Designation: F2016 – 00 (Reapproved 2012)

An American National Standard

# Standard Practice for Establishing Shipbuilding Quality Requirements for Hull Structure, Outfitting, and Coatings[1]

This standard is issued under the fixed designation F2016; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This practice consists of three annexes: hull structure, outfitting, and coating. The subject of these annexes was selected for several reasons. Other commercial shipbuilding nations already have in place widely recognized standards of expectations in these areas. These constitute the most significant areas where workmanship is a critical factor in customer satisfaction. The cost associated with the labor involved in these three areas is a significant factor in construction man-hours and overall schedules.

1.2 The standard criteria provided in this practice are intended to apply to conventional, commercial ship construction. In many cases, specialized, nonconventional vessels using nonstandard materials or built-to-serve sole requirements may require unique acceptance criteria that are beyond those provided in this practice.

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

D4417 Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel

E337 Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures)

2.2 *ISO Standards:*[3]

ISO 8502–3 Assessment of Dust on Steel Surfaces Prepared for Painting (Pressure-Sensitive Tape Method)

ISO 8502–6 Extraction of Soluble Contaminants for Analysis—The Bresle Method

2.3 *NACE Standards:*[4]

NACE No. 5 Surface Preparation and Cleaning of Steel and Other Hard Materials by High-and Ultrahigh-Pressure Water Jetting Prior to Re-coating (SSPC-SP 12)

NACE No. 7 Interim Guide and Visual Reference Photographs for Steel Cleaned by Water Jetting (SSPC-VIS 4(1))

2.4 *SSPC Standards:*[5]

SSPC-AB 1 Mineral and Slag Abrasives

SSPC-AB 2 Specification for Cleanliness of Recycled Ferrous Metallic Abrasives

SSPC-PA 2 Measurement of Dry Coating Thickness With Magnetic Gages

SSPC-SP 1 Solvent Cleaning

SSPC-SP 2 Hand Tool Cleaning

SSPC-SP 3 Power Tool Cleaning

SSPC-SP 7 Brush-Off Blast Cleaning

SSPC-SP 10 Near-White Blast Cleaning

SSPC-SP 11 Power Toll Cleaning to Bare Metal

SSPC-SP 12 Surface Preparation and Cleaning of Steel and Other Hard Materials by High-and Ultrahigh-Pressure Water Jetting Prior to Re-coating (NACE No. 5)

SSPC-VIS 1-89 Visual Standard for Abrasive Blast Cleaned Steel

SSPC-VIS 3 Visual Standard for Power- and Hand-Tool Cleaned Steel

SSPC-VIS 4(1) Interim Guide and Visual Reference Photographs for Steel Cleaned by Water Jetting (NACE No. 7)

2.5 *NSRP Documents:*[6]

National Shipbuilding Research Project 6–97–1 "American Shipbuilding Quality Standards," dated May 28, 1999

## 3. Summary of Practice

3.1 This practice provides workmanship criteria to be applied to commercial shipbuilding or ship repair, or both. The

[1] This practice is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technologyand is the direct responsibility of Subcommittee F25.07 on General Requirements.

Current edition approved May 1, 2012. Published May 2012. Originally approved in 2000. Last previous edition approved in 2006 as F2016 – 00 (2006). DOI: 10.1520/F2016-00R12.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[4] Available from NACE International (NACE), 1440 South Creek Dr., Houston, TX 77084-4906, http://www.nace.org.

[5] Available from Society for Protective Coatings (SSPC), 40 24th St., 6th Floor, Pittsburgh, PA 15222-4656, http://www.sspc.org.

[6] Available from The Librarian, Documentation Center, Marine Systems Division, University of Michigan Transportation Research Institute, 2901 Baxter Rd., Ann Arbor, MI 48109–2150.

criteria covers three primary phases of ship construction, that is, hull structure, outfitting, and coatings. Specific criteria to be selected from this standard should be as contractually agreed between the ship owner and shipbuilder.

## 4. Significance and Use

4.1 To achieve success in ship construction, it is necessary for the ship owner and the ship builder to agree on the level of quality in the final product. Classification rules, regulatory requirements, and ship specifications all help to define an acceptable level of construction quality; however, this guidance alone is not sufficient. It is up to the shipbuilder, therefore, to describe the level of workmanship sufficiently that will be reflected in the delivered ship, and for the ship owner to communicate his expectations effectively for the final product.

4.2 It is the intent of this document to contribute to these objectives in the following ways:

4.2.1 To describe a reasonable acceptable level of workmanship for commercial vessels built in the United States.

4.2.2 To provide a baseline from which individual shipyards can begin to develop their own product and process standards in accordance with generally accepted practice in the commercial marine industry.

4.2.3 To provide a foundation for negotiations between the shipbuilder and the ship owner in reaching a common expectation of construction quality.

4.3 The acceptance criteria herein are based on currently practiced levels of quality generally achieved by leading international commercial shipbuilders. These criteria are not intended to be a hard standard with which all U.S. shipyards must comply. Rather, they are intended to provide guidance and recommendations in the key areas that play a major role in customer satisfaction and cost-effective ship construction.

## 5. Keywords

5.1 coatings; hull structure; outfitting; quality; shipbuilding; workmanship

## ANNEXES

**(Mandatory Information)**

### A1. HULL STRUCTURE

| I. HULL STRUCTURE | | | SHIPBUILDING QUALITY STANDARDS | | |
|---|---|---|---|---|---|
| Division | | Marking | | UNIT: mm | |
| Section | Sub-section | Item | Standard Range | Tolerance Limits | Remarks |
| Cutting line and fitting line compared with correct ones | General members | Size and shape compared with correct ones. | ± 2 | ± 3 | |
| | | | ± 1.5 | ± 2.5 | Especially for the depth of floors and girders of double bottom. |
| | | Corner angle compared with correct ones | ± 1.5 | ± 2 | |
| | | Curvature | ± 1 | ± 1.5 | |
| | | Location of member & mark for fitting compared with correct ones. | ± 2 | ± 3 | |
| | | Block marking(Panel block) compared with correct ones. | ± 2.5 | ± 3.5 | |
| | | Location of member for fitting compared with correct ones. | ± 2.5 | ± 3.5 | |



FIG. A1.1 Hull Structure

| I. HULL STRUCTURE | | | | | SHIPBUILDING QUALITY STANDARDS | | |
|---|---|---|---|---|---|---|---|
| Division | | Gas Cutting | | | UNIT: mm | | |
| Section | Sub-section | Item | Standard Range | Tolerance Limits | Standard Range | Tolerance Limits | Remarks |
| Roughness | Free edge | Strength Shop member Field | 100μ (2nd cl) 150μ (3rd cl) | 200μ (3rd cl) 300μ (Out cl) | The class denoted in parentheses is in accordance with following definition. Less Than 50μ 1st class 50μ ~ 100μ 2nd class 100μ ~ 200μ 3rd class More than 200μ out of class - Special precautions are required in case where grinding or other treatments are requested. - For angle cutting the same as the case in field. | | |
| | | Other Shop Field | 100μ (2nd cl) 500μ (Out cl) | 200μ (3rd cl) 150μ (Out cl) | | | |
| | Weld groove | Strength Shop member Field | 100μ (2nd cl) 400μ (Out cl) | 200μ (3rd cl) 800μ (Out cl) | | | |
| | | Other Shop Field | 100μ (2nd cl) 800μ (Out cl) | 1500μ (Out cl) 1500μ (Out cl) | | | |



FIG. A1.2 Hull Structure

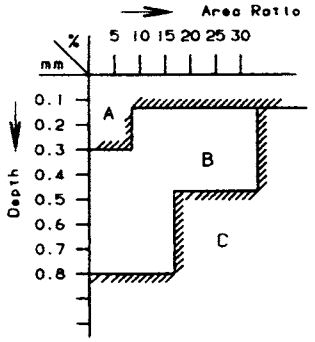
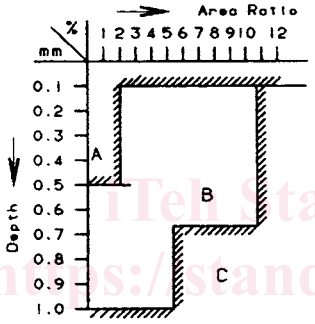
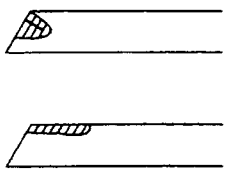
| I. HULL STRUCTURE | | | SHIPBUILDING QUALITY STANDARDS |
|---|---|---|---|
| Division | | Material | |
| Section | Sub-section | Item | Remarks |
| Surface flow | Pitting | Grade of pitting<br>  <br> | 1. Grade A pitting is minor and no repair is necessary. Grade B pitting is moderate and is to be repaired as necessary. Grade C pitting is severe and requires repair.<br>2. Pitting that occurs on the boundary line between Grade A and Grade B can be considered minor and treated as Grade A pitting.<br>3. Repairs shall be made as follows:<br>Depth of pitting :d<br>Plate Thickness :t<br>Where 0.07t>d Grind Smooth<br>(Note:Regardless of plate thickness, at no time should pitting that is 3mm deep or greater be repaired by grinding only)<br>Where 0.2t≥d0.07t Grind and Weld<br>Note: The area ratio is the estimated percentage of the plate surface that is pitted to the point where the surface appearance is unsatisfactory. |
| | Flaking | Grade of surface flaking<br>  <br> | 1. Grade A pitting is minor and no repair is necessary. Grade B pitting is moderate and is to be repaired as necessary. Grade C pitting is severe and requires repair.<br>2. Pitting that occurs on the boundary line between Grade A and Grade B can be considered minor and treated as Grade A pitting.<br>3. Repairs shall be made as follows:<br>Depth of pitting :d<br>Plate Thickness :t<br>Where 0.07t>d Grind Smooth<br>(Note:Regardless of plate thickness, at no time should pitting that is 3mm deep or greater be repaired by grinding only)<br>Where 0.2t≥d0.07t Grind and Weld<br>Note: The area ratio is the estimated percentage of the plate surface that is pitted to the point where the surface appearance is unsatisfactory. |
| Casting Steel | Details of Casting Steel | Applicable to cases where defects are over 20% of thickness, or over 25mm deep and 150mm long. | When the removal of a surface defect exposes other significant defects such as cavities, cracks or inclusions, the casting is to be checked using dye penetrant inspection, magnetic particle inspection or ultrasonic inspection and repaired accordingly, using an appropriate method of repair. |
| Delamination | Local delamination |  <br> | Where delamination is minor it can be chipped or ground out and built-up with weld metal as shown in Figure (a).<br>Where minor delamination occurs close to the plate surface grinding or chipping and weld metal build-up should be as shown in Figure (b).<br>Repair of moderate delamination should be considered on a case by case basis. |
| | Severe delamination, requiring a local exchange of plate | | Where delamination is fairly extensive, plating should be cropped out locally and replaced.<br>The minimum width of plating to be cropped out is to be as follows:<br>Highly Stressed Primary Longitudinal Strength Members: 1600mm<br>Moderately Stressed Primary Longitudinal Strength Members: 800mm<br>All Other Structural Members: 300mm<br>Where severe delamination that affects the whole plate occurs, the whole plate must be replaced. |

FIG. A1.3 Hull Structure

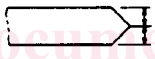
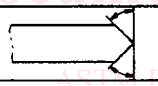
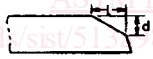
| I. HULL STRUCTURE | | | | SHIPBUILDING QUALITY STANDARDS | |
|---|---|---|---|---|---|
| Division | | Gas Cutting | | UNIT: mm | |
| Section | Sub-section | Item | Standard Range | Tolerance Limits | Remarks |
| Notches & Indentations<br>Note: A notch is defined as a highly localized indent that is three times deeper than the tolerance limits for normal roughness. | Free edge | 1)Upper edge of sheer strake.<br>2)Strength deck between 0.6l ⊕ and free edge of opening of shell plate.<br>3)Main longl strength members. | | Notch<br>0 | Notches are to be welded up prior to grinding in areas where a smooth finish is required. Sufficient weld metal should be laid such that after grinding there are no residual voids or cracks between the weld metal and the parent metal. |
| | | Longitudinal & Transverse Strength members | | Indentation ≤1 | Indentions greater than the stated tolerance limit are to be treated as notches. |
| | | Others | | Indentation ≤3 | Indentions greater than the stated tolerance limit are to be treated as notches. |
| | Weld groove | Butt Weld: Shell plate & Upperdeck between 0.6l⊕ | | Indentation ≤2 | Indentions greater than the stated tolerance limit are to be treated as notches. |
| | | Butt Weld: Others | | Indentation ≤3 | Indentions greater than the stated tolerance limit are to be treated as notches. |
| | | Fillet Weld | | Indentation ≤3 | Indentions greater than the stated tolerance limit are to be treated as notches. |
| Dimension | Straightness of plate edge | Both side submerged arc welding | ±0.4 | ±0.5 | |
| | | Manual welding; semi automatic welding | ±1.0 | ±2.5 | |
| | Depth of edge preparation |  | ±1.5 | ±2.0 | |
| | Angle of edge preparation |  | ±2° | ±4° | |
| | Length of taper |  <br>(l compared with correct sizes) | ±0.5d | ±1.0d | |
| | Size of member | Structural members other than double bottom floors and girders. | ±3.5 | ±5.0 | |
| | | Depth of double bottom floors and girders. | ±2.5 | ±4.0 | |
| | | Breadth of face bar. | ±2.0 | -3.0 ~ +4.0 | |
| | Edge preparation | Automatic welding | ±2° | ±4° | |
| | | Semi-automatic & manual welding. | ±2° | ±4° | |



FIG. A1.4 Hull Structure

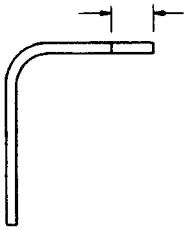
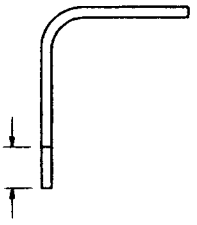
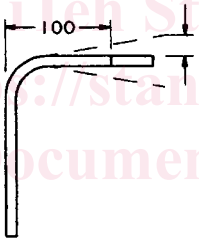
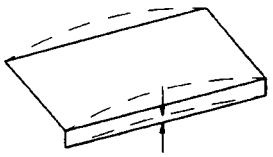
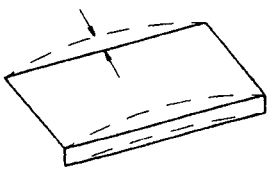
| I. HULL STRUCTURE | | | SHIPBUILDING QUALITY STANDARDS | | |
|---|---|---|---|---|---|
| Division | | Fabrication | | | UNIT: mm |
| Section | Sub-section | Item | Standard Range | Tolerance Limits | Remarks |
| Flanged Longitudinal | Breadth of flange |  Compared with correct size | ±3.0 | ±5.0 | |
| | Depth of web |  Compared with correct size | ±3.0 | ±5.0 | Low and moderately stressed members. |
| | | | ±2.0 | ±3.0 | Highly stressed members. |
| | Angle between flange and web |  Compared with template per 100 mm in breadth of flange | ±2.5 | ±4.5 | |
| | Curvature or straightness in the plane of flange |  Per 10m in length | ±10 | ±25 | |
| | Curvature or straightness in the plane of web |  Per 10m in length | ±10 | ±25 | |



FIG. A1.5 Hull Structure

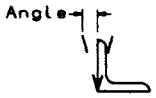
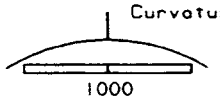
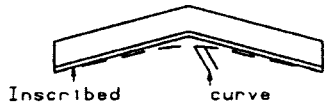
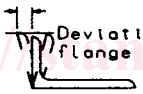
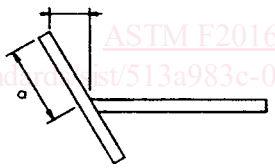
| I. HULL STRUCTURE | | | SHIPBUILDING QUALITY STANDARDS | | |
|---|---|---|---|---|---|
| Division | | Fabrication | | UNIT:mm | |
| Section | Sub-section | Item | Standard Range | Tolerance Limits | Remarks |
| Angle & Built up plate | Stringer angle |  Compared with template | ±1.5 | ±2.0 | |
| | |  Compared with template | ±1.0 | ±1.5 | Maximum permitted curvature per 100mm length of member. |
| | Frame & Long | Curvature compared with template or check line. Per 10m in length. | ±2.0 | ±4.0 | |
| | | Deviation from.  Correct from inscribed. | ±3.0 | ±5.0 | |
| | |  Compared with template | ±1.5 | ±3.0 | |
| | | Deviation of face plate  | ±1.5 per 100mm | ±3.0 per 100mm | |



FIG. A1.6 Hull Structure

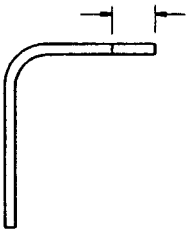
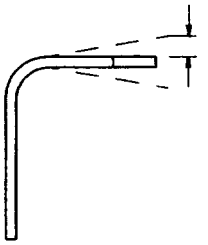
| I. HULL STRUCTURE | | | SHIPBUILDING QUALITY STANDARDS | | |
|---|---|---|---|---|---|
| Division | | Fabrication | | UNIT: mm | |
| Section | Sub-section | Item | Standard Range | Tolerance Limits | Remarks |
| Flanged Bracket | Breadth of flange |  Compared with correct size | ±3.0 | ±5.0 | |
| | Angle between flange and web |  Compared with template per 100 mm in breadth of flange | ±3.0 | ±5.0 | |
| Bending templates (plane or box shape). | Templates for box shapes | Actual line of plate edge, compared with template. | ±2.0 | ±4.0 | |
| | | Actual curved surface, compared with template. | ±2.0 | ±4.0 | For dimensions greater than 1M, ±5.0. |
| | Section templates | Location of check line for leveling by sight, compared with template. (for transverse) | ±1.5 | ±3.0 | |
| | | Location of check line for leveling by sight, compared with template. (for longitudinal) | ±1.5 | ±3.0 | |
| | | Shape, compared with template. | ±1.5 | ±3.0 | |
| | Other templates | Shape, compared with template. | ±1.5 | ±3.0 | |



**FIG. A1.7 Hull Structure**

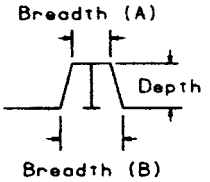
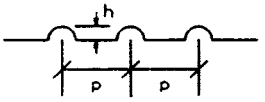
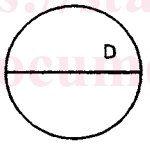
| I. HULL STRUCTURE | | | | | | SHIPBUILDING QUALITY STANDARDS |
|---|---|---|---|---|---|---|
| Division | | Fabrication | | | | UNIT: mm |
| Section | Sub-section | Item | | Standard Range | Tolerance Limits | Remarks |
| Plate | Corrugated bulkhead | Depth of corrugation | | ±3.0 | ±6.0 | |
| | | Breadth of corrugation.   | A | ±3.0 | ±6.0 | |
| | | | B | ±3.0 | ±6.0 | |
| | Corrugated wall |   | Pitch (p) | ±6.0 | ±9.0 | |
| | | | | ±2.0 | ±3.0 | |
| | | | Depth (h) | ±2.5 | ±5.0 | |
| | Cylindrical structure (mast, post etc) | Diameters   | | $\frac{\pm D}{200}$ But, Max. ±5.0 | $\frac{\pm D}{150}$ But, Max. ±7.5 | |
| | Curved shell late | In regard to the check line (for longitudinal) | | ±2.5 | ±5.0 | |
| | | (for transverse) | | ±2.5 | ±5.0 | |
| | | Gap between shell plate and section template | | ±2.5 | ±5.0 | |



FIG. A1.8 Hull Structure

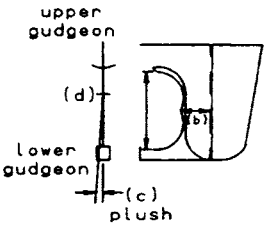
| I. HULL STRUCTURE | | | SHIPBUILDING QUALITY STANDARDS | | |
|---|---|---|---|---|---|
| Division | | Sub-assembly | UNIT: mm | | |
| Section | Sub-section | Item | Standard Range | Tolerance Limits | Remarks |
| Accuracy of Dimensions | Special Sub-assemblies — Block Sub-assembling including Stern frame | Distance between aft edge of boss and aft peak bulkhead (b) | ±5 | ±10 |   |
| | | Twist of Sub-assembly (c) | ±5 | ±10 | |
| | | Deviation of rudder from shaft ℄ (d) | ±4 | ±8 | |
| | Rudder | Twist of Rudder plate over its length | ±6 | ±10 | Correct or re-assemble partially |
| | Main engine bed | Flatness of top plate of main engine bed | ±5 | ±10 | |
| | | Breadth and length of top plate of main engine bed | ±4 | ±6 | |
| | | Others | The same as for flat plate block Sub-assembly | | |

FIG. A1.9 Hull Structure

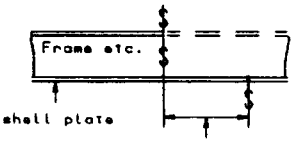
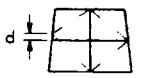
| I. HULL STRUCTURE | | | SHIPBUILDING QUALITY STANDARDS | | |
|---|---|---|---|---|---|
| Division | | Sub-assembly | | | UNIT: mm |
| Section | Sub-section | Item | Standard Range | Tolerance Limits | Remarks |
| Accuracy of Dimensions | Flat plate Sub-assembly | Breadth of Sub-assembly | ±4.0 | ±6.0 | Cut, when too long |
| | | Length of Sub-assembly | ±4.0 | ±6.0 | Cut, when too long |
| | | Squareness of Sub-assembly | ±4 | ±8 | Measured difference of diagonal length of final marking lines. When the difference is over the limits, correct the final marking line. |
| | | Distortion of Sub-assembly | ±10 | ±20 | Measured on the face of web or girder. |
| | | Deviation of Interior members from shell plating | ±5.0 | ±10.0 | Excluding the case when interior members are connected by lapped joint.   |
| | Curved plate Sub-assembly | Breadth of Sub-assembly | ±4.0 | ±8.0 | Measured along the girth. Cut, when too long. |
| | | Length of Sub-assembly | ±4.0 | ±8.0 | Cut, when too long. |
| | | Distortion of Sub-assembly | ±10 | ±20 | Measured on face of web or girder. Correct the final marking line, when the distortion exceeds the limits. |
| | | Squareness of Sub-assembly | ±10 | ±15 | Difference of base line to marking or difference of diagonal lengths along marking   d=\| e1 - e2 \| adjust marking where practicable.   |
| | | Deviation of interior members from shell plating | The same as for the flat plate Sub-assembly above. | | |
| | Plate Block Sub-assembly | Breadth of each panel | The same as for the flat plate Sub-assembly above. | | |
| | | Length of each panel | | | |
| | | Squareness of each panel | | | |
| | | Distortion of each panel | | | |
| | | Distortion of interior members from skin plating | | | |

FIG. A1.10 Hull Structure

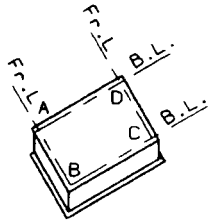
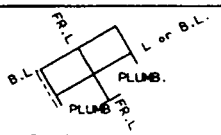
| I. HULL STRUCTURE | | | SHIPBUILDING QUALITY STANDARDS | | |
|---|---|---|---|---|---|
| Division | | Sub-assembly | | | UNIT: mm |
| Section | Sub-section | Item | Standard Range | Tolerance Limits | Remarks |
| Accuracy of Dimensions | Plate Block Sub-assembly | Twist of Sub-assembly<br>B.L. = baseline | ±10 | ±20 | Measured as follows:<br>  <br><br>The points A,B and C are established in the same plane. Measure the deviation of point D from that plane. May re-assemble partially when the deviation exceeds the limits. |
| | | Deviation of upper/lower panel from ℄ or B.L. | ±5 | ±10 |  <br><br>Accuracy of this dimension |
| | | Deviation of upper/lower panel from ℄ or FR.L | ±5 | ±10 | |
| | Block Sub-assembly Including stern frame<br>Plate Block Sub-assembly | Breadth of each panel | | | The same as for the flat plate Sub-assembly (previous page) |
| | | Length of each panel | | | |
| | | Distortion of each panel | | | |
| | | Deviation of interior members from skin plating | | | |
| | | Twist of Sub-assembly | ±15 | ±25 | The same as for the flat plate Sub-assembly (previous page) |
| | | Deviation of upper/lower panel from ℄ or B.L. | ±7 | ±15 | Re-assemble partially when the deviation exceeds the limits |
| | | Deviation of upper/lower panel from ℄ or FR.L | ±7 | ±15 | |
| | | Distance between upper/lower gudgeon (a) | ±5.0 | ±10.0 | |



FIG. A1.11 Hull Structure

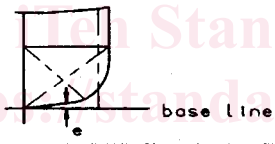
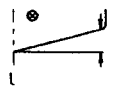
| I. HULL STRUCTURE | | | SHIPBUILDING QUALITY STANDARDS | | |
|---|---|---|---|---|---|
| Division | | accuracy | | | UNIT: mm |
| Section | Sub-section | Item | Standard Range | Tolerance Limits | Remarks |
| Principal Dimensions | Length | Length between Perpendiculars | ±50.0 Per 100M | Not defined | Applied to ships of 100 meters length and below. For the convenience of the measurement the point where the keel is connected to the curve of the stem may be substituted for the fore perpendicular in the measurement of the length. |
| | | Length between aft edge of boss and main engine | ±25.0 | Not defined | |
| | Breadth | Molded breadth Amidships | ±15.0 | Not defined | Applied to ships of 15 meters breadth and above. Measured on the upper deck. |
| | Depth | Molded depth Amidships | ±10.0 | Not defined | Applied to ships of 10 meters depth and above. |
| Deformation of hull form | Flatness of Keel | Deformation for the whole length | ±25.0 | Not defined | Ups(-) and Downs(+) against the check line of keel sighting. |
| | | Deformation for the distance between two adjacent bulkheads | ±15.0 | Not defined | Sighting by the transit or using slits. |
| | Forebody Alignment | Alignment of fore-body to baseline.   | ±30.0 | Not defined | Ups(-) and Downs(+) against the baseline of the keel at the foremost frame on the flat part of the keel. |
| | | Alignment of aft-body to baseline.   | ±20.0 | Not defined | Ups(-) and Downs(+) against the baseline of the keel at the aft-perpendicular. |
| | Rise of Floor | Rise of floor amidships   | ±15.0 | Not defined | The height of the lower turn of the bilge, compared with the planned height. Measured from the plane passing through the outer surface of the keel plate. |



**FIG. A1.12 Hull Structure**

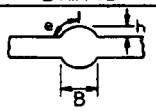
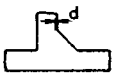
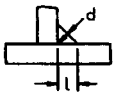
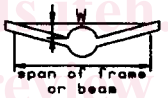
| I. HULL STRUCTURE | | | SHIPBUILDING QUALITY STANDARDS | |
|---|---|---|---|---|
| Division | | Welding | | UNIT: mm |
| Section | Sub-section | Item | Tolerance Limits | Remarks |
| Shape of bead | Height of reinforcement Breadth of bead Flank angle | |  h:not defined B:not defined e≤90° |  In case where e is over 90° it is to be repaired by grinding or welding to make e≤90° |
| | Under cut (butt weld) | Shell plate and face plate between 0.6l ● | over 90mm continuous d≤0.5  | Repair using fine electrode. (Avoid short beads for higher tensile steel) |
| | | Other | d≤0.8 | |
| | Under cut (fillet weld) | |  | |
| | Leg length | Compared with Correct ones (l,d) |  l:Leg length d:Throat depth ≥0.9l ≥0.9d | When over tolerance limits, weld up. (Avoid short beads for higher tensile steels) |
| Distorsion of welding joint | Angular distorsion of welding joint | Shell plate between 0.6L0x |  W≤6 | When over tolerance limits, repair by line heating or re-weld after cutting and re-fitting. |
| | | Fore and Aft shell plating and Transverse strength member | W≤7 | |
| | | Others | W≤8 | |
| Short bead | Tack welding bead Repairing of scar | .50HT .Cast steel TMCP type 50HT (ceq.>0.36%) | ≥50 | In case where short bead is unavoidable, preheat to ±25°C. If short bead is made inadvertently, remove the bead by grinding, and weld over length of visible crack. |
| | | Grade E of mild steel | ≥30 | |
| | | TMCP type 50HT (ceq.≤0.36%) | ≥10 | |
| | Repairing of welding bead | .50HT .Cast steel TMCP type 50HT (ceq.>0.36%) | ≥50 | |
| | | Grade E of mild steel | ≥30 | |
| | | TMCP type 50HT (ceq.≤0.36%) | ≥30 | |

FIG. A1.13 Hull Structure