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OPNAV INSTRUCTION 9072.2A

From: Chief of Naval Operations

Subj: SHOCK HARDENING OF SURFACE SHIPS

Ref: (a) MIL-S-901 (NOTAL)
(b) NAVSEA 0908-LP-000-3010 of September 1995 (NOTAL)
(c) OPNAVINST 9070.1A

Encl: (1) Ship Shock Hardening Criteria
(2) Validation of the Class Integrated Ship System Shock Hardness
(3) Ship Shock Certification Letter Process

1. Purpose. To establish policy and assign responsibility for shock hardening of Navy surface ships to include aircraft carriers referred to, hereafter, as "ships" unless otherwise specifically identified.

2. Cancellation. OPNAVINST 9072.2.

3. Background

a. Loss of capability of Navy ships to perform assigned missions as a result of exposure to underwater explosion shock is a significant risk while operating in a combat environment. Shipboard equipment survivability can be compromised by non-contact underwater explosions, such as influence mines, missiles, torpedoes, near miss anti-ship cruise missiles, improvised explosive devices, underwater nuclear explosions, as well as other extreme loading events. Experience from combat operations and realistic testing of operational ships has shown that shock hardness of primary hull structure and personnel are inherently more robust than ships' equipment. Therefore, shock hardening of Navy ships' systems and subsystems is required to a level balanced with primary hull structure and personnel survivability.

b. References (a) and (b), or their variants as specified in ship platform contractually mandated requirements documents, establish and define the Navy's basic criteria for shock qualification testing and shock design of equipment, systems, and structures.

c. Increasing reliance on commercial off-the-shelf (COTS) systems, COTS equipment, and commercial structural details significantly increases the potential for "cheap kills," i.e., easily achieved major ship system casualties, if strict adherence to proper shock hardening procedures is not achieved and maintained. Requirements to utilize COTS or commercial structural details shall be in parallel with the requirement to shock harden Navy ships' systems and subsystems to a level balanced with primary hull structure and personnel survivability. Achieving these parallel requirements should be accomplished through the use of modified commercial structural details, shock isolation of the equipment at the ship interface, or any other acceptable means necessary to increase shock hardness of the ship and ship's systems to the level required.

4. Policy

a. In support of the Chief of Naval Operations (CNO) commitment to progress in ship platform survivability, any command involved with establishing and or changing the material condition or configuration of Navy ships shall ensure shock hardness is inherent in design of the ship, ship's equipment, and systems that compose the integrated ship system (equipment and systems are referred to as "equipment" in this instruction hereinafter, unless otherwise assigned) is demonstrated and verified by Navy approved shock testing or analysis, is validated at the integrated ship system level, and is effectively maintained throughout the service life of the ship. Shock hardness shall be designed and engineered into ship platforms, aircraft and shipboard interface systems, ordnance and related equipment regardless of naval systems command (SYSCOM) or Department of Defense (DoD) Service branch ownership. For new construction ships, requirements for shock hardening shall be introduced during analysis of alternatives. The shock hardening requirement generation process shall be within the ship class survivability requirements, per reference (c). Shock hardening requirement generation shall be documented in the initial capabilities document and finalized in the

capabilities development document (CDD), operational requirements document (ORD), or other applicable Deputy Chief of Naval Operations, Warfare Systems (CNO (N9)) ship mission requirement documents. The level of shock hardness shall be assessed with appropriate metrics and certified by letter on a periodic basis throughout the service life of the platform. Overhaul and modernization programs, including permanent ship alterations and temporary ship alterations, shall employ required level of shock hardness, particularly in cases where known shock hardness deficiencies exist. The as-built shock hardness of Navy ships shall not be degraded as a result of post-delivery modifications and modifications shall possess shock hardness characteristics consistent with the applicable mission of the ship.

b. All Navy ships with shock hardening requirements, whether they are new construction or are under modernization or conversion, shall be assessed for requirement compliance at specified shock hardness levels and their shock hardness certified by letter after trials, after depot level maintenance availabilities, and after an interim change to a system that requires shock hardness certification because shock hardness capability may have been compromised. A letter certifying shock capabilities of the ship with a summary of the ship shock hardness assessments shall be delivered to the affiliated program executive offices (PEO) and appropriate commands.

5. Applicability and Scope. This instruction applies to new construction and in-service ships with shock hardening requirements and shall be used for the ship and all equipment and systems that compose the integrated ship system. The integrated ship system includes installed and stowed systems and equipment as well as embarked and shipboard items which are designed and furnished by DoD or by any other suppliers. Shock hardening initiatives encompass the development and installation of system improvements to prevent or minimize the broad degrading effects of shock on mission performance. Generic ship class mission areas that typically require shock hardening are identified in enclosure (1).

6. Verification, Validation, and Certification of Ship Shock Hardness

a. Verification of the shock hardness of equipment shall be accomplished through a shock qualification program. Equipment shall be qualified by shock testing per reference (a). When applicable, shock hardness of equipment shall be qualified by analysis conducted per reference (b) or its variants. Shock qualification of specific equipment or systems requires dual approval that equipment meets the shock technical requirements and that the equipment meets equipment user functional or operational requirements during qualification process.

b. Validation of the class design shall demonstrate that integrated ship system shock hardness meets CNO (N9) mission requirements and shall be accomplished by methods contained in enclosure (2).

c. Periodic certification of each ship's shock hardness shall assess ship compliance with ship's specification by methods contained in enclosure (3) and consistent with paragraph 6a of this instruction.

7. Responsibilities and Actions

a. CNO (N9), in conjunction with resource sponsors, shall:

(1) Ensure planning, programming, staffing, and budgeting to support engineering development, procurement and installation of corrective shock modifications aboard all shock hardened ships over the ship's service life.

(2) Provide continuous coordination, direction, management focus, and control to ensure effective implementation of ship shock hardening requirements consistent per reference (c) and this instruction.

(3) Issue directives to ensure ship shock hardening implementation, accountability, and funding across warfare and platform sponsors and fleet commands over shock hardened ship service life. Directives to be issued over shock hardened ship service life include: directing implementation of shock hardening considerations in requirements documents; directing the ship be assessed and shock hardness certified by letter

after trials, after depot level maintenance availabilities, and after an interim change to a system that requires shock hardness certification because shock hardness capability may have been compromised; and directing correction of shock deficiencies.

(4) Define specific mission essential areas for each shock hardened ship class and ensure the specific platform mission essential system and mission critical function shock requirements are within the ship CDD, ORD, or appropriate CNO (N9) mission requirement documents and are distributed across warfare directorates.

b. Fleet commanders shall make ships available in support of integrated ship system shock hardness validation efforts as defined in enclosure (2) and provide fleet support as necessary.

c. Commander, Naval Sea Systems Command (COMNAVSEASYSCOM) is the central designated Navy technical authority for ship shock hardening which resides with the Naval Sea Systems Command (NAVSEASYSCOM) chief engineer. Responsibilities include the following:

(1) Define Navy shock qualification requirements.

(2) Issue shock qualification approval for systems, equipment, stowed ordnance, and structures installed aboard Navy ships, including items furnished by other SYSCOMs or any other sources. The NAVSEASYSCOM shock technical approval authority shall ensure that the requirements per references (a) and (b) or their variants are met. The NAVSEASYSCOM affiliated PEOs or the NAVSEASYSCOM equipment or system authority, as applicable, shall ensure that the user's functional or operational requirements are met.

(3) Ensure cost-effective improvements are integrated into the shock qualification process.

(4) Implement a program to assess and certify ship shock hardness by certification letter after trials, after depot level maintenance availabilities, and after an interim change to a system that requires shock hardness certification because shock hardness capability may have been compromised for all new construction ships, modernized ships, and converted ships.

(5) Develop and implement a program of shock hardness assurance, maintenance, and surveillance for ships and shipboard equipment including weapons systems to prevent degradation of equipment shock hardness during the service life of the ship.

(6) Provide final approval action on any request for non-conformance with Navy shock qualification requirements. This requirement is applicable to equipment procured from any source. Approval of permanent non-conformance from Navy shock qualification requirements shall not be delegated below NAVSEASYSKOM chief engineer.

(7) Provide certification of ship shock hardness periodically. This certification responsibility shall not be delegated below NAVSEASYSKOM chief engineer.

d. NAVSEASYSKOM chief engineer and affiliated PEOs shall work to:

(1) Ensure all applicable military and Federal specifications, standards, manuals, and other directives are updated or developed as necessary to reflect shock hardness performance requirements. Contractual documents shall be reviewed and concurred by the NAVSEASYSKOM chief engineer or designated representative when citing shock hardening requirements.

(2) Ensure shipboard supporting structure is defined in design documentation with sufficient detail that subsequent ship equipment shock qualification and ship shock hardness certification actions will be conducted within all ship installation orientations and interfaces.

(3) Review and provide dual approval that ship equipment meets shock verification technical requirements (NAVSEASYSKOM chief engineer approval) as well as ship equipment owner functional or operational requirements (affiliated PEOs or NAVSEASYSKOM equipment authority as applicable) during ship equipment shock qualification process.

(4) Ensure that the Navy shock data base is supported and maintained for Navy ships in order that ship shock hardness verification certification can be executed per enclosure (3).

e. Affiliated PEOs responsibilities include the following:

(1) Deliver equipment and ships that satisfy shock hardening requirements. Ensure that all applicable shock requirements for contractor furnished equipment (CFE) and government furnished equipment (GFE) are issued via contractual requirements, Navy Enterprise Resource Planning documentation to contractors and participating acquisition resource managers (PARM). Ensure that the requirement for shock qualification is addressed consistently in all applicable program documentation.

(2) Designate the shock grade of ship board items per the ship's CDD, ORD, or other applicable CNO (N9) mission requirement documents and qualify all equipment to be installed on applicable ship. Obtain NAVSEASYSKOM chief engineer concurrence with requirements for shock hardening these items.

(3) Issue shock qualification approval documents for shock hardened systems, equipment, stowed ordnance, and structures installed aboard Navy ships including items furnished by other SYSCOMs, other DoD Service branches, or any other source. Shock verification approval shall be dependent on review and successful shock dual approval per paragraph 7d(3) of this instruction. Equipment that does not meet the shock qualification requirements is considered a shock deficiency and requires the affiliated PEO to identify a shock deficiency correction plan that results in future successful ship equipment shock qualification.

(4) Track and monitor ship shock hardness verification status of all equipment installed aboard Navy shock hardened ships. This information shall include equipment shock qualification approval documentation, shock deficiency documentation, and shock deficiency correction plans.

(5) Provide the NAVSEASYSKOM chief engineer with a comprehensive shock qualification status list for all modernized, converted, or new construction ships per enclosure (3) of this instruction. This list shall be used by the NAVSEASYSKOM chief engineer to assess and certify the shock hardness level of the ship. The comprehensive list shall be derived from ship's shock qualification approval tracking information, ship's shock validation information consistent with

enclosure (2), and information previously identified by NAVSEASYSCOM chief engineer as necessary to assess the ship's shock hardness on delivery.

(6) Initiate and implement all planning for ship shock validation at the integrated ship system level. Manage and conduct shock validation efforts. This includes providing all resources to conduct integrated ship system shock validation as well as pre-event preparation and post-event repair as necessary. Ensure that any shock deficiencies identified by integrated ship system validation will be promptly corrected on a class or fleet wide basis, as appropriate.

(7) Provide NAVSEASYSCOM chief engineer and Board of Inspection and Survey (INSURV) with ship shock deficiency correction plan for each ship under its cognizance with copy to CNO (N9) and ship's commanding officer.

(8) Ensure shock hardening requirements are planned, budgeted, and enforced by the ship acquisition PEO during construction and life cycle maintenance PEO for the remainder of ship's service life per this instruction.

f. SYSCOMs, following the lead of COMNAVSEASYSCOM per reference (c), shall, for their own area of technical authority:

(1) Deliver equipment to ships that satisfy shock hardening requirements. Ensure that all applicable shock requirements for CFE and GFE are issued via contractual requirements to contractors and ship project directive documentation to PARM. Ensure that the issue of equipment shock qualification is addressed consistently in all applicable program documentation.

(2) In conjunction with the NAVSEASYSCOM chief engineer and affiliated PEOs, issue (or distribute as applicable) shock qualification approvals for shock hardened systems, equipment, ordnance, and structures installed aboard Navy ships.

(3) Track status of all shock hardened equipment qualification, including shock deficiencies and shock deficiency correction plans per this instruction. Ensure that the Navy Shock Database (NSDB) is updated in a timely manner to include shock hardened equipment shock qualification status.

(4) Provide affiliated PEOs and NAVSEASYSKOM chief engineer with a shock deficiency correction plan for each item under its cognizance per this instruction, as well as work with the affiliated PEO to implement the plan that will result in future successful shock qualification of the item.

(5) Appoint and maintain a SYSKOM shock coordinator who shall function as the responsible single point of contact for SYSKOM shock hardening matters, and who will support NAVSEASYSKOM and affiliated PEOs in ensuring shock qualification approval of their items prior to shipboard installation.

8. Exception. The administrative requirements of this instruction do not apply to systems or equipment under the cognizance of the Deputy Commander for Nuclear Propulsion (NAVSEASYSKOM 08).

9. Record Management. Records created as a result of this instruction, regardless of media and format, shall be managed per Secretary of the Navy Manual 5210.1 of January 2012.

10. Reports Control. The surface ships shock hardening data being collected throughout this instruction has been assigned OPNAV RCS 9072-3 and is approved for 3 years from the date of this instruction.



T. S. ROWDEN
Rear Admiral, U.S. NAVY
Director, Surface Warfare

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SHIP SHOCK HARDENING CRITERIA

1. Applicability to Ships, Naval Aircraft, Boats, and Craft

a. Ships. Shock hardening is required for all ships which must be capable of operating in the combat shock environment. Examples include, but are not limited to, all naval combatant ships, aircraft carriers, amphibious ships, mineforce ships, and other ships which are intended to retain operational functions in combat zones. CNO (N9) may require shock hardening of other ships on a case-by-case basis.

b. Naval Aircraft. Aircraft, in the stowed configuration, must be capable of operating after exposure to shock. Aircraft mounted items and the hardware used to attach items to aircraft must be shock hardened in their shipboard stowed configurations. Examples include, but are not limited to, auxiliary fuel tanks, bomb racks, ordnance, and avionic pods.

c. Boats and Craft. Shock hardening for air cushion vehicles, hydrofoils, surface effect ships, landing craft, small boats, and similar craft are typically not required by CNO (N9). However, CNO (N9) may invoke shock hardening requirements on such boats and crafts on a case basis. Shock hardening requirements, in such cases, shall be determined by the resource sponsor as part of the CDD, ORD, or appropriate CNO (N9) mission requirements document and approved by CNO. Although shock hardened ships may include landing craft stowed in the well deck, the shock hardening requirements of the host ship do not convey to the landing craft. Therefore verification or validation testing of landing craft shall not be required unless specifically directed by the CNO (N9) resource sponsor in CDD, ORD, or appropriate CNO (N9) mission requirements document and approved by CNO.

d. Mission Modules. Shock hardening qualification requirements for mission modules shall be within the host ship's specifications and mission requirements.

e. Embarked Assets and Temporary Installations. Ground vehicles, training modules, unmanned autonomous vehicles, etc., shall be shock hardened within the host ship's specifications and mission requirements.

f. Ordnance. Weapons and weapons handling systems shall meet operational shock requirements per reference (a) as necessary to meet the ship's requirements:

(1) Expendable shipboard ordnance (stowed, transported, defensive, offensive, embarked, etc.) shall satisfy ship shock requirements while in the stowed configuration. The shock qualification standards of this instruction apply without change to mission-essential items such as missiles or warheads including those designed and furnished by DoD or other U.S. and foreign suppliers.

(2) Applicability of this section applies for both Navy and non-Navy ordnance and weapons handling on platforms with shock hardening requirements. As a minimum, this section is applicable to NAVSEASYSKOM, Naval Air Systems Command, United States Marine Corps, and Special Operations Command weapon, ordnance, and handling systems.

2. Applicability to Shipboard Systems

a. Shock hardening criteria are applicable to both grade A and B items.

(1) Grade A items, as defined in the CDD, ORD, or applicable CNO (N9) mission requirements, are required to maintain performance of direct and vital support of mission essential areas aboard shock hardened ships under and after exposure to a shock event.

(2) Grade B, as well as grade A, items shall not present a hazard to the host ship, other nearby grade A equipment, and ship's force under exposure to shipboard shock.

b. Typical mission-essential systems and function areas (i.e., grade A) include:

- (1) Ship control and propulsion.
- (2) Command and control.
- (3) Navigation.

- (4) Communications.
- (5) Surface, air, and underwater surveillance.
- (6) Countermeasures.
- (7) Launching, retrieving, fueling, defueling, rearming and handling of aircraft, small craft, and unmanned vehicles.
- (8) Essential checkout and maintenance of aircraft and ordnance.
- (9) Launchers, fire control, firing or launching and guidance of missiles and other weapons.
- (10) Stowage, handling, and reloading of weapons.
- (11) Expendable ordnance including stowed, transported, defensive, offensive, embarked, and air launched ordnance.
- (12) Replenishment at sea (stowed configuration).
- (13) Minehunting and sweeping.
- (14) Transporting and landing troops and combat payload (assault ships).
- (15) Damage control and fire fighting.
- (16) Collective protective systems and chemical, biological and radiological detection.

c. Other mission essential capabilities may be established for specific ship classes as designated by CNO (N9).

3. Appropriate Shock Hardening Criteria

a. Acceptance of mission-essential items for installation aboard shock hardened ships shall be based upon pre-acceptance shock testing, per reference (a), if the size and weight of the item permit such testing. Equipment foundations for shock hardened items shall be designed for shock per reference (b) or its variants as applicable. Non-shock testable items should be qualified by analysis using reference (b), variants of reference

(b), if applicable, or alternative transient analysis approaches in some cases pending prior review and agreement by NAVSEASYS COM chief engineer that the approach is effective.

b. Expendable ordnance, weapon handling and loading equipment which is part of the firing cycle, and other weapon handling and loading equipment shall be shock qualified per this instruction and the ship CDD, ORD, or applicable CNO (N9) mission requirements. Specific ordnance shock hardening criteria include:

(1) Expendable shipboard ordnance (stowed, transported, defensive, offensive, embarked, etc.) shall be capable of performing its intended function during operational use after exposure to shock unless otherwise specified by CNO (N9).

(2) As a minimum, all mission-essential ordnance, such as missiles, torpedoes or warheads, including those designed and furnished by other U.S. or foreign suppliers, shall not present a safety hazard to ship's force and the host ship or other deploying platform (e.g., aircraft, small boat, etc.) following a shock event even if there is an attempt to operate the system following shock. To the extent that it is not feasible to modify the ordnance to meet shock requirements, the shipboard mounting shall be designed to appropriately mitigate the applied shock loadings to meet the minimal shock safety requirements. Such items, with their shock mitigation systems, if any, shall be subject to shock testing or analysis, pending prior review and agreement by NAVSEASYS COM chief engineer to verify shock qualification.

(3) Weapons stowage equipment shall meet shock requirements in the loaded and unloaded condition, unless otherwise specified. Stowage equipment for small arms ammunition, pyrotechnics, and miscellaneous ordnance shall meet grade A shock requirements in the unloaded and loaded condition as a minimum, unless otherwise specified. Weapons handling and loading equipment (which is part of the firing cycle and has a specified reload and firing rate) shall meet shock hardening requirements in both the stowed and operating configurations, unless otherwise specified. Other weapon handling and loading equipment, such as fork-lift trucks, munitions transporters,

rolling deck equipment, and weapon elevators, shall meet shock requirements in the stowed condition, unless otherwise specified.

c. The capability of items to withstand shock aboard ship is dependent in part upon the design and arrangement of interfacing shipboard stowage systems, missile magazines, foundations, or other supporting structure. The intended shipboard supporting structure shall be defined in development specifications in sufficient detail to ensure that subsequent shock qualification actions will reflect the planned shipboard structural interface. Similarly, ship design specifications must include previously established interface requirements. Interface shock requirements should be defined and coordinated by NAVSEASYS COM chief engineer.

d. The as-built shock hardness of Navy ships shall not be degraded as a result of post-delivery modifications.

e. Detailed criteria for shock hardening of ships shall be established by the NAVSEASYS COM chief engineer.

VALIDATION OF THE CLASS INTEGRATED SHIP SYSTEM SHOCK HARDNESS

1. Validation of the Integrated Ship System Shock Hardness

a. The process selected to substantiate and document validation of the ship and all equipment and systems that compose the class integrated ship system shock hardness shall demonstrate the ability of new construction ships to carry out their CNO (N9) assigned missions in the combat shock environment.

b. Validation of the integrated ship system shock hardness is explicitly dependent on an actively managed shock qualification plan for all ship equipment. The shock qualification plan shall be robust and implemented to deliver a cost effective shock hardened ship.

c. An important outcome of integrated ship system shock validation is generating a credible estimate of the ability of the ship class to meet the ship CDD, ORD, or applicable CNO (N9) mission requirements during and after exposure to an underwater explosion shock event expected to occur during combat. Cost effective alternatives to the processes in this instruction that provide credible estimates of integrated ship system shock validation are acceptable for use provided the process has been demonstrated to be consistent with this instruction and has been approved by NAVSEASYS COM chief engineer as a technically acceptable integrated ship system validation process.

d. The applicable ship class acquisition PEO shall select the process to be used to validate the integrated ship system shock hardness as well as select the lead or an early ship of each shock hardened class that shall be subjected to the shock validation process as part of post-delivery test and trials when required. The PEO selected validation process and, if necessary, the ship selected for validation shall:

(1) Be reviewed and approved by NAVSEASYS COM chief engineer.

(2) Upon NAVSEASYS COM chief engineer approval, be integrated into the test and evaluation master plan (TEMP) with resources allocated in the appropriate planning document(s) by the applicable ship class acquisition PEO.

e. Modeling and simulation analytical validation efforts shall consist of full ship shock modeling and simulation tools that accurately predict principal unit equipment and integrated system performance, including predicted failure, in order to assess mission keeping capability during a shock event. All modeling and simulation tools used in integrated ship validation efforts shall be reviewed with associated verification, validation, and accreditation (VV&A) data and approved by NAVSEASYS COM chief engineer prior to selection of modeling and simulation.

f. Specific tasks necessary to accomplish validation of integrated ship system shock hardness include, but are not limited to: execution of ship shock hardness program following CDD, ORD, or other CNO (N9) mission requirements, executing ship equipment and system shock qualification, verification of ship material readiness, assessment and documentation of shock deficiencies, and methods used to determine ship shock environments at the equipment foundation interface of equipment to the ship.

2. Process

a. Validation of the integrated ship system shock hardness shall be performed and documented for all ship classes with shock hardening requirements.

(1) The applicable ship class acquisition PEO shall recommend a process for validating integrated ship system shock hardness to NAVSEASYS COM chief engineer for approval per this instruction, the shock hardening requirements of the ship class CDD, ORD, or appropriate CNO (N9) mission requirement document, and reference (c).

(2) The recommendation shall include the following items as a minimum: description or list of capabilities to be validated, technical details of the recommended validation process, and analysis of technical, programmatic, and financial alternatives for capability validation.

(3) The process recommended by the applicable ship class acquisition PEO for validation of integrated ship system shock hardness shall be approved by NAVSEASYS COM chief engineer. Once approved by the NAVSEASYS COM chief engineer, the applicable PEO

shall integrate the process in the ship class TEMP, plan the validation effort including equipment shock qualification, and develop funding lines necessary to execute the effort. The process, including shock qualification of shipboard equipment, shall be funded and implemented per the stakeholder approved plan.

b. Integrated ship system shock hardness is validated by a combination of shock hardened equipment verification through a rigorous shock hardened equipment qualification program coupled with one of the three options to confirm shock design and operability. The three options are:

(1) Ship Shock Trial. The shock trial process shall subject fully manned and operational ships to a series of increasingly severe non-contact underwater explosions to demonstrate ship mission keeping capabilities. The trials shall be developed to maximize the exercise of mission critical equipment. The ship's crew shall respond to casualties resulting from the shock event to restore degraded mission keeping capabilities quickly, safely, and to the maximum extent possible.

(2) Ship Shock Test Supplemented with Modeling and Simulation. This process shall subject fully manned and operational ships to a series of underwater explosions engineered to exercise the integrated ship system, as well as specific ship equipment to demonstrate platform mission requirements compliance performance. The engineering information obtained shall be used to assess casualties, shock deficiencies, and identify system shock hardness compliance risks. Modeling and simulation shall be utilized in conjunction with the shock tests to complete the demonstration of all mission keeping capabilities required for shock hardness validation. Underwater explosion excitation of the vessel may be accomplished using traditional explosives in reduced scope tailored tests or new technologies that utilize alternative means for inducing underwater shock-like response in the ship and its equipment and integrated systems.

(3) Enhanced Shock Qualification, Surrogate Testing, and Modeling and Simulation. This test based process centers on three elements: a thorough shock qualification program, targeted surrogate testing, and VV&A modeling and simulation

focused on prediction of the ship's mission performance capabilities aftershock events. The enhanced shock qualification program will be a thorough test based process conducted at the component, subsystem, and subassembly level as necessary to test the integration of selected complex systems and include surrogate testing with focus on new critical technologies where appropriate. This testing will be leveraged to determine equipment operability metrics to support the development of the modeling and simulation tools necessary to accurately predict integrated system failure and degradation of mission keeping capabilities. This enhanced test based shock qualification program shall include an agreed percentage of completed shock grade A equipment qualification at the time of validation of capabilities necessary to demonstrate integrated ship system shock hardness validation.

c. Preparation, execution, and recovery of validation efforts are the major process elements for validation of integrated ship system shock hardness.

(1) Validation effort preparations shall center upon taking the actions necessary to eliminate potential shock deficiencies. Preparations for the validation effort shall include a comprehensive readiness review consisting of qualification surveys, ship shock inspections, and predictive analysis, if applicable. Shock deficiencies shall be documented and corrected prior to conducting the validation effort to the level sufficient to ensure full system demonstration post shock.

(2) Execution of the validation process shall demonstrate compliance with the ship's mission requirements during and after shock events. For trial or test based validations efforts, casualties resulting from the effort shall be restored by the ship's crew as quickly and safely as possible. Every attempt shall be made to restore the ship to the pre-event condition to the maximum extent possible between shots.

(3) For all validation efforts, post validation activities shall document deficiencies for follow-up corrective action. For trial or test based validation efforts, post validation activities shall also be centered on returning the ship to the pre-effort condition. A follow-up corrective action plan shall provide for repair of shock damage as necessary,

development of engineering fixes, and also shall provide for prompt accomplishment of corrective shock hardening on a class-wide basis (and fleet-wide basis, if necessary) to eliminate the shock deficiencies revealed by the integrated ship system shock hardness validation.

(4) It is acceptable to tailor ship preparation, ship use for validation effort, and ship recovery after shock hardness validation to ensure cost effective execution of the integrated ship system validation as long as the tailored validation effort selected by the applicable ship class acquisition PEO or other ship class PEO is consistent with this instruction, the ship class CDD, ORD, or other CNO (N9) mission requirement, and the validation effort is reviewed and approved by the NAVSEASYS COM chief engineer prior to adoption for use.

SHIP SHOCK CERTIFICATION LETTER PROCESS

1. Purpose. The ship shock certification letter process shall:
 - a. Assess ship shock hardness periodically, per this instruction, in order to provide NAVSEASYS COM chief engineer, INSURV, and the ship's commanding officer a benchmark assessment of shock hardness and ability of the ship to meet its mission in a combat shock environment. Specifically, ship shock certification will assess ship compliance with its shock specifications. This process shall be conducted for all ships with shock hardening requirements.
 - b. Provide the initial shock hardness assessment of the ship by certification letter with an assessment summary enclosure. The certification letter will be used as the baseline for maintaining shock hardness and prioritizing the correction of shock deficiencies throughout the service life of the ship.
2. Process. COMNAVSEASYS COM shall assess ship shock hardness and certify shock hardness by letter as specified by this instruction pending delivery of information provided by affiliated PEOs for all modernized, converted ships, and new construction shock hardened ships.
3. Applicability
 - a. The shock hardness assessment and shock certification letter with assessment summary shall be generated on all ships requiring shock hardening.
 - b. The shock assessment and certification process shall be executed on all modernized, converted ships, and new construction shock hardened ships.
 - c. The shock assessment and certification process is applicable to and fully dependent on a robust shock qualification program.
 - d. The shock assessment and ship shock certification letter process in this enclosure is ship asset specific and is not a replacement of the class design integrated ship system shock hardness validation process contained in enclosure (2).

4. Responsibilities

a. Office of the Chief of Operations Director, Warfare Integration (OPNAV (N9I)). OPNAV (N9I) shall direct and provide resources for correction of shock deficiencies and planned maintenance of the certification assessment over the shock hardened ship service life per this instruction.

b. COMNAVSEASYSKOM and Affiliated PEOs. Affiliated PEOs shall ensure that all appropriate equipment shock qualification has been issued, that the NSDB has been revised with shock qualification data regarding shock hardened equipment applicable to the ship, that ship shock inspections have been performed, and that all shock deficiencies have been documented and placed in an appropriate shock deficiency correction plan per this instruction. COMNAVSEASYSKOM or a delegate shall use this information to assess the ship's shock hardness and provide a ship shock certification letter with shock assessment summary per this instruction that certifies or limits certification of compliance with shock requirements. The ship shock certification letter shall be provided: after trials, after depot level maintenance availabilities, and after an interim change to a system that requires shock hardness certification because shock hardness capability may have been compromised.

(1) COMNAVSEASYSKOM and affiliated PEOs or their delegates shall develop and implement a program to assess and certify shock hardness of ships at time of delivery for all modernized, converted ships, and new construction shock hardened ships.

(2) Affiliated PEOs shall ensure a robust shock qualification plan for ship's equipment. PEOs shall track all shock hardened equipment installed aboard Navy shock hardened combatant ships and its qualification status utilizing the NSDB and shock deficiency correction plans per the ship class CDD, ORD, or appropriate CNO (N9) mission requirement document and this instruction.

(a) PEOs shall provide the NAVSEASYSKOM chief engineer with a comprehensive shock qualification status list of all shock hardened equipment, known shock deficiencies, and all other information necessary to assess the ships shock hardness

after trials for all modernized, converted, or new construction ships. PEOs shall ensure that support providing appropriate equipment shock qualification survey data, ship shock inspections, and predictive analysis are provided in a timely manner such that the information can be used per this instruction to assess, certify, or limit shock hardness certification of the ship.

(b) Ensure ship shock inspections are performed in conjunction with acceptance of ships prior to delivery per this enclosure.

5. Basis of Assessment

a. The following information is required to perform the ship shock certification assessment and shall be provided to the NAVSEASYSKOM chief engineer by cognizant ship platform PEOs, PEO Integrated Warfare Systems (IWS), and other Navy SYSCOMs associated with the platform. PEO IWS and other Navy SYSCOMs shall provide their information directly to the cognizant ship platform PEO who shall compile and forward to the NAVSEASYSKOM chief engineer at ship delivery:

(1) Ship identification information: ship name, class, and survivability level requirements or survivability enhancement capabilities, as applicable, from reference (c).

(2) The list of mission essential systems and mission critical functions derived from the ship class CDD, ORD, or appropriate CNO (N9) mission requirement document.

(3) The shock qualification status list for all grade A and grade B equipment. The shock qualification status list shall include all items and categorize them as qualified, deficient, or not evaluated.

(4) List of known shock deficiencies and shock deficiency correction plan information for all grade A and grade B equipment under the cognizance of applicable PEOs and other Navy SYSCOMs.

(5) Approved deviation requests altering the defined shock hardening requirements.

(6) A ship shock inspection shall be performed to determine the shock hardness of ship's systems and equipment as installed and the results of the ship shock inspection documented in a ship shock inspection report. The ship shock inspection report shall document that the equipment was installed per the ship's specifications and identify equipment installation deficiencies for corrective action.

(7) Compilation of documentation from ship equipment shock qualification and integrated ship system shock hardness validation. Examples of such documentation include: results of equipment qualification testing, such as approval letters and deficiencies, ship inspection reports, ship shock test reports, etc.

(8) Other specific information previously identified by the NAVSEASYS COM chief engineer in the shock hardness validation approval process, per enclosure (2), necessary to assess ship specific or ship class specific issues.

b. Basis of assessment shall include and document remaining actions necessary to correct and eliminate potential shock deficiencies in an expeditious and cost effective manner. This shall include a comprehensive readiness review summarizing the information used as the basis of assessment. Shock deficiencies shall be documented and corrected prior to submitting the basis of assessment wherever possible over the life of the ship to optimize full system post shock performance and minimize life cycle costs.

c. All information shall be prepared using objective quality evidence, i.e., any statement of fact, either quantitative or qualitative, pertaining to the quality of a product or service based on observations, measurements, or tests which can be verified.

d. The basis of assessment shall be prepared per the shock hardening requirements of the ship.

6. Fundamental Process

a. The information forming the basis of the assessment shall be provided by affiliated PEOs with input from other SYSCOMs as necessary.

b. The information shall be transmitted by the responsible PEO to NAVSEASYSYSCOM chief engineer no less 30 days prior to delivery of new construction ships, after completion but no less than 21 days prior to deployment of the ship after depot level maintenance availabilities, or after completion but no less than 21 days prior to deployment of the ship after an interim change to a system that requires shock hardness certification because shock hardness capability may have been compromised.

c. NAVSEASYSYSCOM chief engineer shall review the information provided and provide comments within 2 months of delivery of the information.

d. NAVSEASYSYSCOM chief engineer shall work with PEOs on adjudication of comments prior to final release of assessment.

e. NAVSEASYSYSCOM chief engineer shall provide formal review of the basis of assessment to PEOs. The NAVSEASYSYSCOM chief engineer will document the assessment in a ship assessment summary that depicts the general state of the ship shock hardness using objective quality evidence from the basis assessment. This assessment summary shall include actions necessary to correct shock deficiencies.

f. NAVSEASYSYSCOM chief engineer shall generate a written letter certifying the shock hardness level of the ship 1 month after finalization of the assessment.

g. NAVSEASYSYSCOM chief engineer shall submit the shock certification letter, with the ship assessment summary as an enclosure, to the ship PEO with copy to CNO (N9), appropriate commands, and the specific ship's commanding officer.