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AUTHORITY
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NAVAL SHIP SYSTEMS COMMAND
SYMPOSIUM ON TECHNICAL DATA MANAGEMENT
SEPTEMBER 12-14, 1967
GSA AUDITORIUM AT 18TH AND F STREETS, N.W.,
WASHINGTON, D.C.

COMPUTER-AIDED SHIP SPECIFICATIONS

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ENCL. (1) TO NAVSHIPS LTR SER 2052-T
Ship specifications are the primary technical documentation, referenced in the contract or purchase order, for the construction of all U. S. Navy ships. The ship specifications contain technical requirements and information relating to the construction of a particular ship or class of ships and describe the essential features, functions, and arrangements. Together with the contract drawings and contract guidance drawings, they define the work and responsibilities of the shipbuilding contractor in preparing working drawings and other documentation; and building and equipping the ship. Detailed requirements for equipment are contained in referenced documents, such as Military Specifications, and standard or type drawings.

The basis for each ship specification is the General Specifications for Ships of the U. S. Navy (Gen. Specs.). This specification contains requirements generally applicable to all ships and is updated every 3 months. I would like to quote from the preface of the first Gen. Spec. This preface is dated July 22, 1908, so you can see the Gen. Specs. have been around for quite a while.

In order to secure, as far as practicable, uniformity of practice, workmanship, and procedure in the construction of vessels of like type at the various building yards, and to avoid unnecessary repetition . . . .

You can see that the intent of the Chief Constructor in issuing the Gen. Specs. was to achieve standardization of shipbuilding practices and specifications. Detail (e.g.,) specifications were first prepared
in an inference style, containing statements of exceptions and additions to the Gen. Specs. This was later changed to a ship specification format consisting of page and line changes to the Gen. Specs. In 1958 a new system of printing called Cardotype allowed us to go to a self-contained ship specification, and still retain the standardized text from the Gen. Spec. In this system each line of text is typed on a standard EAM card. These cards are processed through a high speed camera and the resulting negative used in a standard printing process. The Gen. Spec. deck of cards is used for ship specifications, with new cards added and Gen. Spec cards removed as necessary. This system greatly reduces the amount of typing and proofreading necessary and therefore reduces errors.

In one of our early self-contained specifications a typist was carrying a tray of cards to the camera to be processed. She dropped the tray and cards spilled all over the floor. Being new at the job and maybe not too sure of her job security, she hurriedly put the cards back in the tray and continued on her way. You can imagine what the resulting portion of the specifications, did to our confidence in the system.

I would like to go briefly into how we presently prepare ship specifications.

A single column copy of the Gen. Spec. is used as the basis. This specification is broken into sections and distributed to the cognizant NAVSEC branches. One engineer is responsible for each section, obtaining information from other branches as necessary to complete the section. The single
column Gen. Spec. is marked up by crossing out the material that is not applicable and adding material unique to that design, as well as other standard information applicable to that particular type of ship.

On a preassigned date the specification sections are assembled, checked for compatibility, accuracy and completeness and sent to be duplicated by a direct photographic process. The resulting copies of the marked up specifications are packaged with the contract drawings and contract guidance drawings and circulated for comment, to approximately 60 different NAVSEC and NAVSHIPS branches and interested Navy activities.

Comments on each section are forwarded to the cognizant code, for the section, for adjudication and update of the master copy.

The specifications are then reassembled and in conjunction with the drawings, reviewed, as a package, for correctness and compatibility by the appropriate engineers at a technical reading session.

A final coordination review is held for the ship Project Manager and NAVSEC Project Coordinators, followed by the approval signature of the design package and final typing and printing.

In 1964, serious consideration was given to use of the computer to prepare ship specifications. Prior to this time various methods of using automatic data processing equipment had been investigated and rejected. After considerable preliminary planning and investigation, a contract was awarded to the RCA Service Company on 2 September, 1966 to
develop the computer programs. These programs have been developed and are presently being revised to include preparation of a list of referenced documents. The programs use the IBM 7090 and the IBM 360/30 computers. Preparation of the master specification tape file has not yet been started, except for 5 trial sections used in developing and validating the programs.

Figures 1, 2, 3, and 4 are examples of the Gen. Spec. computer output. Note that the computer both left and right justifies each line. The print chain contains two upper case fonts and one lower case. At the time these pages were produced, the program still contained a few bugs. For instance, column 1, line 65 in Figure 1, is not properly indented. However, the program has now been debugged. Figure 1 shows mathematical equations in the text. Figure 2 is a single column print-out used by the engineer in checking the specifications. The blank side of the page is used by the engineer for entering comments and changes. Figure 3 has a one-column table; and Figure 4 has a two-column table.

The master file will be prepared by adding to the Gen. Specs. that material presently included in ship specifications, but not suitable for inclusion in the Gen. Spec. Material, such as specific design heads for structure, which can be included in the master file with blank spaces left for insertion of the appropriate figures, is an example.

Figure 5 shows how the master file will be broken into units of
information. You will note the varying lengths of the units. These can range from a single punctuation mark to several paragraphs or even several pages. Each unit is assigned a descriptor number in the left-hand margin.

Note the editorial corrections. "Plans" is no longer used, so it has been changed to "drawings". The word "explicitly" has been changed to correct the spelling. The computer chain used to print the output in the automated system does not have a square root sign. Consequently, the words must be spelled out.

 Concurrently with the preparation of the master file, a Yes/No questionnaire is prepared, Figure 6. Each unit of information is tied to a question by means of the descriptor number. A Yes answer to a question means that the corresponding unit or units of information will be printed in the ship specification. The questions will be combined to insure that each question needs to be answered only once, to withdraw the corresponding information, wherever it may be, throughout the specifications. One of the computer programs sorts the questionnaire by functional area of NAVSEC branch cognizance. Figure 7 shows a sample questionnaire printout sorted for one branch. This sort capability enables us to assign each question to the engineer most qualified to answer it, regardless of the unit's location in the specification. For instance, the section on painting contains a statement similar to: "The rudder(s) shall be coated the same as the adjacent structure." The paint specialist doesn't necessarily care how many Rudders the ship
has, but under the present system he must find out in order to properly write the sentence. With the new procedure, when the question on the number of the rudders is answered for the rudder section of the ship specification, it will automatically print the right word in the painting section.

Figure 8 illustrates a portion of the specification as it appears in the master file. The figure "110" in column 1 refers to the section, in this case section 9110-0 of the Gen. Spec. or any ship specification. The next column, from "120" to "230" indicates the unit number within that section. The third column indicates the line within the unit. The next column of figures, running from "3" to "68" are descriptor numbers, tying the unit of text to a particular question. The "N" in the next column stands for non-Gen. Spec. material. By one command the program can delete this material and print a completely up to date Gen. Spec. The figures and letters in the next column are an external edit code controlling paragraphing, indentation etc. Burried within the text is an internal edit code controlling type font, spacing etc.

The last six-digit control number is presently unused and provides sufficient flexibility for later improvements in the system. We must recognize that this computer program can also be used to print any material, where there is some logic between reading for printing or not printing the material. This extra control field might be required for some of these later programs, such as the preparation of Military Specifications.
Note the formula in figure 8 and as it appears in figure 9 with the internal edit codes processed.

Presently the Gen. Specs. are revised quarterly, with the computer program the master tape can be updated daily if necessary or at least immediately prior to each ship specification or Gen. Spec. printout, therefore the latest available information will always be included.

The system will also produce a listing of all references contained in the specifications. The listing will be produced by specification paragraph number for review. This review will insure that all references are current and correct. The final printout will be in alpha-numeric order by category, such as, all Military Specifications sorted in numeric order.

Now let's go through the preparation of a ship specification using the computer system.
Once the ship design is developed to the point where all the questions can be answered, the computer prints an up to date questionnaire sorted by cognizant code. These questionnaires are distributed to the proper engineers. The engineer answers each question Yes or No. Since each engineer involved will be checking only questions which are the center of his concern, for a design which he has just completed, it is anticipated that the time required for completion of this questionnaire by individual engineers will be negligible.

The yes answers are keypunched and fed into the computer (IBM 7090). In effect, the computer reads a bit string indicating the applicability of descriptor numbers. It then enters an array of each descriptor and selects the applicable unit numbers. The computer then sorts the units into the correct order and prints a tape. This tape is the ship tape for that particular ship design. All future processing of this tape is on the IBM 360/30 computer.

The ship tape is processed to interpret the internal and external edit codes and format the pages including assigning page and line numbers. This original specification is produced in a single column format, using the universal character set chain. The ship tape contains no descriptor numbers or unit numbers and all future changes to this tape are made by use of the page and line numbers.

This specification is broken into sections and distributed to the appropriate engineers for review and adding of any needed additional information. The time required for this step depends on how effective we are in preparing the master tape and how well we succeed in keeping
it current. Corrections are coded, keypunched, and fed into the computer to produce the comment copy, again a single column copy. The comment copy computer output is reproduced by a standard printing process to provide the copies required for circulation for comments. From this point to signature, the process is the same as under the present system. After signature the corrections are coded, keypunched and fed into the computer to produce the final double column ship specification.

Advantages

A large portion of the Ship Systems Engineering and Design Department manpower is used to produce ship specifications. This computer-aided ship specification system will greatly reduce this engineering manpower requirement.

By using a Yes/No questionnaire we can assign preparation responsibility, for each unit of information, to the engineer most knowledgeable of the area, in lieu of the present method of assigning preparation responsibility by specification sections. This also reduces the chance for conflict between sections of the specifications.

By putting all generally used non-Gen. Spec. material in the computer, we standardize the wording and prevent each engineer from using slightly different wording and possibly getting different interpretations at the user end. It is not uncommon to receive a telephone call from a shipbuilder asking "Why did you change 'such and such' requirement in the specification?" and to discover that, in fact, there was no intention to change the specification, but that different wording was used by a different engineer.
Ore of the major sources of error or conflict in the ship specifications is last minute changes in the design. Presently we catch the obvious places, but someone doesn't get the word and one or more affected requirements remain unchanged. With our questionnaire and descriptors we can rapidly locate all the text that requires change.

**Problems and Future Improvements**

The biggest problem is to get the master tape accurate and complete, and to insure that it is maintained current at all times. The manpower and effort required, must be expended to insure this initial accuracy. Also, changes must be made with the least possible effort on the part of the engineer, while still maintaining strict control of all changes.

Computer output has many limitations when compared with standard printing, such as legibility, and range of type fonts and characters available. We are investigating the use of the Linotron presently being installed at the Government Printing Office. This equipment takes standard computer tape and processes it through a standard printing process. Our early checks show that only minor changes will be required in our present computer system to use the Linotron for our output device.

We may want in the future to reduce the quantity of questions to be answered for each ship specification. This would involve having several questionnaire tapes, one for surface ships, one for submarines, one for commercial type ships, etc., or by adding another program to the system we may be able to do this by answering certain key questions prior to the printing of the questionnaire.
Presently the system uses a card input, several possibly more efficient methods are presently available, or are under development. These are being followed with interest and will be considered for future inclusion in the system.

In summary, we have now developed a system which permits us to do an excellent job of preserving experience, standardizing ship specifications, assuring completeness, coping with dynamic technology, and assuring that the ship specifications are tailored to the particular project. Additionally, the system produces an output which is easily used, and which can be produced at a reduced cost, both in preparation and in use.
GENERAL SPECIFICATIONS FOR SHIPS
IN THE UNITED STATES NAVY
DEPARTMENT OF THE NAVY
NAVAL SHIP ENGINEERING CENTER

05 | 1 JULY 1963

SECTION 9110-0
GENERAL REQUIREMENTS FOR
10 NULL STRUCTURE
RevisedAea section 9110-0,
Dated 1 January 1963

9110-0.1. Design
15 General. The contractor shall assure
that the scantlings depicted on the
intended purpose. Compliance with such
drawings or subsequent approval of changes
made by the Contractor does not relieve
the Contractor from making the necessary
structural calculations, preparing an
equate structural design, and building
an adequate ship structure in accordance
with the design criteria given herein.
Ship structure shall be designed so that
allowable stresses or deflections will not
be exceeded, and failure will not occur
from a condition of plastic instability.
Design data sheets DSS9110-1, DSS9110-2,
DSS9110-3, and DSS9110-4 illustrate
acceptable methods of ship structural
design.

35 Structure for which loads are not
explicitly specified shall be rated
enough to withstand the stresses which can
reasonably be expected in service.
Additional local stiffening, if found
necessary, shall be installed to prevent
excessive vibration, pitting, or spreading
of decks or plating.

Design Loads. Ship structure shall be
designed to withstand the following loads
45 Ship Motion. The bounding loads on
the hull as a whole from gravity and inertia
forces, with the ship statically balanced in
stabilizing and trimming conditions. Waves
shall be assumed to be trochoidal of length L
and height 1.1 times the square root of
L. where L is the length of the ship
between perpendiculars, in feet. For
the design of members which constitute
the uniaxial strength gadget, working stresses
tension and bending stresses are to be
assumed to be a of the larger of the
values calculated for the extreme
tapers. (See DSS9290-2). Stresses shall
be for neutral axis to the extreme tapers.
Deck live loads. As specified.
Dead loads. Weight of structure and
equipment.

Ship motion. Inertial forces and
gravity components resulting from
motion of the ship in a wave.

Sea forces. Static equivalent head, in the
language of the design loads, stresses in structural
members, including normal stresses in plating
panels, shall not exceed the following
limits.

55 Pretension and bending stresses. Where
there is no danger of failure from

FIGURE 1

areal

areal

areal
GENERAL SPECIFICATIONS FOR SHIPS
OF THE UNITED STATES NAVY
DEPARTMENT OF THE NAVY
NAVAL SHIP ENGINEERING CENTER

1 JULY 1965

SECTION 9110-0
GENERAL REQUIREMENTS FOR
HULL STRUCTURE
Replaces section 911-0,
Dated 1 January 1963

9110-0a. Design

General.-The contractor shall assure
that the scantlings depicted on the
structural drawings are adequate for the
intended purpose. Compliance with such
drawings or subsequent approval of changes
made by the Contractor does not relieve
the Contractor from making the necessary
structural calculations, preparing an
adequate structural design, and bulding
an adequate ship structure in accordance
with the design criteria given herein.

Ship structure shall be designed so that
when subjected to specified loads, the
allowable stresses or deflections will not
be exceeded, and failure will not occur
from a condition of elastic instability.

Design Data sheets DDS9110-1, DDS9110-2,
DDS9110-3, illustrate acceptable methods of ship structural
design.

Structure for which loads are not
explicitly specified shall be rugged
enough to withstand the stresses which can
reasonably be expected in service.

Additional local stiffening, if found
necessary, shall be installed to prevent
excessive vibration, painting, or springing
of plating.

Design loads.-Ship structure shall be
designed to withstand the following loads

Ship bending.-The bending loads on the
hull as a whole from gravity and inertia
forces, with the ship statically balanced in hogging and
sagging conditions. Waves shall be
assumed to be trochoidal, of length L
and height 1.1 times the square root of L, where L is the length of the ship
between perpendiculars, in feet. For the
design of members which constitute
the longitudinal strength girder, ship-harmonizing stresses (tension and
compression) at the neutral axis shall be assumed to be 0.5 of the larger of the
values calculated for the extreme
fibers. (See DDS9290-2). Stresses shall
be assumed to increase uniformly from
the neutral axis to the extreme limits.

Deck live load.-As specified.

Dead loads.-Weights of structure and

equipment.

Ship motion.-Inertia forces and
gravity components resulting from
motion of the ship in a seaway.

Area forces.-Static-equivalent
heads, representing the effects of wave
action on the shell and weather decks.

Tank pressures.-Hydrostatic heads
on tank boundaries, including the

R1 area
R2 area
R3 area
R4 area

FIGURE 2
### General Specifications for Ships

<table>
<thead>
<tr>
<th>Web Diameter</th>
<th>Spacing Center of Hole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
<td>Inches</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>8</td>
<td>3.5</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>12</td>
<td>4.5</td>
</tr>
<tr>
<td>14 and 15</td>
<td>5 by 5(1)</td>
</tr>
<tr>
<td>16 to 18</td>
<td>6 by 6(1)</td>
</tr>
<tr>
<td>Over 18</td>
<td>7(1)</td>
</tr>
</tbody>
</table>

1. Long dimensions shall be parallel to the girders.
2. Depth of hole shall not exceed 60 percent of the depth of web, and the length of hole shall not exceed twice its own depth.
3. Holes shall be spaced so that the distances between edges of adjacent holes will not be less than one and one-fourth times the length of the holes.

### For Submarines

- Lightening holes in transverse floors shall be increased in size in locations where quick flooding demands fore and aft of flow of water through the frame, where this is done, the weight of the floors shall be increased to maintain the strength of the floors, and flat bar reinforcement shall be fitted around the edges of the holes.
- Corner radii of rectangular openings in pressure hull plating shall be as specified in 910-1.

### 65 Area

#### Fairways

- For surface ships, the departure from the molded form shall be held within the following limits:
  - Plus or minus 1 inch in 100 feet of length.
- For submarines, the circularity measurements of pressure hull plating shall be taken throughout those portions of the pressure hull and pressure hull appendages which are intended to be circular.

#### Dimensions

- The radius of the mean circle may be considered to be the mean circle. The radius of the mean circle may be considered to be the mean circle.
- The circularity measurements shall be taken 100 in the following locations:
  - One set shall be taken on or adjacent to each deep frame.
  - One set shall be taken on or adjacent to the first unsupported frame.
  - One set shall be taken on or adjacent to bulkheads and between frames.
  - One set shall be taken on or adjacent to each frame.
  - One set shall be taken on or adjacent to each frame.

#### Curvature

- The radius of the mean circle shall not be greater than 135 inches in any one place.
- The radius of the mean circle shall not be less than 135 inches in any one place.

#### Fairness

- For surface ships, the fairness shall not deviate from the mean circle by more than 1/2 the thickness of the pressure hull plating plus 0.1 inch, whichever is less.
- The radius of the mean circle shall not depart from the design radius by more than 1/2 the thickness of the pressure hull plating plus 0.1 inch, whichever is less.

#### Measurement

- Measurements shall be taken after all major welding in the vicinity has been completed.
- The installation of closure plates shall be considered major welding.
**TABLE 1**

<table>
<thead>
<tr>
<th>Use</th>
<th>Spec. No.</th>
<th>Alloy</th>
<th>Grade or Class</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castings</td>
<td>QQ-A-601</td>
<td>356</td>
<td>H4</td>
<td>Note 1</td>
</tr>
<tr>
<td>Castings</td>
<td>QQ-A-601</td>
<td>19%</td>
<td>54</td>
<td>Note 2</td>
</tr>
<tr>
<td>Plates</td>
<td>QQ-A-250/3</td>
<td>5036</td>
<td>H32</td>
<td>Note 4</td>
</tr>
<tr>
<td>Plates</td>
<td>QQ-A-250/9</td>
<td>5456</td>
<td>H321</td>
<td>Note 5</td>
</tr>
<tr>
<td>Plates</td>
<td>QQ-A-250/10</td>
<td>5456</td>
<td>H32</td>
<td>Note 6</td>
</tr>
<tr>
<td>Plates</td>
<td>QQ-A-250/11</td>
<td>6061</td>
<td>T6</td>
<td>Note 7</td>
</tr>
<tr>
<td>Extruded or rolled</td>
<td>QQ-A-200/5</td>
<td>5036</td>
<td>H111</td>
<td>Note 4</td>
</tr>
<tr>
<td>Extruded or rolled</td>
<td>QQ-A-200/7</td>
<td>5456</td>
<td>H111</td>
<td>Note 5</td>
</tr>
<tr>
<td>Extruded or rolled</td>
<td>QQ-A-200/8</td>
<td>5456</td>
<td>H111</td>
<td>NOTE 6</td>
</tr>
<tr>
<td>Extruded</td>
<td>QQ-A-200/8 or ASTM B221</td>
<td>6061</td>
<td>T6</td>
<td>Note 7</td>
</tr>
<tr>
<td>Tubing</td>
<td>WW-7-700/5</td>
<td>5036</td>
<td>H32</td>
<td>Note 4</td>
</tr>
<tr>
<td>All sizes</td>
<td>WW-7-700/8 or WW-7-700/8</td>
<td>6061</td>
<td>T6</td>
<td>Note 7</td>
</tr>
</tbody>
</table>

**Note 1** - For use with complex castings where castability, pressure tightness, strength, and resistance to corrosion are required, will respond to heat treatment to improve strength. For applications requiring high casting quality and excellent fluidity. 

**Note 2** - High tensile, with less corrosion resistance than class 1, 3, 5, 7, and 8. Heat treatment is required. For uses such as ammunition stowages, frames and sills for joining floors, and ladder treads.

**Note 3** - For use wherever good tensile strength and relatively high resistance to corrosion is required. Heat treatment is not required. For applications similar to class 5 but requiring resistance to corrosion at a sacrifice of tensile properties. 

**Note 4** - Shall be used for applications where higher strength is not required.

**Note 5** - Shall be used for applications where high strength is required and where higher cost is warranted.

**Note 6** - For structure subject to elevated temperatures over 150 degrees F., such as upper portion of smokestacks.

**Note 7** - This alloy shall be used for nonwelded structure only.

*Drawn preferred - Consideration must be given to wider dimensional tolerances when extruded tubing is used.*

Note: tubing manufactured from plate having a longitudinal welded seam may be used for tubing sizes that are not available in drawn tubing.
GENERAL REQUIREMENTS FOR HULL STRUCTURE

9110-0 Design

General...The Contractor shall assure that the scantlings depicted on the structural drawings are adequate for the intended purpose. Compliance with such scantlings, subsequent approval of changes made by the Contractor does not relieve the Contractor from making the necessary structural calculations, preparing an adequate structural design, and building an adequate ship structure in accordance with the design criteria given herein. Ship structure shall be designed so that when subjected to specified loads, the allowable stresses or deflections will not be exceeded, and failure will not occur from a condition of elastic instability. Design

Sheets CDS/H10-1, CDS/H10-2, and CDS/H10-4 illustrate acceptable methods of ship structural design.

Structure for which loads are not explicitly specified shall be rugged enough to withstand the stresses which can reasonably be expected in service. Additional local stiffening, if found necessary, shall be installed to prevent excessive vibration, panting, or sprunging of plating.

Design loads...Ship structure shall be designed to withstand the following loads:

Ship-bending...The bending loads on the hull as a whole from gravity and inertia forces, with the ship statically balanced in hogging and sagging conditions. Waves shall be assumed to be trochoidal, of length L and height 1.1

\[ \frac{L}{\text{times the square root of } L} \]

where L is the length of the ship between perpendiculars, in feet. For the design of members which constitute the longitudinal strength girders, ship-bending stresses (tension and compression) at the neutral axis shall be assumed to be one-half of the larger of the values calculated for the extreme fibers. (See D0290-2). Stresses shall be assumed to increase uniformly from the neutral axis to the extreme fibers.

Deck live loads...As specified.

Dead loads...Weights of structure and equipment.
## AUTOMATED QUESTIONNAIRE FORM FOR THE GENERAL SHIP SPECIFICATION SYSTEM

<table>
<thead>
<tr>
<th>SECTION NO.</th>
<th>NAVAL CODE</th>
<th>DESCRIPTOR NO.</th>
<th>YES</th>
<th>NO</th>
<th>QUESTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>6445</td>
<td>1</td>
<td></td>
<td></td>
<td>APPLIES TO GEN SPEC ONLY</td>
</tr>
<tr>
<td>110</td>
<td>6445</td>
<td>2</td>
<td></td>
<td></td>
<td>IS THIS A SURFACE SHIP</td>
</tr>
<tr>
<td>110</td>
<td>6443</td>
<td>3</td>
<td></td>
<td></td>
<td>IS THIS A LONGITUDINALLY FRAMED SURFACE SHIP</td>
</tr>
<tr>
<td>110</td>
<td>6443</td>
<td>4</td>
<td></td>
<td></td>
<td>IS THIS A SURFACE SHIP WITH COMPARTMENT BOUNDARIES DESIGNED TO A HEAD TO THE DAMAGE CONTROL DECK</td>
</tr>
<tr>
<td>110</td>
<td>6447</td>
<td>5</td>
<td></td>
<td></td>
<td>IS THIS A SURFACE SHIP WITH GUNS</td>
</tr>
<tr>
<td>110</td>
<td>6447</td>
<td>6</td>
<td></td>
<td></td>
<td>IS THIS A SURFACE SHIP WITH A MISSILE LAUNCHER</td>
</tr>
<tr>
<td>110</td>
<td>6447</td>
<td>7</td>
<td></td>
<td></td>
<td>IS THIS A SURFACE SHIP WITH ONE MISSILE MAGAZINE</td>
</tr>
<tr>
<td>110</td>
<td>6447</td>
<td>8</td>
<td></td>
<td></td>
<td>IS THIS A SURFACE SHIP WITH MORE THAN ONE MISSILE MAGAZINE</td>
</tr>
<tr>
<td>110</td>
<td>6447</td>
<td>9</td>
<td></td>
<td></td>
<td>IS THIS A SURFACE SHIP WITH ONE MISSILE ASSEMBLY ROOM</td>
</tr>
<tr>
<td>110</td>
<td>6447</td>
<td>10</td>
<td></td>
<td></td>
<td>IS THIS A SURFACE SHIP WITH MORE THAN ONE MISSILE ASSEMBLY ROOM</td>
</tr>
<tr>
<td>110</td>
<td>6447</td>
<td>11</td>
<td></td>
<td></td>
<td>IS THIS A SURFACE SHIP WITH ONE MISSILE CHECK-OUT AREA</td>
</tr>
<tr>
<td>110</td>
<td>6447</td>
<td>12</td>
<td></td>
<td></td>
<td>IS THIS A SURFACE SHIP WITH MORE THAN ONE MISSILE CHECK-OUT AREA</td>
</tr>
<tr>
<td>110</td>
<td>6443</td>
<td>13</td>
<td></td>
<td></td>
<td>IS THIS A SURFACE SHIP DESIGNED FOR NUCLEAR BLAST</td>
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**Figure 6**
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FIGURE 7
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**FIGURE 9**

Dead loads—weights of structure and equipment.

Ship motion— inertial forces and gravity.

Components resulting from motion of the ship in a seaway.

Static-equivalent heads, representing the effects of wave action on the shell and weather decks.

Hydrostatic heads on tank boundaries, including the effects of filling to overflow.

Dynamic shock loads—dynamic shock loads from installed equipment.

The foregoing design loads, where applicable, shall be combined to produce the most adverse conditions of stress.

Structure shall also be designed for the following loadings, considered individually:

- Flooding—hydrostatic head to the damage control deck, on the boundaries of any combination of watertight compartments.
- Blast—static equivalent head, in feet of sea water, equal to

\[ \frac{2.257 \sin \gamma \sqrt{0.0221/\sin \gamma}}{A/32} \]

Where:

- \( R \) is the radius vector, in inches, from the muzzle of the nearest gun to the point in question;
- \( D \) is the diameter of the gun bore in inches;
- \( \beta \) is the angle between the radius vector and the axis of the gun barrel;
- \( x \) is the area of the surface in question, in square inches, bounded by the blast cone. (The blast cone is having a three-degree divergence from the axis and passing through the circumference of the exit nozzle.)
- \( X \) is the total area, in square feet, of blowout openings. (Such openings, having hinged covers and...