Quality Assurance Manual
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GENERAL</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>MATERIALS</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>EDGE PREPARATION</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>WELDING</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>ASSEMBLY WELDING</td>
<td>9</td>
</tr>
<tr>
<td>6</td>
<td>STRUCTURAL COMPONENT-FABRICATION AND ASSEMBLY</td>
<td>17</td>
</tr>
<tr>
<td>7</td>
<td>STRAIGHTNESS / FAIRING</td>
<td>17</td>
</tr>
<tr>
<td>8</td>
<td>REMOVAL OF TEMPORARY FABRICATION MATERIAL</td>
<td>19</td>
</tr>
<tr>
<td>9</td>
<td>TIGHTNESS TEST</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>HULL PRINCIPAL DIMENSIONS</td>
<td>21</td>
</tr>
<tr>
<td>11</td>
<td>PIPING</td>
<td>22</td>
</tr>
<tr>
<td>12</td>
<td>QUALITY OF SMALL ITEMS</td>
<td>24</td>
</tr>
<tr>
<td>13</td>
<td>PAINTING</td>
<td>25</td>
</tr>
<tr>
<td>14</td>
<td>GENERAL DELIVERY FOR STOCK HULLS (ONLY FOR GUIDANCE)</td>
<td>28</td>
</tr>
</tbody>
</table>
1 - **GENERAL**

1.1. This booklet has been introduced to acknowledge the control of an “assembly line” type of ship construction in selected shipyards, involving essential working standard and acceptable tolerances enforced by quality control.

1.2. The working standards and tolerances are intended to form common criteria between builders and surveyors to achieve a high quality standard of hatch cover construction.

1.3. In order to accommodate unavoidable inaccuracies in workmanship and to maintain a high quality standard tolerances have been defined in this document. Where “Standard” and “Limit” values are stated, the former is expected to occupy 95% of all work and the latter not more than 5%. Where only “Limit” values are stated, these values are not to be exceeded. When the above mentioned values are exceeded the defects are to be repaired adopting the procedures indicated, or other improved procedures.

1.4. In certain circumstances, deviations from these recommended tolerances may be accepted after written agreement between Buyers, Builders and Classification Societies Surveyors.

1.5. This booklet is used by the Buyers surveyors for guidance to complement their experience and judgement as to the acceptability of workmanship and the necessary remedial action.

1.6. This document will be kept under review so that experience gained from the application of these standards and/or from further development of technology, can be reflected in future updating.
2 - MATERIALS

2.1 - Quality of material

2.1.1. All materials have to be in conformity the requirement of the Classification Society as laid down in their rules.

2.1.2. Materials and material certificates have to be checked by the Buyers surveyor.

2.2 - Surface Defects

2.2.1. The most common discontinuities on plates and wide flat surfaces are as follows:
rolled-in scale, pitting, depressions and protuberances, scratches and grooves, spills and slivers, blisters, hot tears, sand patches, cracks, material overlap and sliding of layers during forging and casting.

2.2.2. Surface imperfections will be either isolated or clustered. Isolated imperfections have to be considered individually, and treated by grinding, chipping of drilling followed by welding according to their actual depth.

2.2.3. Clustered imperfections are to be considered in groups and treated according to both depth value and surface area involved.

2.2.4. The limits of depth and extend of discontinuities on plate surfaces in relation to plate thickness are shown in Table 2.1. and associated notes.

2.2.5. Grinding only or by chipping or grinding and welding may carry out repair of defects.

2.2.6. Repairs by grinding only will be acceptable provided the plate thickness is not reduced by more than 7% of the nominal thickness.

2.2.7. When the limits in 2.2.6. are exceeded, repairs are to be carried out by grinding or chipping followed by welding.

Table 2.1. Limits of surface discontinuities

<table>
<thead>
<tr>
<th>Nominal Thickness of Plate (mm)</th>
<th>Maximal Permissible Depth of Defect (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Area affected –unlimited</td>
</tr>
<tr>
<td>t &lt; 8</td>
<td>0.2</td>
</tr>
<tr>
<td>8 &lt; t ≤ 25</td>
<td>0.3</td>
</tr>
<tr>
<td>25 &lt; t ≤ 40</td>
<td>0.4</td>
</tr>
<tr>
<td>t &gt; 40</td>
<td>0.5</td>
</tr>
</tbody>
</table>

NOTES :
- Defects are to be measured after shot blasting.
- The depth of the deepest imperfection has to be considered.
- Discontinuities not exceeding the limits shown above need not be repaired.
- Where the depth of the discontinuity reduces the material thickness to below the rolling tolerance, mentioned in the Classification Society Ship Rules, the values in column 2 and 3 will be accepted provided the areas involved do not exceed 15 % and 2 % respectively, of the plate surface.
- Discontinuities exceeding the above limits have to be repaired.
- Crack-like discontinuities shall always be repaired irrespective of their depth.
2.2.8. Where the depth of the deepest imperfection exceeds 20 % of the nominal thickness, or the total surface area to be repaired by welding exceeds 2 % of the plate surface area on one side, the plate has to be rejected.

2.2.9. Complete removal of the defects is to be verified by suitable non-destructive testing techniques and after welding the repair is to proved free from further defects.

2.2.10. Great care is to be taken in the repair of defects on higher tensile steel materials. Low hydrogen electrodes of matching strength should be used and preheating should generally be considered.

2.2.11. Surface defects on plates of profiles always have to be discussed with the Surveyor of the Classification Society.

2.2.12. Repair using insert plates in bottom, shell, deck plating and in deck/wheel house is not permitted without written permission of Buyers/Class Society.

2.3 - **Plate Laminations**

2.3.1. Plates in which laminations have been detected are to be subjected to ultrasonic testing in order to determine accurately the full extent of the laminations before corrective action is taken.

2.3.2. Complete removal of the defect is to be verified by suitable non-destructive testing techniques, and has to be provided free from further defects.

2.3.3. Plate laminations have always to be discussed with the surveyor of the Classification Society.

2.3.4. Repair using inserts plates in bottom, shell, deck plating and in deck/wheelhouse is not permitted without written permission of Buyers/Class Society.

2.4 - **Plate Thickness Tolerances**

These specify the permissible reduction of the nominal plate thickness “t”, generally measured on the plate edges.

<table>
<thead>
<tr>
<th>Nominal plate thickness</th>
<th>Max. tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>t &lt; 10 mm</td>
<td>≤ 0.4 mm</td>
</tr>
<tr>
<td>10 ≤ t &lt; 20 mm</td>
<td>≤ 0.5 mm</td>
</tr>
<tr>
<td>20 ≤ t &lt; 45 mm</td>
<td>≤ 0.02 t + 0.1 mm</td>
</tr>
<tr>
<td>t &gt; 45 mm</td>
<td>≤ 1 mm</td>
</tr>
</tbody>
</table>
3 - **EDGE PREPARATION**

3.1. Wherever possible gas cutting of plate edges should be carried out with machine controlled equipment. Edges that are to be incorporated in a welded joint should be examined for irregularities that may interfere with the achievement of a weld of an acceptable standard.

3.2. The depths of imperfections of gas cut edges must generally not exceed the values shown in the following table.

When these values are exceeded the defective surfaces are to be dressed by grinding.

<table>
<thead>
<tr>
<th>Position</th>
<th>Item</th>
<th>Standard depth</th>
<th>Limit depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free Edge</td>
<td>Strength Members</td>
<td>0.2 mm</td>
<td>0.3 mm</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>0.3 mm</td>
<td>0.5 mm</td>
</tr>
<tr>
<td>Welding Edge</td>
<td>Strength Members</td>
<td>0.3 mm</td>
<td>0.5 mm</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>0.5 mm</td>
<td>0.8 mm</td>
</tr>
</tbody>
</table>

3.3. All irregularities in plate edges such as serration or “stops and starts” due to erratic gas flow, are to be welded and ground smooth.

3.4. Flame cutting slag and burrs are generally removed. Burrs caused by roller or guillotine shears have to be ground smooth.

3.5. Sharp edges on free edges must be slightly rounded by grinding (preferable before assembly). Sharp edges in all areas where a special coating has to be applied (inside tanks and coerdams) must be rounded \( r_{\text{max}} = 1.5 \text{ mm} \) or otherwise mentioned in the documentation.
4 - WELDING

4.1 - General
The Buyers surveyor must apply the welding list/table used for the type of vessel and must check by random inspections that the angle of preparations duly conforms to the drawings or list/table if this list/table exist.

4.2 - Precautions to be taken before welding
The edges of the parts must be prepared as specified and should be clean without burrs and cutting slag, and free from grease or paint, except for protective shop primers.
The joint should not be wet.
Tack welds should not be too thick and of the tack weld should be so that certain that they could be effectively remelted.
Before performing the welding, the inspector must be sure that all tack welds are in a good condition. Bad and broken tack welds have to be removed before welding.

4.3 - Welding in cold weather
Care must be taken in cold weather welding main structure components. In principle, the minimum temperature below which welding should not be carried out without taking precautions is -5°C, taken in an wind sheltered place in contact within the steel.
As a general rule the following precautions are recommended:
- For normal shipbuilding steel, for manual and automatic welding, no special precautions are needed in calm, dry weather for temperatures above -10°C.
- If it is windy and wet, the temperature is -5°C.
At too low temperatures, too brutal cooling after welding should be avoided by means screens or padding.

4.4 - Non-destructive examination
The location and number of welds to be examined by non-destructive examination is to be agreed between the Builder, Classification Surveyor and Buyers Surveyor and for indication of recommended locations and numbers of non-destructive examination to be applied see the classification rules.
Where defects are observed at or near the ends of the radiographs additional radiography is to be carried out to determine the full extent.
Unacceptable defects should be repaired and a second non-destructive examination has to be carried out.
4.5 - **Welding Standards**

4.5.1. Abrupt change of section plate thickness has to be avoided. When the difference in thickness exceeds 3 mm the thicker plates has to be prepared with a taper not exceeding 1 in 3, or a beveled edge to form a welded joint proportioned correspondingly only when not clearly indicated in documentation.

4.5.2. Where fillet welds attach stiffening members and crosses completely finished butt or seam welds, these welds has to be made flush in a way of the faying surfaces.

4.5.3. Where intermittent welding is used, the welding is to be made continuous in way of brackets, lugs and scallops and at the orthogonal connections with other members, according to Classification Society Regulations.

4.5.4. Where structural members pass through the boundary of a tank or W.T. bulkheads, and leakage into the adjacent space could be hazardous or undesirable, full penetration welding is to be adopted for the members for at least 150 mm on each side of the boundary. Alternatively a small scallop of suitable shape may be cut in the member close to the boundary outside the compartment and carefully welded all around.

4.5.5. It is of course forbidden to fill a gap between joined components with electrode wires or steel scarp etc.

4.5.6. Pinholes in continuous welds in tanks, wet spaces, sanitary spaces, bilge parts and on the outside of the hull are not permitted.

4.5.7. Fresh watertanks, ballasttanks, foamtanks, sewagetanks, chainlockers, air intake channels, sanitary spaces, wetspaces and all outside structure, must be welded continuously.

4.5.8. Throat thickness has to be checked and may never be under the limit as given on the welding table/list. Special attention has to be paid the welding are not extremely heavier than mentioned, to prevent unnecessary deformations.

4.5.9. A high quality standard of visual appearance of welds has to be maintained. Butts and seams should be straight / lines in shaped parts of the hatch covers the seams should be faired lines. The deviation from the straight / faired lines must be roughly taken within 5 % of the welding width. The appearance of the weld should have a regular structure and the surface roughness should not have a difference more than 1÷1.5 mm measured from the highest to the lowest points of the welding sharp points in valleys are not permitted. Undercutting in welding on the hatch cover plating is not permitted. Undercutting has to be repaired by welding and ground smooth. Undercutting by fillet weld on stiffening is not permitted (see classification rules for allowable tolerances).

4.5.10. Welding slag and spatters have to be removed.

4.6 - **Electrode storage**

To avoid contamination, damage or undue moisture pick-up, electrodes must be stored in a clean, dry place. The various types of electrodes require different moisture content control. For drying, redrying and moisture control follow the instruction as mentioned on the documentation of the electrodes.
5 - **ASSEMBLY WELDING**

5.1 - *Assembly welding*

5.1.1. Alignment of butt and fillet joints is shown in table 5.1.

**Table 5.1. Alignment of joints**

<table>
<thead>
<tr>
<th>Joint</th>
<th>Location</th>
<th>Standard</th>
<th>Limit</th>
<th>Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BUTT JOINT</strong></td>
<td>Strength members</td>
<td>a = 0.15 (t) (max.3 mm)</td>
<td>When limit is exceeded joint to be re-aligned</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>a = 0.2 (t)</td>
<td>When limit is exceeded joint to be re-aligned (see also 4.5.1.)</td>
<td></td>
</tr>
<tr>
<td><strong>FILLET JOINT</strong></td>
<td>Strength members</td>
<td>a ≤ (t/3)</td>
<td>When (t/3 \leq a \leq t/2) increase fillet A and C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>a ≤ (t/3)</td>
<td>When (a \geq t/2) joint to be re-aligned</td>
<td></td>
</tr>
</tbody>
</table>

\(t =\) thickness of thinner plate,
5.2 - **Type of welding joint**

5.2.1. Whenever practicable weld joint configuration should be arranged so that all major portions of the weld are deposited in the down-hand or flat position.

5.2.2. The design and dimensions of the butt joint edge preparation depends on the plate thickness, welding process, position and technique employed. The examples of joint configuration in the subsequent tables are intended for guidance purposes.

5.2.3. Limits for gap and root face weld preparations for manual and automatic welding are given in next tables. For automatic processes closer tolerances can be necessary, depending on the characteristics of the welding process, as established through procedure tests.

5.2.4. Root gaps for butt and tee joint are to be within the limits specified in the tables. Where these are exceeded, build-up by welding on the joint surfaces is permitted. The amount of weld build-up to be applied should be limited to the thickness of the plates to be butt welded, to a maximum of 25 mm. Built up edges are to be dressed as required before re-assembly for welding.

5.2.5. Where root gaps exceed the permissible limits that can be built up by welding, the joint members have to be partially renewed. The criteria for repair should be agreed between Classification Surveyors, Builders, and Buyers.

5.2.6. Welding consumables used for the weld build-up should be same as those specified for the main weld. If this is not practicable other consumable approved by Classification Surveyor for the materials involved may be employed.

5.2.7. Where weld metal has been deposited on joint surfaces to reduce root gaps to acceptable dimensions, non-destructive examination of the built up areas is to be carried out before the joint is welded.

5.2.8. Where welding be employed on both sides of a butt joint, unsuitable metal at the root on the reverse side of the weld has to be removed to sound metal by an classified approved method before applying subsequent welds runs.
<table>
<thead>
<tr>
<th>Type of joint</th>
<th>Type of welding</th>
<th>Standard</th>
<th>Limit</th>
<th>Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SQUARE BUTT</td>
<td>Manual welding</td>
<td>G = t/2</td>
<td>G ≤ 5 mm</td>
<td>t ≤ 6 mm. max. When 5 &lt; G &lt; 12 mm joint face to be beveled, backing strip fitted and joint welded. Back gouge after removal of strip and complete weld. When G&gt;12 mm. part renew plate</td>
</tr>
<tr>
<td></td>
<td>Machine Welding</td>
<td>G = 0+2 mm</td>
<td></td>
<td>t = 19 mm max. See 5.2.3.</td>
</tr>
<tr>
<td>2. SINGLE BEVEL BUTT</td>
<td>Manual welding</td>
<td>G ≤ 3 mm</td>
<td>G ≤ 5 mm</td>
<td>t = 6 to 16 mm.</td>
</tr>
<tr>
<td></td>
<td>Machine Welding</td>
<td>G ≤ 3 mm</td>
<td>R ≤ 5 mm</td>
<td>G ≤ 5 mm R = 5 mm θ = 50°- 75°</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>θ = 50°- 75°</td>
<td>t = 6 to 16 mm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>θ = 45°- 75°</td>
<td>See 5.2.3.</td>
</tr>
<tr>
<td>3. DOUBLE BEVEL BUTT</td>
<td>Manual welding</td>
<td>G ≤ 3 mm</td>
<td>G ≤ 5 mm</td>
<td>t = 19 to 38 mm.</td>
</tr>
<tr>
<td></td>
<td>Machine Welding</td>
<td>G ≤ 3 mm</td>
<td>R ≤ 5 mm</td>
<td>G ≤ 5 mm R = 5 mm θ = 50°- 75°</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>θ = 50°- 75°</td>
<td>t = 19 to 38 mm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>θ = 45°- 75°</td>
<td>See 5.2.3.</td>
</tr>
<tr>
<td>4. SINGLE VEE BUTT ONE SIDE ONLY WELDING</td>
<td>Manual welding</td>
<td>G ≤ 3 mm</td>
<td>G ≤ 5 mm</td>
<td>t = up to 16 mm.</td>
</tr>
<tr>
<td></td>
<td>Machine Welding</td>
<td>G ≤ 3 mm</td>
<td>G ≤ 5 mm</td>
<td>t = up to 16 mm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>θ = 60° +/- 5°</td>
<td>θ = 40° +/- 50°</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>θ = 60° +/- 5°</td>
<td>t = up to 16 mm.</td>
</tr>
<tr>
<td>5. SINGLE VEE BUTT ONE SIDE WELDING WITH TEMPORARY BAKING STRIP</td>
<td>Manual welding</td>
<td>G = 2-6 mm</td>
<td>G ≤ 3 mm</td>
<td>t = up to 38 mm. Temporary backing material</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>θ = 60° +/- 5°</td>
<td>t = up to 38 mm. Temporary backing material</td>
</tr>
</tbody>
</table>
## Type of joint

<table>
<thead>
<tr>
<th>Type of joint</th>
<th>Type of welding</th>
<th>Standard</th>
<th>Limit</th>
<th>Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="#">Diagram</a></td>
<td>Machine Welding</td>
<td>G = 2-6 mm</td>
<td>( \theta = 60^\circ ) +/-5°</td>
<td>( t = \text{up to} \ 38 \text{ mm.} ) See 5.2.3.</td>
</tr>
<tr>
<td>6. SINGLE VEE BUTT NORMAL WELDING AND BACK GOUGING</td>
<td>Manual welding</td>
<td>G ( \leq 3 ) mm</td>
<td>R ( = 2-3 ) mm</td>
<td>( \theta = 50^\circ \div 70^\circ )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>G ( \leq 5 ) mm</td>
<td>R ( \leq 5 ) mm</td>
<td>( \theta = 45^\circ \div 75^\circ )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( t = \text{up to} \ 38 \text{ mm} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. DOUBLE VEE BUTT UNIFORM BEVELS</td>
<td>Manual welding</td>
<td>G ( \leq 3 ) mm</td>
<td>R ( = 2-3 ) mm</td>
<td>( \theta = 50^\circ \div 70^\circ )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>G ( \leq 5 ) mm</td>
<td>R ( \leq 5 ) mm</td>
<td>( \theta = 45^\circ \div 75^\circ )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( t = \text{up to} \ 38 \text{ mm} )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. DOUBLE VEE BUTT NON UNIFORM BEVELS</td>
<td>Manual / Machine Weld</td>
<td>G ( \leq 3 ) mm</td>
<td>R ( \leq 2 ) mm</td>
<td>( \theta \geq 45^\circ ) ( \theta \geq 40^\circ )</td>
</tr>
<tr>
<td></td>
<td>Weld Combination</td>
<td>G ( &lt; 5 ) mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>( t = \text{16 to} \ 39 \text{ mm.} ) Max. R depends on approved limit of procedure</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>h ( = t/3 ) Overhead position (( \alpha ) side) first</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of joint</td>
<td>Type of welding</td>
<td>Standard</td>
<td>Limit</td>
<td>Repair</td>
</tr>
<tr>
<td>---------------</td>
<td>----------------</td>
<td>----------</td>
<td>-------</td>
<td>--------</td>
</tr>
<tr>
<td>9. SINGLE BEVEL BUTT NON UNIFORM BEVELS</td>
<td>Manual welding</td>
<td>( G \leq 3 \text{ mm} ) ( R = 2-3 \text{ mm} ) ( \theta \geq 50^\circ )</td>
<td>( G \leq 5 \text{ mm} ) ( R \leq 3 \text{ mm} ) ( \theta \geq 45^\circ )</td>
<td>( t = 6 \text{ to } 19 \text{ mm.} )</td>
</tr>
<tr>
<td>10. DOUBLE BEVEL TEE</td>
<td>Manual welding</td>
<td>( G \leq 1 \text{ mm} ) ( R \geq 3 \text{ mm} ) ( \theta \geq 45^\circ )</td>
<td>( G \leq 5 \text{ mm} ) ( R \leq 5 \text{ mm} ) ( \theta \geq 45^\circ )</td>
<td>( t = 19 \text{ to } 38 \text{ mm.} ) See also Type 11</td>
</tr>
<tr>
<td>11. DOUBLE “J” TEE</td>
<td>Manual welding</td>
<td>( G \leq 1.5 \text{ mm} ) ( R \leq 5 \text{ mm} ) ( \theta \geq 25^\circ ) ( r = 6 + 8 \text{ mm} )</td>
<td>( G \leq 5 \text{ mm} ) ( R \leq 7 \text{ mm} ) ( \theta \geq 20^\circ ) ( r = 6 + 10 \text{ mm} )</td>
<td>This joint may be used where thickness of material exceeds 39 mm. For ( t &lt; 38 \text{ mm.} ) use joint no.10.</td>
</tr>
</tbody>
</table>
| 12. TEE FILLET |  | \( G \leq 3 \text{ mm.} \) |  | 1. When \( 3 < G \leq 5 \text{ mm} \) Leg length to be increased i.e. Rule leg + (\( G - 3 \))  
2. When \( 5 < G \leq 16 \text{ mm} \) Weld against temporary backing strip remove strip and complete by back welding |
<table>
<thead>
<tr>
<th>Type of joint</th>
<th>Type of welding</th>
<th>Standard</th>
<th>Limit</th>
<th>Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. When $10 \leq G \leq 16$ mm
In areas other than WT or OT boundaries and where subjected to tensile loading

4. When $G > 16$ mm

Point 3 and 4 always in negotiation with the Classification Surveyor
5.3 - **Welding Sequences**

5.3.1. The overall welding sequence should be considered primarily from the point of view of minimizing distortion and facilitating fabrication.

The welding sequence can be important, especially when thick plates are welded, and cracking has to be avoided during welding. In small insert pieces, tensile stresses will be built up within the insert plating.

A welding sequence should be simple and practical.

The following figures show some typical and usual sequences.

**Fig. 5.3.1.a.**

1. Weld butt between B & C
2. Weld seam

*Welding sequence at intersection of butt and seam*

**Fig. 5.3.1.b.**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>1</td>
<td>B2</td>
</tr>
</tbody>
</table>

1. Weld butt 1
2. Weld seam 2
3. Weld seam 3

*Welding sequence for plate butt and adjacent seams*
**Fig. 5.3.1.c.**

Typical welding sequence for plate butts and seams where butts are staggered

**Fig. 5.3.1.d.**

Butts 1 and 2 and seams 3 and 4 previously welded. Continue welding in sequence indicated.

**Fig. 5.3.1.e.**

Welding sequence as indicated.

Typical welding sequence for inserts
6 - STRUCTURAL COMPONENT-FABRICATION AND ASSEMBLY

6.1 - Minimum distance from neighboring weld seams

6.1.1. Butt weld to butt weld

Butt weld to butt weld

\[ e \geq 50 + 4g \]

[Diagram of butt weld to butt weld]

6.1.2. Butt weld to web connection

Butt weld to web connection

\[ e \geq 30 + 2S \] if fillet weld is welded first
\[ e_1 \geq 10 \] if butt weld is welded first

Local exceptions are permissible, in the case of acute angular crossing stiffeners.

6.1.3. Butt weld to plate end / connection

Butt weld to plate end / connection

\[ 300 \]

[Diagram of butt weld to plate end]

7 - STRAIGHTNESS / FAIRING

7.1 - Measurement of plate deformations is to be carried out as shown below.
Table 7.1. Permissible values of deformation.

<table>
<thead>
<tr>
<th>Item</th>
<th>Thickness more than 10 mm</th>
<th>Thickness equal or less than 10 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength deck, shell envelope, tank top, webs of girders, stringers and transverses, all within 0.6 L admiships.</td>
<td>$\omega_o = s/200$</td>
<td>$\omega_o = s/133$ or $t$ whichever is the lesser</td>
</tr>
<tr>
<td>All other plating including internals and effective superstructure for full ship length.</td>
<td>$\omega_o = s/120$</td>
<td>$\omega_o = s/100$ or $t$ whichever is the lesser</td>
</tr>
<tr>
<td>Other superstructure and deckhouses (including funnel.)</td>
<td>$\omega_o = s/100$</td>
<td></td>
</tr>
</tbody>
</table>

1Effective superstructure as defined in the Rules of the Classification Society.

Panels with deformations exceeding the permissible values are to be fairied by local heating.

7.2 - **Fairing**

7.2.1. Panels with deformations exceeding the permissible values are to be fairied by local heating. When flame straightening is employed for fairing purposes the local heating of the steel should not exceed a temperature of 900°C, i.e. a visible red heat. In order to reduce the time involved in the cooling process, water cooling is permitted provided the temperature of the heated zone is allowed to cool back to below 600°C i.e. a black heat before water is applied. It is essential to ensure that the above stated temperatures are not exceeded and, in this respect the heating and cooling operations carried out in the fairing of deformed plate materials are to be strictly controlled.

7.2.2. Fairing by fitting extra materials is in principle not allowed, but in essential cases there are to other possibilities it has to be agreed by Buyers.

7.3 - **MacGregor Tolerance Requirements**

8 - REMOVAL OF TEMPORARY FABRICATION MATERIAL

8.1. Assembly assistance material should be removed after its use and tack welds to be ground smooth. Possible defect in base material is filled by welding and ground smooth. The repaired surface may never be under the original surface in Classification Society tolerances.

8.2. In non-obstructing areas damages in base materials must be filled by welding, in this case grinding is not necessary. Sharp broken tack welds must be ground and/or welded smooth. In tanks where special coatings have to be applied like fresh water tanks, ballast tanks, foam tanks etc. repaired damages must be grounded smooth.
9 - TIGHTNESS TEST

9.1 - Pressure Testing

9.1.1. All tanks, skegs, cooling channels, trim wedges, hollow steel fenders, pipe systems, etc., should be pressure tested in presence of the classification society surveyor and the Buyers representative. The test / pressure is 0.2 atm. over pressure or as mentioned in documentation or as requested by the Classification Society. (hollow steel fenders should also be tested from the inside of the hull i.w.o. butts and seams).

9.2 - Correction of Defects

9.2.1. Smaller spots / leaks should be welded after release of pressure. A renewed pressure test has to be carried out.

9.2.2. Larger spots / leaks should be corrected by V-grooving and re-welding after release of pressure, a renewed pressure test has to be carried out.

9.3 - Closing Devices

9.3.1. Watertight doors, hatches, windows, have to be tested by a water jet (water pressure not less than 2 bar from a distance not more than 1.5 m.)

9.3.2. Gastight, fire-resistant or non water tight doors and hatches have to be tested by a “chalk print”.

9.3.3. Tightness tests of closing devices have to be tested in accordance with the rules of the Classification Society.
10 - HULL PRINCIPAL DIMENSIONS

10.1 - Permissible Deviations from Principal Dimensions

10.1.1 - Length over all
± 1 mm. per meter length

10.1.2 - Width over all
± 1 mm. per meter width

10.1.3 - Depth
± 1 mm. per meter depth

10.1.4 - Cargo holds / cargo hatch coamings
For tolerances on dimensions, see construction drawings.

10.1.5 - Draught marks
Marking accuracy is ± 2 mm. and must be checked by the Classification Society surveyor and Buyer inspector before welding.
Bottom of keel shall be an averaged ideal line; ends indicating substantial deviations are to be neglected when averaging.
11 - PIPING

11.1 - Pipeline Materials

11.1.1 - Pipe materials
All pipe materials have to be conform the Documentation and as per requirement of the Classification Society as laid down in their rules. Materials and material certificates have to be checked by the Buyers Surveyor.

11.1.2 - Surface Defects/Deviations
The tubes shall have a smooth outside and inside surface. Slight irregularities in the surface resulting from the manufacturing process, such as raised or depressed areas or shallow grooves are permitted as long as the remaining wall thickness fulfills the requirements specified in the table.

Proper removal of shallow surface defects using appropriate means is permitted as long as the remaining wall thickness fulfills the requirement specified in the table.

Table of permissible deviations in wall thickness.

| Permissible deviation in wall thickness(es) for outside diam “d” |
|---------------------------------|-----------------|-----------------|-----------------|
| d ≤ 130 mm                     | 130 mm - d ≤ 320 mm | 320 mm - d ≤ 660mm |
| S ≤ 2                           | 2-S ≤ 4          | > 4             |
| +15%                            | +12.5%           | ± 9%            |
| - 10%                           | - 10%            | ± 12.5%         |
|                                 |                  | ± 10%           |
| +17.5%                          | ± 12.5%          | ± 10%           |
| - 15%                           | - 15%            | - 10%           |

11.1.3 - Pipe Bending / Pipe Elbow
All pipe-bends are to be machine bent without "flat sides" and ribbed surfaces. Plate-elbows are only permitted after consultation and written approval of Buyers.

Bend radius is \( R = (1.5 \div 2.5) \times \) nominal diameter unless otherwise noted.

11.2 - Welding

11.2.1 - General
The surveyor must check at random inspections that the preparations duly conforms with documentation.

11.2.2 - Precautions to be taken before welding
The edges of the parts must be prepared as specified and should be clean without burrs and cutting slag, and free from grease or paint, except for protective primers.

The joint should not be wet.

Tack welds should not be too thick and the position is so that when carrying out the weld it is certain that they can be effectively remelted.

Before the welding, the inspector must be sure that all tack welds are in a good condition. Bad and broken tack welds have to be removed.
11.2.3 - **Welding Standards**

All welds in pipelines must be of the full penetration type. The weld penetration on the inside of the pipeline must be smooth and never be under the original surface. In general the bead on the inside of the weld must not protrude more than 1 mm. at pipe diameter DN < 50 mm. and not more than 2 mm. at pipe diameter DN > 50 mm. Undercutting in pipeline by welding and ground smooth.

Welding spatters have to be removed.

A high quality standard of visual appearance of welds to be maintained.

11.3 - **Tightness Test**

11.3.1. Pipelines should be pressure tested in presence of the Classification Society Surveyor and the Buyers representative.

   The test pressure for leakage test is 0.2 atm. overpressure. The test on work pressure should be done as per requirement of the Classification Society.

   Unless otherwise stated, the test pressure of all systems shall be twice the normal working pressure.

11.3.2. Correction of welding defects should be done by V-grooving and rewelding after release of pressure, a renewed pressure test has to be carried out.

11.4 - **Galvanizing**

Galvanizing shall be done after complete fabrication of piping. Welding on a already galvanized pipes is not permitted. Pipe passages through bulkheads, deck etc. and connection should be done with prefitted sleeves and special connections so that the galvanized coating cannot be damaged.

11.5 - **Cleanliness of Pipe systems**

All pipelines should be properly cleaned before fitting.

Properly cleaned means free of rust, dust and grease or according special instruction in documentation.

All open ends of pipes outside tanks to be blinded with blind flanges where possible, otherwise with wooden plugs.

11.6 - **Fitting of Pipelines**

All pipelines should be fitted “stress free” and sufficiently fibration free clamped.

Joining flanges of pipes through tank tops, decks etc. shall have at least 150 mm. clear space, if not otherwise mentioned in documentation. Bulkheads and decks shall not be used as flanges. Spool pieces through bulkheads and decks should be of extra heavy thickness and far enough away from obstructions so that flanges can be worked upon.

Where pipes pass through bulkheads, they shall not form a rigid connection between the bulkhead and any internal structure.

11.7 - **Packing Materials**

All packing materials should be oil and water resistant and free asbestos.
12 - **QUALITY OF SMALL ITEMS**

- The quality of all used small items / parts should be of a good shipbuilding quality, for example:
- Bolts, nuts, washers if not otherwise described always to be 8.8. quality (according to D.I.N.).
- Bolts, nuts and washers on deck/outside if not otherwise described to be electrolytically zinc coated/galvanized.
- All bolts and nuts to be used, if not otherwise described, to be metric.
13 - **PAINTING**

13.1 - **General**

For application of all paint work the product data sheets and all other instructions of the paint manufacturer are to be followed strictly.

The external and internal surfaces of materials should be cleaned, shotblasted and shopprimed before erection on the vessel.

13.2 - **Cleaning**

All materials, which will be blasted must be free of grease, oil etc; If there is grease or oil on the surface it must be properly cleaned before blasting. Effective method for degreasing is to apply an approved water soluble oil and grease removing fluid and brush or spray it on to the surface, then all contamination must washed with freshwater. Oil and grease may not be removed by cloth and thinner ( only if small areas are involved ) because then a small film of oil/grease and thinner mix remain on the surface of the material.

13.3 - **Shot blasting**

Before application of the shop primer the materials have to be shot blasted to SA 2,5 (Swedish standard).

This has to be checked by the paint inspector or the Buyers representative as per photographs shown in the booklet of Swedish standards.

13.4 - **Shop primer**

During application of the shopprimer, which should never be applied with handguns, the following has to be checked.

- mixing ratio of the two components as mentioned at the product datasheet;
- environmental datasheet;
- steel temperature;
- dew point;
- relative humidity.

Application should not take place if the steel temperature is less than 3°C (5°F) above the dew point. The relative humidity may never be higher then 85 %.

Application may only be done at temperatures as mentioned on the product datasheets.

Shopprimer application may never be done over another film of shopprimer, because there is an very bad adhesion between the two shopprimer layers.

During application of the shopprimer the dry film thickness has to be checked and may never be more that mentioned in the product datasheet.

**NOTE**: special care has to be taken during shotblasting and application of the shopprimer, because this is the basic layer of the final paint system.
13.5 - **Surface Preparation**

(During/after construction before the application of the final paint scheme).

Before application of the first layer of the final paint scheme there must be a surface preparation of the already shopprimed areas.

When the shopprimer is in a bad condition those areas have to be blasted to SA 2,5 again, or power tool cleaned to St 2 – 3, according to specification.

When the shopprimer is in a good condition, hand / power tool cleaning by disc to ST 2-3 (Swedish standard) for burned spots, weld joints, edges and angular parts where the shopprimer has been damaged is sufficient. Removing of intact shopprimer is not required.

Above mentioned surface preparation is always a decision of the Paint inspector or Buyers inspector.

Of great importance is that before paint application the area, which will be painted, must be free of oil, grease and dust.

Dust removal must be performed by vacuum cleaner.

Will be not allowed the presence of dust more than according degree 3, class 2 of ISO 8502-3.

When there is a zinc-shopprimer applied also the zinc-salts have to be removed by freshwater hosing and brushing by nylon brushes, approved by the Paint inspector or Buyers inspector.

When the surfaces are shotblasted to SA 2,5 it is not required that another layer of shopprimer must be applied.

In this situation the first layer of the final paint scheme can be applied.

13.6 - **Paint Application**

Before and during application the following points have to be checked:

- paint specification;
- if correct paint and thinners are available/used;
- clean-liness of equipment
- clean-liness of substrate
- weather forecast
- enviromental temperature
- steel temperature
- dewpoint
- relative humidity
- overcoating interval

The application should not take place when the steel temperature is less than 3°C (5°F) above the dewpoint.

The relative humidity may never be higher than 85 %.

Application of paint may only be done at temperatures as mentioned on the product datasheet.

Paint in tanks may only be applied after tanktesting and acceptation of construction.

Paint on the underwater part, inside, may only be applied before launching.

Paint may only be applied to surfaces which have been maintained in a dry and icefree condition.

After cleaning and surface preparation, all weldjoint, edges, angular parts and parts, which are difficult to paint, have to be stripecoated with the same type of paint of the following layer. Stripecoating must be done by brush.
All galvanized railings, parts must be precoated with an etch primer if mentioned in the paint specification. The paint must be mixed, as mentioned on the product datasheets, by mechanical stirrer/mixer.

All paint, except stripecoating, must be applied by airless spray system, or other method mentioned on the product datasheets.

During application of the paint the wet film thickness has to be checked by measuring with a wet film thickness gauge.

This obtain an indication of the dry film thickness.

The figures wet-dry film thickness are mentioned on the product datasheets.

13.7 - Measuring Dry Film Thickness

If the measurements dry film thickness at any paint is either well bellow or above the target thickness it may be stipulated that the measured thickness should not fall below a minimum. Typically such guide lines take the from:

80% of readings will be at the specified thickness or better and no readings will be less than 80 % not more than 150 % of specified thickness.

During the total paintjob the Buyer inspector has to fill in the “paint statement” where is mentioned weather conditions, type and quality of paint etc (see paint statement).

13.8 - Paint Storage

The paint has to be stored undercover in cool and dry conditions.

13.9 - Paint Attention

- All stainless steel toggles on hatches, doors etc. to be kept free of paint;
- All grease nipples to be kept free of paint;
- All rubber gaskets in hatches and doors to be kept free of paint;
- All installed valves to be kept free of paint;
- All piping except exhaust to be prepainted before installing;
- Before fitting door/hatch, manhole rubbers etc. all steel to be painted underneath;
- All pipe clamps to be painted completely before fitting the pipework;
- All copper/brass caps of fitting/sounding systems to be kept free of paint;
- All rubber seals in sterntubes, rudderstocks etc. to be kept free of paint.
14 - GENERAL DELIVERY FOR STOCK HULLS (ONLY FOR GUIDANCE)

In view of a longer period during which the Hull eventually will be kept in stock at the yard in Holland the following should be given special consideration:

- All compartments except tanks to be equipped with 2 ventilation pipes with gooseneck and closing device of approx. 100 mm diameter.
- All parts that can collect any volume of water must have adequate means of drainage or provided with blind flange and packings.
- If applicable and particle some parts may, in view of the above be delivered “loose” acc. Buyers drawings.
- All parts delivered loose on board should be well founded to the Hull structure in such a way that appropriate sweep blasting and painting on those parts remains possible, also in a later stage.
- At least 8 fender tires (of 1m.diameter ) to be fitted for transport.
- Window openings must be weathertight closed.
- Application of grease after finishing paint system.
- All moving :parts, such as hinges, toggles, etc. should be thoroughly greased before transport of the Hull is undertaken.
- Buyers Hull numbers to be provided in white painted characters height approx. 240 mm on the forecastle bulwark at both sides.
- Before delivery the hull should be cleaned and well dried before final acceptance by the Buyer can take place.