METRIC

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SECTION 072 - PART 3A
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SECTION 072 - PART 3
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(See 6.4)

MILITARY STANDARD

INTERFACE STANDARD FOR SHIPBOARD SYSTEMS

SECTION 072 - PART 3

BLAST ENVIRONMENT, NUCLEAR WEAPONS (METRIC)

AMSC N/A
FSC 1990

DEPARTMENT OF THE NAVY
NAVAL SEA SYSTEMS COMMAND

Washington, DC 20362-5101

Interface Standard for Shipboard Systems, Blast Environment, Nuclear Weapons

1. This military standard is approved for use by all interested Commands of the Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

2. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, Naval Sea Systems Command, SEA 55Z3, Department of the Navy, Washington, DC 20362-5101 by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FOREWORD

1. Purpose. This section defines the standard interface requirements for, and the constraints on, the design of ship structure and equipment which may be exposed to the shipboard topside air blast environment caused by nuclear weapon explosions.

2. Nature of the interface. Navy ships may be subject to air blast resulting from nuclear weapon explosion. This blast environment is variable both in its nature and in its effects which may weaken or deform the ship structure and degrade the performance of exposed shipboard equipment. To reduce the potentially adverse effects of the blast environment, the ship structure and exposed equipment are required to satisfy established test or design standards. The effects of shipboard blast may also be reduced through the application of arrangement or installation blast mitigating measures.

3. Structure. The technical content first delineates the characteristics in terms of blast overpressure parameters. The constraints on equipment design and installation which are necessary to achieve shipboard compatibility with these characteristics are then established.

4. Numerical quantities. Numerical quantities stated in this section are expressed in metric (SI) units and may be followed by inch-pound units in parentheses. The SI equivalents of the inch-pound units are approximated to a practical number of significant figures. When parenthetical values are given in inch-pound units, the inch-pound units are to be regarded as the current specified magnitude.

CONTENTS

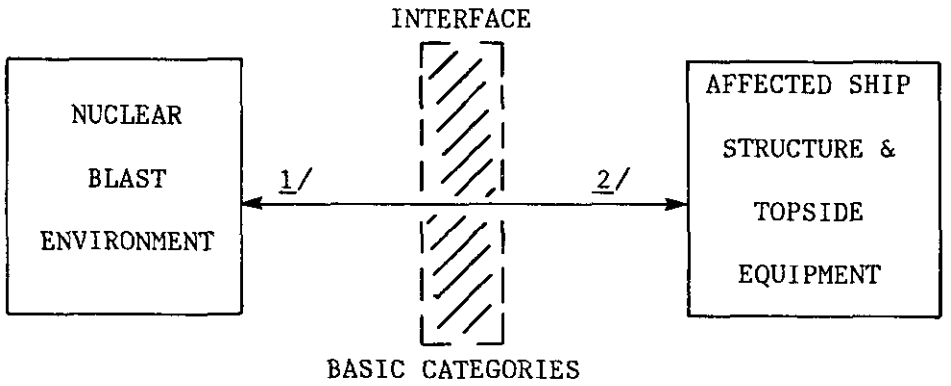
FIGURES

1. GENERAL, SCOPE, INTERFACE, AND APPLICABILITY

1.1 General. The procedures established by DOD-STD-1399 are mandatory. This section and the basic standard, that is, DOD-STD-1399, shall be viewed as an integral single document.

1.2 Scope. This section establishes interface requirements for ship structure and ship topside equipment whose performance will be adversely affected by nuclear weapons air blast (including thermal pulse) to ensure compatibility between such structure/equipment and the effects of nuclear air blast.

1.3 Interface. The basic characteristic and constraint categories concerned with this interface are shown symbolically on figure 1 (see definitions of DOD-STD-1399).



1/ CHARACTERISTICS

- Peak overpressure
- Peak dynamic pressure
- Positive phase duration
- Thermal pulse
- Reflected overpressure

2/ CONSTRAINTS

- Compatibility
- Design - (structure/equipment)
- Location
- Protection

FIGURE 1. Interface.

The particular interface characteristics and constraints pertinent to this section are described in 5.3 and 5.4.

1.4 Applicability. The criteria of this section shall be applicable to new ship acquisitions, modernizations or conversions, and to equipment intended for installation on board such ships. Equipment intended for installation on board active fleet ships shall possess blast resistance characteristics equal to or better than those originally required for the ship in question. The criteria of this section do not apply to non-combatant ships. For shock effects resulting from nuclear air blast, nuclear thermal radiation and the nuclear electromagnetic pulse (NEMP) see DOD-STD-1399.

2. REFERENCED DOCUMENTS

2.1 Government document.

2.1.1 Standard. Unless otherwise specified, the following standard of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DoDISS) specified in the solicitation forms a part of this standard to the extent specified herein.

STANDARD

MILITARY
DOD-STD-1399 - Interface Standard for Shipboard Systems.

(Copies of standards required by contractors in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Order of precedence. In the event of a conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence.

3. DEFINITIONS

3.1 Overpressure. Overpressure is the air pressure, above ambient pressure, measured behind the shock front.

3.1.1 Reflected overpressure. Reflected overpressure is the resulting pressure which occurs when the incident overpressure wave strikes a surface and is then reflected, resulting in an instantaneous increase in pressure above the existing overpressure. The value of the reflected overpressure includes the incident overpressure.

3.2 Dynamic pressure. Dynamic pressure is associated with the blast wind and is the result of gross violent movement of the air accompanying the blast wave. A dynamic pressure proportional to the square of the wind velocity and to the density of air in the shock wave accompanies the blast overpressure. For overpressure less than 480 kilopascals (kPa) (70 pounds per square inch (lb/in^2)), the dynamic pressure is less than the overpressure (see 5.3.2).

3.3 Positive phase duration. Positive phase duration is the elapsed time from arrival of the blast wave until it decays to ambient pressure.

3.3.1 Negative phase duration. The negative phase duration follows the positive phase. For the purposes of this standard, it is of no consequence because of its real value and may be ignored.

3.4 Thermal pulse. Thermal pulse is the intense radiated heat generated by the nuclear air burst preceding the blast wave. It is expressed in joule per square meter (J/m^2).

3.5 Arrival time. Arrival time is the time from detonation to the arrival of the blast front at the point in question.

4. GENERAL REQUIREMENTS

4.1 General requirement. The specific interface requirements and constraints established herein are mandatory and shall be adhered to by SYSCOMs, project managers, contractors, and all others engaged in any aspect of ship design and shipboard equipment design to which these requirements and constraints apply including systems or equipment design, production, and installation (see requirements of DOD-STD-1399).

5. DETAILED REQUIREMENTS

5.1 Interface characteristics and constraints. Interface characteristics and constraints shall be in accordance with 5.2 through 5.4.3.

5.2 General considerations. The in-air noncontact explosion of a nuclear weapon will produce a blast environment which will adversely affect topside structure and installed equipment of any ship which may be exposed to this environment. This blast environment is pervasive, and covers the entire topside area of the ship. The blast wave travels outward from the source at high velocity and is characterized by a very sharp rise in pressure above ambient followed by a somewhat gradual decay back to the ambient pressure. The magnitude of the nuclear blast environment will be defined in terms of peak overpressure, peak dynamic pressure, positive phase durations, and thermal pulse. The magnitude of the blast parameters will vary depending on the weapon yield and the distance of the explosion from the ship. The overriding effect of very large weapons in air bursts tends to be thermal radiation while the effect of middle and small tactical size weapons tends to be air blast. Since it is neither reasonable nor practical to attempt to protect a ship to survive a direct hit with a nuclear weapon, design decisions for the feasible levels of protection shall be required.

5.3 Interface characteristics. The interface characteristics of the ship's nuclear blast environment are specified in 5.3.1 through 5.3.4. These characteristics will be present on all ships exposed to this environment and will have an adverse effect on topside structure and exposed equipment.

5.3.1 Overpressure. Nuclear explosions create a shock wave traveling outward at a velocity greater than the speed of sound. At the ship an instantaneous overpressure above ambient occurs, at a very short time after detonation. This overpressure then decays to ambient in a given time period (positive phase duration). This overpressure creates a diffraction loading which is particularly important on large solid structures and whose duration is time-dependent on the geometry of the structure concerned. The typical time-phased variations of the overpressure parameters are shown on figure 2. The Principal Development Activity (PDA) will provide the peak overpressure and positive phase duration values to be used in specific ship and acquisition specifications (see 5.3.4).

5.3.1.1 Reflected overpressure. When the incident overpressure wave strikes a surface, it is reflected and there is an instantaneous increase in the pressure at the surface above the overpressure, followed by a rapid decay to the overpressure stagnation pressure, which is the sum of the overpressure and dynamic pressure. The instantaneous peak reflected overpressure for a flat surface normal to the shock wave front is directly related to and may be two to eight times as great as the peak overpressure, and it is given by:

$$P_r = 2p \left(\frac{7p_o + 4p}{7p_o + p}\right)$$

where: p_r = the instantaneous peak reflected overpressure
p = the peak overpressure
p_o = the ambient pressure ahead of the shock front

The value of the reflected overpressure includes the incident overpressure.

5.3.2 Dynamic pressure. There is a gross violent movement of the air which accompanies the overpressure blast wave and creates a dynamic pressure whose magnitude is related to the overpressure and whose pressure time history is similar in shape to that of the overpressure. The peak dynamic pressure for a given peak overpressure is given by:

$$q = \frac{5}{2} \frac{p^2}{7p_o + p}$$

where: q = the peak dynamic pressure
p = the given peak overpressure
p_o = the ambient pressure ahead of the shock front

The dynamic pressure of concern is less than the overpressure, and its positive phase duration may be assumed to be the same (see figure 2). The high velocity winds associated with the dynamic pressure generate a drag loading which is particularly important on open frame structures such as some types of antennas, masts, and other exposed equipment. This drag pressure loading is obtained by multiplying the dynamic pressure by the appropriate drag coefficient for the particular structure. The PDA will provide the peak dynamic pressure and positive phase duration values to be used in specific ship and acquisition specifications (see 5.3.4).

5.3.3 Thermal pulse. A thermal pulse precedes the air blast. This pulse is expressed in total J/m^2 received prior to arrival of the blast front. For design purposes, the thermal pulse shall be considered in connection with the air blast effects. The PDA will provide the numerical values to be used in specific ship and acquisition specifications (see 5.3.4).

5.3.4 Protection parameters. The PDA will select the specific protection parameters for overpressure and dynamic pressure. The PDA will also provide the specific protection parameters for thermal pulse as required by current ship protection policy.

5.4 Interface constraints. The interface characteristics of the shipboard nuclear weapon air blast environment impose certain constraints on the design of topside ship structure and installed equipment exposed to this environment. These constraints are as specified in 5.4.1 through 5.4.3.

5.4.1 Compatibility. The design of shipboard structure and equipment exposed to the nuclear weapon air blast environment shall be compatible with the interface characteristics given in 5.3.

5.4.2 Equipment design. Equipment which will be adversely affected by the nuclear blast environment shall be designed to withstand that environment. Such equipment shall be tested (or if testing is not practical, be designed) for conformance to the blast design requirements of the acquisition document.

5.4.3 Location criteria. To the maximum extent practical, equipment and appurtenances which will be adversely affected by the nuclear blast environment shall be located in the interior of the ship structure rather than topside.

6. NOTES

6.1 Intended use. This standard is intended for new ship and equipment acquisition, ship modernization in the active fleet and for technical development plans, where applicable.

6.2 Conditions. In achieving the purpose of this section, it is recognized that there must be some flexibility of application. During the early design stage of ship structure and equipment which will be exposed to the nuclear weapon air blast environment it may become apparent that significant advantages in the overall design operation of such structure or equipment may be achieved by deviating from the standard characteristics specified herein. In such instance, the deviation provisions of DOD-STD-1399 must be complied with.

6.2.1 Requests for deviations should be submitted to the NAVSEA Surface Ship Protection group.

6.3 Subject term (key word) listing.

Air blast, shipboard topside
Blast mitigating measures
Blast overpressure parameters
Interface shipboard
Reflected overpressure
Thermal pulse, nuclear blast

6.4 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Review activity:
EC

User activities:
SA, OS, AS, SS

Preparing activity:
Navy - SH
(Project 1990-N049)

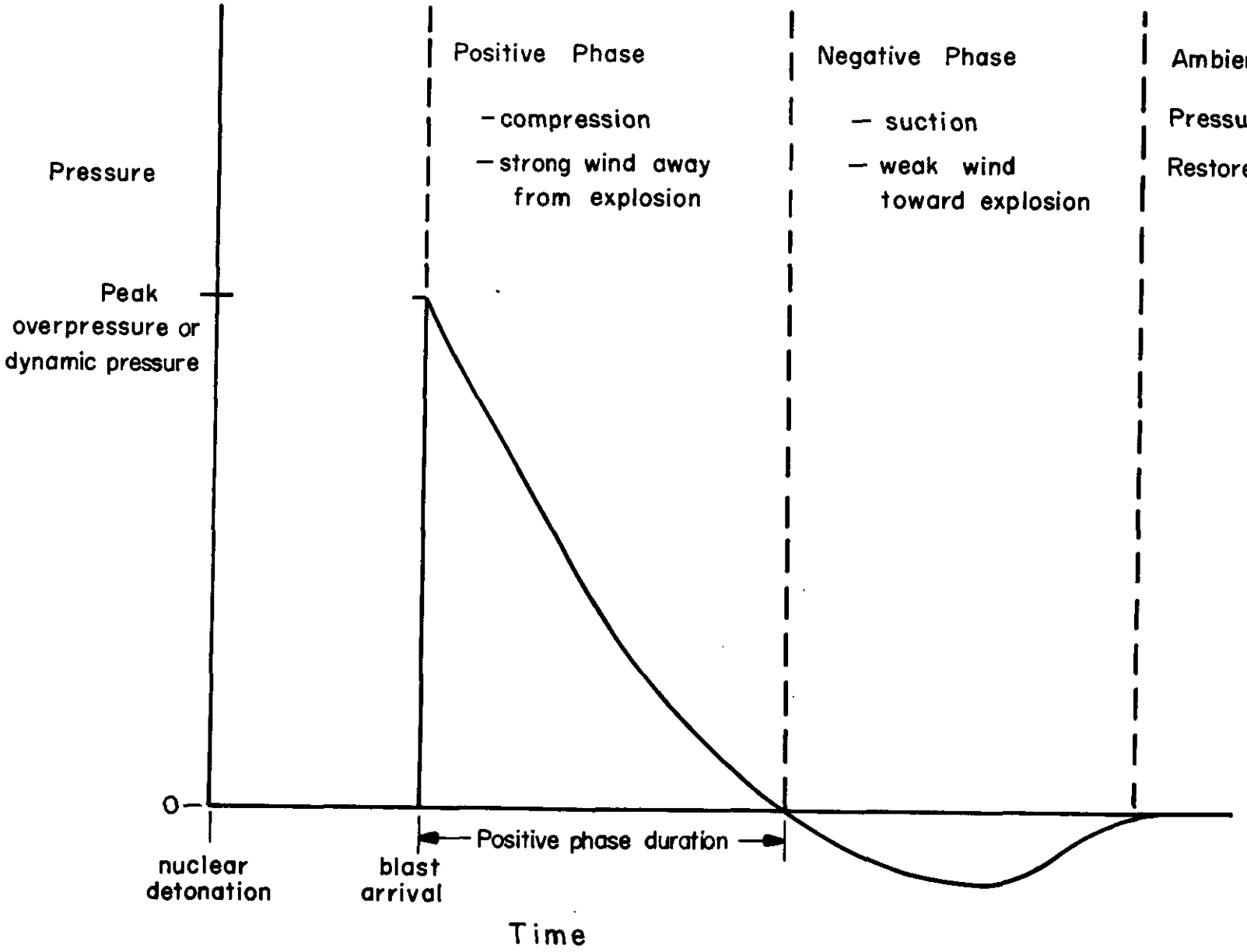


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FIGURE 2. Free field nuclear blast wave.