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# Guidelines for Ships of Polyethylene

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These guidelines are non-mandatory, but are intended to provide practical technical materials to ship owners, ship operators, shipyards, designers and manufacturers. It might be amended periodically or upgraded to rules and guidance as future technology develops and matures.

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# CHAPTER 1 GENERAL

## Section 1 General

### 101. Application

1. This guidelines is to apply to design, construction, exhaust emission and noise emission, etc. of maritime recreational craft(hereinafter called "recreational craft") such as leisure boat and yacht of hull length from 2.5m to 24m.
  - (1) With regard to design and construction, to:
    - (A) recreational craft and partly completed crafts;
    - (B) following components.
      - (a) ignition-protected equipment for inboard and stern drive engines;
      - (b) start-in-gear protection devices for outboard engines;
      - (c) steering wheels, steering mechanisms and cable assemblies;
      - (d) fuel tanks intended for fixed installations and fuel hoses;
      - (e) prefabricated hatches and port-lights.
  - (2) With regard to exhaust emissions, to:
    - (A) propulsion engines which are installed or specifically intended for installation on or in recreational craft;
    - (B) propulsion engines installed on or in recreational craft that are subject to a major engine modification.
  - (3) With regard to noise emissions, to:
    - (A) recreational craft with stern drive engines without integral exhausts or inboard propulsion engine installations;
    - (B) recreational craft with stern drive engines without integral exhausts or with inboard propulsion installations which are subject to a major craft conversion
    - (C) outboard engines and stern drive engines with integral exhausts intended for installation on recreational craft;
  - (4) The provisions of (2) and (3) are to apply to only products which are first made
2. The following are to be excluded from the scope of this Guidance:
  - (1) With regard to design and construction, to:
    - (A) craft intended solely for racing, including rowing racing boats and training rowing boats, labelled as such by the manufacturer;
    - (B) canoes and kayaks, gondolas and pedalos;
    - (C) sailing surfboards;
    - (D) surfboards, including powered surfboards;
    - (E) craft specifically intended to be crewed and to carry passengers for commercial purposes, regardless of the number of passengers;
    - (F) submersibles;
    - (G) air cushion vehicles;
    - (H) hydrofoils;
    - (I) external combustion steam powered craft, fuelled by oil or gas.
    - (J) personal watercraft
    - (K) inflatable boat
  - (2) With regard to exhaust emissions, to:
    - (A) propulsion engines installed or specifically intended for installation on the following:
      - (a) craft intended solely for racing and labelled as such by the manufacturer
      - (b) craft specifically intended to be crewed and to carry passengers for commercial purposes, regardless of the number of passengers,
      - (c) submersibles,
      - (d) air cushion vehicles
      - (e) hydrofoils;
      - (f) personal watercraft
      - (g) inflatable boat
  - (3) With regard to noise emissions, to:
    - all craft referred to (2)

3. Where deemed appropriate by the Society, ISO, KS or internationally recognized standards considered as equivalent may be applied for the items which are not specified in the Guideline. Fire protection and fire extinction are to be complied with the requirements of Flag Administration in addition to the Guideline.

## 102. Classification

1. Recreational crafts built and surveyed in accordance with this Guideline or with the alternatives equivalent to this Guideline will be assigned a class notation by the Society and registered in the Registration Master.
2. For the classification of recreational craft the requirements, not mentioned in this chapter, are to be in accordance with Pt 1 of Rules for the Classification of Steel Ships.
3. Recreational crafts classed with the Society are, for continuation of the classification, to be subjected to the periodical and other surveys, and are to be maintained in good condition in accordance with the requirements of this Guideline.

## 103. Plans and documents for approval

1. In planning the building of a recreational craft which will comply with Classification requirements 3 copies of the following plans and documents are to be submitted for the approval of the Society prior to commencement of the work.
  - (1) Midship section
  - (2) Construction profile
  - (3) Shell expansion
  - (4) Watertight and oiltight bulkheads
  - (5) Deck plans
  - (6) Structure plans of stem, sternframe and rudder
  - (7) Superstructure and deckhouse plans
  - (8) Engine room structure plans
  - (9) Hatchways, hatch covers and coamings arrangements
  - (10) Foundations and relevant structure plan of boilers, main engines, thrust bearings, intermediate shaft bearing, generators and other heavy weight auxiliary components
  - (11) Final stability data
  - (12) Machinery room arrangement plan
  - (13) Arrangement and details of propulsion system and stern tube
  - (14) Attaching method of stern tube, bracket or shaft support
  - (15) Exhausting piping system with material and cooling system (If cooling method is a water spray type, drainage method is to be included.)
  - (16) Starting system
  - (17) Arrangement of bilge pump and bilge piping system
  - (18) Pipes, sea water and over board scupper pipes arrangement
  - (19) Contamination product discharge prevention and shore discharge arrangement
  - (20) Fuel oil system
  - (21) Fuel oil tanks other than hull structure exceeding 200 in capacity
  - (22) LPG fuel arrangement for onboard use
  - (23) Ventilation arrangement for gasoline engine or gasoline fuel tank installation compartment
  - (24) Fire control plan
  - (25) Steering gear arrangement
  - (26) Escape arrangement
  - (27) Torsional vibration calculation for main engine exceeding 500 PS
  - (28) Circuits arrangement for electric equipment
  - (29) Scope and detail of type for electric equipment
  - (30) Thruster's arrangement and details
  - (31) Anchor windlass's arrangement and details
  - (32) Other plans and documents specified by the Society
2. Manufacturers of main engine and shaft arrangement shall submit 3 copies of plans and documents in accordance with Pt 5, Ch 1 of Rules for the Classification of Steel Ships for the approval of the Society prior to commencement of the work.

**104. Plans and documents for reference**

1. In planning the building of a craft which will comply with Classification requirements, 3 copies of the following plans and documents are to be submitted for reference.
  - (1) General arrangement
  - (2) Specifications
  - (3) Calculation sheets of longitudinal strength
  - (4) Calculation sheets for midship section modulus and scantlings
  - (5) Other plans and documents specified by the Society
2. The capacity plans, sea trials records and various test reports are to be submitted before delivery of the craft.

**106. Sea Trial**

1. The operation tests for windlass(if fitted) and all mechanical system including steering gear are to be carried out after manufacturing of the recreational craft.
2. The propulsion engines are to be carried out sea trial at least one(1) hour with full speed and the condition of operation for starting, stopping and astern etc. are to be of satisfactory.
3. Where the engines are controlled from the deck, the operating tests are to be carried out and the necessary remote indicators are to be installed in control room.

**107. Government regulations**

1. The Society may require to apply the governmental regulations for items not specified in this Guideline.
2. Where the ships have undergone survey according to relevant governmental regulation and allowed to operate within costal area, the application of this Guideline may be dispensed with.

**108. Definitions**

In addition to Chapter 1, Section 1, 108 of the Guidance for Recreational Crafts, the definitions used in the guidelines are as follows.

**1. Low density polyethylene**

Low density polyethylene means polyethylene having a density of less than 0.930g/cm<sup>3</sup>. It is also called soft polyethylene or high pressure polyethylene. It is the first polyethylene developed, and the color is milky white, translucent, and it is a material with flexibility similar to rubber.

**2. Middle density polyethylene**

Medium density polyethylene means polyethylene having a density of 0.930g/cm<sup>3</sup> to 0.945g/cm<sup>3</sup>. Properties occur within the range of low density polyethylene and high density polyethylene.

**3. High density polyethylene**

High density polyethylene refers to polyethylene having a density of 0.945g/cm<sup>3</sup> to 0.972g/cm<sup>3</sup>. Because polymerization takes place at low pressure using a catalyst, it is also called medium and low pressure polyethylene. Because of its high rigidity, it is also called hard polyethylene.

**4. Polymerization**

It refers to a phenomenon in which two or more units combine to form a compound with a large molecular weight.

## Section 2 Essential Requirements

Follow Guidance for Recreational Crafts Chapter 1, Section 2. ⚓

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## CHAPTER 2 PERIODICAL AND OTHER SURVEYS

Follow Guidance for Recreational Crafts Chapter 2. ↴

## CHAPTER 3 MATERIALS

### Section 1 General

#### 101. Application

1. The provisions of this section apply to the polyethylene material and moulding used in the hull structure of leisure ships.
2. Polyethylene materials not specified in this guideline may be used only when specially approved in relation to the design. In this case, detailed data on the manufacturing method and physical properties of the material are to be submitted and approved by the Society.
3. Polyethylene materials are to be approved by the Society in accordance with the relevant provisions of this guideline and the Guidance for manufacturing process and type approval, etc.
4. For the approval of polyethylene material, the manufacturer is to prove that he has the necessary manufacturing and testing facilities and is supervised by qualified personnel.
5. It is the responsibility of the craft's owner to follow the instructions of the recreational craft manufacturer, especially concerning.
  - (1) The possible reduction of mechanical properties by the induction of heat

### Section 2 Material

#### 201. Polyethylene material

1. LDPE and MDPE shall comply with the requirements in Table A2-2 in Annex 2.
2. HDPE shall comply with the requirements in Table A2-3 in Annex 2.

#### 202. Workshop conditions

##### 1. General

- (1) The buildings used for production and storage shall be of suitable construction, and equipped to provide the environment specified by the material manufacturer or supplier
- (2) To minimize contamination or impairment of the material, the production area shall be separate from the storage area and, wherever practicable, the various manufacturing processes shall be carried out in separate sections.
- (3) The workshop and equipment shall be properly maintained and kept in a clean condition, substantially free from debris, surplus material, and equipment that is not essential for the production process.

##### 2. Temperature and humidity

- (1) Buildings for production and storage are to have appropriate structures and facilities to provide the environment specified by the polyethylene material manufacturer or supplier.

##### 3. Ventilation

- (1) Buildings for production and storage are to have appropriate structures and facilities to provide the environment specified by the polyethylene material manufacturer or supplier.

##### 4. Dust control

- (1) Systems are to be made to minimize the accumulation of harmful dust on the material.

##### 5. Illumination

- (1) Provisions shall be made to avoid any harmful effects on the resin cure due to direct sunlight or artificial lighting.

## 203. Material storage and handling

### 1. General requirements

- (1) Storage areas shall be arranged and equipped in such a way that the material manufacturer's requirements for storage and handling can be followed.
- (2) The procedures for the reception, verification against certificates of conformity, storage and handling of materials shall be detailed in the conformity assurance procedures provided by the boat builder (see clause 10) to ensure that the materials suffer no contamination or degradation and carry adequate identification at all times.
- (3) Storage shall be arranged so that wherever possible materials are used in order of receipt.
- (4) Structural parts shall be manufactured from materials that have not passed the material manufacturer's date of expiry.
- (5) Materials found to be defective or not in compliance with the specifications of raw-material supplier(s) shall be rejected unless treated in accordance with the conformity assurance procedure, provided by the boat builder

## Section 3 Welding

### 301. General

1. For welding of polyethylene used in the hull structure of leisure ships, DVS 2207 is to be complied with in addition to this guideline.
2. Details of welded joints of major structural members are to be included in the structural drawings and/or detailed drawings.
3. Welding is to be performed by welding materials approved in accordance with the previously approved welding method and by a welder who has the qualifications of the Society.
4. Welding of polyethylene plate may be generally performed through the following method.
  - (1) Hot gas welding using a torch separate from the welding electrode
    - (A) As shown in Figure 3-1, base material and electrode are heated with a stream of hot gas directed to the joint through the circular nozzle of a welding torch.
    - (B) The welding torch moves continuously along the welding line.
    - (C) Welders move manually the plasticized electrode along the weld line while applying pressure.
    - (D) The main areas of application are hard-to-reach places and weld roots.



Figure 3-1 Hot gas welding using a torch separated from the electrode

- (2) High-temperature gas string bead welding
    - (A) As shown in Figure 3-2, the welding electrode is supplied to the joint area through the welding nozzle channel. The welding nozzle channel should be suitable for the shape of the cross-section of the welding electrode.
    - (B) The required welding pressure is applied through the tip of the nozzle end.



- (C) If welding is performed properly, it has the characteristics of being able to work more uniformly and quickly than hot gas welding using a torch separated from the welding electrode.
- (D) The welding electrode is supplied under pressure to the joint through the nozzle shoe, which is the tip of the draw nozzle.
- (E) The base material is preheated prior to the start of welding due to the hot air coming out of the main nozzle hole.
- (F) The electrode is fed into the nozzle and preheated.
- (G) As soon as the surface of the joint is plasticized, the welding electrode is compressed along the welding line while uniformly applying the welding pressure with a welding torch.



Figure 3-2 High-temperature gas string bead welding

### 302. Weld design

1. Cross welding is to be avoided.
2. The distance between the weld lines is to be at least three times the width of the weld bead, and at least 30mm.
3. Where access is only possible from one side, welding groove is to be selected so that the thin-thickness joint can be fully joined.
4. The joint surfaces are to allow proper movement of welding torch.
5. As shown in Figure 3-3, The groove of butt welding such as V groove, X groove, one-side bevel, K groove, etc. may be used.
6. The welding electrode may be circular or shaped. Circular electrodes are commonly used for multi-layer welding. Shaped electrode are generally used for single-layer welding.
7. Table 3-1 shows the groove angles for V groove and X groove. 45° and 90° are generally used for groove angle of fillet weld.

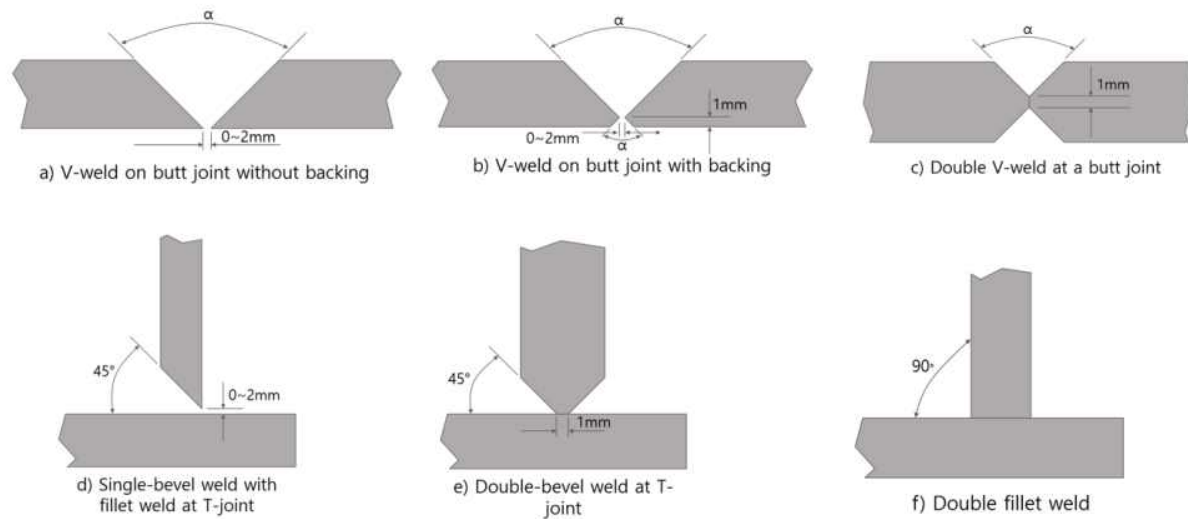


Figure 3-3 Shape of weld groove

Table 3-1 Material and groove angle for V groove and X groove

Material	Groove angle
Polyethylene	60°~70°

8. Table 3-2 shows the general hot gas temperature, hot gas flow rate, welding speed, and force applied to the welding electrode for the welding method and may be used as a reference.

Table 3-2 Examples of welding conditions per welding method

Welding method	hot gas temperature °C	hot gas flow rate l/min	welding speed mm/min	force applied to the welding electrode(N)	
				3mm	4mm
Hot gas welding using a torch separated from the electrode	300~320	40~50	70~90	8~10	20~25
Hot gas string bead weld	300~340	45~55	250~350	15~20	25~35

### 303. Welding practice

1. Welding Practice, which is the detailed statement of the general welding works for hull structure, is to contain welding process, standard of welding and its quality control, application of welding consumables, welding procedures specification(WPS) and welding sequence of main hull structure and be submitted to the Society.
2. The welding procedure specification(WPS) specified above is to be those satisfactorily complying with the welding procedure qualification tests specified in Sec 4.

**304. Tack weld**

1. Tack welding prevents movement of the joint during welding and fixes the joint at the original intended position

**305. Welder**

1. Hot gas welding requires the welder to have a high knowledge of the welding material and welding machine and working technique.
2. The welder is to pass the welder qualification test related to polyethylene material(eg. DVS 2212-1) and the certificate is to be valid.

**306. Main welding**

1. The ends of important welded joints are to be fitted with run-off tabs or are to have proper extensions, which are to be cut off after finished welding.
2. Butt welded joints are to be back chipped to remove the defects in root of welds before applying the closing bead, except in case of one side welding or other approved procedures.
3. Special consideration is to be given to welding under excessive restraints and welding of very thick polyethylene plates.
4. The weld surface is not to be damaged, oxidized or soiled.
5. Grinding is only permitted if surface contamination may be avoided.
6. If the joint is exposed to UV light for a long time, the residual wall thickness should be checked after mechanical treatment because the damage layer will form deeply.
7. If the welding surface needs to be cleaned, a non-fat detergent should be used.

**307. Weld quality**

1. The surface of the welded part is to be uniform in shape, and there shall be no defects such as excessive welding and under cut, underfill, overlap etc that are recognized as harmful.
2. The welding structure shall not show significant deformation due to welding.
3. For welded joints, non-destructive inspection is to be carried out in accordance with the separately stipulated guidelines.
4. Among the welding defects found by appropriate non-destructive inspection including visual inspection, those deemed harmful by the surveyor shall be removed and repaired.

**308. Re-welding**

1. It is usually not necessary to reweld.
2. In the case of re-welding, the surface should not be scratched.
3. If re-welding is to be performed, it should be performed after the weld has been sufficiently cooled.

**309. Reheat**

1. Residual stress in the weld can be reduced by tempering heat treatment.
2. Tempering temperature conditions are material and component dependent.
3. The specifications of the base material manufacturer is to be observed.

**310. Welding record document**

1. Weld record documents document welding conditions and welding parameters.
2. Classification surveyors may use weld record document to evaluate weld quality.

## Section 4 Welding Procedure Qualification Tests

### 401. General

#### 1. Application

- (1) The welding procedures to be applied to hull construction, machinery and piping specified in this Chapter are to be those satisfactorily complying with the welding procedure qualification tests specified in this Section.

#### 2. Definitions

- (1) Welding procedure specification(WPS) : A specification of materials, detailed methods, welding parameters etc. to be applied in the welding of a particular joint.
- (2) Welding procedure qualification tests(WPQT) : A test carried out in order to demonstrate that a weld made according to a specific welding procedure specification meets the given requirements.
- (3) Welding procedure qualification record(PQR) : The record of the actual parameters employed during welding of the qualification test piece according to the requirement of (2), and results from the non-destructive inspection and mechanical testing.

#### 3. General requirements of WPQT

- (1) The manufacturers are to obtain the approval of the welding procedure qualifications before the welding works in the following cases specified in (A) through (B).
  - (A) Where the welding procedure is first adopted for welding works
  - (B) Where the welding variables specified in 402. 2 (1) through (11) are changed beyond the extent of those described in the approved welding procedure specifications.
- (2) For the approval of welding procedure qualification, the preliminary welding procedure specification specified in 402. is to be reviewed by the Society and the welding procedure qualification test specified in 404. or 405 is to be carried out with satisfactory results. In addition, the approved welding procedure specification is to be accompanied by a qualification test record recording the actual welding characteristics applied during the welding of the test assembly and the results of nondestructive testing and mechanical testing.

### 402. Welding procedure specification

1. A welding procedure specification (WPS) is to be prepared by the manufacturer which intends to perform the welding procedure qualification test. This document is also referred to as a preliminary welding procedure specification (pWPS). The shipyard or manufacturer is to submit to the Society a pWPS for review prior to the tests.
2. The pWPS can be modified and amended during procedure tests as deemed necessary however it is to define, at least, the following welding variables
  - (1) Kind of polyethylene base material
  - (2) Nominal thickness
  - (3) Welding process
  - (4) Joint or groove designs with tolerances
  - (5) Welding position(s) and direction of progression
  - (6) Welding consumables(grade, section shape, diameter, force applied to welding consumables, etc.)
  - (7) Welding torch details
  - (8) Hot gas temperature/flow rate
  - (9) Travel speed
  - (10) Preheat and maximum interpass temperature(if any)
  - (11) Post weld heat temperature (if any)
  - (12) Other conditions necessary for the welding procedure
3. Welding electrodes used in welding procedure qualification tests should be approved in accordance with the requirements specified in this guidelines.
4. In case that the test pieces welded according to the pWPS show unacceptable results the pWPS is to be adjusted by the manufacturer. The new pWPS is to be prepared and the test pieces welded in accordance with the new pWPS.
5. The WPS is to be used as a basis for the production welds, and upon satisfactory completion of the tests based on the pWPS, the Society may approve it as a WPS.

**403. Welding procedure qualification tests(WPQT)**

1. Where procedure qualification test is required, the test assembly is to be welded in the same or similar environment and the qualification tests are to be carried out under the welding conditions given in the pWPS.
2. Welding of the test assemblies and testing of test specimens are to be witnessed by the Surveyor
3. The laboratory or testing establishment used to perform the tests is to have the necessary equipment, maintained in good order and suitably calibrated.
4. If tack welds and/or start and stop points are a condition of the weld process they are to be fused into the joint and are to be included in the test assemblies.
5. Tests or test conditions other than those specified in this Section for the welding procedure qualification may be required, where deemed necessary by the Society

**404. Tests for butt welded joints****1. Application**

- (1) The requirements stated hereunder apply to the butt joints welded by manual welding.

**2. Kinds of test**

- (1) Kinds of test and number of test specimens are to be given in Table 3-3. Additional test may be required where found necessary by the Society.

**3. Test assemblies**

- (1) Test assemblies are to be prepared with the same or equivalent material used in the actual work.
- (2) The dimensions and types of test assembly are to be as indicated in Figure 3-4.
- (3) Test assemblies are to be welded in the same welding positions as the actual work.

**Table 3-3 Kinds of Test for Plates with Butt welded joints**

Grade	Kinds and number of specimens for test(1)						
	Visual insp.	Tensile test	Bend test	Impact test	Macro structure insp.	Hard. test	Non-destructive insp.
Polyethylene	Welding of whole length	2	4	(2)	1	1	Welding of whole length
(Notes)							
(1) Where found necessary by the Society, microscopic test and tests other than these may be required.							
(2) No. of test sets and position of notch are as shown in Figure 2.							

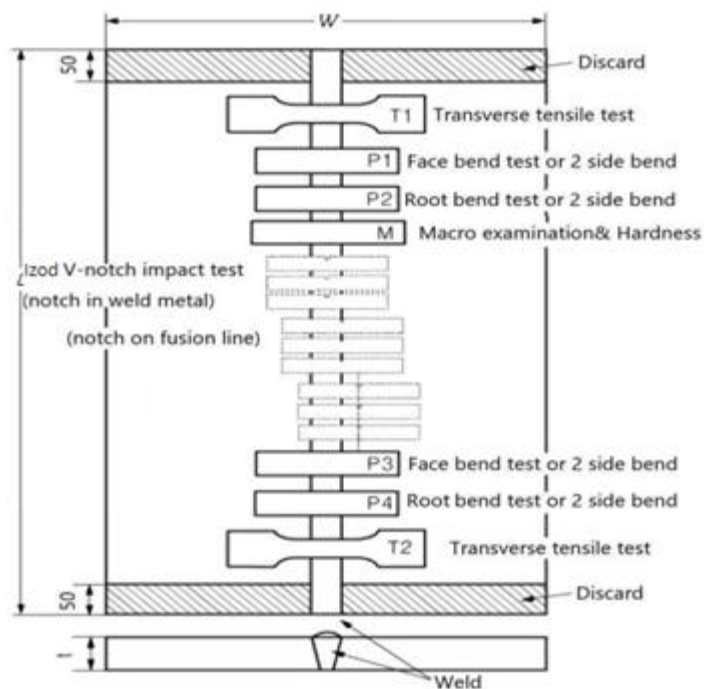


Figure 3-4 Welding procedure test assembly(Unit : mm)

#### 4. Tensile tests

- (1) The number of tensile test specimens taken from each test assembly is to be as shown in Table 3-3 and the position of specimen is to be as shown in Figure 3-4.
- (2) Tensile tests are to be carried out with the test specimen shown in ASTM D-638 or ISO 527. The tensile strength is not to be less than the minimum tensile strength specified for the base material. When butt welds are made between plates of different grades, the tensile strength to be obtained on the welded assembly is to be in accordance with the requirements relating to the grade having lower strength.

#### 5. Bend tests

- (1) The number of bend test specimens taken from each test assembly is to be as shown in Table 3-3, and the position of specimen is to be as shown in Figure 3-4.
- (2) The shape and dimension of face bend specimen, root bend specimen or side bend specimen are to be as indicated in ASTM D-790. Bend test procedure and inside bend diameter are to be as indicated in Table 3-4. There is to be no crack nor any other defect greater than 3 mm in length in any direction on the surface of bend specimen

Table 3-4 Bend Test Requirements

Kind of testing material	Inside bend diameter(mm)	Bending angle
Polyethylene	4t	180°
NOTES :		
(1) t is the thickness of the test specimen.		

#### 6. Impact tests

- (1) The test specimen is to be Izod V-notch impact test specimen as shown in ASTM D-256 or ISO 180 and to be taken from the position in Figure 3-4.
- (2) The number of test specimens taken from test assemblies and the position of notch for the test specimen are as specified in Figure 3-5.

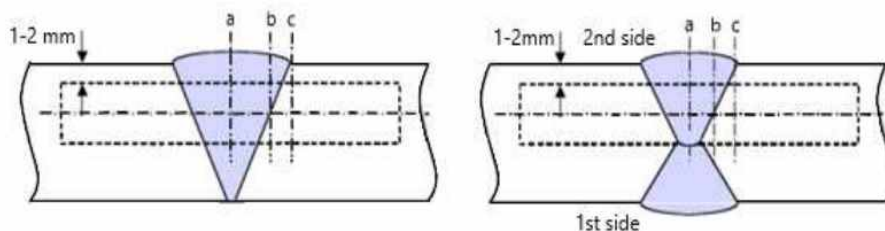


Figure 3-5 No. of test sets and locations of V-notch

- (3) Test specimen is to be sampled from 1 to 2 mm below the surface of the base material, transverse to the weld and on the side containing the last weld run.
- (4) Test temperature and absorbed energy are to be in accordance with Table 3-5.

Table 3-5 Impact test requirements for butt joints

Test temp.(°C)	Average absorption energy(J/m)
0	196

### 7. Macro-structure inspection

- (1) The test specimens are to be prepared and etched on one side to clearly reveal the weld metal and the fusion line. Macro examination is to include about 10 mm unaffected base metal.
- (2) The examination is to reveal a regular weld profile, through fusion between adjacent layers of weld and base metal and the absence of defects such as cracks, lack of fusion etc.

### 8. Visual & Non-destructive inspection

- (1) Test assemblies are to be examined for the whole length by visual and by non-destructive testing prior to the cutting of test specimen. Visual and non-destructive examinations should be carried out after any required post weld heat treatment, natural or artificial ageing, and prior to the cutting of the test specimens.
- (2) NDT procedures are to be agreed with the Society. The results of non-destructive testing are to show that there are no cracks or other injurious defects
- (3) Acceptance criteria is in accordance with DVS 2202-1 and DVS 2206.

### 9. Hardness test

- (1) Hardness distribution at positions shown in Figure 3-6 is to be measured. The hardness is measured using the ISO 868 Type D shore.

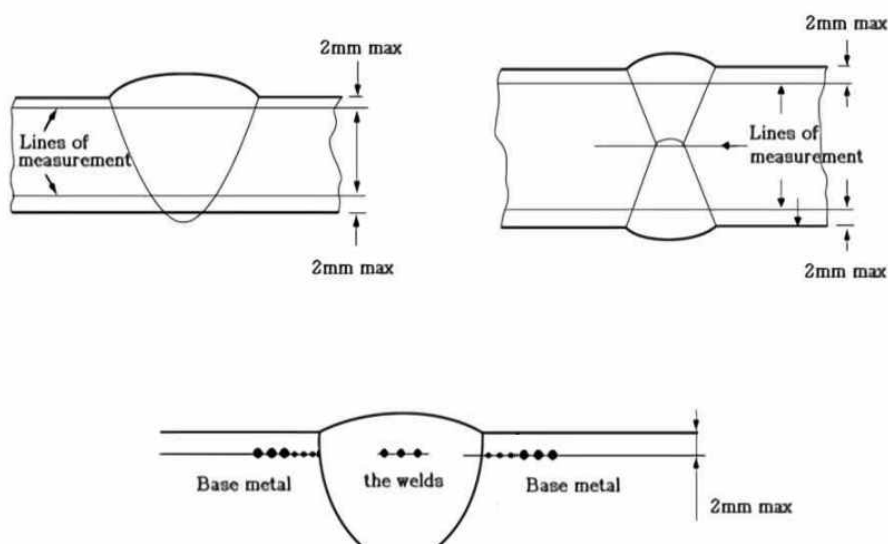


Figure 3-6 Hardness Test for butt welded joint

#### 405. Tests for fillet welded joints

##### 1. Application

- (1) The requirements stated hereunder apply to the fillet joints welded by manual welding in any welding position.

##### 2. Kinds of test

- (1) Fillet weld joints are to be subjected to visual inspection, surface crack detection, macro-structure inspection, hardness test and fracture test. Additional tests may be required if found necessary by the Society.

##### 3. Test assemblies and welding

- (1) Test assembly is to be prepared with the same or equivalent material used in the actual work
- (2) Dimensions and type of test assembly are to be as indicated Figure 3-7.

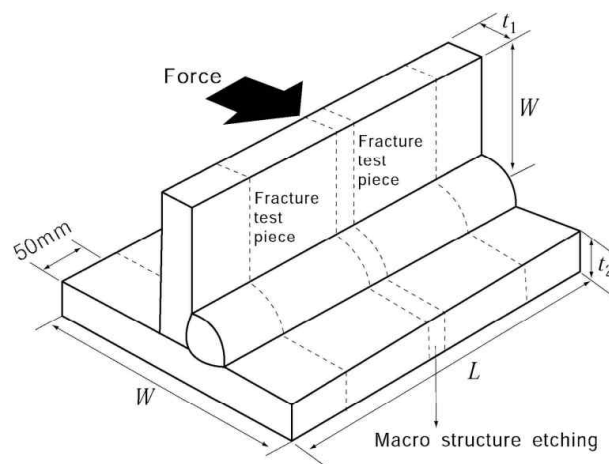


Figure 3-7 Test assembly for fillet weld joint  
(Unit : mm)

- (3) Test assembly is to be welded in the same welding positions as the actual work
- (4) The assembly is to be welded on one side only, except in case deemed necessary by the surveyor.
- (5) For manual welding, a stop/restart is to be included in the test length and its position is to be clearly marked for subsequent examination.

##### 4. Visual & non-destructive inspection

- (1) Test assemblies are to be examined by visual and by non-destructive testing prior to the cutting of test specimen. In case that any post-weld heat treatment is required or specified non-destructive testing and visual inspection are to be performed after heat treatment
- (2) NDT procedures are to be agreed with the Society. The results of visual & non-destructive testing are to show that there are no cracks or other injurious defects
- (3) Acceptance criteria is in accordance with DVS 2202-1 and DVS 2206.

##### 5. Macro-structure inspection

- (1) The test specimen is to be taken from the position in Figure 3-7.
- (2) The test specimens are to be prepared and etched on one side to clearly reveal the weld metal, fusion line and root penetration. Macro examination is to include about 10 mm unaffected base metal.
- (3) The examination is to reveal a regular weld profile, through fusion between adjacent layers of weld and base metal, sufficient root penetration and the absence of defects such as cracks, lack of fusion etc.

##### 6. Hardness test

- (1) Hardness distribution at positions shown in Figure 3-8 is to be measured. The hardness is measured using the ISO 868 Type D shore.



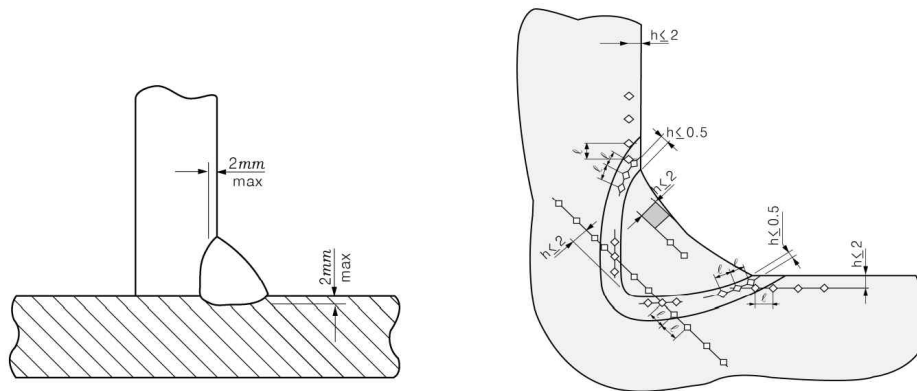


Figure 3-8 Hardness test for fillet welded joint(unit : mm)

### 7. Fracture tests

- (1) The remaining test assemblies after the macro-structure test specimen has been removed are to be broken by pressing as shown in Figure 3-7 and it shall be evaluated cracks, blow holes, poor penetrations and any other injurious defects in the fractured surface. Acceptance criteria is in accordance with DVS 2202-1 and DVS 2206. ⚡

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## CHAPTER 4 HULL STRUCTURES

Follow Guidance for Recreational Crafts Chapter 4. ↕

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## CHAPTER 5 STABILITY AND BUOYANCY

Follow Guidance for Recreational Crafts Chapter 5. [↓](#)

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## CHAPTER 6 HULL EQUIPMENT

Follow Guidance for Recreational Crafts Chapter 6. ↕

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## CHAPTER 7 STEERING SYSTEM

Follow Guidance for Recreational Crafts Chapter 7. [↓](#)

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## CHAPTER 8 MACHINERY INSTALLATIONS

Follow Guidance for Recreational Crafts Chapter 8. ↕

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## CHAPTER 9 ELECTRICAL EQUIPMENT

Follow Guidance for Recreational Crafts Chapter 9. ↴

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## CHAPTER 10 LPG SYSTEM FOR DOMESTIC USE

Follow Guidance for Recreational Crafts Chapter 10. ⚓



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## CHAPTER 11 FIRE PROTECTION AND FIRE EXTINCTION

Follow Guidance for Recreational Crafts Chapter 11. ⚓

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## CHAPTER 12 ESSENTIAL REQUIREMENTS FOR EXHAUST EMISSIONS FROM PROPULSION ENGINES

Follow Guidance for Recreational Crafts Chapter 12. ↴

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## CHAPTER 13 ESSENTIAL REQUIREMENTS FOR NOISE EMISSIONS

Follow Guidance for Recreational Crafts Chapter 13. ↴

## ANNEX 1 Approval of Manufacturing Process

### Section 1 Polyethylene

#### 101. Application

1. The requirements in this Section apply to tests and inspection for the approval of manufacturing process of polyethylene material for hull structure of polyethylene ship.

#### 102. Data to be submitted

The following reference data in addition to those specified in Guidance for Approval of Manufacturing Process and Type Approval, Etc, Chapter 2, Section 1, 102. are to be submitted to the Society.

- (1) Dimensions
- (2) Design temperature
- (3) Installation instructions
- (4) Details of marking
- (5) Drawings and supporting documentation
  - (A) Certificates and reports for relevant tests previously carried out
  - (B) Details of relevant standards
  - (C) All relevant design drawings, catalogues, data sheets, calculations and functional descriptions
  - (D) Fully detailed sectional assembly drawings
- (6) Materials
  - (A) The polyethylene type
- (7) Packing and marking methods
- (8) Process of manufacture
- (9) Service records
- (10) The outline of company and data on major manufacturing facilities
- (11) Data of quality control system

#### 103. Approval tests

##### 1. Test samples and specimen

- (1) For each grade and for each manufacturing process, test samples are in general to be selected for each kind of product.
- (2) Test samples are to be taken in the presence of the Surveyor from the product.
- (3) The position of the samples to be taken in the length of the product and the direction of the test specimens with respect to the final direction of rolling of the material and the position of the samples in the width of the product is to be in compliance with table A1-2.
- (4) Test samples are to be taken from the product with the maximum thickness (dimension) to be approved. In addition, for initial approval, the Society will require selection of one test product of average thickness.

##### 2. Approval test and acceptance criteria

- (1) Approval tests are to be carried out in the presence of the Surveyor at the manufacturing plant and approval test items are to be as given in Table A1-1
- (2) Test methods and acceptance criteria are to be as given in Table A1-2. However, where accordance with these requirements are difficult, decisions are left to the discretion of the Society

Table A1-1 Approval Test Items for polyethylene

Base material test	Density
	Melt Mass Flow Rate
	Tensile Test
	Bending Test
	Hardness Test
	Shear strength Test
	Compression Test
	Izod V notch Impact Test
	Aged Izod V notch Impact Test
	Pore contents analysis
	Water absorption test
	Heat deflection temperature test
	Vicat Softening Temperature test
	Falling weight impact test
Weldability test	Weldment Tensile Test
	Weldment Izod V notch Impact Test
	Weldment Hardness Test
	Weldment Fatigue Test
High temperature characteristic test	Creep Test

Table A1-2 Test Items and Selection of Test Specimens

Approval test items		Position of the Sample	Direction of the test specimens	Approval testing method	Acceptance criteria
Base material test	Density	Top		ASTM D-792, ISO 1183 or equivalent.	Annex 2
	Melt index	Top		ASTM D-1238, ISO 1133 or equivalent.	Annex 2
	Tensile test	Top	T	ASTM D-638, ISO 527 or equivalent.	Annex 2
		Bottom	T		
	Bending test	Bottom	T	ASTM D-790, ISO 178 or equivalent.	Annex 2
	Hardness test	Top		ASTM D-2240, ISO 868 or equivalent. Use Type D	Annex 2
	Shear strength test	Top		ASTM D-732 or equivalent.	Annex 2
		Bottom			
	Compressive test	Top		ASTM D-695 or equivalent.	Annex 2
	Izod V notch impact test	Top	P	ASTM D-256, ISO 180 or equivalent.	Annex 2
		Bottom	P		
	Aged Izod V notch impact test	Top	P	ASTM D-256, ISO 180 or equivalent.	Annex 2
	Pore contents analysis	Top			Annex 2
	Water absorption	Top		ASTM D-570 or equivalent.	Annex 2
	Heat deflection temperature test	Top		ASTM D-648, ISO 75 or equivalent.	Annex 2
	Vicat Softening Temperature test	Top		ASTM D-1525, ISO 306 or equivalent.	Annex 2
	Falling weight impact test	Top		ASTM D-5420, D-3763 or equivalent.	Annex 2
Weldability test	Weldment tensile test	Top	T(to the welding direction)	Tensile test of Rule Part 2, Chapter 2, Section 2. Tensile test of base material of the same thickness is to be performed according to Rule Part 2, Chapter 1, Section 2, which is used as acceptance criterion for the tensile test of the weldment tensile test.	Base material
	Weldment Izod V notch impact test	Top	T(to the welding direction)	ASTM D-256, ISO 180 or equivalent. Take one set(3 pieces) of Izod V-notch impact test specimens with the longitudinal direction of the test specimen at right angles to the weld line with the position of the notch at fusion line, 2mm, 5mm, and 20mm from the fusion line to the base material side. The fusion line is determined by consid-	Base material

				ering the weld toe and groove shape.	
	Weldment Hardness test	Top		ASTM D-2240, ISO 868 or equivalent. Use Type D. Measure the hardness distribution parallel to a depth of 1mm from both surfaces of the face and root surface of the weld cross-section. Measure at interval of 0.7mm from the fusion line to base material.	Base material
	Weldment Fatigue test	Top	T(to the welding direction)	It is performed for butt and fillet welded joints.	For reference
High temperature characteristics test	Creep test	Top	P	ISO 899-1 or equivalent.	Annex 2

### 3. Weldability test

- (1) Preparation of the test assemblies
  - (A) Welded joints tests are to be carried out on samples of the thickest plate
- (2) Welding of the test assemblies
  - (A) The butt weld test assemblies are to be prepared with the weld seam transverse to the plate rolling direction, so that impact specimens will result in the longitudinal direction.
  - (B) The bevel preparation should be preferably 1/2V or K.
  - (C) The welding procedure should be as far as possible in accordance with the normal welding practice used at the yards for the type of steel in question. The welding parameters including consumables designation and diameter, pre-heating temperatures, inter-pass temperatures, heat input, number of passes, etc. are to be reported.
- (3) Type of tests and acceptance criteria
 

Kinds of tests, test methods and acceptance criteria are to be as given in Table A1-2.
- (4) Other tests

Additional other tests may be required in the case of when deemed necessary by the Society.

4. A reduction of the indicated number of product and thickness to be tested or complete suppression of the approval tests may be considered subject to the approval by the Society on the basis of the preliminary information submitted by the manufacturer in case any of the following (1) or (4) is relevant. On the other hand, an increase of the number of product and thicknesses to be tested may be required in the case of newly developed types of polyethylene product or manufacturing processes.

- (1) Approval for any grade also covers approval for any lower grade (impact test temperature) in the same strength level, provided that the method of manufacture and condition of supply are similar.
- (2) For higher tensile polyethylene, approval of one strength level covers the approval of the strength level immediately below, provided the manufacturing process is similar.
- (3) Change of the approval conditions.
- (4) Grades of polyethylene to be approved and availability of long term statistic results of mechanical properties.

### 104. Changes in the manufacturing process

In addition to those specified in 107., the manufacturer has to submit to the Society the documents together with the request of changing the approval conditions, in the case of the followings:

- (1) Change of the manufacturing process
- (2) Change of the maximum thickness (dimension)
- (3) Subcontracting the rolling and heat treatment, etc

#### 105. Dealing after approval

Polyethylene which conform to the requirements in this Section are to be dealt with as [an approved case], unless otherwise specified by the Society. The manufacturer can detached the test samples from material without being stamped by the Surveyor.



## ANNEX 2 Part 2 Materials and Welding

### Section 1 Polyethylene

#### 1. General

##### (1) Application

- (A) This Guideline applies to the polyethylene base materials used in the construction or repair of Polyethylene ships.
- (B) Polyethylene materials other than those prescribed in this Guideline may be used where specially approved in connection with the design. In such cases, the detailed data relating to the manufacturing process and mechanical properties, etc. of the materials are to be submitted for approval.

##### (2) Approval

- (A) Polyethylene materials are to be type approved in accordance with this Guideline and the Guideline specially specified by the Society in advance
- (B) The manufacturing process of Polyethylene ships which are to be certified or are intended for classification is to be approved in accordance with the Guideline specially specified by the Society in advance.
- (C) In order that a Polyethylene materials can be approved, the manufacturer is required to demonstrate to the satisfaction of the Society that the necessary manufacturing and testing facilities are available and are supervised by qualified personnel.

##### (3) Manufacturing control

- (A) It is the manufacturer's responsibility to assure that effective process and production controls in operation are adhered to within the manufacturing specifications.
- (B) Where control imperfection inducing possible inferior quality of Polyethylene materials occurs, the manufacturer is to identify the cause and establish a countermeasure to prevent its recurrence. Also, the complete investigation report is to be submitted to the Surveyor.
- (C) For further use, each Polyethylene material affected by previous (B) is to be tested to the Surveyor's satisfaction. The frequency of testing for subsequent products offered may be increased to gain confidence in the quality at the discretion of the Society
- (D) The manufacturer is to provide the material producer with such information as is essential to ensure that the Polyethylene materials to be used are in accordance with the approval requirements and the product specification. This information is to include any survey requirements for the materials.

##### (4) Retest procedure

- (A) Where test material fails to meet the specified requirement, two additional tests of the same type may be made at the discretion of the Surveyor
- (B) Where an individual test result in a group (minimum five) deviates from the mean by more than two standard deviations in either the higher or lower direction, the result is to be excluded and a re-test made. Excluded results of tests are to be reported with confirmation that they have been excluded. Only one exclusion is acceptable in any group of tests.

##### (5) Quality

- (A) Polyethylene materials are to be free from surface or internal defects which would be prejudicial to their proper application in service.
- (B) In the event of any material proving unsatisfactory during subsequent working or fabrication, such material may be rejected, notwithstanding any previous satisfactory testing and/or certification where the Surveyor considers necessary.

##### (6) Identification and marking of polyethylene material

- (A) The manufacturer of approved Polyethylene materials is to identify each batch with a unique number or code.
- (B) The manufacturer of Polyethylene products is to adopt a system of identification which will enable all finished products to be traced to the original batches of base materials. Surveyors are to be given full facilities for tracing any component or material when required

## (7) Certification

The manufacturer is to provide the purchaser with test reports or certificates of conformity for each batch of Polyethylene material supplied indicating the relevant values are to comply with this Guideline.

**2. Polyethylene material**

(1) Test method for polyethylene material is according to Table A2-1. If deemed necessary by the Society, additional test may be required.

**Table A2-1 Test method for polyethylene**

Properties		Test method	Notes
Density		ASTM D-792 or ISO1183	
Melt Index		ASTM D-1238 or ISO 1133	
Base material	Yield Strength	ASTM D-638 or ISO 527	Obtain the curve at 20°C and 65°C. When the thickest thickness is more than 10mm, specimens are taken from the surface and center.
	Tensile Strength		
	Elongation at Yield		
	Elongation at Break		
Weldment	Tensile Strength	Rule 2, Chapter 2, Section 2	Obtain the curve at 20°C for the thickest thickness. Tensile test of base material of the same thickness is to be performed according to Rule Part 2, Chapter 1, Section 2, which is used as acceptance criterion for the tensile test of the weldment tensile test.
Creep Test		ISO 899-1	2 specimens at least 3 stress value Stress-strain diagram is to be obtained for 0.1hour, 1hour, 10hour, 100hour and 1000hour at 20°C and 65°C
Fatigue Test			Test for Butt and fillet welded joints
Compression Strength		ASTM D-695	
Shear Strength		ASTM D-732	
Flexural Strength		ASTM D-790 or ISO 178	
Flexural Modulus		ASTM D-790 or ISO 178	
Hardness		ASTM D2240 or ISO 868	Measure by shore D method at 20°C
Falling weight impact test		ASTM D-5420 or D-3763	Striker shape, GA Test temperature of 0°C and 20°C Use crack occurrence on visual inspection as failure criterion Calculate failure energy
Izod Impact Strength		ASTM D-256 or ISO 180	Test at 0°C and describe the fracture mode
Pore contents			Measure by machining the cross-section
Izod Aged Impact Test		Impact test : ASTM D-256 or ISO 180 Accelerated aging : ASTM G155, ISO 4892-2	Aging time of 4 years for natural aging or 5,000hour for accelerated aging should be considered.
Water absorption		ASTM D-570	
Heat deflection temperature test		ASTM D648 or ISO 75	
Vicat Softening Temperature test		ASTM D1525 or ISO 306	

(2) Properties of LDPE and MDPE are to comply with Table A2-2.

**Table A2-2 Required properties of LDPE and MDPE**

Properties		LDPE	MDPE	Notes
Density[g/cm <sup>3</sup> ]		<0.930	0.930 ~ 0.945	
Melt index[g/10min]		Value suggested by manufacturer $\pm$ 1.0 Max. 3.5	Value suggested by manufacturer $\pm$ 1.0 Max. 3.5	
Base material	Yield strength[N/mm <sup>2</sup> ]	7.5 $\leq$	13.0 $\leq$	20°C
		4.5 $\leq$	8.0 $\leq$	60°C
Weldment	Tensile Strength[N/mm <sup>2</sup> ]	Tensile strength of base material	Tensile strength of base material	Tensile test of base material at the thickest thickness, 20°C is to be performed.
Compressive strength[N/mm <sup>2</sup> ]		9.6 $\leq$	15 $\leq$	
Shear strength[N/mm <sup>2</sup> ]		8 $\leq$	12 $\leq$	
Flexural strength[N/mm <sup>2</sup> ]		8~15	20 $\leq$	
Flexural modulus[N/mm <sup>2</sup> ]		250 $\leq$	500 $\leq$	
Hardness[Shore D]		Value suggested by manufacturer $\pm$ 3.0	Value suggested by manufacturer $\pm$ 3.0	
Falling weight impact[J]		15.0 $\leq$	15.0 $\leq$	test temperature of 0°C
Izod Impact Strength (with notch)		no brittle fracture	no brittle fracture	test temperature of 0°C
Pore contents [thickness %]		$\leq$ 15	$\leq$ 15	
Izod Impact strength of aged material(with notch)		no brittle fracture	no brittle fracture	test temperature of 0°C
Water absorption		Value suggested by manufacturer	Value suggested by manufacturer	
Heat deflection temperature[°C]		45 $\leq$	55 $\leq$	
Vicat Softening Temperature[°C]		92 $\leq$	105 $\leq$	

(3) Properties of HDPE are to comply with Table A2-3.

**Table A2-3 Required properties of HDPE**

Property		Required values	Notes
Density[g/cm <sup>3</sup> ]		0.946 ~ 0.972	
Melt Mass Flow Rate[g/10min]		0.030 ~ 10	190°C/2.16kg condition
Base material	Yield Strength[N/mm <sup>2</sup> ]	17≤	
	Tensile Strength[N/mm <sup>2</sup> ]	24≤	
	Elongation at Yield[%]	1.0 ~ 27	
	Elongation at Break[%]	10 ~ 1500	If no break has occurred, the elongation at the end of the test is assumed.
Weldment	Tensile Strength[N/mm <sup>2</sup> ]	Tensile strength of base material	Tensile test of base material at the thickest thickness, 20°C is to be performed.
Tensile Creep Modulus[N/mm <sup>2</sup> ]		292≤	After 1000 hours
Fatigue		Value suggested by manufacturer	
Compressive Strength[N/mm <sup>2</sup> ]		20≤	
Shear Strength[N/mm <sup>2</sup> ]		18≤	
Flexural Strength[N/mm <sup>2</sup> ]		24≤	
Flexural Modulus[N/mm <sup>2</sup> ]		750≤	
Hardness		Value suggested by manufacturer ± 3.0	Shore D condition
Falling weight impact[J]		15.0≤	test temperature of 0°C
Izod Impact Strength (with notch)		196J/m ≤ no brittle fracture	test temperature of 0°C
Pore contents [thickness %]		≤15	
Izod Impact strength of aged material(with notch)		no brittle fracture	test temperature of 0°C
Water absorption[%]		≤0.017	24 hours
Heat deflection temperature[°C]		69≤	
Vicat Softening Temperature[°C]		120≤	

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## **Guidelines for Ships of Polyethylene**

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