIONS INVOLVED

Naval Sea Systems Command, Surface Ship Technology Directorate (SEA 53) is the STF program manager.

Naval Surface Warfare Center Dahlgren Division (NSWC DD), Weapons Integration and Technology Branch (Code G72), is the sole STF designated technical direction agent.

6.5 SCHEDULE

STF may be conducted as a separate event or may be conducted during the Combat System Ship Qualification Trials (CSSQT), discussed in a later chapter in this manual. STF must, however, be accomplished prior to the ship's initial deployment with the new weapon system configuration.

Preliminary planning for STF should commence approximately one year prior to the scheduled conduct of the tests, primarily to ensure allocation of the required Blast Test Vehicles (BTVs).

The preliminary STF survey is conducted three to six months prior to STF conduct to allow enough time to correct any major deficiencies prior to STF conduct. This survey is coordinated with the shipyard and conducted by NSWC DD to ensure the installation will not present any hazard to personnel and equipment.

The STF test plans are finalized two to three months prior to conduct.

Prior to the tests, the ship must take on the required ammunition and BTVs required for the testing. This load out is generally performed at a Naval Weapons Station. Other locations can be used for load-out by special arrangement. This is primarily the ship's force responsibility.

Four to ten days are generally required dockside to load and install the instrumentation and photographic equipment required aboard the ship during the tests and to brief the ship's force on the conduct of the tests and the methods of obtaining data.

Two to five days are generally required for STF conduct. The tests are conducted in an operating area where gunnery is performed or at a weapons range.

6.6 DETAILED DESCRIPTION

Unless otherwise directed by the Chief of Naval Operations (CNO) ship class sponsor, the lead ship in a new or modified-repeat ship class must undergo structural test firing.

For follow-on ships, the STF program manger reviews the particular ship installation and, based on the data acquired for previous structural test firings for the ship class determines whether a full or abbreviated structural test firing is necessary for the follow-on ship. Abbreviated tests may be conducted by ship's force at the discretion of the STF program manager. Considerations taken into account include: when different ordnance is installed, when new antenna systems are located in close proximity to weapons systems, or when changes to foundations or adjacent structures make such tests advisable.

For in-service ships completing an availability or overhaul, STF is conducted when the ship's topside configuration has been modified to an extent which may impact the nearby weapon system. The STF program manager determines whether a full or abbreviated STF is warranted.

There are generally three distinct classes of weapons systems aboard a ship that require different procedures in the conduct of structural test firings.

- Missile launchers
- Gun mounts/turrets larger than 76 millimeter (mm)
- Other weapons, such as: .50 caliber; 20mm; 25mm; 40mm mounts; mortars; projectors; rocket and Super Rapid Blooming Offboard Chaff (SRBOC) launchers; NULKA launchers
- Torpedo tubes are exempted from the STF requirement

NSWC DD will designate a test director for STF on missile launchers and large caliber guns (76mm and greater). Assistance from other Navy organizations will be obtained as required.

For small caliber guns (smaller than 76mm), mortars, and rocket launchers (excluding missile launchers) the STF is generally conducted by ship's force. NSWC DD will provide guidance and assistance for STF on these installations at the request of ship's force or Type Commander.

The test director will generally visit the ship three to six months prior to the test in order to examine the ship installation and configuration. Factors considered during this preliminary survey include, for each launcher or gun mount and turret location:

- Relationship of various portions of the adjacent ship structure
- Proximity of other equipment, both exposed and internal
- Location of manned stations in the vicinity; and
- Locations of ship ventilation intakes and exhausts

The test director will report any installation discrepancies, which require corrective action prior to the conduct of the test. The test director will also verify the location of non-firing zones and the installation of the firing cutout cams.

After this preliminary survey of the ship, the test coordinator will prepare a test plan for the conduct of the required structural test firing. Based on the ship configuration and the past history of similar tests, the test conductor will determine the relative train and elevation angles and the number of rounds to be fired from each launcher or gun mount and turret.

Instrumentation will be installed to measure and record the following parameters during tests of missile launchers and gun mounts or turrets larger than 76mm:

- Toxic gas concentration in manned topside areas, adjacent compartments, and spaces served by ventilator systems
- Temperatures and pressures at decks and bulkheads in the vicinity of launchers
- Sound pressure levels in adjacent manned areas
- High-speed motion picture coverage of blast effects; and
- Other specialized instrumentation as required (e.g., acceleration, strain, etc.)

6.6.1 Missile Launchers

Missile blast tests are conducted using Blast Test Vehicles (BTVs). The BTV consists of the booster rocket motor and a simulated shape for the remainder of the missile assembly. Only the launch phase of the missile is tested. The number of BTVs to be fired from each launcher will vary with the configuration of the surrounding area. Specific missile exhaust impingement areas, the relative train and elevation angles

required, and the instrumentation requirements will be determined by the test conductor and detailed in the test plan.

BTVs are generally fired only on the lead ship of the class, unless related structural changes are made in any of the follow-on ships or unless the correction of discrepancies on the follow-on ships that were identified during lead ship structural test firing warrant re-testing.

6.6.2 Gun Mounts or Turrets Larger than 76mm

Gun blast tests are conducted on each gun mount and turret. One mount or turret is tested at a time. The relative train and elevation angles are selected to impose maximum stress from gun shock, muzzle blast, and flying objects on adjacent structures. Standard relative train and elevation angles in the gun's arc of fire include:

- Center of arc of fire in train and 0 degrees or minimum elevation
- 15 to 25 degrees at each side of nonfiring zone in train and 60 degrees or maximum elevation; and
- Approximately midway between center of arc of fire and the nonfiring zone in train and approximately 30 degrees elevation

In addition to the above, worst-case stress circumstances shall be tested. For each train and elevation combination several rounds are fired at the maximum practicable rate. The types of ammunition and projectiles are also selected to cause worst case stress effects.

6.6.3 Other Weapons

Unless otherwise directed by the Type Commander, ship's force will conduct STF of these other weapons at the earliest opportunity during the post-delivery phase. NSWC DD is available to provide guidance and recommendation to the ship's force if necessary. The required number of rounds will be fired from each weapon at angles of train and elevation as selected by the Commanding Officer. Reports of damage or other unsatisfactory conditions that would make the installation unfit for combat or would constitute an unacceptable safety hazard will be reported by message.

6.6.4 Ship's Force STF Responsibilities

During the conduct of the structural test firings, the ship's force will:

- Maintain firing area surveillance
- Alter ship heading and speed when practical to obtain worst-case relative wind conditions
- Be in combat ready status in test areas during tests
- Record data including:
  - Relative wind speed and direction
  - Barometric pressure
  - Ambient temperature, and
  - BTV motor serial number
- Operate the missile launcher, gun mounts, and fire control systems with assistance of field engineers
- Clear personnel from areas about launchers and guns prior to firing
- Check mechanical operation of launchers and guns prior to and after each test
- Assign the damage control party to stand ready for all firings; and
- Check operation of electronic equipment prior to and after the test

6.6.5 Other Considerations During Conduct of STF

During structural test firing, it is recommended that the maximum practicable amount of electronic equipment be energized and in an operational state during the tests. Equipment should be observed before, during and after the tests for indications of problems or failures induced by the firing such as inadequate mounting, excessive vibration, blown fuses, degraded performance, or catastrophic failure.

If damage occurs as a result of the firing, the ship’s damage control party will take no immediate repair action beyond that required to prevent further damage. The test conductor will photograph the damage. Data collected by ship's force will be reported to the test conductor.

Structural test firings should not be conducted under severe weather conditions, which would create undue hazards to personnel or render the weapons useless in combat. The tests must also be carefully controlled to ensure that a projectile or weapon does not actually impinge on any part of the ship structure. Longwire and whip antennas are often within firing zones, and care should be taken that they are not unnecessarily damaged nor destroyed during these exercises.

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7.0 SHIPBOARD ELECTRONIC SYSTEM EVALUATION FACILITY TESTS

7.1 PURPOSE

Shipboard Electronic System Evaluation Facility (SESEF) tests provide data to be used by the ship and other agencies to:

- Certify the installed Tactical Air Navigation (TACAN) system
- Determine system operational performance and material readiness under at-sea conditions following new construction or industrial periods.
- Provide antenna radiation patterns
- Validate engineering design by verifying conformance of ship test results to engineering design and model range data for new and upgraded systems
- Identify and assist in the correction of deficiencies in the ship's combat system electronic suite
- Support INSURV testing during at-sea Acceptance Trials, Final Contract Trials, and Underway Material Inspections (UMI)
- Support Combat System Readiness Reviews (CSRR), Combat Systems Assessment (CSA) and other inspections or assist teams

7.2 SOURCE OF REQUIREMENT

Although there is no specific directive requiring the use of SESEF, previous Ship Program Managers and Type Commanders have found that SESEF provides convenient and effective electromagnetic system test and evaluation services. SESEF supports other post-delivery events by helping to minimize requirements for aircraft services and by ensuring that shipboard electronics systems such as communication systems and radars are operational prior to conduct of more extensive combat system tests and scenarios.

The utility of SESEF has been recognized in OPNAVINST 4700.8 series, “Trials, Acceptance, Commissioning, Fitting Out, Shakedown and Post-Shakedown Availability”, which identifies SESEF testing as an event conducted during Post-Delivery Test and Trials (PDT&T).

Additionally, each SESEF is granted the authority by Commander Naval Air Systems Command, Air Traffic Control and Landing Systems Office (PMA 213) to perform Tactical Air Navigation (TACAN) certification as required by OPNAVINST 3120.28 series, “Certification of the Aviation Capability of Ships Operating Aircraft” in accordance with the Federal Aviation Act of 1958 passed by Congress. This authority is renewed based on an annual inspection conducted by the TACAN In-Service Engineering Agent, Space and Naval Warfare Systems Center San Diego (Code D33). SESEF use obviates the need for Federal Aviation Administration flight inspection aircraft to conduct TACAN certification. TACAN certification is discussed in NAVSEA S9040-AA-GTP-010/SSCR, “Shipboard systems Certification Requirements for Surface Ship Industrial Periods (non-nuclear) Manual, available on the web at: www.navsea.navy.mil/navysea-te/library.htm.

Further, SESEF tests provide the antenna radiation patterns required by INSURVINST 4730.1 series, “Trials and Inspections of Surface Ships” and by Naval Ships Technical Manual, Chapter 400, "Electronic," NAVSEA S9086-ND-STM-000.

7.3 GENERAL DESCRIPTION

SESEFs are land based test facilities designed to provide tests of shipboard electromagnetic transmitting and receiving equipment in an operational environment. SESEFs are located, as listed in Table 7-1, near major fleet concentrations in order to conduct tests on ships during transit and in nearby operational areas.

The electromagnetic testing capabilities of SESEF sites are also listed in Table 7-1. However, SESEF capabilities continue to be upgraded, and the most current information is available on the SESEF web page: http://www.sesef.com.

SESEF tests provide both detailed system performance tests and quick-look operability tests. These are discussed in more detail later in this chapter.

7.4 ORGANIZATIONS INVOLVED

Naval Sea Systems Command, Test and Evaluation Office (SEA 91T) is the sponsor of the SESEF program.

Naval Undersea Warfare Center (NUWC) Division Newport On-Site Office (OSO) Fort Story, VA, is both the SESEF Program Manager and the Technical Direction Agent (TDA) for all SESEFs. East Coast sites (Norfolk and Mayport) are administered and manned by the NUWC OSO SESEF. West Coast and Hawaii sites (San Diego, Ediz Hook and Pearl Harbor) are administered and manned by NUWC Division Keyport. The site in Yokosuka, Japan is administered and manned by the Ship Repair Facility (SRF), Yokosuka.

TABLE 7-1

SESEF ELECTROMAGNETIC TESTING CAPABILITIES

CAPABILITY / SITE	COMMUNICATIONS				ARP	RBA	RADIO DIRECTION FINDING		TACAN	LINK 4A	LINK 11	EW		IFF	URMTT
	CLEAR	SECURE	HAVEQUICK	SATCOM			CALIBRATION	QUICKLOOK				ECM	ESM		
NORFOLK VA	●	●	●	X	●	●	●	●	●	●	●	●	○	●	●
MAYPORT FL	●	●	X	●	●	●	X	X	●	●	●	●	○	●	X
SAN DIEGO CA	●	●	●	X	●	●	X	X	●	●	●	●	○	●	●
EDIZ HOOK WA	●	●	X	X	●	●	○	●	●	●	●	●	●	●	X
HAWAII	●	●	●	X	●	●	●	●	●	●	●	●	○	●	X
YOKOSUKA JA	●	●	X	●	●	●	●	●	●	●	●	●	○	●	X

● = FULL ○ = PARTIAL X = NONE

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7.5 SCHEDULE

During SESEF system performance testing, no other training, drills, tests or trials that would impact required ship maneuvers or disturb the electromagnetic fields undergoing test are to be scheduled.

For system performance tests, at least two weeks advance notice to the SESEF site is required. The following basic schedule requirements apply for system performance testing:

- SESEF personnel conduct a briefing conference approximately ten days prior to scheduled SESEF tests, if requested by the ship or the shipyard's Combat System Office
- Ship confirms time and date at least one week prior to testing
- Allow for at-sea testing on the SESEF range of one to two days' total duration depending on system complexity and number of patterns and other tests to be performed
- SESEF provides a final test report of all radiation patterns and conclusions approximately 30 days after tests

7.6 DETAILED DESCRIPTION

SESEF tests fall into two basic categories:

(1) System performance tests, which provide a detailed analysis and evaluation of the system(s) under test. They are conducted on new installations or after major repair, typically. They are usually characterized by the following:

- Long duration (up to several hours)
- Require the ship to maneuver in pre-defined geometry's
- Require the ship to be in a certain geographic area
- Require advance coordination and scheduling with SESEF
- Require internal shipboard coordination
- Formal test results via message or test report

(2) Quick-Look operability tests, which are generally conducted during transit to and from port or while pier side and are characterized by the following:

- Short duration (less than 1 hour)
- Require little or no test ship maneuvering
- Require little or no advance scheduling
- Require minimal internal shipboard coordination
- Informal test results via voice radio or short summary message

For additional test descriptions and pre-test setup requirements, review the SESEF Shipboard Test Execution Manual (STEM). This manual is available for download from the SESEF web page: www.sesef.com.

The types of systems to be evaluated include:

- Tactical Air Navigation (TACAN)
- Active Electronic Countermeasures (ECM)
- Passive Electronic Support Measures (ESM)
- Antenna Radiation Patterns (ARP)
- Radio communications (Secure & non-secure voice and data)
- Search and Fire Control radar
- Tactical Digital Information Link A (TADIL A) (Link 11)
- Tactical Digital Information Link C (TADIL C) (Link 4A)
- Identification Friend or Foe (IFF)
- Radio Direction Finding (DF/RDF)
- Radar Beacon Acquisition (RBA)

7.6.1 TACAN

TACAN certification is required following initial installation, after major component replacement, topside silhouette modifications or periodically as dictated by fleet instructions. A report and certification document is generated after successful completion of the TACAN certification evolution.

The entire TACAN certification system performance test requires approximately 30 minutes of dedicated ship time.

Quick-look testing provides an operational evaluation of the TACAN equipment. Results for quick-look testing are normally provided via radio circuit. TACAN quick-look testing can be performed during ingress and egress from port and the time required is approximately 10 - 15 minutes.

7.6.2 Active Electronic Countermeasures (ECM)

The AN/ULM-4 test set provides a qualitative and quantitative assessment of the ECM capabilities of the AN/SLQ-32 active variants. The AN/ULM-4 can determine the AN/SLQ-32's ability to acquire and engage a simulated threat throughout the entire 360 degrees. The fidelity and consistency of the ECM engagement is measured and recorded. On-range AN/ULM-4 testing requires that test equipment such as heading data link and, if applicable, polar recorders be installed on the ship.

A complete AN/ULM-4 range run requires approximately one hour of dedicated test time. A formal report and analysis is provided after a complete AN/ULM-4 system performance test.

An ECM AN/ULM-4 quick-look can be performed during ingress and egress from port and the time required is approximately 10 - 15 minutes. Real-time qualitative assessments are provided over radio by the SESEF operator to assist the shipboard technician in troubleshooting should problems be detected.

7.6.3 Passive Electronics Support Measures (ESM)

SESEF provides dedicated, high fidelity radar sources for the test and evaluation of shipboard ESM equipment. The ability to track the test signal throughout the entire 360 degrees is measured. The shipboard ESM equipment's capability to identify specific threat emitters can be evaluated and accuracy of receiver bearing can be measured. A graphical report showing receive angle errors throughout the entire 360 degrees is provided for each frequency or band tested.

The time required to complete an ESM equipment evaluation depends on the shipboard equipment and the number of frequencies required. A typical evaluation requires approximately 1 hour.

An ESM quick-look can be performed during ingress or egress from port in approximately 10 - 15 minutes.

7.6.4 Antenna Radiation Patterns (ARPs)

Naval Ships Technical Manual, Chapter 400, "Electronics," NAVSEA S9086-ND-STM-000 requires a complete set of antenna radiation patterns for the first ship of a class. Representative antenna radiation patterns of key antennas are required for each follow-on ship to validate the correlation of patterns to the lead ship.

Antenna Radiation Patterns are a graphical representation of antenna field strength versus ships sector or relative position. The pattern shape depicts nulls or blockages, which are normally caused by the ship's superstructure. It is in these null areas that the ship's ability to communicate or detect targets is adversely affected.

Real-time feedback is provided for problem correction, and a formal report and analysis is provided after the ship completes ARP testing.

The length of the ARP evolution varies due to the population of shipboard antennas, but 4 to 8 hours of dedicated time is typical.

At least 15 days prior to testing, the SESEF is provided antenna photographs (topside views) of the ship showing antenna locations and a list of all antennas. This information will be used to develop the test sequence. A copy of the most current topside arrangement drawing (antenna rigging drawing) appropriately annotated (e.g., red-lines) should also be made available.

ARP testing requires the installation of test equipment, such as heading data link, on-board ship.

7.6.5 Radio Communication Testing

Communications testing provides the shipboard technician with a qualitative assessment of the functionality of the communications equipment under test. All transmitter modes are tested for proper operation. Voice is normally used during transmitter mode evaluation, but audio tones may be supplemented if a higher degree of accuracy is desired. SESEF has the capability to provide cryptographic operability testing for the VINSON (KY-58), ANDVT (KY-5) and KG-84C equipment.

The time required to perform communication testing varies considerably and depends on the number and type of transmitters under test.

7.6.6 Search and Fire Control Radar

The Universal Radar Moving Target Transponder (URMTT) is a new system capable of providing a synthetic RF “target” that can be detected and tracked by all currently deployed Navy radar and fire control systems. These controlled, calibrated, repeatable “targets” can be used for test and calibration of radar systems, testing and training exercises, Detect to Engage (DTE) sequences, combat system alignments, and deception scenarios.

A radar system operability test can be performed in as little as 15 minutes while within Line of Sight (LOS) of the SESEF building. A more detailed testing or training evolution will require a longer period of time depending on the scenario.

7.6.7 LINK-11 (TADIL A)

The SESEF LINK 11 system verifies the proper operation of the Link-11 system equipment prior to entering the Operational Area (OPAREA) and the Fleet Area Control & Surveillance Facility (FACSFAC) data link. The SESEF system provides a static "link-picture" for the shipboard operator and decodes the shipboard tracks via M-message format. The link operation and proper track numbers are verified with the shipboard operator via covered radio circuit. Link-11 parameter analysis can be conducted utilizing the Navy standard LMS-11 equipment.

A Link-11 operability test can be performed in as little as 15 minutes, while a detailed testing and training evolution requires a longer period of time depending on the scenario

7.6.8 LINK-4A (TADIL C)

The SESEF Link-4A test system provides the shipboard Aircraft Intercept Controller (AIC) with simulated aircraft (maximum of 10 simultaneous aircraft) that verifies proper operation of the shipboard Link-4A equipment. The shipboard AIC can provide discrete commands to the simulated aircraft and "see" the appropriate response as if providing intercept commands to a live aircraft.

A Link-4A operability test can be performed in as little as 15 minutes. A more detailed testing and training evolution will require a longer period of time depending on the scenario.

7.6.9 Identification Friend or Foe (IFF)

IFF testing is performed for both the interrogator and the transponder and provides the shipboard operator with a "reliable-partner" to verify proper operation. All IFF modes (M1, M2, M3, M4 & C) are tested and the proper codes for each mode are verified.

IFF testing can be performed during ingress and egress from port and the time required is approximately 5 -10 minutes.

7.6.10 Radio Direction Finding (RDF) Calibrations

Naval Ships Technical Manual, Chapter 400, "Electronics," NAVSEA S9086-ND-STM-000 requires a complete set of Radio Direction Finding (RDF) calibration curves/measurement data for the first ship of a class. Representative RDF curves are required for each follow-on ship to validate the correlation of patterns to the lead ship.

The SESEF provides the RF transmissions required to perform RDF equipment calibrations. SESEF provides multiple, high quality, RF signals with various modulation schemes to fulfill the equipment calibration requirements. Transmission reports are provided as required.

The time required to perform an RDF evolution varies from 8 to 48 hours of dedicated test time.

RDF quick-looks can be performed during ingress and egress from port, and the time required is approximately 30 minutes to 1 hour depending on signal requirements.

7.6.11 Radar Beacon Acquisition (RBA)

SESEF provides RBA services for Naval Gun Fire Support (NGFS) capable ships in accordance with the Naval Surface Forces Training Manual 3210.1 (series). RBA exercises are conducted utilizing the AN/PPN-19 beacon. The exercise is normally conducted with the SESEF operator providing 2 "known" codes followed by seven "unknown" codes, which the shipboard operator must identify. Results are provided via voice radio circuit or hard-copy message upon request.

RBA testing can be performed in approximately 10 - 15 minutes.

8.0 COMBAT SYSTEM SHIP QUALIFICATION TRIALS

8.1 PURPOSE

Combat System Ship Qualification Trials (CSSQT) demonstrate combat system readiness, safety, effectiveness, crew proficiency, and logistic adequacy. CSSQT assists the Commanding Officer in achieving a stable level of combat systems operational and material readiness that can be maintained by ship's force on a continuing basis.

8.2 SOURCE OF REQUIREMENT

a. OPNAVINST 4700.8 series, “Trials, Acceptance, Commissioning, Fitting Out, Shakedown and Post-Shakedown Availability”, identifies CSSQT as an event conducted during the Post-Delivery Test and Trials period.

b. NAVSEAINST 9093.1 series, Combat System Ship Qualification Trials For Surface Ships”, establishes the policy that surface combatants, aircraft carriers, amphibious and auxiliary ships will be scheduled for CSSQT after completion of construction, conversion or modernization.

8.3 GENERAL DESCRIPTION

CSSQT is a series of logistic support audits, system demonstrations, test events and operationally realistic and challenging exercises and scenarios that are conducted dockside, at-sea and at various range facilities where live ordnance may be expended. CSSQT demonstrates system performance capability and material readiness of both the overall combat system and of selected combat system support elements.

8.4 ORGANIZATIONS INVOLVED

Each Ship Program Manager (SPM) for surface ships and each Program Manager for installed weapon systems under their cognizance is responsible for planning, budgeting and funding of the CSSQT and for allocation of resources to support CSSQT.

Naval Surface Warfare Center Port Hueneme Division (NSWC PHD) is responsible for planning and executing CSSQT for surface ships. However, for ships with specialized missions, the SPM in coordination with NSWC PHD may task other activities to plan and conduct CSSQT. For example, NSWC Coastal Systems Station Dahlgren Division Panama City was assigned responsibilities for the conduct of CSSQT on mine warfare ships.

8.5 SCHEDULE

Program Managers for installed weapon system should begin planning their CSSQT support requirements for missile expenditure, aerial target and seaborne target allocations three to five years in advance.

Detailed planning by NSWC for CSSQT begins at least one year prior to scheduled conduct to ensure sufficient engineering of technical objectives, to ensure adequate time to develop the test plan and to ensure availability of ranges and support services.

The duration of CSSQT depends upon the number and complexity of the installed combat systems. CSSQT, which may last from 3 to 12 weeks, is generally conducted during the post-delivery period in a contiguous time period. However, it may become necessary to split the CSSQT into phases to accommodate Type Commander (TYCOM) inspection and training events. Close coordination with the TYCOM is required. In such cases, it may become necessary to conduct selected CSSQT dockside events during the industrial period prior to delivery. Additionally, coordination with or integration of other post-delivery test and trials events into the CSSQT test plan should help shorten the overall post-delivery test and trials schedule.

8.6 DETAILED DESCRIPTION

8.6.1 Objectives

Primary Objectives

- Verify, through actual demonstration, the operational performance of the applicable systems
- Demonstrate the proficiency of ship's force to maintain and operate the systems and equipment in a safe and effective manner
- Achieve the level of readiness required by the TYCOM to begin final pre-deployment preparations by conducting team-training scenarios
- Demonstrate the adequacy of systems documentation and tests, e.g., Combat System Technical Operations Manual (CSTOM), Combat System Alignment Manual (CSAM), Overall Combat System Operability Test (OCSOT), Combat System Operational Sequencing System (CSOSS) and Planned Maintenance System (PMS)
- Demonstrate the adequacy of logistic support

Secondary Objectives

- Identify any deficiencies in the applicable installed system and equipment
- Identify any deficiencies in the documentation, logistics support, or support equipment required to support these systems
- Identify any deficiencies in ships force training that would adversely impact the ship's individual or battle group capabilities or ability to maintain a stable level of combat readiness.

8.6.2 CSSQT Plan Development

NSWC assigns a CSSQT Project Officer who develops and conducts the CSSQT according to an overall CSSQT Test Plan. This plan details the testing to be accomplished and provides a detailed schedule for the overall CSSQT.

Development of the CSSQT Test Plan by the CSSQT Project Officer is begun at least one year prior to scheduled conduct and is delivered to the ship approximately one month prior to commencing CSSQT.

8.6.3 CSSQT Coverage

CSSQT exercises ship’s force in all elements of the combat system. The elements of the combat system to be included in CSSQT vary depending on the configuration of the ship. CSSQT has in the past encompassed a combination of the following systems:

- Surface Missile Systems
- Cruise Missile Systems
- Undersea Warfare (USW) Systems
- Search Radar Systems (Including Repeaters, Consoles and Identification Friend or Foe)
- Gun Weapon Systems (Including self defense systems)
- Command and Control Systems
- Communication Systems
- Combat System Support Elements (Power, Dry Air, Heating Ventilation Air Conditioning, etc.)

- Interior Communications/Navigation Systems
- LAMPS (Lightweight Airborne Multi-Purpose System) helicopter
- Combat Direction Finding Systems
- Underway Replenishment Systems
- Electronic Warfare Systems (both Active Electronic Countermeasures and Passive Electronic Support Measures)
- Mine Warfare Systems

Normally, for aircraft carrier or amphibious assault ships, neither the air wing detachment nor amphibious assault elements are included as part of the combat system. However, in order to demonstrate the shipboard communication, command and control equipment on amphibious assault ships, in the recent past when resources have been available, an Integrated Combat System Exercise (ICSE) has been conducted during CSSQT. The ICSE utilized available Marine detachments to demonstrate command and control of landing craft assets using an amphibious assault scenario in conjunction with simultaneous air and surface tracking exercises.

8.6.4 CSSQT and Other Post-Delivery Test and Trials Events

Careful judgement must be exercised during development of the CSSQT test plan when other post-delivery test and trial events, such as Acoustic Trials, Structural Test Firings (STF), Weapon Systems Accuracy Trials (WSAT), Sensor Accuracy Tests (SAT) and Underway Replenishment Ship Qualification Trial (UNREP SQT), discussed elsewhere in this manual, are considered for integration into or for coordination with the CSSQT. Considerable liaison, coordination, and cooperation between the activities responsible for the individual events is required. Benefits in the form of time and resource savings can arise when dockside periods can be used concurrently for dockside testing and training and for preparations for on-range testing for the various events, by reducing personnel travel costs, by minimizing idle time and by reducing the number of transits to operational areas and ranges. However, the benefits must be balanced against the risk that deficiencies found in during these other test and trial events could affect the achievement of CSSQT objectives. Combining post-delivery test and trial events with CSSQT may be more feasible on follow-on ships after completion of lead ship post-delivery testing has reduced risks.

Coordination of CSSQT with Developmental Test and Evaluation (DT&E) or Operational Test and Evaluation (OT&E) events, planned in the ship or weapon system’s Test and Evaluation Master Plan, may also be considered in order to reduce

test duplication. However, incorporating DT&E and OT&E events should not take precedence or diminish accomplishment of CSSQT objectives.

8.6.5 Off-Ship Services

Off-ship services such as missiles, aerial and seaborne targets, weapons ranges, operational areas, aircraft for tracking or electronic warfare exercises and ordnance are utilized during conduct to achieve CSSQT objectives. These services must be requested in advance of the scheduled test conduct date.

8.6.5.1 Missile Expenditure Allocation

CSSQT missile expenditure allocations are issued annually by the CNO. Allocations allowed by the CNO are generally one missile of each type applicable to the system per fire control system plus backups. Planning for missile expenditure allocations should be begun by the Program Manager for the missile system three to five years in advance of CSSQT.

8.6.5.2 Aerial Targets Allocation

Program Managers for weapon systems should submit a preliminary request to the NAVSEA Test and Evaluation Office (SEA91T) for CSSQT aerial targets three to five years in advance of the expected conduct date. Final allocations are made on an annual fiscal year basis and are made in the last quarter of the preceding fiscal year. Therefore, final requirements for aerial targets to support the CSSQT should be submitted in the April to June period preceding the fiscal year in which the CSSQT will be conducted.

8.6.5.3 Seaborne Targets Allocation

Program Managers for weapon systems should submit a request for allocation of seaborne targets required for the CSSQT to Program Executive Office, Expeditionary Warfare (PEO EXW), Support Ships, Boats and Craft Program (PMS 325). A six-year projection is submitted annually. Allocations are made on an annual fiscal year basis and are made in the final quarter of the preceding fiscal year. Therefore, final requirements for seaborne targets to support the CSSQT should be submitted in the April to June period preceding the fiscal year in which the CSSQT will be conducted.

8.6.5.4 Aerial and Seaborne Target Types

CSSQT firings are made against standard Navy targets or commercial targets, such as those listed in Table 8 -1.

TABLE 8-1

TARGETS

Aerial*	**Seaborne****
BQM-34S (subsonic)	QST-35 SEPTAR
BQM-74C/E (subsonic)	ISTT
AQM-37C (supersonic)	QST-33 (limited inventory)
MQM-8G (supersonic)	HSMST (replaces QST-33 and RHIB)
MQM-8G/ER/EER (supersonic)	RHIB (limited inventory)
QF-4 (supersonic)	Williams Sled
TDU-32 (towed target)	Trimaran
TDU-34 (towed target)	FAST
CHUKAR III (commercial variant of BQM-74)	Roboski (used by SURFLANT, not currently available from PMS 325)
MA-31 (supersonic)	

* NOTE: Refer to Pacific Missile Test Center Technical Publication TP000007, “US Navy Target Systems Users Manual”, available from Program Executive Officer Cruise Missiles and Joint Unmanned Aerial Vehicles, Navy Aerial Target Program Manager, PEO (W) PMA 208, for detailed descriptions of each aerial target.

** NOTE: Refer to Naval Air Warfare Center Weapons Division CD-ROM, “Seaborne Targets Users’ Guide”, available from PMS 325, for detailed descriptions of each seaborne target.

The standard target systems, as allocated, are generally adequate to meet CSSQT objectives. Each target type may be augmented with additional devices such as radar beacons or reflectors, infrared devices or Electronic Countermeasures (ECM) devices. Augmentation devices are available to enhance targets for Rolling Airframe Missile (RAM) exercises. The Ship Program Manager or the weapon system Program Manager is required to fund any non-standard target requirements.

Target presentation costs for special requirements such as DT&E or OT&E are funded by the Ship Program Manager or the applicable weapon system Program Managers.

8.6.5.6 Operational Areas, Weapons Ranges and Aircraft Services

The CSSQT Project Officer provides the ship with a recommended schedule for off-ship services and assists the ship in generating the required message requests to the Type Commander (TYCOM). TYCOM scheduling conferences are conducted quarterly and require, one month prior to the date of the scheduling conference, the service request information for the following, second and third out quarters.

East Coast Operational Areas (OPAREAs) for air tracking and gunnery exercises are located in the Virginia and North Carolina coastal area and offshore in the Jacksonville-Mayport, FL, area.

In the Roosevelt Roads Naval Station, Puerto Rico area, the Atlantic Fleet Weapons Training Facility (AFWTF) operates ranges near Puerto Rico and the Virgin Islands of St. Croix, St. Thomas, and Vieques. Various ranges can accommodate aircraft tracking, and gun and missile firing exercises.

West Coast air tracking and live ordnance firing exercises may be conducted at the Sea Test Range located off Point Mugu, CA, the Southern California Offshore Range (SCORE) located off San Clemente Island, CA, and the Pacific Missile Range Facility (PMRF) off Kauai, HI.

Aircraft services have been provided either by fleet assets, depending on availability, or by commercial air services.

8.6.5.7 Ordnance Loadout

One to two days must be allowed in the schedule, either prior to or during the CSSQT period, for loadout of the required missiles and gun projectiles.

The required missiles and gun projectiles are assembled, and shipped to a loadout point. Loadout is, in most cases, accomplished at a Naval Weapons Station. Other port facilities can be designated for loadout, but considerable planning must be done to load explosive materials at other ports.

8.6.6 CSSQT Team Composition

Composition of the CSSQT team, including team leaders, system engineers and other technical personnel, will be determined by the CSSQT Project Officer based on the systems installed on the ship and the experience level of ship's force. The size of the team, typically from ten to thirty personnel, will vary with the schedule of CSSQT events during dockside and at-sea phases. Team members may be drawn from various Navy activities and, in some cases, contractor personnel who represent

equipment vendors. The CSSQT Team composition is flexible and may increase or decrease in size as necessary to support the ship's needs.

8.6.7 Ship's Responsibilities

a. Ship's responsibilities include:

- Ensuring all prerequisites for the readiness of the ship for the CSSQT are met
- Performing the required onboard testing and maintenance
- Requisitioning missiles, ammunition and follow-up of logistics items
- Providing the CSSQT Project Officer with pertinent message traffic, etc.
- Providing adequate berthing, messing, and emergency medical services for CSSQT personnel during the CSSQT at-sea period

8.6.8 Initial Visits and Pre-CSSQT

The CSSQT Project Officer will conduct the initial ship visit and follow-on visits to:

- Establish liaison between the ship and cognizant CSSQT activities
- Discuss the Pre-CSSQT and Special Assistance Team (SAT) visits
- Discuss the CSSQT program and requirements

Pre-CSSQT visits may be conducted at dockside availabilities of opportunity. These availabilities should, however, be of sufficient length to accomplish the required pre-CSSQT tasks.

Pre-CSSQT visits by Special Assistance Teams (SAT) are conducted to validate documentation, test equipment, onboard spares, PMS procedures and to ensure proper operation of support systems such as dry air, electrical power, heating and cooling systems. These visits must be conducted as early as possible, at or near the end of the industrial period, to ensure that any appropriate corrective action can be taken before commencement of CSSQT.

8.6.9 Prerequisites to Conduct of CSSQT

Prerequisites for the readiness of the ship for the CSSQT include:

- Ship's force must complete the Type Commander's Naval Surface Fire Support (NSFS) training requirement prior to conducting live firings.
- A sufficient number of trained personnel must be onboard to adequately maintain and operate the weapon systems
- PMS must be implemented for the weapons systems
- Correct Allowance Parts List (APL) aboard and all logistics deficiencies identified by the Integrated Logistics Overhaul (ILO) received, onboard or on order
- CSSQT essential test equipment must be onboard with calibration dates covering the CSSQT period
- Support systems must be operable and capable of supporting the weapons systems during CSSQT
- All weapons systems documentation with proper change levels inserted and catalogued must be onboard and readily available

In addition, if the installed system has not been kept current by the installation of Ordnance Alterations (ORDALTS), these should be installed prior to the CSSQT if possible.

8.6.10 CSSQT Conduct

Ship's personnel perform the tests required by the CSSQT test plan with support from the CSSQT Team.

Initial phases of CSSQT are conducted dockside and are devoted to determining the basic operational condition of the equipment and the level of training of ship’s personnel through performance of applicable Planned Maintenance System (PMS) tests. Accomplishment of PMS by ship’s force allows the CSSQT team to provide instruction in both preventive and corrective maintenance.

As the CSSQT progresses, at-sea live tracking and exterior communications exercises are introduced to further assess the performance of the systems and to train system operators on individual console operations.

After successful and stable system performance has been established, integrated combat system scenarios are introduced to support combat system operations training for the Combat Information Center (CIC) team, and when possible, operations training in all warfare environments.

The final phase of the CSSQT consists of live firings of gun and missile systems to serve as a final verification of combat system operability and as a final verification of ship's force ability to safely and effectively use the combat system to engage threats.

Progress in the overall CSSQT will depend on several factors that include equipment status, crew training, and availability of off-ship services. The time required for each phase of the CSSQT will be determined by the time required to meet the CSSQT objectives. In most cases, time will initially be consumed to correct system and equipment deficiencies. As the number of deficiencies are reduced and maintenance instruction progresses, a pattern of steady improvement should evolve.

At successful completion of CSSQT, ship's crew and combat systems performance will have been demonstrated and evaluated.

8.6.11 Briefings

From the early planning stages of a CSSQT through the end of the CSSQT, numerous briefings are conducted by the CSSQT Team for the ship to ensure that CSSQT events will be safely and effectively conducted. Examples of the broad spectrum of briefings conducted include kickoff meetings, in-briefs to detail CSSQT events, doctrine briefings, threat briefings, lessons learned, range briefs, safety briefs, and out-briefs.

8.6.12 Reports

Situation Reports (SITREPs) are sent weekly by naval message. Special SITREPs will be sent if problems arise which require immediate attention. SITREPs will be serially numbered to cover the period from commencement to completion of the CSSQT program. The CSSQT Project Officer in conjunction with the ship, prepare SITREPs for release by the Commanding Officer of the ship. Contents of the SITREP will (at a minimum) include:

- Operational status of systems/equipments
- Significant CSSQT activities since the last SITREP
- Present status including changes in CSSQT schedules, requirements, objectives, or personnel

8.6.13 Critiques

Upon completion of each major phase of CSSQT, a critique will be conducted onboard and will include:

- Summary of operations
- Problem areas at commencement and any problems at the end of CSSQT, highlighting problems resolved
- Recommendations
- Preliminary overall evaluation

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9.0 SENSOR ACCURACY TESTS (SAT)

9.1 PURPOSE

Sensor Accuracy Tests (SAT) measure the accuracy of Anti-Submarine Warfare (ASW), Anti-Air Warfare (AAW), Anti-Surface Warfare (ASUW) and navigation sensors installed on the ship. These tests are conducted under static conditions while in-port and under operational conditions in an at-sea environment.

The objectives of SAT are to:

- Determine bearing, range and heading accuracy of shipboard sensors
- Identify sensor errors or malfunctions
- Identify required corrective maintenance
- Indicate ship's sensor systems' readiness
- Provide statistical data for analysis of overall system performance measurement
- Verify corrective action for deficiencies noted and corrected while the ship is still under test

9.2 SOURCE OF REQUIREMENT

Although there is no specific directive requiring the alignment of weapon systems on non-ASW equipped ships, Ship Program Managers have in the past included alignment criteria for performance of weapons systems in ship procurement contracts. As cited in OPNAVINST 4700.8 series, “Trials, Acceptance, Commissioning, Fitting Out, Shakedown, and Post Shakedown Availability”, it is only after delivery that the ship may be taken to the special ranges and facilities that have the capability to demonstrate and complete the alignment of weapon systems. Further, the ship’s ability to accurately report target data becomes an increasingly important factor in efficient and effective battle space management within a Battle Group.

9.3 GENERAL DESCRIPTION

SAT is conducted on non-ASW equipped ships and ASW equipped ships. However, on ASW equipped ships, SAT is conducted as Phase III of Weapon System

Accuracy Trials (WSAT), as discussed elsewhere in this manual. SAT may be conducted as a part of RDT&E programs for new or modified sensor systems.

SAT uses standardized test procedures, instrumentation, and facilities so that results can be compared for accuracy and repeatability. Standardized testing permits database archive of test results that are used to generate class statistical performance analyses from the SAT database.

Accuracy and alignment testing of combat system sensors are conducted in two phases, dockside and underway. The at-sea portion of SAT is conducted on a Fleet Operational Readiness Accuracy Check Site (FORACS) that is equipped with instrumented tracking range and optical, acoustic and electromagnetic targets. FORACS range locations are listed in Table 9-1, below.

Bearing, heading and range (if applicable) accuracy of the following sensors are measured:

- Surface Search Radar
- Fire Control Radar (Non Doppler)
- Gyrocompass/Inertial Navigation System (INS)
- Sonar
- Radar Range-Azimuth Indicators
- Electronic Support Measures (ESM), Electronic Countermeasures (ECM) and Radio Direction Finders (RDF)
- Optical System, Peloruses

Accuracy of speed data from the Speed Indicator (EM Log or Doppler Sound Velocity (DSV) Log) can also be measured.

TABLE 9-1

FORACS RANGES

Location	Nearby Ports
San Clemente Island, California	San Diego
Nanakuli, Oahu, Hawaii	Pearl Harbor
Andros Island, Bahamas	Port Everglades, Port Canaveral, or West Palm Beach

Note: The above ranges are also known as: FORACS I at San Clemente Island; FORACS III at Nanakuli; and Atlantic Undersea Test & Evaluation Center (AUTEC) at Andros Island.

9.4 ORGANIZATIONS INVOLVED

Naval Sea System Command, Test and Evaluation Office (SEA 91T), is the SAT Program Manager.

Naval Undersea Warfare Center (NUWC) Division Newport, ASW Shipboard Test Team (Code 7015), is both the Technical Direction Agent (TDA) for the SAT program and the Test Conduct Activity (TCA) for East Coast SATs. NUWC Detachment Hawaii, Fleet Operational Support Department (Code 90) is the TCA for West Coast and Mid-Pacific SATs.

9.5 SCHEDULE

For non-ASW equipped ships, SAT may be scheduled for conduct either as a standalone test or in conjunction with Combat System Ship Qualification Trial (CSSQT), discussed elsewhere in this manual.

For ASW equipped ships, SAT is conducted as Phase III of Weapon System Accuracy Trial (WSAT) discussed elsewhere in this manual.

The following schedule requirements apply to the conduct of SAT:

- Preparation and promulgation of SAT test plan - approximately 60 days prior to the trial

- Initial pre-SAT shipboard briefing - approximately 30 days prior to the trial
- Dockside installations and testing - one day minimum
- Transit from nearby port to range - one day or less
- Underway on-range tests - one to two days
- Post test shipboard debriefing immediately following conclusion of on-range test evolution
- SAT message report (non-ASW ships only) - within 5 days upon completion of SAT
- SAT final report (non-ASW ships only) - within 30 days of completion of SAT

9.6 DETAILED DESCRIPTION

9.6.1 Shipborne Equipment Installation

Shipborne equipment installed to support SAT includes a deck theodolite, communications equipment, and the Integrated Data Acquisition Test Systems (IDATS) comprised of data acquisition and analysis equipment, configured as a computer local area network. Some shipboard sensors are connected to IDATS to provide automatic recording, readout and data analysis. Other sensor data is provided by keyboard entry. IDATS is used to identify any sensor deficiencies and confirm adequate data acquisition. IDATS provides the Test Director with graphical displays and reports of the analyzed data.

9.6.2 Pre-Test Dockside Alignment

Dockside testing lasts one day and begins with establishment the ship's centerline.

Then the deck theodolite to be used during the on-range tests is usually placed on the stern and located on the ship's centerline so that its visibility is relatively unobstructed by superstructure and to provide a relatively smooth and vibration free ride and closer proximity to the roll axis. Another theodolite is installed forward, as close to centerline as possible. A third theodolite is placed onshore approximately one-fourth to one-half mile from the ship. By translation through the shore-based theodolite, the stern theodolite is aligned to the bow theodolite. Once aligned, reference punch

marks are installed on the ship's superstructure so that both crosslevel alignment and fore, aft, and athwartship alignment of the stern theodolite can be reclaimed quickly for the on-range test.

During the dockside phase, the physical location of each sensor to be tested must be accurately determined in relationship to the location of the deck theodolite and the Global Positioning System (GPS) antennas. Both fore-and-aft position and athwartship position of each sensor must be established. Also, parallax corrections used during the data reduction process are determined by consulting the Ship's Booklet of General Plans for the necessary information that is then checked by ruler measurement from the forward perpendicular of the ship.

9.6.3 Dockside Tests

Shipboard sensors, fire control directors and navigational systems are tested for proper alignment and operability.

Once alignment is established, settled error testing of heading sensors is conducted followed by transmission error checks of the heading sensors. Benchmark and lost motion checks may also be performed to test gun/missile director alignments.

9.6.4 On-Range Testing

a. Speed Indicator Calibration

1. Doppler Sonar Velocity (DSV) Log

If the sound heads of a DSV Log installation have not been repaired or moved since initial installation and calibration, it should not be necessary to recalibrate. If it is necessary to recalibrate, the ship will maneuver in a series of Williamson turns while GPS and speed data are collected and analyzed. The results are then used to adjust the DSV Log.

2. Electromagnetic Log Calibration

If the ship has not had an earlier opportunity to calibrate the Electromagnetic Log (EM-Log), the calibration may be accomplished at the FORACS range. The at-sea runs on the test range consist of several constant heading and constant speed runs across the range. Runs are made at 4-knot (or as otherwise designated) increments. Adjustments are made as necessary and additional runs are made to verify the calibrations.

b. SAT Runs

During testing on the test range, the ship maneuvers in accordance with the test plan while range, bearing and heading data are collected simultaneously on the tested sensors.

SAT generally consists of two runs with the target to starboard, and two runs with the target to port. Additional runs may be required to obtain data where the original runs did not provide adequate data, or were affected by sea direction and condition, or by sound propagation conditions for sonar.

c. Debriefings

The Test Director conducts debriefings of SAT results as analyzed by IDATS for cognizant shipboard personnel immediately after completion of on-range testing.

9.6.5 FORACS Range Description

Each FORACS range generally consists of tracking systems, electromagnetic and acoustic targets fixed at known locations, and on-shore buildings to house range control functions and a GPS base station. Targets are fixed at known locations.

a. Tracking

Differential Global Positioning System (DGPS), which provides more accurate tracking than regular GPS, is the primary means of determining ship's surface position on all FORACS ranges.

An underwater acoustic tracking range or three-dimensional (3-D) range is also available to provide accurate tracking of submerged submarines, targets and weapons. 3-D ranges consist of underwater hydrophones and shore-based signal processing hardware that track the on-range ship acoustically.

FORACS ranges have optical position and heading instrumentation consisting of three digital theodolite stations ashore and one on the deck of the on-range ship. If theodolite tracking is employed, the bearings are automatically transmitted by RF link to the IDATS aboard the ship. Optical position tracking is a backup capability to either DGPS or acoustic tracking systems.

b. Electromagnetic Targets

Radar transponders provide targets for active testing of pulse modulated search and fire control radar with frequencies of 2 through 18 GHz.

A computer controlled transmitter system generates signals from 2-2000 MHz to provide targets for testing Radio Direction Finding (RDF) Systems.

Signal sources covering the frequency range of 1 -18 GHz provide targets for Electronic Support Measures (ESM) receivers.

Radar reflector targets, mounted atop extended masts attached to submerged tethered buoys with a watch circle less than one yard or on poles embedded on the sea floor, provide passive radar targets.

c. Acoustic Targets

The acoustic targets consist of shorebased electronics and typically two transducer arrays. Each array consists of three transducers mounted on a tripod set on the ocean floor. Signals generated include broadband noise and tonals throughout the frequency range of 160 Hz to 14 kHz. A transponder capability is provided between 3 kHz and 30 kHz.

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10.0 WEAPON SYSTEM ACCURACY TRIALS

10.1 PURPOSE

Weapon System Accuracy Trials (WSAT) demonstrates the ability of the installed Anti-Submarine Warfare (ASW) combat system to meet prescribed standards of system and subsystem performance. WSAT is the final test in the ASW combat systems certification process and its results are used by the Naval Sea Systems Command, Surface Ship Directorate (SEA 91) for certifying to the Type Commander and the ship's Commanding Officer that the material condition of the ASW combat system is operationally ready.

10.2 SOURCE OF REQUIREMENT

NAVSEAINST 3360.1 series, “Anti-Submarine Warfare (ASW) Systems Test Program”, assigns responsibility for implementation and conduct of the ASW test program. Ship Program Managers for recent ASW capable surface combatant ships have conducted WSAT during the process of achieving ASW combat system certification.

10.3 GENERAL DESCRIPTION

WSAT is a standardized NAVSEA test program conducted on ASW capable surface ships as part of the new construction or overhaul process. WSAT consists of a series of increasingly comprehensive test phases which culminate in exercise weapon firings on a three-dimensional (3-D) tracking range, where the dynamic performance accuracy of the entire system is evaluated. Depending upon the ship type, class, and the installed ASW suite, six to ten days are required to complete testing.

10.4 ORGANIZATIONS INVOLVED

Naval Sea Systems Command, Test & Evaluation Office (SEA 91T) is the WSAT program manager.

Naval Undersea Warfare Center (NUWC) Division Newport, ASW Shipboard Test Team (Code 7015), is the Technical Direction Agent (TDA) and Test Conduct Activity (TCA) for East Coast WSATs. NUWC Detachment Hawaii, Fleet Operational Support Department (Code 90) is the TCA for West Coast and Mid-Pacific WSATs.

10.5 SCHEDULE

WSAT is normally conducted after ship delivery and before PSA. Whenever possible, WSAT is combined with other events (e.g., CSSQT). Actual trial dates are scheduled by the appropriate Type Commander in conjunction with the WSAT TCA and representatives of the test range where the trial will be conducted.

The following schedule requirements apply to the conduct of WSAT:

- Preparation and promulgation of WSAT test plan - approximately 60 days prior to conduct

- Ship's force requisition Mk 46 Recoverable Exercise Torpedoes, also known as Settable Dummy Torpedoes, (normally 4) approximately 60 days prior to conduct

- Initial pre-WSAT shipboard briefing - approximately 30 days prior to the trial

- WSAT

  - Dockside preparations and system alignment/verification tests (Phase I) and Mk 46 Settable Dummy Torpedo firings (Phase II) - three to five days

  - Transit from dockside to range test site - one day or less

  - Underway Sensor Accuracy Tests (SAT) on FORACS range (Phase III) - one to two days

  - Weapon firing exercises, instrumented test range (Phase IV) - one to two days

- WSAT message report - within 5 days upon completion of WSAT

- WSAT final report - within 30 days of completion of WSAT

Actual length of each time period will be dependent upon the complexity of the ship's system and the extent of required tests.

10.6 DETAILED DESCRIPTION

WSAT is performed by a combination of ship's force and a WSAT TCA test team. Assistance and guidance are provided to ship's force by the test team, where needed, to complete all required system testing.

Additional discussion of WSAT is included in TW000-AC-MAN-010/ WSAT "Weapon System Accuracy Trials (WSAT) Program Manual" and NAVSEA OD 40087, "ASW Weapon System Accuracy Trials Program for Surface Ships".

WSAT ranges are located at: Andros Island, Bahamas; San Clemente Island, California; and Nanakuli, Oahu, Hawaii.

10.6.1 Phase I - Dockside Preparations and System Alignment/Verification Tests

Phase I is conducted dockside and begins with a shipboard arrival conference, during which details of the trials and test event schedules are confirmed with both key shipboard and support activity personnel.

During Phase I, the operability, alignment, computational accuracy of, and interfaces between, all of the component systems and subsystems of the ASW combat suite are tested.

If not already on board, exercise torpedoes are loaded aboard for use during Phases II and IV.

10.6.2 Phase II - Settable Dummy Torpedo Firings

Phase II is conducted dockside or underway in the harbor area and demonstrates the fire control-torpedo tube-weapon interface by presetting and launching a MK 46 Settable Dummy Torpedo from each torpedo tube. Each dummy torpedo is inspected for the occurrence of launch damage. Post-fire readbacks of the MK 46 Settable Dummy Torpedoes are made to verify the accuracy of transmissions of fire control settings.

10.6.3 Phase III - Underway Sensor Accuracy Tests

Phase III Sensor Accuracy Tests (SAT) are conducted underway on a two dimensional (2-D) (satellite or optical tracking) or 3-D (underwater acoustic tracking) range. SAT is discussed elsewhere in this manual.

10.6.4 Phase IV - Weapon Exercises

Exercise weapons are fired on a 3-D range in accordance with the test plan. The firing ship, exercise weapons, and target are all instrumented for 3-D tracking. The tracking range data together with shipboard and environmental data are the basis for a detailed computer- assisted analysis to determine ASW combat system dynamic accuracy.

10.6.5 ASW Combat System Certification

SEA 91 certifies by letter that the material condition of the ship’s ASW Combat System is operationally ready to the Type Commander and the Ship's Commanding Officer. This is done after satisfactory completion of all ASW combat system certification requirements.

11.0 AIRCRAFT COMPATIBILITY TESTS

11.1 PURPOSE

Naval Air Systems Command (NAVAIR) issues flight clearances for aircraft operations on surface ships based upon successful completion of aircraft compatibility tests. The appropriate Fleet Commander-in-Chief (CINC) authorizes the conduct of air operations based on flight clearances.

11.2 SOURCE OF REQUIREMENT

a. OPNAVINST 3120.28 series, “Certification of the Aviation Capability of Ship Operating Aircraft”, requires that aviation facilities be certified and that safe aircraft operating envelopes be established on aviation capable ships.

b. NAVAIRINST 3120.1 series, “Lead Systems Command Procedures and Responsibilities for Certification of Aviation Facilities and Equipment in Naval Ships Operating Aircraft”, requires the certification of shipboard aviation facilities and the conduct of flight tests to define the ship/aircraft dynamic interface envelopes including launch and recovery envelopes.

11.3 GENERAL DESCRIPTION

Aircraft compatibility tests are conducted on aviation capable surface ships utilizing each type of aircraft that will use the ship for flight operations. The tests to be conducted on installed systems include:

- Aircraft Dynamic Interface Tests
- Visual Landing Aids Tests
- Approach and Landing Equipment Tests
- Launch and Recovery Tests
- Approach and Landing Systems Tests

Suitability of ship's aviation facilities for aircraft operations is also evaluated.

There are three distinct types of aviation capable surface ships:

- Aviation (CV/CVN)
- Amphibious Aviation (LPD/LPH/LHA/LHD)
- Air Capable (all other ships from which aircraft can takeoff, land, or routinely receive or transfer personnel/materiel)

The aircraft that are supported on aviation capable ships include:

- Fixed wing
- Rotary wing (helicopters)
- Vertical/Short Take-off and Landing (V/STOL)
- Unmanned Aerial Vehicles (UAV)
- Vertical Take-off Unmanned Aerial Vehicles (VTUAV)

11.4 ORGANIZATIONS INVOLVED

Naval Air Systems Command (NAVAIRSYSCOM), Aircraft Launch and Recovery Equipment (ALRE) Program Office (PMA 251), provides liaison, planning, and coordination for aircraft compatibility testing.

11.5 SCHEDULE

Aircraft compatibility tests should be accomplished prior to evolutions that require flight operations. Detailed planning should begin at least 270 days before the at-sea period.

Test personnel will conduct a pre-sail briefing with ship's personnel to discuss testing requirements prior to the ship getting underway for the tests.

At-sea testing requires 10 - 14 days or more, depending of the types of aircraft that will operate with the ship. Adverse weather and sea-state conditions could cause either an extension of the period or a termination of the testing.

Post-test reporting is tailored to individual customer requirements, but typically includes a message report of the test results, a preliminary report within one month after testing, and a final report of test results within six months after testing.

11.6 DETAILED DESCRIPTION

11.6.1 General

Aircraft compatibility testing consists of dynamic interface, visual landing aids, launch and recovery, and approach and landing systems tests, as discussed below.

Prior to conduct of aircraft compatibility testing, the ship must have a current shipboard aviation facilities certification, which has normally been achieved prior to delivery. See NAVSEA S9040-AA-GTP-010/SSCR, “Shipboard systems Certification Requirements for Surface Ship Industrial Periods (non-nuclear) Manual, available on the web at: www.navsea.navy.mil/navysea-te/library.htm, for more information.

The ship's aviation facilities must be configured in the same manner as that intended for operational use. Any changes in the configuration, such as relocation of visual landing aids or lighting, would require re-certification.

During aircraft compatibility testing, other aircraft handling operations aboard the ship are also analyzed. These include fire fighting and rescue procedure, lighting control for night operations, Vertical Replenishment (VERTREP) operations, Helicopter In-Flight Refueling (HIFR), and additional operations as applicable to the ship's aviation facilities. Recommendations for improving the safety of aircraft operations are made by the test team.

11.6.2 Aircraft Dynamic Interface Tests

Aircraft Dynamic Interface (DI) tests are required on the first ship of a class and whenever changes are made to subsequent follow ships that affect the ship’s flight deck characteristics. Separate tests must be conducted for each type of aircraft that will use the ship for flight operations.

DI tests determine safe limits for launching and recovery of aircraft, also known as operational envelopes. These limits are affected by wind-over-deck and ship motion conditions on a given ship class. With these safe limits determined, the ship's Commanding Officer (CO) will have the greatest flexibility in course and speed selection during aircraft launch and recovery operations. Without these envelopes, the ship would be severely restricted while operating with aircraft.

DI tests are of particular importance to both rotary wing and V/STOL aircraft that have the ability to hover and are most affected by air turbulence caused by air wake effects of superstructure. Air turbulence also affects fixed wing aircraft during landing approaches and recovery.

DI testing includes day and night aircraft flight operations, and deck-handling operations each of which are repeated many times under varying wind-over-deck and ship motion conditions.

The DI test periods must be dedicated to flight operations because of the need for the ship to maneuver periodically for desired relative wind direction and velocity and to obtain desired ship motion. Ideally, fairly calm conditions are desired on the first day with increasingly severe conditions for subsequent days.

Flight test periods consist of repeated launch and recovery operations with periodic adjustments of the ship's course and speed to obtain the various wind-over-deck and ship motion conditions. Each operation is given a rating of slight, moderate, maximum, or unsatisfactory with respect to aircraft flying qualities and performance, visual cues, and pilot workload required to perform the operation, based on the capabilities of average fleet pilots.

Ship data recorded for each evolution includes relative wind velocity and direction, maximum roll and pitch, temperature, landing aids status, line-up lines used, and other pertinent conditions. Envelopes are generally derived for the following flight operations:

- Day launch and recovery
- Night launch and recovery (with or without night vision device usage)
- Aircraft degraded flight control system recoveries

The resultant envelopes are polar plot presentations of wind-over-deck direction and maximum velocity (in knots) for safe aircraft operation under the stated conditions.

Aircraft on-deck operations may also be evaluated for wind/ship motion limits. These operations may include:

- Manual deck handling
- Rotor engage/disengage (helicopter only)
- Rotor blade spread/fold (helicopter only)

11.6.3 Visual Landing Aids

Visual Landing Aids (VLA) include deck and island lighting, flight deck markings, optical landing systems (discussed elsewhere in this chapter), and any other devices or installations which provide the aircraft pilot with visual cues in the approach phase of

the recovery operation. VLA will be tested for performance, operational suitability and operational effectiveness as well as for compatibility with night vision technology.

116.4 Launch and Recovery

Catapults, jet blast deflectors, arresting gear and traversing gear, as applicable, are tested for structural and functional performance for safe launch and recovery of aircraft. Tests onboard ship using aircraft are conducted to determine the suitability of the launch and recovery equipment under conditions approximating those expected in service use.

11.6.5 Approach and Landing Systems

Optical Landing Systems (OLS) provide displays to aid in fixed wing and rotary wing and V/STOL aircraft recovery operations glide slope, horizontal approach path indicator, hover position indicator.

Electronic Landing Systems (ELS) provide displays showing aircraft position in relationship to the desired glide path and provide the fixed wing or V/STOL aircraft pilot automatic, semi-automatic or manual control of landings.

Precision Approach and Landing System (PALS) is a system used for all-weather recovery of carrier-based aircraft. Testing of PALS covers both the aircraft and ship installed systems in order to verify that they are working together in all modes of operation. A PALS certification clearance is issued for the ship based on successful completion of the tests. PALS certification clearance authorizes the use of designated PALS modes of operation with specified PALS qualified aircraft. Appropriate restrictions such as ceiling and visibility, maximum and minimum wind-over-deck conditions, air turbulence levels, and deck motion limitations, are included in the clearance.

11.6.6 Reports

Post-test reporting is tailored to individual customer requirements, but typically includes a message report of the test results, a preliminary report within one month after testing, and a final report of test results within six months after testing. This final report will include:

- Recommended operating envelopes
- Definition of how the results should be used by Fleet personnel
- Further definition of handling procedures

- Deficiencies found in the aviation facilities and recommendations for their correction
- Recommendations and requirements for further testing

12.0 UNDERWAY REPLENISHMENT SHIP QUALIFICATION TRIALS

12.1 PURPOSE

Underway Replenishment (UNREP) Ship Qualification Trials (SQT) verify the material readiness of the ship and demonstrate the proficiency of the crew to safely conduct UNREP.

12.2 SOURCE OF REQUIREMENT

While NAVSEAINST 9093.1 series, “Ship Qualification Trials for Surface Ships”, only includes UNREP systems as an element of the Combat System Ship Qualification Trial discussed elsewhere in this manual, in the past, Ship Program Managers for carriers, and amphibious and auxiliary ships with extensive UNREP systems have conducted UNREP SQT separate from the CSSQT.

12.3 GENERAL DESCRIPTION

UNREP provides the means by which logistic support, such as fuels, stores, weapons and personnel, are transferred between ships while underway.

UNREP consists of Connected Replenishment (CONREP) rigs between ships alongside and Vertical Replenishment (VERTREP) via helicopters flying between two ships.

CONREP consists of cargo replenishment and fuel replenishment. Both types of replenishment use a constant tensioned wire rope, rigged from the Combat Logistics Force (CLF) UNREP ship to the receiving ship, as the means of suspension for movement of cargo or hoses between the ships. The CONREP rigs authorized for use on each specific ship along with rigging details are identified in each ship's selected record rigging drawing. Details of the concepts, procedures and rigging methods for CONREP are found in Naval Warfare Publication NWP 4-01.4 "Underway Replenishment". Other supporting publications are Allied Tactical Publication ATP-16 which covers procedures employed when conducting operations with ships of NATO nations.

VERTREP procedures are contained in NWP 3-04.1, which covers shipboard helicopter operating procedures.

12.4 ORGANIZATIONS INVOLVED

Naval Sea Systems Command, Deck Systems Group (SEA 05P8), provides policy for the conduct of UNREP SQT.

Naval Surface Warfare Center, Port Hueneme Division (NSWC PHD), conducts the UNREP SQT.

12.5 SCHEDULE

UNREP SQT on combatant ships, with receive capability only, is normally conducted concurrently with Combat System Ship Qualification Trials (CSSQT), discussed elsewhere in this manual.

UNREP SQT on Combat Logistic Force (CLF) ships, such as oilers, stores and ammunition ships, aircraft carriers, and major amphibious ships, which have complicated UNREP systems that include delivery systems, are normally conducted separate from the CSSQT.

An UNREP SQT consists of a Pre-SQT phase, an inport phase, and an at-sea phase. Time requirements for these phases are:

- Pre-SQT phase is approximately five days for delivery capable ships and four days for other surface combatants, several weeks prior to scheduled UNREP SQT conduct
- In-port phase is five days for delivery capable ships and three days for other surface combatants
- At-sea phase is five days for delivery capable ships and two days for surface combatants

12.6 DETAILED DESCRIPTION

12.6.1 Pre-SQT

The pre-SQT objective is to conduct a checkout of all UNREP logistics and equipment to ensure system readiness and equipment operability. During the pre-SQT the Port Hueneme team will assist ship's force in achieving proficiency in the operation and maintenance of UNREP equipment and stations.

12.6.2 In-port UNREP SQT

The in-port SQT objective is to train all UNREP rig teams in safely passing each of the CONREP rigs specified in the ship's selected record rigging drawings. This phase consists of conducting complete CONREP evolutions with an assist ship across a pier or slip. Service of a delivery capable assist ship that is configured to provide maximum use of CONREP rigs and stations, is required.

12.6.3 At-Sea UNREP SQT

The at-sea SQT objective is to confirm ship CONREP capability as designed and to develop rig team proficiency in passing, receiving and operating fuel, stores, weapons, and personnel rigs. All CONREP stations are operated in the various rig configurations of the ship's selected record rigging drawing, passed by all rig teams in at-sea conditions, in a day and night environment. Rendezvous with a delivery capable assist ship, that is configured to provide maximum use of CONREP rigs and stations, is required. VERTREP operations will be conducted. Night UNREP procedures will be conducted.

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13.0 RADAR CROSS SECTION TESTS AND INFRARED AND VISUAL TRIALS

13.1 PURPOSE

Radar Cross Section (RCS) tests and Infrared and Visual (IR/VIS) trials are conducted to assess the effectiveness of those ship signature control features designed into and installed on the ship that reduce detection, targeting, and classification of the ship by radar systems, passive infrared sensors, electro-optical devices or the human eye.

13.2 SOURCE OF REQUIREMENT

OPNAVINST 9070.2 series, “Signature Control Policy for Ships and Craft of the U.S. Navy”, establishes policy for the design and installation of ship signature control features on new construction ships. While there is no specific requirement in this instruction for RCS tests and IR/VIS trials, such tests have in the past been conducted in order to demonstrate that specified ship signature levels have been attained and to fully characterize the ship’s RCS and IR/VIS signatures to the Type Commander.

13.3 GENERAL DESCRIPTION

RCS tests are conducted while underway on each new construction combatant ship and whenever significant topside changes have occurred.

IR/VIS trials are conducted while underway on the lead ship of the class. IR trials are also conducted, when new significant infrared signature sources are installed, in order to define the emitted (ship-generated) and reflected (externally-generated) infrared characteristics of the ship which can be detected by passive infrared sensors

13.3.1 Radar Cross Section (RCS) Testing

RCS testing uses an approved mobile measurement system housed in a van which may be moved to various East or West coast facilities. RCS testing consists of two separate events:

- Radar signature testing provides quantifiable levels of the RCS signature and diagnostic information that can be used to identify the scattering areas that contribute to the ship’s overall signature

- Radar detection testing provides detection ranges of the ship for various threat sensors or seekers

Radar Cross Section (RCS) tests are conducted to:

- Define the RCS characteristics of the ship
- Define and identify the sources that may degrade the operational capability of the ship
- Provide the RCS data necessary to evaluate Electronic Warfare (EW) tactics
- Determine counter-detectability of the ship by various threat sensors
- Determine effects of systems and equipment on ship's RCS characteristics and form the basis for the correction of any deficiencies that occur therefrom
- Provide technical background necessary to initiate development of design improvements to reduce RCS

13.3.2 Infrared and Visual (IR/VIS) Trials

IR/VIS trials may be conducted on either the East or West coasts. The choice of airborne, shipborne or land based measurement system used to conduct IR/VIS trials is based on the required look down angles, ranges, and environmental surroundings appropriate for the ship being tested.

IR/VIS trials are conducted to:

- Define the emitted (ship-generated) and reflected (externally-generated) infrared characteristics of the ship which can be exploited by passive infrared sensors
- Identify and define the sources of infrared energy (hot spots) that govern the operational capability of the ship
- Establish the optimum low visibility system and equipment operating conditions (machinery bills) for various ship operating modes
- Determine effects of systems and equipment on ship's infrared characteristics and form the basis for the correction of any infrared signature deficiencies

- Provide the infrared and visual data necessary to evaluate and aid in tactical decisions to reduce vulnerability to threats

- Define characteristics of the ship by which electro-optical devices or the human eye can detect the ship

- Provide technical background and data necessary to initiate and continue development of design improvements and analytical models to reduce infrared and visual signatures, including the ship's wake

13.4 ORGANIZATIONS INVOLVED

Naval Sea Systems Command, Ship Signatures Group, Non-Acoustic Signatures Division (SEA 05T1) is the lead planning activity for RCS testing and IR/VIS trials.

13.5 SCHEDULE

Approximately one year prior to completion of Post Shakedown Availability, SEA 05T1 will begin planning for RCS tests and IR/VIS trials.

The RCS test or Infrared and Visual Trials may commence after completion of topside work and installation of signature control features and equipment.

The length of testing will vary with ship complexity and the requirements for testing. The dockside availability prior to tests is used to install instrumentation, confirm ship configuration, perform a topside inspection, and to inspect machinery and air system vents.

RCS tests and IR/VIS trials are each separate events that require different shipboard instrumentation and different operating areas. A typical RCS test or IR/VIS trial schedule is as follows:

Briefing of ship's force	Approximately one month prior to tests
Dockside availability	1-2 days (no more than two weeks before the trial)

Underway test or trials	1-3 days
Dockside, offload instruments	1 day
Preliminary report	30 days after trial
Final report	3 months after trial

13.6 DETAILED DESCRIPTION

A detailed description, available to authorized recipients, may be obtained from SEA 05T1 upon request.

14.0 FINAL CONTRACT TRIALS

14.1 PURPOSE

The objective of Final Contract Trials (FCT) is to determine if equipment and systems have operated satisfactorily or if there is any defect, failure, or deterioration, other than that due to normal wear and tear during the guarantee period of ships that have been constructed, converted or modernized. FCT is conducted by a Trial Board that is assigned by the President, Board of Inspection and Survey (PRESINSURV).

Material deficiencies that are noted by the Trial Board, both shipbuilder responsible and government responsible, will be used to formulate part of the work package for the Post-Shakedown Availability (PSA).

14.2 SOURCE OF REQUIREMENT

OPNAVINST 4700.8 series, “Trials, Acceptance, Commissioning, Fitting Out, Shakedown and Post-Shakedown Availability”, requires the conduct of FCT.

14.3 GENERAL DESCRIPTION

FCT is a trial and material inspection conducted in-port and underway.

The FCT will be conducted in accordance with the trial schedule, however, additional tests and demonstrations may be conducted as requested by the Trial Board.

During the pre-underway dockside phase of FCT, safety related tests and demonstrations will be conducted.

During the underway phase of FCT, the ship’s force will exercise and demonstrate all ship systems, including full power run and weapon system demonstrations.

During the post-underway dockside phase of FCT, an open and inspect examination will be conducted of hull, machinery and equipment as designated by the Trial Board.

14.4 ORGANIZATIONS INVOLVED

The Trial Board is composed of a Senior Member, Inspectors and technical assistants.

The Type Commander will act as or designate an officer to be the Presenting Authority. On past ships the designated officer has normally been the ship's Commanding Officer.

Representatives from the Ship Program Manager (SPM) and the shipbuilder may observe the FCT.

14.5 SCHEDULE

FCT is conducted toward the conclusion of, but within, the guarantee period. The end of the guarantee period is set forth in the shipbuilding contract, but in the past has typically been six months.

The Presenting Authority should begin liaison with the INSURV Recorder approximately 10 months in advance of FCT to address any questions regarding any aspect of the trial.

The Trial Board will task an activity to develop a combat systems demonstration test package that will be delivered approximately six weeks in advance of FCT.

The Presenting Authority will propose dates for the conduct of FCT to the President, Board of Inspection and Survey and Commander, Naval Sea Systems Command (COMNAVSEASYSCOM) at least 60 days in advance.

The Presenting Authority will provide a proposed schedule for the conduct of FCT, including the combat systems events, to the Trial Board at least 30 days in advance. Where possible, the underway phase of FCT should be scheduled to last one day, but large combatants and auxiliary ships may require a longer at-sea period. The FCT is concluded with two to three days of post-underway dockside inspections.

Prior to the scheduled FCT, a period of approximately two weeks is generally allowed for the preparation of the ship for FCT.

The Presenting Authority will certify to the Trial Board that the ship is ready for trial and inspections.

14.6 DETAILED DESCRIPTION

INSURVINST 4730.1 series, “Trials and Inspections of Surface Ships”, provides guidance and information in preparing a ship for presentation to the Trial Board.

Naval Ships Technical Manual, NAVSEA S9086-C4-STM-000, Chapter 094, "Trials", discusses FCT requirements and responsibilities.

The trial schedule will include demonstrations of all propulsion, hull, electrical, auxiliary, and combat systems equipment. Mutually compatible demonstrations may be scheduled simultaneously. The Trial Board will request additional tests and demonstrations when unsatisfactory or marginal performance is observed. The Trial Board may request that ship’s guns be fired.

As soon as practicable after the underway portion of the FCT, the Trial Board will conduct an open and inspect examination of machinery and equipment that the Trial Board designates.

On the final day of FCT, the Trial Board will present a critique, summarizing those deficiencies which seriously affect the ship’s capability to perform its mission or significantly affect the welfare of the crew. All deficiencies identified will be included in the trial report.

A trial card conference will be held by SPM and shipbuilder representatives to assign either shipbuilder or government responsibility for the correction of each identified deficiency.

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15.0 DEPERMING AND DEGAUSSING

15.1 PURPOSE

In order to minimize a ship's susceptibility to magnetic influence weapons, the magnetic field of a ship needs to be controlled. This is accomplished by deperming the ship and then calibrating the ship's degaussing system.

The purpose of deperming is to alter the characteristics of the ship's permanent magnetic field to desired conditions. An additional purpose of deperming is to characterize the permanent magnetization of all ships in the same class into a standard condition where the permanent magnetization of each ship is approximately the same.

The purpose of a shipboard degaussing system is to actively minimize the ship's magnetic signature (both permanent and induced components) as it moves in the earth's magnetic field. This system needs to be calibrated in order for it to effectively minimize the ship's magnetic signature.

The magnetic field of the ship is measured, also known as ranging, at the degaussing range.

15.2 SOURCE OF REQUIREMENT

a. OPNAVINST 9070.2 series, "Signature Control Policy for Ships and Craft of the U.S. Navy", establishes policy for the design and installation of ship signature controls on new construction ships.

b. OPNAVINST 4700.8 series, Trials, Acceptance, Commissioning, Fitting Out, Shakedown, and Post Shakedown Availability", requires that degaussing and deperming be accomplished prior to commencement of the Post-Shakedown Availability (PSA).

c. OPNAVINST C8950.2 series, Magnetic Silencing (U)", requires deperming and degaussing, and sets the maximum allowable magnetic signature for various sizes and types of ships.

15.3 GENERAL DESCRIPTION

15.3.1 Deperming

The permanent magnetization of a ship can be changed by a process called deperming. The ship is rigged and wrapped with large electrical deperming cables, which create coils around the ship. By control of electrical current applied to these coils, the characteristics of the permanent magnetization of the ship is altered to a desired condition.

15.3.2 Degaussing

The shipboard degaussing system creates a magnetic field approximately the same as the ship's magnetic field but opposite in sense so that the resultant field is greatly reduced. The calibration of the shipboard degaussing system is accomplished by applying a series of known currents to the ship’s degaussing coils and measuring the resultant magnetic field. The resulting data necessary to operate the degaussing system effectively is compiled and provided to the ship in a Degaussing Folder.

The shipboard degaussing system consists of the following permanently installed equipment:

- The degaussing coils
- A power source to supply direct current to the coils
- A control system to control coil currents and thereby change the strength of the magnetic field produced by the coils
- Compensating equipment to prevent magnetic field sensitive equipment, such as magnetic compasses, from not operating correctly

15.3.3 Degaussing Range

A degaussing range consists of an array of magnetometers placed on the sea floor. The ship’s magnetic signature is determined by measuring the magnetic field of the ship as the ship transits the degaussing range.

15.4 ORGANIZATIONS INVOLVED

Naval Sea Systems Command, Magnetic Ship Signatures Division (SEA 05T3) is the Magnetic Signature Technical Authority. Naval Surface Warfare Center, Carderock Division (NSWC CD) Code 85, is the Magnetic Signature Technical Development Agent.

15.5 SCHEDULE

Preliminary scheduling should begin about one year before the planned date of the event. Updates of the schedule should be coordinated with the Magnetic Silencing Facility (MSF) to preclude schedule conflicts.

At least two months prior to the ship's arrival or as requested by the MSF, documentation such as the Booklet of General Plans and the completed Degaussing Installation Information Forms should be forwarded to the deperming facility. For the first ship of a class, the NAVSEA Degaussing System Block Wiring, Isometric Wiring, and Elementary Wiring Diagrams should also be provided to the MSF.

Depending on the size of the ship, deperming and degaussing can be accomplished in three and one-half days to five days. Additional time before these events may be required in order to remove magnetically sensitive material and equipment from the ship and to prepare the deperming facility for ship’s arrival.

15.6 DETAILED DESCRIPTION

The following discussion describes the permanent and induced magnetization characteristics of the ship and the deperming and degaussing process. Additional detail is available in the Naval Ships Technical Manual (NSTM), Chapter 475, "Magnetic Silencing", NAVSEA S9086-QN-STM-000.

15.6.1 Background

The ship contains ferrous material in its hull, machinery, and payload. This material is capable of acting as a magnet. The combined magnetic effects of the ferrous material creates a magnetic field that surrounds the ship. The strength of this magnetic field is greatest near the ship and becomes smaller at increased distances from the ship. The firing mechanisms of magnetic influence mines and torpedoes sense the disturbance in the earth's magnetic field due to the changes caused by the presence of the ship’s magnetic field. In an ideal condition, if the magnetic field of the ship were reduced to zero, the earth's magnetic field would be undisturbed just as if the ship were not there. Even though such an ideal condition cannot be realized, an approximation to the condition decreases the vulnerability and susceptibility of the ship to magnetic influence mines and torpedoes.

The shipboard degaussing system is designed to minimize the ship’s magnetic field. A ship's magnetic field is the result of two components, permanent magnetization and induced magnetization.

15.6.1.1 Permanent Magnetization

Permanent magnetization is that component that is fixed in the ship's ferrous structure. As a ship is being constructed, or when a ship lies in one position for a long

period of time, the ferrous material in the ship becomes permanently magnetized in the presence of the earth's magnetic field. Many factors determine the extent and characteristics of the permanent magnetization. These factors include the characteristics of the earth's magnetic field at the time and place of construction, orientation of the ship with respect to the earth's field during construction, the materials of which the ship is constructed, and the permanent magnetization characteristics of individual parts added to the ship during construction. This means that even ships delivered from the same shipyard may have different permanent magnetic characteristics from each other. Additionally, changes in the characteristics of this component occur during the life of the ship as it interacts with the earth’s magnetic field. Permanent magnetism can also be changed by a process called deperming.

15.6.1.2 Induced Magnetization

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

15.6.2 Magnetic Silencing Facilities

Deperming and degaussing are conducted at Magnetic Silencing Facilities (MSFs).

MSFs are located at the following locations and have the following capabilities:

a. Norfolk, Virginia

Deperming Facility - Single pier for ships up to and including aircraft carriers. The facility is located at Lambert's Point.

Degaussing Range - Three ranges at varying depths for various size ships. The facility is located off the breakwater at Sewell's Point.

b. San Diego, California

Deperming Facility - Single pier for ships to 31-foot draft. The facility is located at Point Loma.

Degaussing Range - Located in the main channel at harbor entrance.

c. Pearl Harbor, Hawaii

Deperming Facility - Single pier for ships to 30-foot draft.

Degaussing Range - Located in the main channel.

d. Mayport, Florida

Deperming Facility - None

Degaussing Range - Located in the main channel to Naval Station.

e. Yokosuka, JA

Deperming Facility – None

Degaussing Range – Located in the main channel to Fleet Activities Yokosuka.

f. Other facilities –

Other degaussing ranges are located at: New London, CT; Kings Bay, GA; and Bangor, WA. These facilities are primarily used by submarines, but can be used by some surface ships when pre-arranged. There is also an MSF in Ingleside, TX specifically designed for minesweepers. Ships smaller than Mine Counter Measures, MCM-1 class with the same draft could use this facility for ranging.

15.6.3 Conduct of Deperming and Degaussing

The following describes, in general, the procedures used for deperming and degaussing the first ship of a class. Procedures will vary with the MSF utilized, size of ship, complexity of degaussing system, and whether the ship is the first ship of a class or a follow-on ship.

15.6.3.1 PREREQUISITES

Since the current applied to these deperming coils can be in the thousands of amperes, a ship must either have full fuel tanks or they must be emptied and cleaned to preclude the accumulation of flammable vapors. This is a safety requirement. Should a cable short to the hull, severe arcing and sparking might result, which could ignite such vapors. Details of this requirement are in NSTM Chapter 475.

The ship will provide fire watches to alert the deperming facility personnel to close down the operation if severe heating, smoke, sparking, or fire occurs in the deperming coil cables.

Just prior to the deperming operation, the ship's force will also assist in removing all magnetic sensitive equipment and items from the ship as required by NSTM Chapter 475.

15.6.3.2 Procedures at Degaussing Range and Deperming Station

a. Preliminary Testing

The ship should complete the degaussing range measurements at least two working days prior to the arrival of the ship at the deperming facility to allow for reduction of the data and final planning.

The ship will make at least six passes through the range, three in each direction. Prior to each pass, the range officer at the degaussing range will contact the ship and provide the desired settings of the currents in the coil loops in the ship’s degaussing system. The ship's responsibilities for accurate ranging include:

- Passing directly over the range at a constant speed and heading
- Setting the currents in the degaussing coils correctly and notifying the range officer of the coil settings
- Notifying the range officer of the ship's draft, forward and aft, to the nearest six inches for depth correction of data

b. Deperming

Deperming facilities schedule the ship for arrival at the facility on Monday mornings to allow contingency time to resolve problems. Deperming and calibration of the degaussing system generally require three and one-half days for small and medium size ships to a minimum of five days for a ship the size of a carrier.

Ship's force is required for three to four days prior to the arrival of the ship to assist in staging the deperming cable on the pier.

Upon arrival at the deperming pier, the ship is positioned over a magnetometer array installed on the sea floor in close proximity to the pier. A series of magnetometer readings are taken. The ship is then turned 180 degrees, and repositioned over the magnetometer array.

Ship's force then rigs and wraps the ship with the required coils of electrical deperming cables. Any remaining magnetic field sensitive equipment is removed from the ship. A second set of magnetometer readings is taken. The complete set of readings determines the ship's pre-deperm signature.

Small electric currents are applied to the deperming coils to simulate earth's field in order to identify induced longitudinal magnetization as opposed to permanent longitudinal magnetization and the effects measured by the magnetometer array.

The ship is then depermed by a series of electric current "Shots" starting at a high value and then decreasing in magnitude. Each shot is in the opposite polarity of the previous shot. The combined schedule of shots results in demagnetizing the ship's permanent longitudinal and athwartship magnetization and placing the permanent vertical magnetization into equilibrium.

Additional magnetometer array readings are again taken of the resultant magnetization signature of the ship. If required, additional "shot schedules" are accomplished. When the permanent magnetization is reduced to the desired level, the deperming coils are removed.

c. Calibration of Degaussing System

The effects of the applied current in the degaussing coils of the degaussing system aboard ship is also calibrated at the deperming pier. With the ship over the magnetometer array, the degaussing coil currents are varied in magnitude and polarity in each coil and the resultant change in the magnetic field for various coil currents is calculated from the magnetometer data. These calibration data are used to produce the necessary current and turn data for the Degaussing Folder (an official ship log) which the Magnetic Silencing Facility (MSF) will prepare for the ship. The Degaussing Folder shows the electric current needed in each coil for all positions on the earth's surface by zones and for all headings by sectors.

In addition, the compass compensating equipment installation for magnetic compasses is calibrated. Because the degaussing coils produce large magnetic fields in order to provide satisfactory degaussing, these magnetic fields may affect the operation of magnetic compasses. The purpose of the compass compensating installation is to set up a magnetic field, which is equal and opposite to the degaussing coil field in the immediate vicinity of the magnetic compass. This procedure does not apply to ships with only a digital flux gate compass.

d. Post-Calibration Testing

After the ship leaves the deperming facility, it will be required to make several passes over the degaussing range to determine if the ship's degaussing installation is operating satisfactorily. If the ship is to remain in the area, the passes through the degaussing range may be made as the opportunity exists during entry to or exit from the harbor area.

Post-calibration testing of the degaussing system, by transiting through the degaussing range, is generally accomplished at times of opportunity during entrance and exit of the harbor area.

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16.0 SHOCK TRIALS

16.1 PURPOSE

Shock Trials are conducted to:

- Validate the ability of the ship to carry out its assigned missions in a combat shock environment
- Identify flaws in shipbuilder workmanship with respect to equipment installation practices, foundations, and support service hookups
- Validate shock criteria and standards specified for the class
- Evaluate shock-hardening features that have been installed and to define any additional shock-hardening modifications that may be required for the class and for other applicable ships
- Provide a basis for refinement of shock hardening criteria for future ships
- Determine failure modes and necessary corrective action for failure of shock-qualified equipment

16.2 SOURCE OF REQUIREMENT

OPNAVINST 9072.2 series, "Shock Hardening of Surface Ships", requires the conduct of ship shock trials.

16.3 GENERAL DESCRIPTION

Shock trials consist of a series of underwater detonation of explosive charges at controlled depths and distances from the ship in order to test the resistance of the hull, machinery, and payload equipment to underwater shock. Sensors and cameras placed throughout the ship record, for later analysis, the effects of the underwater shock.

The lead ship of each shock hardened class will be subjected to shock trials. Follow-on ships will be subjected to shock trials at the discretion of the Chief of Naval Operations (CNO) ship class sponsor when necessary to validate shock-hardening modifications. Service craft and small landing craft normally are not shock tested. However, at the discretion of the CNO ship class sponsor, landing craft may be subjected to shock trials while stowed in the well deck of shock hardened amphibious ships.

No special range facilities are required for shock trials that are conducted in an open ocean site. However, technical, logistic, economic, operational, political and environmental considerations affect the choice of location. These considerations include:

- Water depth (100 fathoms minimum to reduce effects of reflected shock waves)
- Climatology (wave heights, current, wind, visibility conditions)
- Ship logistics support (proximity to ship repair facilities; homeport; airfields for observer, technical personnel, medivac transfer)
- Proximity to charge stowage, handling, towing and dumping facilities
- Areas where swimmers or divers may be cleared to a distance of 20 miles
- Avoidance of commercial shipping lanes and submarine transit lanes
- Avoidance of commercial fishing areas, protected habitats and preserves
- Avoidance of Foreign Economic Exclusion Zones (EEZ)
- Compliance with environmental policy

In the past, the operating areas listed below have met technical requirements, and during certain months of the year may be found suitable from the environmental protection standpoint:

- Key West, FL
- Mayport, FL
- Port Canaveral, FL
- Virginia Capes, VA
- Roosevelt Roads, PR

16.3.1 Environmental Compliance

Because of the possible impact of shock testing on the environment, there are legislative, federal and state regulations and requirements that may effect where and when shock testing is conducted. The National Environmental Policy Act (NEPA), the Marine Mammal Protection Act (MMPA), the Endangered Species Act, the Migratory Bird Treaty Act, and at least six other laws must be considered during shock trial planning. The goal is to ensure that the shock trial will have the least practicable environmental impact on the site where the trial is held.

In general, a two to three year lead time may be required to obtain the necessary permits. The SPM must work closely with several environmental agencies, particularly with National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (USFWL) during the approval process. Environmental Impact Statements or Environmental Assessments, as applicable, on each candidate site must be filed by the Ship Program Manager as part of the permit process. This process will also consider the technical adequacy of the site. Approval to conduct shock trials requires an approved mitigation plan that implements measures such as seasonal constraints, command and control of the test site, and pre-test and post-test site surveys conducted by qualified biologists acting as surface and airborne observers, and a qualified Marine Mammal Recovery Team.

16.4 ORGANIZATIONS INVOLVED

The Ship Program Manager (SPM) is the Shock Trials Director. Naval Sea System Command (NAVSEA), Ship Survivability Division of the Platform Systems Group (SEA 05P3) is the Shock Trials Advisor. Naval Surface Warfare Center Carderock Division/ Underwater Explosions Research Division (NSWC CD/UERD) is the Shock Trials Manager.

An environment protection issues planning group consisting of representatives from the Ship Program Manager, the NAVSEA Environmental Protection Office (SEA 00T), the NAVSEA Office of Counsel (SEA 00L), the Assistant Secretary of the Navy for Installation and Environment (ASN (I&E)), the ASN for Research, Development and Acquisition (ASN (RD&A)), and the Chief of Naval Operations, Environmental Protection Division (OPNAV N45), will undertake informal consultations with the National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS) to begin the environmental compliance process.

16.5 SCHEDULE

Shock trials are preferably performed after the Final Contract Trial (FCT) and prior to the Post-Shakedown Availability (PSA), which are discussed elsewhere in this manual, so that any damage incurred during shock trials can be identified and then repaired during PSA. Additional shock-hardening modifications may also be installed during PSA.

Approximately two to three years prior to the scheduled shock trials, SEA 05P3 will meet with the SPM on the general requirements and major milestones for the shock trials. Environmental protection issues have emerged as the principal schedule driver of shock trials planning.

At least six months prior to the scheduled shock trials, a detailed shock trials plan is provided by the Shock Trials Manager. Meetings will be conducted with Shock Trials Team Managers, Naval Supervising Authority , ship's representatives, and shipbuilder representatives. Details of the shock trials, the ship's role in the trials, the expected effect of the tests on the ship, and other matters of interest will be discussed. Readiness reviews will be conducted as necessary. Training of ship’s crew will be conducted as necessary.

Approximately three to five weeks prior to the shock trials, the Shock Trials Team will begin the instrumentation installation and preparation of the ship for shock trials.

One day is required for each shot. One to two days between shots are required for post-shot inspections, equipment checkouts, and documentation, plus three to four days contingency for bad weather and other adverse conditions and at least two to four days at the conclusion for the final follow-up investigations. A total of 21 days are usually required for a typical 4-shot series.

Two to five days are normally required at the end of the shock trials series to remove instrumentation and other special shock trial installations.

16.6 DETAILED DESCRIPTION

Of the many man-made hostile environments that a ship may be exposed to during its life, underwater shock is one of the more potentially serious threats. Because water is a very efficient transmission medium of sonic energy, conventional high-explosive weapons (e.g., mines, bombs, and torpedoes) can produce underwater shock that, even at a considerable miss distance, may be felt at localized points as the shock wave passes through the ship. Similarly, the shock from a distant underwater nuclear explosion can be transmitted for miles and the resulting shock wave may be felt through the entire ship almost co-instantaneously. Experience from combat operations and testing of operational ships has shown that, while the crew and basic hull possess an inherently high degree of shock resistance, the highly sophisticated and complex system payloads aboard the ship are susceptible to damage because of high shock loading. In order to minimize damage to these system payloads, mitigation through design and installation of shock hardening features is required. The performance of these features are demonstrated during shock trials.

Publication NAVSEA 0908-LP-000-0010, "Test Plan for Routine Shock Testing of Ships (U)," contains detailed information on shock trial procedures.

During construction, ship inspections are conducted to identify any potential shock problems that might require correction. Also, it is desirable to plan for and install the initial bulkhead penetrations and cable runs necessary for shock trials during ship construction, particularly in cases where considerable instrumentation will be required.

The shock trials plan identifies participants, shock trial team responsibilities, schedules, operation areas, ship status during shock trials, combat systems scenarios, and reporting procedures. The shock trials plan will also identify required logistic support such as explosives, tugs, barges, service craft, helicopters, Underwater Demolition Team (UDT) services, additional ships to provide area clearance, and other services as may be required.

During conduct of shock trials, the Officer in Tactical Command (OTC), normally the tested ship's Commanding Officer, has overall cognizance of all at-sea shock trials operations. A Shock Trials Team, comprised of NSWC CD/UERD personnel, provides technical direction and instrumentation for the shock trials and documents the results of each shot. The SPM as the Shock Trials Director manages the Shock Trials Team, with assistance from a senior technical representative from SEA 05P3, and assists the OTC in an advisory capacity for all matters concerning the shock trials. The shipbuilder and the cognizant Naval Supervising Authority (NSA) may have representatives aboard the ship during the shock trials because shock trials normally occur within the guarantee period.

16.6.1 Shock Factor

Shock trials requires a series of detonations, or "shots", (typically three or four), in a progression of increasing intensity, or shock factor.

The shock factor is the relative measure of the shock intensity delivered to a ship by an underwater explosion. The shock factor is a function of the type and size of the explosive charge, the depth and distance from the ship, and the orientation relative to the ship. In order to obtain the desired shock factor during shock trials, specially designed explosive charges are used. Additionally, the depth of the explosive charge and the distance from the ship are closely controlled by use of a pontoon from which the explosive charge is suspended at the desired depth and the distance of the pontoon from the ship can be monitored and maintained. More detailed information can be found in NAVSEA 0908-LP-000-0010, "Test Plan for Routine Shock Testing of Ships (U)".

16.6.2 Instrumentation and Special Equipment

Ship-mounted instrumentation may involve from 100 to 1,000 transducers, consisting of wire strain gauges, velocity meters, displacement gages, and accelerometers. These transducers are positioned to obtain shock effect data on:

- Main ship structure such as frame members, strength bulkheads, superstructure, masts, etc.
- Vital, main, and auxiliary equipment and foundations

- Equipment and foundations in engineering and payload electronics spaces
- Weapon systems, including launchers and missile bodies
- New or specialized ship installations that have not previously been subject to tests
- Equipment or structures suspected of low shock tolerance

Shielded wire cables from each transducer are routed through the ship via multiplex stations to self-contained recorder packages. Each recording package will require from 50 to 200 square feet of unencumbered area in a compartment. Recording package instrumentation installed includes portable magnetic tape recorders, signal conditioning amplifiers, time code generators, monitor devices, and associated power supplies. Electric power and lighting to the compartment are required.

Additional space is required aboard ship for the trailers containing centralized data recording and reduction equipment as well as space for electrical generators required for isolated power. The number of trailers will depend on the complexity of the instrumentation required and the space required varies from 8 ft. by 13 ft. to 12 ft. by 40 ft.

High-speed motion picture cameras may be used to record the relative motion of objects in the field of view as a result of the shock. Such views may include:

- Superstructure and masts, and equipment mounted thereon
- Launchers and missiles
- Stowed craft and vehicles
- Specific equipment installations
- Other areas of interest

Communication equipment required includes hand-held portable transceivers for communication aboard the ship and a UHF radio link for communication with support craft.

A winch for the explosive’s special firing cable may be installed on the test ship. This winch requires a 6 ft. by 7 ft. space and 440 volts, 3 phase, 60 Hz, 50 amps power.

16.6.3 Shock Trials Procedures, Damage Assessment, and Data Collection

Data collected during the shock trials includes narrative descriptions of the condition of the ship and payload, narrative descriptions of the effects of the shock on the ship, and recorded instrumentation data.

Each shot is conducted in the following sequence:

a. Preshot Condition

A survey is conducted and the pre-test condition of the ship is documented. Any condition that might be mistaken for shock damage is identified. All potential personnel hazards are identified and corrected. Sea and meteorological conditions are recorded.

A Preshot Condition Report is prepared for each department prior to each shot. Reports submitted for Shot 2 and succeeding shots are usually expressed as modifications to the Shot 1 report.

The explosive charge is prepared and rigged in the proper position on the pontoon and armed for firing.

b. Explosive Charge Detonation

When the charge is positioned, the final countdown begins with personnel aboard ship at general quarters. Tape recorders, motion picture cameras, and other recording instruments are started. The OTC authorizes the detonation of the explosive charge. Immediately after the shot and for a predetermined period after the shot (approx. 15-min) the ship "fights" through the shock and operates all combat equipment. Where equipment drops off line, ship's force attempts to bring systems back on line through standard shipboard procedures.

c. Initial Post-Test Inspection

During the "fight the ship" period, the ship’s damage control party conducts an initial inspection and takes immediate corrective action, if required, to restore the ship to a safe operable condition.

d. Casualty Reporting

Detailed documentation of the damage begins after completion of the initial Post-Test Inspection by the damage control party and the "fight the ship" period. The Shock Trials Team and ship's force conducts a thorough inspection. Systems are checked and tested for proper operation. The following is documented in a casualty report:

- Physical damage or leakage, even if minor in effect

- Items adrift due to shock, even if no damage occurs
- Shock induced malfunctions, even if no physical damage occurs, such as tripping of circuit breakers, temporary loss of calibration
- Degradation of system capabilities
- Safety hazards caused by shock

Photographic documentation of damage is made.

e. Follow-Up Investigation

Shock Trial Team Manager will assign members of his inspection team to perform follow-up investigations of the damage. A shock test damage summary report for the test is prepared from the compilation of the individual casulty reports.

f. Situation Reports

After each shock trials shot, a situation report (SITREP) is prepared by the Shock Trials Manager and Director in conjunction with senior SEA 05P3 representative and the Commanding Officer and forwarded to the Commander, Naval Sea Systems Command with information copies to cognizant commands and the Shipbuilder. The SITREP summarizes the condition and status of the ship and other information pertinent to the test and subsequent tests.

Samples of the Casualty Report, Shock Test Damage Report Summary, and the SITREP are included in NAVSEA 0908-LP-000- 0010, "Test Plan for Routine Shock Testing of Ships (U)".

g. Final Report

A final report is prepared describing the conditions and results of the shock trials, and providing an evaluation of the damage and the preliminary recommendations for corrective action. The Shock Trials Test Team personnel support the preparation of the final report.

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APPENDIX A

ACRONYMS

2-D	Two Dimensional
3-D	Three Dimensional
AAW	Anti-Air Warfare
ACDS	Advanced Combat Direction System
AIC	Aircraft Intercept Controller
ALRE	Aircraft Launch and Recovery Equipment (ALRE)
ANSI	American National Standards Institute
APL	Allowance Parts List
ARP	Antenna Radiation Pattern
ASN (RDA)	Assistant Secretary of the Navy, Research Development & Acquisition
ASROC	Anti-Submarine Rocket
ASUW	Anti-Surface Warfare
ASW	Anti-Submarine Warfare
AT	Acceptance Trials
ATG	Afloat Training Group
ATP	Allied Tactical Publication
AUTEC	Atlantic Undersea Test & Evaluation Center
BTV	Blast Test Vehicle
C4I	Command, Control, Communication, Computer & Intelligence
CART	Command Assessment for Readiness and Training
CASREP	Casualty Report
CDS	Combat Direction System
CFE	Contractor Furnished Equipment
CFM	Contractor Furnished Material
CIC	Combat Information Center
CINC	Commander In Chief
CLF	Combat Logistic Force
CNO	Chief of Naval Operations
CO	Commanding Officer
COMNAVSEA	Commander, Naval Sea Systems Command
COMSOT	Communications System Operability Test
CONREP	Connected Replenishment
CP	Controllable Pitch
CPA	Closest Point of Approach
CSA	Combat System Assessment
CSAM	Combat System Alignment Manual
CSOSS	Combat System Operational Sequencing System
CSQT	Combined Ship Qualification Trials
CSRR	Combat System Readiness Review
CSSQT	Combat System Ship Qualification Trials
CSTOM	Combat System Technical Operations Manual

Acronyms - Continued:

dB	Decibel
DF	Direction Finding
DGPS	Differential Global Positioning System
DOD	Department of Defense
DSV	Doppler Sound Velocity
DT	Developmental Test
DTE	Detect To Engage
DT&E	Developmental Test & Evaluation
E^3	Electromagnetic Environmental Effects
ECM	Electronic Countermeasures
ECP	Engineering Change Proposal
EED	Electro-Explosive Device
EEZ	Economic Exclusion Zone
ELS	Electronic Landing System
EM	Electromagnetic
EMC	Electromagnetic Compatibility
EMCON	Emissions Control
EME	Electromagnetic Environment
EMF	Electromagnetic Field
EMI	Electromagnetic Interference
EMR	Electromagnetic Radiation
ENGQUAL	Engineering Qualification
EQT	Engineering Qualification Team
ESM	Electronic Support Measures
EW	Electronic Warfare
FAA	Federal Aviation Administration
FACSFAC	Fleet Area Control & Surveillance Facility
FAST	Floating At-Sea Target
FCT	Final Contract Trials
FCTC	Fleet Combat Training Center
FM	Frequency Modulated
FORACS	Fleet Operation Readiness Accuracy Check Sites
FOT&E	Follow-on Operational Test & Evaluation
FXP	Fleet Exercise Publication
GFCS	Gun Fire Control System
GFE	Government Furnished Equipment
GFM	Government Furnished Material
GHz	Giga-Hertz
GMI	Guarantee Material Inspection
GPETE	General Purpose Electronics Test Equipment
GPS	Global Positioning System
HARM	High speed Anti Radiation Missile
HBX	Designation for Desensitized torpedo explosive
HDI	Helicopter Dynamic Interface
HERF	Hazards of Electromagnetic Radiation to Fuel
HERO	Hazards of Electromagnetic Radiation to Ordnance

Acronyms - Continued:

HERP	Hazards of Electromagnetic Radiation to Personnel
HIFR	Helicopter In-Flight Refueling
HSMST	High Speed Mobile Ship Target
ICSE	Integrated Combat System Exercise
IEEE	Institute of Electric and Electronic Engineers
IFF	Identification Friend or Foe
ILO	Integrated Logistics Overhaul
IMAV	Intermediate Maintenance Availability
IMI	Intermodulation Interference
INS	Inertial Navigation System
INSURV	Board of Inspection and Survey
IPT	In-Port
IR	Infrared
ISAR	Inverse Synthetic Aperture Radar
ISE	Independent Steaming Exercise
ISEA	In-Service Engineering Agent
ISIC	Immediate Superior In Command
ISTT	Improved Surface Tow Target
KHz	Kilo-Hertz
LAMPS	Light Airborne Multi-Purpose System
LINK	either ship to ship or ship to air data channel
LOA	Light Off Assessment
LOGREP	Logistics Representative
LOGSAT	Logistics Special Assistance Team
LOS	Line of Sight
MCM	Mine Counter Measure
MHz	Mega-Hertz
MILSTRIP	Military Standard Requisitioning & Issue Procedure
MMPA	Marine Mammal Protection Act
MMS	Motion Measurement System
MRC	Maintenance Requirement Card
MSF	Magnetic Silencing Facility
NATO	North Atlantic Treaty Organization
NATOPS	Naval Air Training and Operation Procedures Standardization
NAVAIR	Naval Air Systems Command
NAVSEA	Naval Sea Systems Command
NAVOSH	Navy Occupational Safety and Health
NAWCAD	Naval Air Warfare Center Aircraft Division
NAWC WD	Naval Air Warfare Center Weapons Division
NEPA	National Environmental Policy Act
NFA	NATO FORACS AUTEC
NFG	NATO FORACS Greece
NFN	NATO FORACS Norway
NGFS	Naval Gun Fire Support
NMFS	National Marine Fisheries Service
NOSSA	Naval Ordnance Safety and Security Activity

Acronyms - Continued:

NRWATS	Naval Rotary Wing Aircraft Test Squadron
NSA	Naval Supervising Authority
NSFS	Naval Surface Fire Support
NSSMS	NATO Sea Sparrow Missile System
NSTM	Naval Ships Technical Manual
NSWC CD	Naval Surface Warfare Center Carderock Division
NSWC CD/UERD	Naval Surface Warfare Center Carderock Division Underwater Explosions Research Division
NSWC CD-SSES	Naval Surface Warfare Center Carderock Division Ship System Engineering Station
NSWC DD	Naval Surface Warfare Center Dahlgren Division
NSWC PHD	Naval Surface Warfare Center Port Hueneme Division
NULKA	Australian Aboriginal word meaning “to be quick”
NUWC	Naval Undersea Warfare Center
NWAI	Nuclear Weapons Acceptance Inspection
NWP	Naval Warfare Publication
OCSOT	Overall Combat System Operability Test
OLS	Optical Landing Systems
OPAREA	Operational Area
OPNAV	Office of the Chief of Naval Operations
ORDALT	Ordnance Alteration
OSO	On-Site Office
OT	Operational Test
OT&E	Operational Test & Evaluation
OTC	Officer in Tactical Command
OTCIXS	Officer in Tactical Command Information Exchange Subsystem
OWLD	Obligation Work Limiting Date
PALS	Precision Air Landing System
PDT&T	Post-Delivery Tests and Trials
PEL	Permissible Exposure Limit
PEO	Program Executive Office
PMRF	Pacific Missile Range Facility
PMS	Planned Maintenance System; Program Manager Ship
PMTC	Pacific Missile Test Center
PRAIRIE	Propulsor Air Ingestion and Emission
PSA	Post-Shakedown Availability
PUBSAT	Publications Special Assistance Team
PVST	Port Visit
RADHAZ	RFR Hazard
RAM	Rolling Airframe Missile
RAST	Recovery Assist, Secure, Traverse
RAV	Restricted Availability
RBA	Radar Beacon Acquisition
RCS	Radar Cross Section
RDF	Radio Direction Finding
RF	Radio Frequency

Acronyms - Continued:

RFR	Radio Frequency Radiation
RFS	Ready For Sea
RHIB	Rigid Hull Inflatable Boat
RPM	Revolutions Per Minute
SAT	Sensor Accuracy Test
SCIUR	San Clemente Island Underwater Range
SCN	Ship Construction, Navy
SCORE	Southern California Offshore Range
SEMCIP	Shipboard Electromagnetic Compatibility Improvement Program
SEPTAR	Seaborne Powered Target
SESEF	Shipboard Electronic System Evaluation Facility
SHIPALT	Ship Alteration
SITREP	Situation Report
SM	Standard Missile
SMS	Standard Missile System
SPAWAR	Space and Naval Warfare
SPM	Ship Program Manager
SQT	Ship Qualification Trials
SRBOC	Super Rapid Blooming Offboard Chaff
SRF	Ship Repair Facility
SSC SD	Space & Naval Warfare Systems Center San Diego
SSDS	Ship Self-Defense System
SSES	Ship System Engineering Station
SSRNM	Surface Ship Radiation Noise Measurement
STAN	SEMCIP Technical Assistance Network
STEM	Shipboard Test Execution Manual
STF	Structural Test Firing
SWOP	Special Weapons Operating Procedure
TACAN	Tactical Air Navigation
TADIL	Tactical Digital Information Link
TCA	Test Conduct Activity
TDA	Technical Direction Agent
TDS	Tactical Data System
TEMP	Test & Evaluation Master Plan
TIP	Technical Inspection Procedure
TSTA	Tailored Ship’s Training Availability
TYCOM	Type Commander
UAV	Unmanned Aerial Vehicle
UDT	Underwater Demolition Team
UHF	Ultra High Frequency
UMI	Underway Material Inspection
UNREP	Underway Replenishment
URMTT	Universal Radar Moving Target Transponder
US	United States
USFWS	United States Fish and Wildlife Service

Acronyms - Continued:

USNS	United States Naval Ship
USW	Undersea Warfare
UWS	Underwater Weapon System
VDS	Variable Depth Sonar
VERTREP	Vertical Replenishment
VHF	Very High Frequency
VIS	Visual
VLA	Vertical Launch ASROC; Visual Landing Aid
V/STOL	Vertical/Short Take-Off and Landing
VTUAV	Vertical Take-Off Unmanned Aerial Vehicle
WSAT	Weapon System Accuracy Trials
XBT	Expendable Bathythermograph
XCTD	Expendable Conductivity, Temperature & Depth