



DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
2000 NAVY PENTAGON
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OPNAVINST 9070.1A
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OPNAV INSTRUCTION 9070.1A

From: Chief of Naval Operations

Subj: SURVIVABILITY POLICY AND STANDARDS FOR SURFACE SHIPS AND
CRAFT OF THE U.S. NAVY

Ref: (a) DoD Instruction 3150.09 of 17 September 2008
(b) CJCS 3170.01H
(c) OPNAVINST 9070.2
(d) OPNAVINST C8950.2G (NOTAL)
(e) OPNAVINST 9072.2
(f) OPNAVINST 3541.2B
(g) OPNAVINST 3401.3A
(h) OPNAVINST 3400.10F
(i) OPNAVINST 8010.13D
(j) OPNAVINST 3300.53
(k) OPNAVINST 3300.55
(l) OPNAVINST F3300.53C
(m) OPNAVINST 2400.20F
(n) SECNAVINST 5000.2E
(o) OPNAVINST 3400.11
(p) OPNAVINST 5239.1C
(q) SECNAVINST 5400.15C

Encl: (1) Platform Survivability Requirements in Capability
Development Document (CDD) Generation Process
(2) Survivability Components of Surface Ships

1. Purpose. To establish policy and assign responsibility for conducting an assessment to determine a balance of survivability performance and risk and cost in surface ship, combat systems and equipment designs, overhauls, conversions, and modernizations within program objectives. Survivability over naval nuclear propulsion plant systems, equipment and facilities falls under the cognizance of the Naval Sea Systems Command (NAVSEASYS COM) Deputy Commander, Nuclear Propulsion Directorate (SEA 08). Executive Order 12344, statutorily prescribed by Public Law 98-525 (7158 note of title 42, United States Code), establishes the responsibilities and authorities of SEA 08 over

all facilities and activities which comprise the Naval Nuclear Propulsion Program, a joint Department of Energy and Navy organization. These responsibilities and authorities include all technical and logistical matters related to naval nuclear responsibilities and propulsion. Accordingly, nothing in this instruction supersedes or changes those authorities, and SEA 08 shall be consulted concerning all matters related to naval nuclear propulsion.

2. Cancellation. OPNAVINST 9070.1.

3. Background. Naval surface ships and craft are required to perform missions; avoid and withstand battle damage and chemical, biological, radiological and nuclear (CBRN) exposure; avoid and recover from accidents; and survive either when operating alone or as part of a strike group. The total ship comprised of ship's crew, combat warfare systems, hull structure, mechanical systems, electrical systems, networks, and components must be sufficiently protected or hardened to withstand damaging effects from designated threats, within program objectives. Design attributes, such as signature control, equipment separation and redundancy, fire resistance, armor, other passive protection features, and personnel protection form an integral part of the ship. Training (e.g., damage control (DC), firefighting (FF) and chemical, biological and radiological (CBR) defense) and maintenance of ship survivability features are also essential elements to ensure survivability of the ship's crew and sustained mission capability.

a. The details of the specific technical design criteria for each technical design attribute addressed above are not included herein but reference to the applicable policy and requirements documents are provided below:

(1) Reference (a) assigns responsibilities for the execution of the Department of Defense (DoD) CBRN Survivability Policy. It establishes processes for ensuring the survivability of CBRN mission-critical systems in a CBRN environment. It also describes how CBRN mission-critical systems shall be identified, reviewed, and considered in the context of the Joint Capabilities Integration and Development System (JCIDS).

(2) Reference (b) is a deliberate and analytical capabilities based assessment process that formally articulates future warfighter needs in an initial capabilities document (ICD) and or a doctrine, organization, training, materiel, leadership and education, personnel, and facilities change recommendation.

(3) Reference (c) establishes policy for implementing signature reduction and signature control on surface ships.

(4) Reference (d) establishes policy for magnetic and acoustic signature control for mine warfare.

(5) Reference (e) establishes policy for implementing the shock hardening of surface ships.

(6) Reference (f) establishes policy for implementing the passive fire protection program and DC and FF initiatives for surface ships.

(7) Reference (g) requires that nuclear hardness be considered fundamental to ship design and acquisition, and that hardness levels be maintained.

(8) Reference (h) establishes mission requirements and implements policy governing CBR defense capabilities in association with the DoD Counterproliferation Initiative.

(9) Reference (i) provides policy relative to insensitive munitions requirements.

(10) References (j) through (l) address the Navy's program for combating terrorism to protect Navy personnel and activities against acts of terrorism and political turbulence.

(11) Reference (m) establishes electromagnetic environmental effects (E3) policy which includes high-altitude electromagnetic pulse (HEMP) and other electromagnetic threat environments such as electronic jammers, high power microwave, radiofrequency weapons and directed energy weapons.

(12) Reference (n) establishes Secretary of the Navy (SECNAV) policy for the implementation and operation of the Defense Acquisition System and JCIDS.

(13) Reference (o) establishes Navy policy and alignment for combating weapons of mass destruction.

(14) Reference (p) establishes Navy policy for implementing a platform cyber defense in depth architecture to ensure network survivability.

b. The previous version of this instruction, dated 23 September 1988, established the policy that "Survivability shall be considered a fundamental design requirement of no less significance than other inherent ship characteristics." This basic premise has not changed although survivability is now considered in terms of capabilities vice characteristics. The previous version established a minimum baseline of survivability. This revision recognizes the changing nature of naval ship design and system threats and eliminates the prescriptive survivability characteristics while establishing the new requirement to derive a minimum survivability baseline that is based on the programs' ICD and defined concept of operations (CONOPS). Survivability shall be addressed on all new surface ship, combat systems and equipment designs, overhauls, conversions, and modernizations in order that the design is provided a balance of survivability performance, risk, and cost within program objectives. Prior ship and system requirements and survivability levels established in the previous version of this instruction remain valid.

4. Discussion

a. For the purposes of this instruction the following terms are defined:

(1) Survivability. A measure of both the capability of the ship, mission critical systems, and crew to perform assigned warfare missions, and of the protection provided to the crew to prevent serious injury or death. Both of these capabilities are applicable whether in combat or in either combat or non-combat related accidents (e.g., groundings, collisions, fires). The three principal disciplines of survivability are susceptibility, vulnerability, and recoverability.

(2) Susceptibility. A measure of the capability of the ship, mission critical systems, and crew to avoid and or defeat

an attack and is a function of operational tactics, signature reduction, countermeasures, and self-defense system effectiveness.

(3) Vulnerability. A measure of the capability of the ship, mission critical systems, and crew to withstand the initial damage effects from conventional, CBR or asymmetric threat weapons, or accidents, and to continue to perform assigned primary warfare missions, and protect the crew from serious injury or death.

(4) Recoverability. A measure of the capability of the ship and crew, after initial damage effects, whatever the cause, to take emergency action to contain and control damage, prevent loss of a damaged ship, minimize personnel casualties, and restore and sustain primary mission capabilities.

(5) Mission-Critical System. A system whose operational effectiveness and operational suitability are essential to successful mission completion or to aggregate residual combat capability. If this system fails, i.e., the system is damaged and cannot be restored within a required time, the mission likely will not be completed. Such a system can be an auxiliary or supporting system, as well as a primary mission system.

(6) Threats. Whether they are by design or for assessment, threats are broken up into four categories:

(a) Conventional. Includes all military threats in combat, other than CBRN or terrorist threats.

(b) CBRN. Includes all military use of such weapons in combat.

(c) Terrorist/Asymmetric. Include all forms of threats associated with terrorists or terrorist groups. Terrorist threats may include weapons or other devices that would be a subset of either conventional or CBRN to include toxic industrial chemicals (TICs).

(d) Network-Based Information Systems. Include all threats aimed at denial of service or for covert monitoring and access.

(7) Nuclear Survivability. The capability of a system to withstand exposure to a nuclear environment without suffering the loss of ability to accomplish its designated mission throughout its life-cycle. Nuclear survivability may be accomplished by hardening, timely re-supply, redundancy, mitigation techniques (including operational techniques), or a combination thereof.

(8) HEMP. The electromagnetic radio-frequency radiation from a high-altitude nuclear explosion caused by Compton-recoil electrons and photoelectrons from photons scattered in the materials of the nuclear device or in a surrounding medium. The resulting electric and magnetic fields may couple with electrical or electronic systems to produce damaging current and voltage surges.

(9) CBRN Mission Critical. That subset of mission-critical systems with operational concepts requiring employment and survivability in a CBRN environment.

(10) CBRN Mission Critical List Report. An annual report due from the Services to Office of the Secretary of Defense. These reports identify which systems are mission critical, and of these which must operate and survive in CBR or nuclear environments, such as a HEMP. These reports are intended to be a useful instrument for managing CBRN survivability programs.

(11) CBRN Survivability. The capability of a system to avoid, withstand, or operate during and or after exposure to a CBRN environment (and relevant decontamination), without losing the ability to accomplish the assigned mission. CBRN survivability is divided into CBR survivability, which is concerned with CBR contamination including fallout, and nuclear survivability, which covers initial nuclear weapon effects including blast, HEMP, electromagnetic pulse (EMP) and other initial radiation and shockwave effects.

b. Survivability features for naval ships are provided to protect the ship and crew and to provide the capability for the ship to continue its missions. Thus when determining the appropriate survivability features for a ship design, one of the first questions that must be addressed is to what extent is the ship platform expected to survive and continue to perform its

mission and in what period of time. There are many factors that must be entered into consideration. The traditional factors include the projected mission of the ship being designed, the projected operating environment (POE), the potential threat, and the inherent capabilities of the design being considered. The potential impact on the overall mission of the engaged carrier strike group, expeditionary strike group or in the general war-at-sea region, if this platform were damaged or lost, shall also be considered. These include, but are not limited to, the number and location of personnel onboard, the cost of the platform and the cargo that is being carried, or the potential environmental risk if the ship is damaged or sunk. The decisions made during the early design of the platform are likely to have significant impact on the overall capabilities of the ship and the potential costs of the ship, both initial cost and life-cycle costs. In order to establish an effective survivability requirement for a ship design, overhaul, conversion, or modernization, it is critical that each ship be individually assessed and evaluated, using a systems engineering approach that incorporates all three disciplines of survivability (susceptibility, vulnerability, and recoverability).

5. Objective. To establish a process to be used in the development of specific survivability requirements for surface ships that:

a. Emphasize the necessity for properly assessing and incorporating survivability features early in the ship design process for new construction and implementing critical survivability features within the fleet modernization, service life extension, weapons improvement programs, or other in-service life-cycle programs.

b. Establish a systems engineering approach which supports the generation, modification and refinement of ship specific survivability requirements to account for the specific missions, specific threats, and specific POE for which the ship is being designed, as well as other program specific issues. These requirements may need further modification and refinement as the operational requirements and the details of the design progress. Mission critical and vital systems need to be identified to ensure meeting mission requirements. Enclosure (1) defines the recommended process for deriving survivability requirements.

c. Provide the basis for developing an investment strategy to relate affordability and mission effectiveness issues and for applying priorities to implement survivability enhancements in new construction and critical equipment and systems upgrades.

6. Applicability and Scope. This instruction applies to all Navy surface ship classes and craft, hereinafter referred to as ships, and those procured by the Navy in support of Navy missions, and encompasses all aspects of survivability throughout all phases of the life-cycle.

7. Policy

a. Survivability shall be considered as a fundamental capability similar to other inherent ship capabilities such as weight margins, maneuverability, structural integrity, and combat systems capability. The derived survivability capability constitutes a technical performance requirement.

b. A systems engineering approach shall be used to assess crew and ship survivability performance, risk, cost, and schedule throughout all phases of the ship's life cycle (e.g., requirements generation, design, construction, modernization, backfit, etc.) against the anticipated types of threats, including terrorist or asymmetric, and accidents. These assessments shall consider the ship mission(s), the POE, or any other program specific issues that are applicable and critical.

c. Ship mission performance degradation due to combat damage or accidents shall be addressed in tradeoff and effectiveness assessments (e.g., cost, performance, etc.) conducted during ship design, modifications and overhaul. The focus should be to combine individual functions in a manner that addresses overall system survivability requirements (i.e., susceptibility, vulnerability and recoverability) while minimizing the total ownership cost (TOC). The assessment shall include the impact on operational readiness. These assessments will be used to establish a minimum survivability baseline to be implemented through the inclusion of protective features and processes per appropriate standards.

d. The level of protection against the damaging effects of enemy weapons or accidents shall be a function of the ship size or type, the POE, the projected threat environments, the

projected mission, and other factors that may be unique to the ship design or acquisition program. Enclosure (2) defines the baseline survivability capabilities that must be modified and refined to account for the specific missions, POE, and threats for which the ship is being designed.

e. The survivability requirements established for a specific ship design shall be reviewed (see enclosure (1)), and modified as necessary, to account for changes in the POE, threat, mission, or, when appropriate, the materiel condition of the ship.

f. Ship survivability requirements and objectives shall be approved at the appropriate level during all phases of the life-cycle. The Navy technical authorities shall verify and validate that the ship has met the survivability requirements during all appropriate phases of the life-cycle.

8. Responsibilities and Actions

a. Office of the Chief of Naval Operations Director, Assessments Division (OPNAV (N81)) shall provide associated campaign analysis and CONOPS to the respective program executive office (PEO) and Commander, Naval Sea Systems Command (COMNAVSEASYS COM) chief engineer prior to development of the capabilities development document (CDD).

b. Director, Surface Warfare (OPNAV (N96)) shall implement the responsibilities of the Chief of Naval Operations (CNO) with regard to the determination of survivability requirements and capabilities of surface combatants and naval craft as follows:

(1) Per references (h) and (o), OPNAV (N96) is designated as the CNO's executive agent (EA) for CBRN defense.

(2) The OPNAV's EA for CBRN defense shall be a stakeholder in all naval platform CDD working groups to ensure compliance with CBRN survivability requirements.

(3) Shall direct appropriate programming and budgeting actions to ensure ship survivability initiatives are supported to the maximum extent practicable.

(4) Ensure compliance with reference (a) by appointing a representative to the DoD CBRN Survivability Oversight Group (CSOG) and ensure Navy CBRN mission-critical systems be CBRN survivable per the ICD, CDD and capability production document (CPD) survivability requirements.

c. Director, Air Warfare (OPNAV (N98)) shall implement the responsibilities of the CNO with regard to the determination of survivability requirements and capabilities of nuclear aircraft carriers, and shall direct appropriate programming and budgeting actions to ensure nuclear aircraft carrier survivability initiatives are supported to the maximum extent practicable. Ensure compliance with reference (a) by appointing a representative to the DoD CSOG and ensure Navy CBRN mission-critical systems be CBRN survivable per the ICD, CDD and CPD survivability requirements.

d. Director, Expeditionary Warfare (OPNAV (N95)) shall coordinate with OPNAV (N96) to implement the responsibilities of the CNO with regard to the determination of CBRN survivability capabilities of amphibious and mine warfare ships and shall direct programming and budgeting actions to ensure ship survivability initiatives are supported to the maximum extent practicable.

e. Resource, Requirement, and Review Board (R3B) shall adjudicate cross-platform specific survivability issues referred by Director, Warfare integration (OPNAV (N9I)) or resource sponsors.

f. Director, Strategic Mobility and Combat Logistics (OPNAV (N42)) shall implement the responsibilities of the CNO with regard to the determination of survivability capabilities of the strategic sealift ships and Combat Logistics Force and service support ships assigned to the Military Sealift Command (MSC). Unlike other naval surface ships, ships assigned to MSC are not designed to withstand or recover from battle damage. They will be built to commercial, American Bureau of Shipping Classification Steel Vessel Rules and United States Coast Guard Certification standards. The standards are designed for safety and reliability and to limit the loss of life in the event of fire or flooding. OPNAV (N42) will nominate additional

survivability features to be included in the vessels CDD as appropriate. These additional capabilities will be reviewed and approved by the OPNAV R3B.

g. Deputy Chief of Naval Operations for Information Dominance (CNO (N2/N6)) shall coordinate with resource sponsors to ensure network based information, information operations related systems, and electromagnetic threats are addressed and considered, and HEMP and EMP survivability are coordinated with OPNAV (N42), OPNAV (N95), OPNAV (N96) and OPNAV (N98), respectively. Additionally, CNO (N2/N6) shall be responsible for directing programming and budgeting actions for systems within their cognizance that affect survivability capabilities (e.g., SLQ-32, Surface Electronic Warfare Improvement Program (SEWIP), NULKA, etc).

h. NAVSEASYSKOM (including PEOs and program managers), in coordination with the CNO and in compliance with the oversight and management roles and responsibilities as defined by reference (q), paragraphs 5c and 5f, shall:

(1) Develop and maintain a NAVSEASYSKOM overarching instruction that implements the policies of this instruction.

(2) Act as the surface ship survivability advocate for the U.S. Navy and, in coordination with other systems commands (SYSKOMs), develop programmatic and budgeting plans to implement surface ship survivability requirements in ship design, equipment procurement, and installation processes.

(3) Develop methodologies, measures-of-effectiveness and perform survivability assessments applicable to all phases of the life-cycle to approve the acceptability of the design to the initial, development, and production capabilities documents and operational phase. When feasible, the assessments shall include determination of ship-level survivability effectiveness impact on the task force.

(4) Develop and maintain survivability technical criteria and processes for approving the acceptability of the ship design for each appropriate life-cycle phase. Develop and maintain methods, processes, handbooks, applicable military and federal specifications, manuals, and other directives for designing and evaluating survivability performance against

realistic threats and scenarios. Incorporate battle and accident damage lessons learned into ships during the appropriate life-cycle phases.

(5) Establish and validate survivability assessment standards and procedures matched to actual and anticipated threat effects and accidents, and establish and maintain a responsive test and evaluation capability.

(6) Ensure state-of-the-art awareness of technology and processes that may serve to improve the survivability of ships or craft and ensure transfer of this technology to the acquisition program offices, shipbuilders or other contractors. Evaluation of this technology to minimize TOC shall be included.

(7) Co-chair the Survivability Review Group (SRG) when convened. The SRG shall be a panel of subject matter experts typically convened for the purpose of assessing the survivability features of a ship design. Provide recommendations for improving personnel protection (e.g., CBR, DC, FF, body armor) and individual ship or class survivability, as required. Maintain and update the historical database of lessons learned and SRG recommendations. Establish an incident response capability to provide technical support involving combat or accident damage events.

(8) Act as the technical authority for the CNO whenever events dictate. Provide recommendations for improving personnel protection (e.g., CBR, DC, FF, body armor) and individual ship or class survivability, as required.

(9) Act as the security classification authority for the CNO in regards to classification of ship survivability information. This authority shall not extend to certain aspects of non-acoustic signatures for which Program Manager Research (PMR) 51 at the Office of Naval Research is the classification authority.

(10) Identify capability gaps related to ship survivability, define and prioritize research and development to address those gaps, and act as an advocate for survivability technology investments.

(11) Provide recommendations on updates to enclosure (2) to maintain currency of survivability components for surface ships and craft.

(12) Identify, evaluate and implement changes to survivability features that reduce the TOC of ships while not decreasing the overall ship survivability. TOC reductions shall be considered for implementation throughout all phases of the ships life cycle.

(13) The NAVSEASYSKOM chief engineer shall ensure that the appropriate warranted technical authority has certification responsibility for the first ship in the class or for any new ships whose class has not yet already been certified to meet the established survivability requirement.

i. Other SYSKOMs and all PEOs, in compliance with roles and responsibilities as defined by reference (q) and in conjunction with COMNAVSEASYSKOM, shall:

(1) Provide comprehensive technical management, coordination, assessment, and focus for implementing platform and system survivability requirements across the life-cycle including development, acquisition, operation, and disposal phases as required.

(2) Ensure that the ship survivability requirements and objectives established for development, acquisition, operation and disposal phases of new acquisitions, or for conversions, modernizations, modified-repeat designs and backfit ships are approved at the appropriate level during all phases of the life cycle. Additionally, mission systems and non-mission related systems and equipment shall also be approved at the appropriate level.

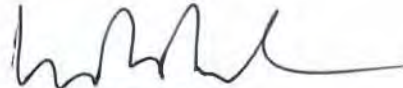
(3) Ensure that survivability requirements are achievable and validated by the Navy technical authorities and approved by the OPNAV for each appropriate phase of the life-cycle.

(4) Incorporate battle and accident damage lessons learned into ships during the appropriate life-cycle phases.

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

10. Report Controls. Reporting requirements contained within this instruction are exempt from reports control per SECNAV Manual 5214.1 of December 2005.

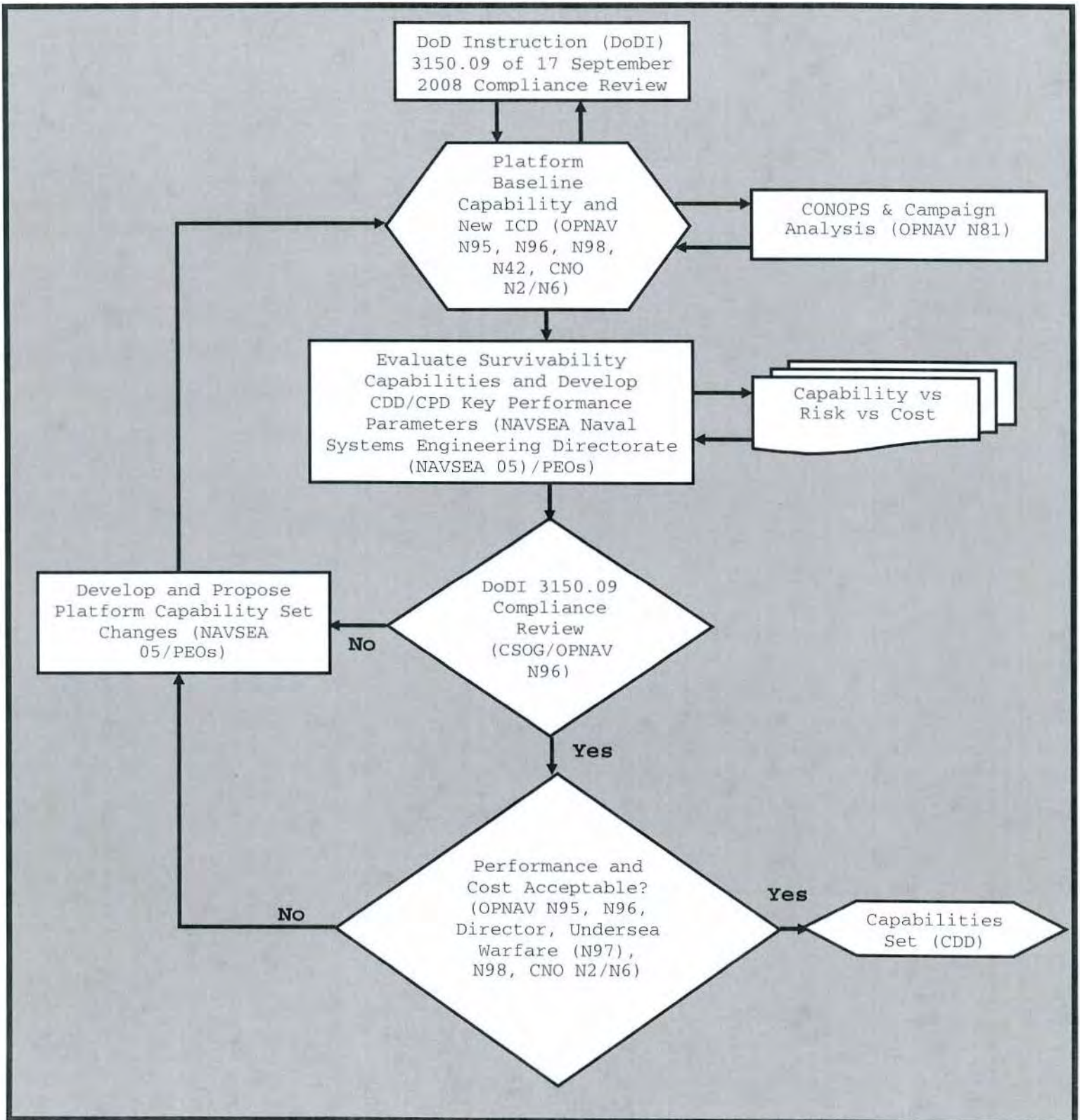


W. R. BURKE
Vice Admiral, U.S. Navy
Deputy Chief of Naval Operations
Warfare Systems

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PLATFORM SURVIVABILITY REQUIREMENTS IN CAPABILITY DEVELOPMENT
DOCUMENT (CDD) GENERATION PROCESS



SURVIVABILITY COMPONENTS OF SURFACE SHIPS

Components of Survivability: Ship survivability components may be categorized in terms of efforts to reduce the ship's susceptibility, vulnerability, or to increase its recoverability capabilities as outlined in the matrices below. These core capabilities may be used to establish survivability baselines for individual ship types, acknowledging the differences in mission, ship size, configuration, and the POE. These guidelines are generally considered to be cost-effective methods to provide protection to personnel and to support sustained mission capability in the applicable projected threat environment. It is not intended to mandate specific systems that are currently in use or production, but rather to outline general survivability enhancement capabilities.

Susceptibility Reduction			
Susceptibility Type	Warfare Area	Susceptibility Reduction	Capability or Component
Detection and targeting avoidance	Air warfare (AW) and surface warfare (SUW)	Signature	Absorbent materials, ship design, insulation, cable shielding
	Undersea warfare (USW)	Signature	Silencing, degaussing, mechanical masking
Hit avoidance and reduction	AW and SUW	Active defenses	surface-to-air missile systems, active electronic warfare measures
		Passive defenses	Point defense systems Decoys
	USW	Active defenses	Point defense systems
		Passive defenses	Decoys, tactical doctrine
Information integrity and accessibility	Information warfare (IW)	Active defenses	Information systems and command, control, communications, computers, intelligence, surveillance and reconnaissance (C4ISR)
		Passive defenses	Information systems, C4ISR

Susceptibility Reduction Cont'd			
Susceptibility Type	Warfare Area	Susceptibility Reduction	Capability or Component
Mitigation of CBRN attacks		Passive defenses	Countermeasure washdown (CMWD) system, decon stations

Vulnerability Reduction (Damage Tolerance)		
Tolerance Type	Vulnerability Mitigation	Capability or Component
Ship loss	Magazine mass detonation prevention	Passive protection, armor, ballistic plating, side and bottom protection.
Conventional Damage Reduction (Blast, Shock and Whipping)	Structural and equipment design improvements	Hull, structural and equipment strength improvements
Nuclear damage reduction	Nuclear protection	Hull, structural and equipment strengthening, shielding and hardened equipment, CMWD system
Fallout removal	Removal of nuclear radiation (fallout, particulate matter) from the exterior of the ship.	A system capable of removing radiological contamination
Chem and bio liquid and particulate	Removal of all forms of chemical and biological liquid and or particulate matter from the exterior of the ship	A system capable of removing chemical and biological contamination
CBR and toxic gases	A network of chemical, biological, toxic gas, and radiological sensors that should be placed both external and internal to the ship	Sensors placed in critical interior and exterior airflow paths that would allow for the early detection and warning to the crew
EMP and HEMP	EMP protection	EMP hardened equipment, shielding, filtering, protective devices, spares

Vulnerability Reduction (Damage Tolerance) Cont'd		
Tolerance Type	Vulnerability Mitigation	Capability or Component
CBR, toxic gases, and TICs	Identification, warning, monitoring (Sense and Shape)	Automatic fixed and portable detection and identification systems, alarms
	Protect personnel (Shield)	CMWD system, collective protection system, individual protective equipment, set circle William, purging procedures
	Collective protection system	Air purification and monitoring system designed to provide fresh air to critical portions of the ship: command and control spaces, medical spaces, and crew rest and recovery area
	Limit external and internal ship contamination (Sustain)	CMWD system, decontamination stations, decontamination agents, collective protections, set circle William, medical prophylaxis
Munitions sensitivity	Damage reduction	Insensitive explosives
Loss of mission critical and vital systems	Redundancy, alternate systems	Primary and alternate power sources, separation of primary and alternate mission systems, ships drawings and common diagrams
Cyber attacks and hacking (internal and external)	Information assurance	Information systems
Malware and malicious code	Information assurance	Information systems

Vulnerability Reduction (Environmental Tolerance)		
Tolerance Type	Vulnerability Mitigation	Capability or Component
Sea state	Structural design improvements	Hull, structural and equipment strength improvements
Icing	Coatings	Paints, composites
Sea water temperature	Temperature regulation systems	Cooling
Air temperature	Air regulation systems	Air conditioners, heat exchangers
Sand and dust	Airtight structures, filtration	Ship design, filtering systems
Vulnerability Reduction (Incidents and Accidents)		
Tolerance Type	Vulnerability Mitigation	Capability or Component
Collisions, groundings	Indications, warnings	Sensors, alarms
	Structural design improvements	Hull and structural strength improvements
Recoverability Enhancements (Fire and Damage Detection, Containment, and Control)		
Recovery Area	Mission Recovery Enhancement	Capability or Component
Smoke	Detection	Sensors
	Desmoking	Smoke ejection system, portable blowers, ventilation, shipboard training
Fire	Detection	Sensors, shipboard training
	Fire suppression and extinguishing	Distributed and redundant seawater sprinkling and hoses, freshwater, aqueous film forming foam systems and hoses, hi-expansion foam, water mist, gaseous agents, portable extinguishers, shipboard training

Recoverability Enhancements (Fire and Damage Detection, Containment, and Control) Cont'd		
Recovery Area	Mission Recovery Enhancement	Capability or Component
Flooding	Dewatering	Main drainage, portable eductors
	Structural design improvements	Increased watertight subdivisions
Heat and fire spread	Structural design improvements	Compartmentalization
	Fire resistant materials, reduced fire load	Insulation, paints, coatings deck coverings, interior finishes, cables, habitability materials, outfitting.
	Fire resistant bulkheads and decks, penetrations	N-class divisions, fire insulation, shipboard training
Recoverability Enhancements (Personnel Protection)		
Recovery Area	Mission Recovery Enhancement	Capability or Component
Heat and fire	Detection, resistance	Sensors, FF ensemble, FF equipment
CBR	Detection, monitoring, protect personnel	Individual protective equipment, automatic fixed and portable detection and identification systems, collective protection system, medical prophylaxis
CBR decontamination	One or more decontamination stations which allow passage from the exterior of the ship into interior areas which are clean of liquid or particulate contamination	Decontamination stations should be capable of processing ambulatory personnel and the processing of litter borne causalities
Hazardous atmospheres	Detection, ventilation	Sensors, emergency breathing devices, portable blowers, ventilation, shipboard training

Recoverability Enhancements (Capability Restoration)		
Recovery Area	Mission Recovery Enhancement	Capability or Component
Loss of mission critical and vital systems	Reconfiguration and reconstitution	Casualty power, ships drawings and common diagrams, portable communications, spares, separation and redundancy of systems