INCH-POUND

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section 072.1
24 October 1991

SUPERSEDING
MIL-STD-1399(NAVY)
Section 072.1
14 October 1977

MILITARY STANDARD

INTERFACE STANDARD FOR SHIPBOARD SYSTEMS
SECTION 072.1
BLAST ENVIRONMENT, MISSILE EXHAUST

AMSC N/A FSC 1990

FOREWORD

1. This Military Standard is approved 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 self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

3. Navy ships are subject to the blast created by the launch of their own missiles, The blast environment is variable both in its nature and in its effects which may damage ship structure, degrade the performance of shipboard systems and equipment or cause injury to personnel. To reduce the potentially adverse effects of the blast environment, ship structure is required to meet established design standards, while ship systems, equipment and personnel must be protected through proper arrangement, shielding and protective practices.

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L SCOPE

1.1 Purpose. Policies and procedures established by MIL-STD-1399 are mandatory. (This section defines the standard interface requirements for the design of systems, equipment and structure which may be subjected to the blast generated by missile launches.) This section and the basic standard are to be viewed as an integral single document.

1.2 Scope. This section addresses the intake characteristics of missile blast effects generated by the launch of anti-air, anti-surface anti-submarine, and point defense missiles from surface ship arm launchers, vertical launchers and boa launchers. This section does not apply to submarine launched missiles.

1.3 **Interfaces.** The basic characteristics and constraint categories of this interface are shown symbolically on figure 1. The specific interface characteristics and constraints pertinent to this section are described in section 5.

1 0 4 Applicability. The criteria of this section are applicable to new ship acquisitions, modernizations, or conversions, and to systems and equipment intended for installation on board such ships. Systems and equipment intended for installation on board active fleet ships shall possess blast resistance characteristic not less than those originally required for the ship in question. The criteria of this section apply only to ships designed for the installation of missiles.

2. APPLICABLE DOCUMENTS

2.1 Government publications. The following Government publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation.

PUBLICATIONS

NAVAL SEA SYSTEMS COMMAND (NAVSEA)

S9072-AJ-MAN-010/BLAST PROT	Design Guidance Manual for Gun and Missile Blast Protection

(Application for copies should be addressed to Standardization Document Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2 Order of **precedence.** In the event if a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 Missile blast. Missile blast (consists of a highly directional stream of erosive, high velocity, high temperature combustion products resulting from the launch of a missile, In addition to gas products, the axhaust stream may contain a signifant amount of liquid and solid particles of aluminum oxide, which is highly abrasive

3.2 Direct Blast Areas. Direct blast areas are those, areas exposed to direct line of impingement by the exhaust phone of the missile as it leaves its launcher. This applies fo potential missile launching orientations and fly-away paths. The direct blast area for rotating launchers will be based on the projected or actual launcher orientations allowed by the fixing control cut-out cam. The direct blast area for vertical launch systems will include considerations for worst-case conditions of missile fly-away angles, ship motion and relative wind. The direct blast area for missiles in fixed canister and box launcher will consist of the area encompassed by a 45 degree conic projection on adjacent deck/bulkhead areas unless a blast deflector is provided.

3.3 Reflected blast areas. Reflected blast areas are those areas outside the direct blast areas onto which the exhaust stream is deflected after impinging on **a** deck or bulkhead in the direct blast area. The reflected blast area also include areas where concentrations of exhaust gasses may collect.

3.4 Blast shields. Blast shields are structural plates used to protect an item from the missile exhaust stream in direct blast areas.

4. GENERAL REQUIREMENTS

4.1 General requirements. 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 shipboard design to which these requirements and constraints apply including systems/equipment design, production, and installation.

5. DETAILED REQUIREMENTS

5.1 General considerations. The launch of ship's missiles creates high localized temperatures and prussures, high energy erosive debris, smoke and toxic gases within the vicinity of the launcher. The nature of this environment may cause damage to nearby equipment and structure, cause discomfort or a health hazard to crew members exposed to the gases, and may interfere with the peformance of certain topside systems. Shipboard equipment exposed to missile blast are typically damaged by one or more of the following effects:

a. Burning
b. Surface erosion
c. Paint blistering

d. Gasket deterioration
e. Warping
f. Local structural failure of small fittings and attachments
g. Coating by aluminum oxide

Additionally, personnel stationed on weather decks maybe subjected to exhaust gases or the gases may be ingested into interior spaces of the ship through ventilation intakes or other openings. Visual observation from the bridge and operation of line-of-sight systems such as laser designators and optical and infrared sensors will be impaired by the exhaust aloud until it dissipates

5.2 Interface characteristics. The interface characteristics of the missile blast environment consist of the following elements:

a. Temperature (see 5.2.1)
b. Pressure (see 5.22)
c. Erosive debris (see 5.2.3)
d. Smoke (see 5.24)
e. Toxic gases (see 5.25)

These characteristics will be present on all ships with installed missile systems.

5.2.1 Temperature. The missile exhaust stream forms a long, narrow **cone-shaped plume** of high temperature gases. Temperatures at the core of the plume range from 1500 degrees Fahrenheit **(°F)** for a Tomahawk booster to 6000 °F for a Standard Missile 2 (SM2) booster. Gas temperatures over 1000 °F may be experienced up to 100 feet downstream of the SM2 These high temperatures exist, however, for only a very short period of time, generally under 1 second.

5.2.2 Pressure. The overpressure experienced by objects in a direct blast area results from the direct impingement of the supersonic stream of exhaust gases and particles. Pressures in the direct blast areas range from a few psi for the Tomahawk Mk 106 to 100 psi for the SM2 Mk 70, as an example.

5.2.3 Erosive debris. Liquid droplets and solid particles of aluminum oxide are present in the exhaust stream of those boosters which use aluminum as a constituent element. These droplets and particles are a major contributor to the heating and erosion effects of the missile exhaust stream. The solid particles cause an abrasive ‘sand blasting" effect, while the liquid droplets penetrate crevices and openings before solidifying on exposed surfaces. The SM family is the main concern with regard to erosive debris.

5.2.4 Smoke. Missile launch creates large clouds of smoke which may remain in the vicinity of the launch point from a few seconds to a few minutes depending on the relative wind and weather conditions. While this cloud will not create any interference with radio wave systems, it will degrade the performance of sensors which operate in the lower electromagnetic spectrum, such

as laser designators, and optical and infrared devices. The infrared and visible light emission/ absorption characteristics of the launch cloud may pose a significant problem for these systems. Visual observation from the bridge may also be impaired during ripple or salvo launches.

5.2.5 Toxic gases. The principal toxic gases contained in the launch cloud are hydrogen chloride (HCI), a colorless gas with an irritating pungent odor, and carbon monoxide (CO). Both gases are hazardous to crew members. HC1, in particular, is an immediate danger to life, if in excess of allowable limits. Launch cloud and toxic gas concentration prediction methods are addressed in NAVSEA S9072-AJ-MAN-010/BLAST PROT.

5.3 Parameters. The missile blast parameters for application to any specific ship or equipment design must be developed on a case basis from:

a. Missile and booster type
b. Launcher type
c. Ship Configuration
d. Launcher train and elevation arcs if applicable
e. Missile fly-away paths
f. Smoke and toxic gas production

The blast characteristics arc determined from pressure-temperature curves specific to each missile booster type which plot temperature and pressure as a function of axial and radial distance from the nozzle centerline, as shown on figures 2 and 3 for a Standard Missile Mk104 Dual Thrust Rocket Motor (DTRM). These curves, which when overlaid on a ship configuration drawing along with the envelope of potential missile fly-away paths, determine the local direct blast environment. The reflected blast areas are determined from an evaluation of the exhaust stream flow paths and areas of concentration of exhaust gases. Figure 4 shows the direct and reflected blast areas developed for a vertical launching system The local blast pressures and temperature as shown on figures 5 and 6 for the forward vertical launching system on DDG 51, can be developed by hand for rough approximations, by computer program, or by actual shipboard measurements. Smoke and toxic gas spread must be estimated from wind flow patterns around the ship's superstructure and ship system arrangements, with consideration given to the potential concentration of smoke and gases in flow stagnation areas.

5.4 Areas of application. The direct and reflected blast areas will be designated by the Principal Development Activity (PDA).

5.5 Interface constraints. Interface characteristics of the missile blast environment impose certain constraints on the design of ship structure, and on the design and installation of systems and equipment located in the designated blast areas. These constraints are described in 5.5.1 through 5.5.5.

5.5.1 System/equipment location and installation. To the maximum extent practicable, equipment which may be damaged by or malfunction as a result of the missile blast temperature, pressure, or erosive debris, shall be located out of designated missile blast areas The susceptability of equipment to damage by missile blast shall be determined by the developing activity. Items located in blast areas shall be installed and protected in accordance with NAVSEA S9072-AJ-MAN-010/BLAST PROT and other applicable specifications.

5.5.2 Shielding. Shielding may be provided for susceptible items which must be located in direct blast areas and are subject to the blast temperature, pressure and erosive debris. small items should utilize the natural shielding of larger items where possible Blast shields shall be designed to take into account the worst case effects of a restrained burn should a missile hang up at launch. NAVSEA S9072-AJ- MAN-010/BLAST PROT provides guidance concerning shielding methods.

5.5.3 Weather openings. Protection of the ventilation collective protection system (CPS) from missile blast is concerned primarily with preventing the ingestion of gases and smoke into the interior of the ship. Weather openings for ventilation or CPS intakes shall not be located in blast areas unless not practicable otherwise. In such cases, automatic gas exclusion devices to prevent ingestion of gases shall be installed. NAVSEA S9072-AJ-MAN-010/BLAST PROT provides guidance concerning protection of weather openings.

5.5.4 Structural design. Ship structure located in direct blast areas shall be designed in accordance with NAVSEA S9072-AJ-MAN-01 O/BLAST PROT. In some instances, a protective ablative mating may be required to protect deck or bulkhead surfaces from the missile exhaust stream close in to the launcher. NAVSEA S9072-AJ-MAN-01 O/BLAST PROT includes information on ablative protection coatings.

5.5.5 Toxic gases. Exposure of personnel to the toxic gases generated by missile Launchings is limited under guidelines issued by the Bureau of Medicine and Surgery (BUMED). NAVSEA S9072-AJ-MAN-01 O/BLAST PROT discusses these guidelines.

5.6 Compatibility. Design, location, and installation of ship systems, equipment, and structure shall be compatible with the missile blast interface characteristics given in 5.2 to the extent specified by the PPA.

5.7 Deviations

5.7.1 Conditions In achieving the purpose of this section, it is recognized that there must be some flexibility of application. If during the design of ship structure and systems/equipment, it becomes apparent that significant advantages can be achieved by deviating from the standard characteristics specified herein, then the provisions of 5.7.2 shall be complied with.

5.7.2 Deviation procedure. When a deviation from the requirements of this standard can be justified, requests for deviation shall be prepared (see 62).

6. NOTES

(This section **contains** information of a general or explanatory nature that maybe helpful, but is not mandatory.)

6.1 Intended use. This standard is to be used in technical development plans and in design and acquisition specification for ship acquisitions, modernizations, or conversions, and shipboard systems and equipment.

6.2 Data requirements. The following Data Item Descriptions (DID's) must be listed, as applicable, on the Contract Data Requirements List (DD Form 1423) when this standard is applied on a contract, in order to obtain the data expect where DOD FAR Supplement 27.475-1 exempts the requirement for a DD Form 1423.

Reference paragraph	DID No.	DID title	Suggested tailoring
5.7.2	DI-CMAN-80639	Engineer Change Proposals (ECP's)	
5.72	DI-CMAN-80644	Engineer Change Proposals (ECP's) (Short Form)	

The above DID's were those cleared as of the date to this standard. The current issue of DOD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL), must be researched to ensure that only current, cleared DID's are cited on the DD Form 1423.

63 Subject term (key word) listing.

Blast shield
Direct blast area
Launcher
Missile blast

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

Review activities
EC, AS, OS

Preparing activity
Navy - SH
(Project 1990-N070)

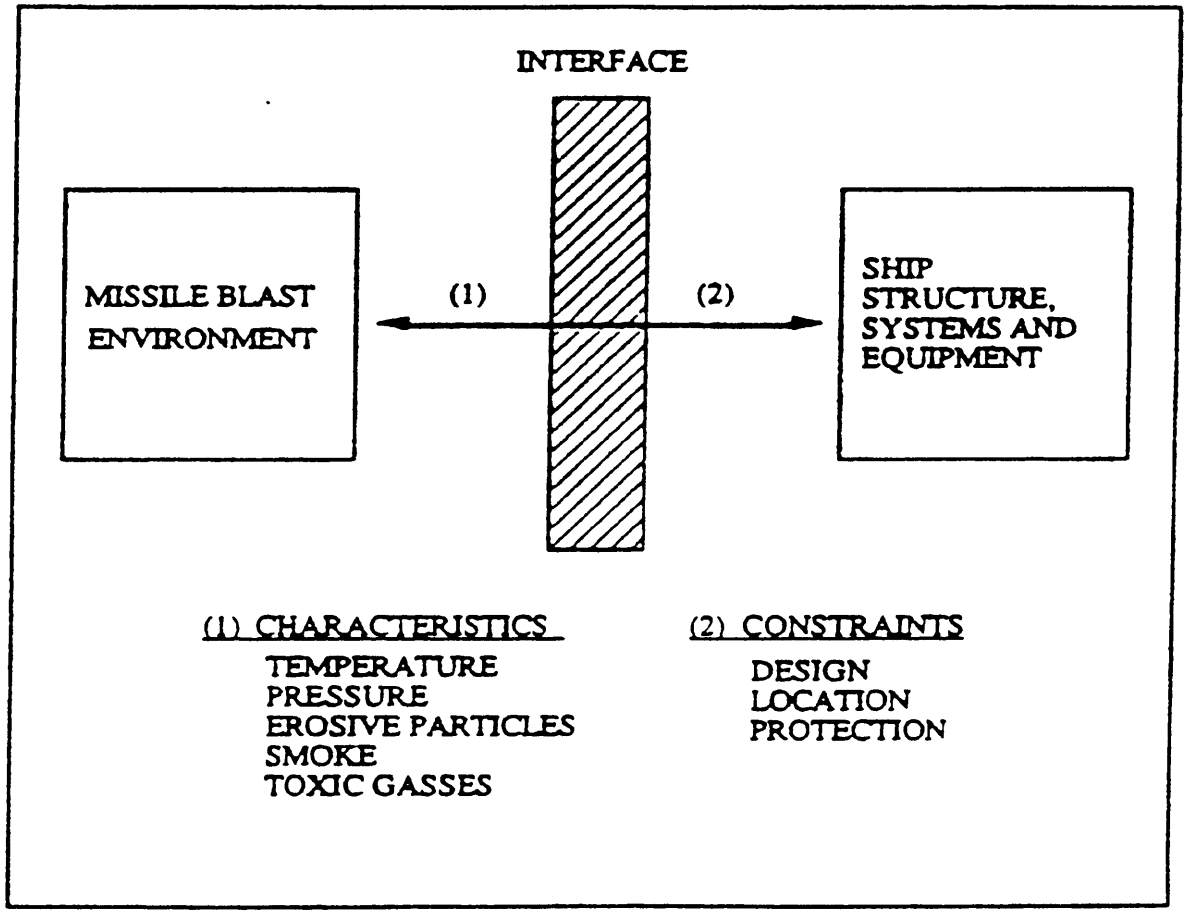

FIGURE 1. *Missile blast interface diagram.*

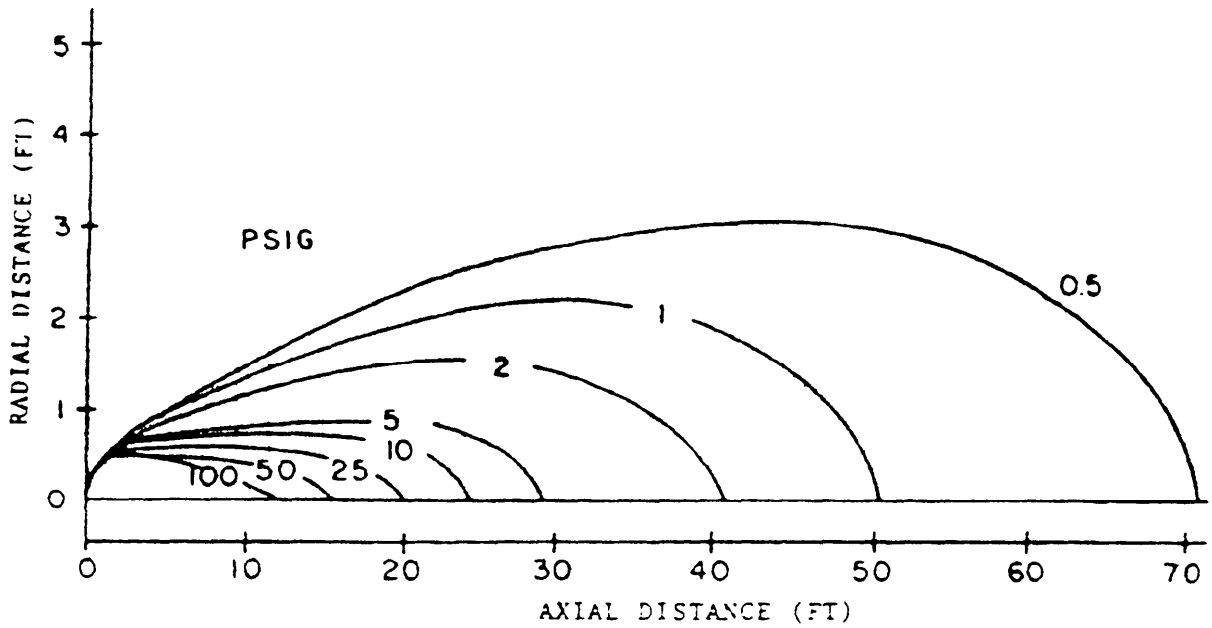

FIGURE 2. *Standard Missile Mk 104 DTRM stagnation pressure contours.*

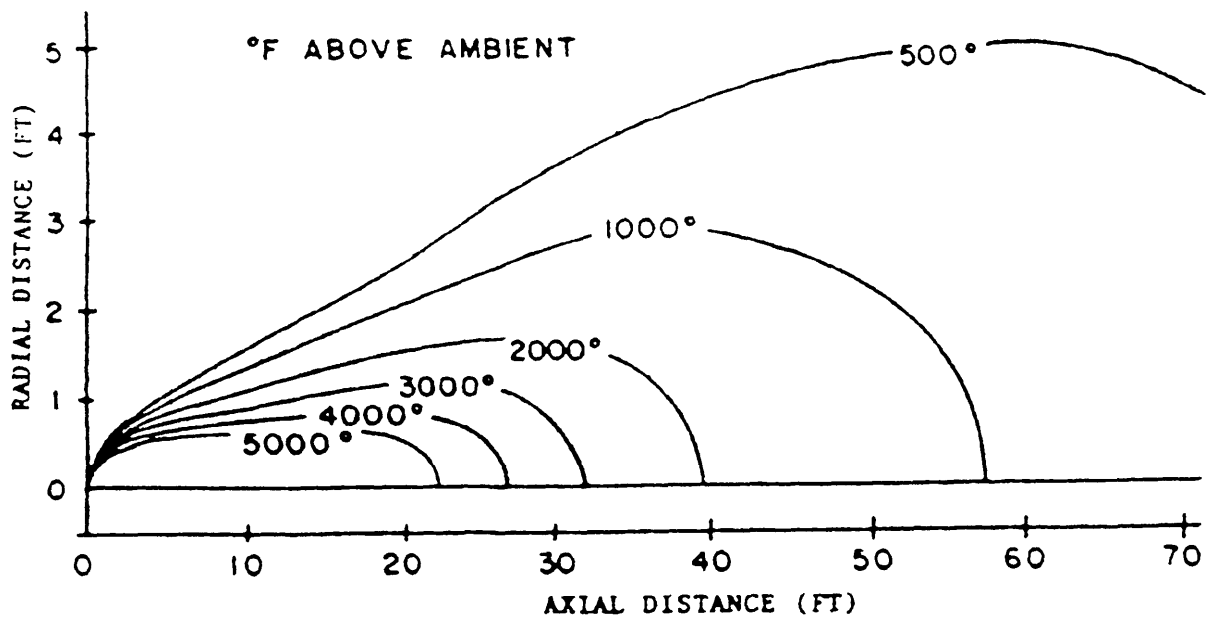

FIGURE 3. *Standard Missile Mk 104 DTRM stagnation temperature contours.*

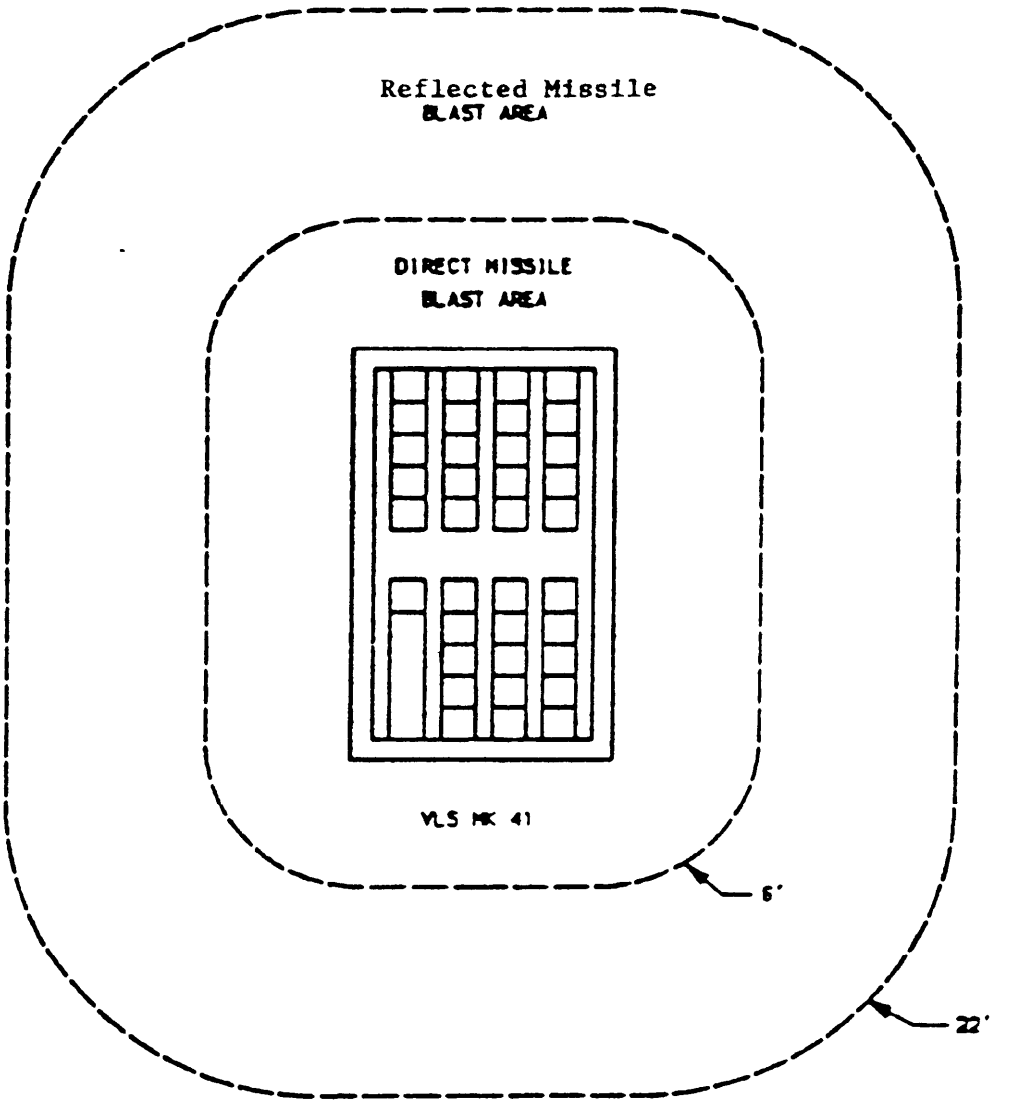

FIGURE 4. *Typical direct and reflected blast areas around vertical launch system.*

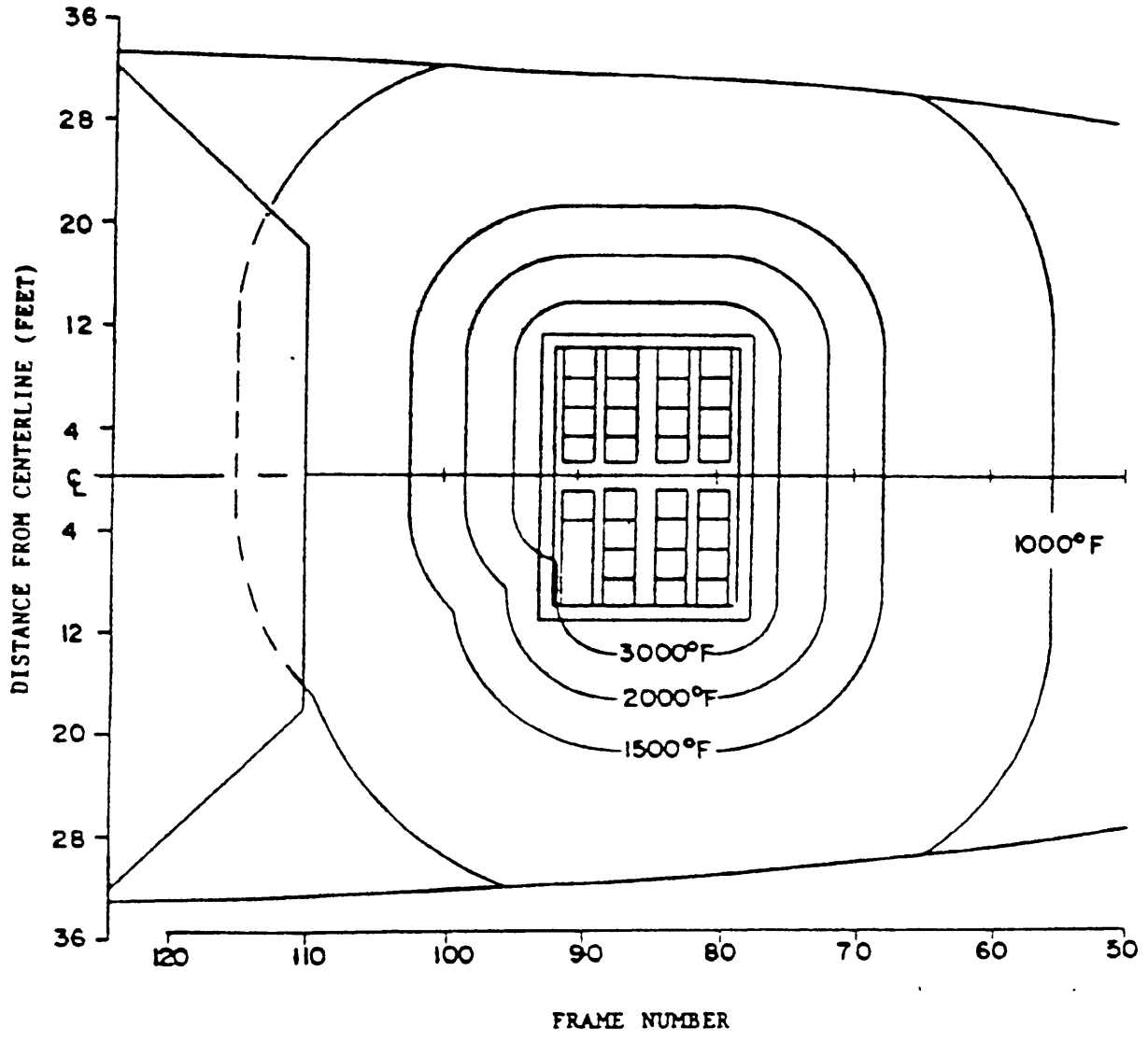

FIGURE 5. *Missile blast temperatures on forward deck of DDG 51 around vertical launch system.*

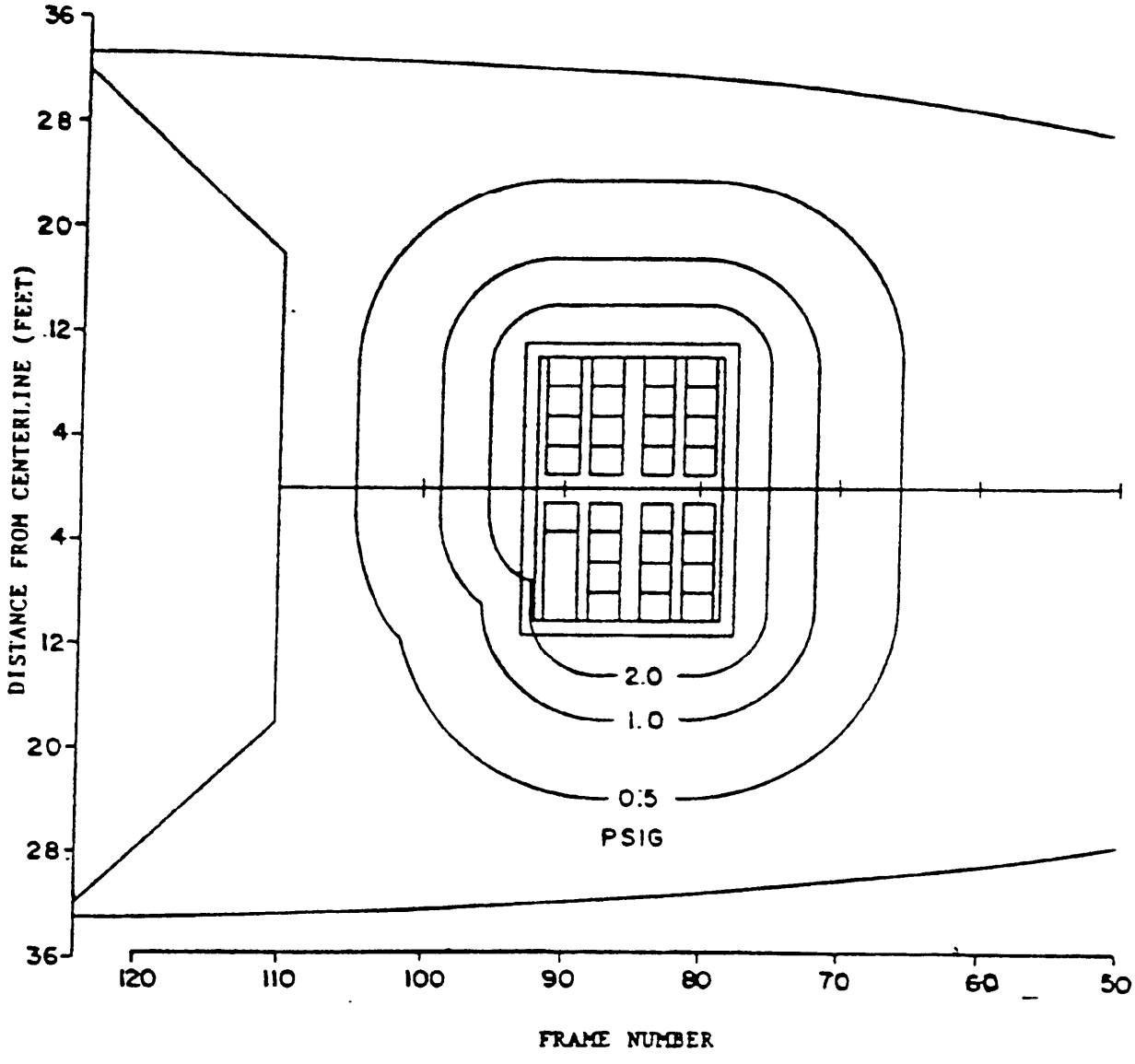

FIGURE 6. *Missile blast pressures on forward deck of DDG 51 around vertical launch system.*

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

INSTRUCTIONS

1. The preparing activity must complete blocks 1, 2, 3, and 8. In block 1, both the document number and revision letter should be given.
2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

NOTE: This form may not be used to request copies of documents, nor to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

1. DOCUMENT NUMBER	2. DOCUMENT DATE (YYMMDD)
MIL-STD-1399A(SH) SECTION 072.1	911024

3. DOCUMENT TITLE
INTERFACE STANDARD FOR SHIPBOARD SYSTEMS SECTION 072.1 BLAST ENVIRONMENT, MISSILE EXHAUST

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME	b. ORGANIZATION
c. ADDRESS (Include Zip Code)	d. TELEPHONE (Include Area Code)	e. DATE SUBMITTED (YYMMDD)
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7. PREPARING ACTIVITY

a. NAME	b. TELEPHONE (Include Area Code) (1) Commercial	(2) AUTOVON
TECHNICAL POINT OF CONTACT: Mr. Michael Said, SEA 55X12	703-602-2379	332-2379
c. ADDRESS (Include Zip Code)	IF YOU DO NOT RECEIVE A REPLY WITHIN 45 DAYS, CONTACT:
COMMANDER, NAVAL SEA SYSTEMS COMMAND SEA 55Z3 WASHINGTON, DC 20362-5101	Defense Quality and Standardization Office 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466 Telephone (703) 756-2340 AUTOVON 289-2340