Australian Government
Australian Maritime Safety Authority

Generic Equivalent Solution[1]:
2016/16

NSCV PART C3 - CONSTRUCTION
CONSTRUCTION OF VESSELS FROM POLYETHYLENE

Application

This equivalent solution applies to Polyethylene vessels up to 13m in measured length which:

- are not novel vessels;
- are fitted only with outboard motors for propulsion;
- operate only in areas C, D or E; &
- operate in water temperatures not less than 10°C and air temperature not normally greater than 40°C

Note: Vessels fitted with inboard engines are not included in this solution and must make application to be considered as equivalent means of compliance on a case by case basis. Applications for these types of vessels must address the additional requirements associated with inboard engines, such as those contained in the machinery and fire sections of the National Standard.

Current Requirement

NSCV Part C Section 3 - Construction states:

2.1 SUFFICIENT STRENGTH TO WITHSTAND STATIC LOADING

A vessel must be designed and constructed to withstand all static loading in both normal and abnormal conditions of operation.

2.2 SUFFICIENT STRENGTH TO WITHSTAND DYNAMIC LOADING

A vessel must be designed and constructed to withstand the dynamic loading that may arise in both normal and abnormal conditions of operation.

2.3 SUITABILITY FOR OPERATING ENVIRONMENT

A vessel must be designed and constructed to withstand the loads that arise from the intended operating environment, in normal and abnormal conditions.

2.4 CONCENTRATED LOADING

A vessel must be designed and constructed to withstand any concentrated loading that might occur in normal or abnormal conditions of loading.

2.5 DEFORMATION

The structure of a vessel must be designed and constructed to

a. avoid permanent deformation in normal operations unless specifically designed to do so; and

b. limit the extent of deformation in normal or abnormal conditions of operation where such deformations would compromise the safety of the vessel or damage to adjacent structure.

2.6 REDUNDANCY

A vessel must be designed and constructed to incorporate a measure of redundancy to maintain serviceability in the event of structural degradation that might be expected over a period of time in normal operation.

2.7 IMPACT RESISTANCE

A vessel must be designed and constructed to reduce the risks of impact loading that could cause structural failure and/or loss of watertight integrity.

[1] This solution is approved by the National Regulator for the purposes of NSCV Part B 1.6.

Current Requirement - cont

2.8 FATIGUE

Structure subject to cyclical loadings or repeated stress fluctuations must be designed and constructed to avoid or control the risks of fatigue failure.

2.9 AVOIDANCE OF CAUSES OF HIGH STRESS CONCENTRATION

The structure of a vessel must be designed and constructed to avoid or minimise the effect of discontinuities, abrupt changes in section of structural members, misalignments, penetrations and other causes of high stress concentration.

The applicable deemed to satisfy solutions for compliance with these outcomes for vessels of measured length ≤ 13m, not in class and conducting either light or robust operations are listed in Clause 3.2.2, Table 1 of NSCV Part C3 as follows:

Measured Length	Robust Operations	Light Operations
< 13 m and > 7.5 m	The relevant Lloyd's Rules	The relevant Lloyd's Rules; or ISO 12215
< 7.5 m	The relevant Lloyd's Rules	The relevant Lloyd's Rules; or ISO 12215; or AS1799

Note: "relevant" rules are specified in NSCV Part C3 - Clauses 3.3, 3.4 and 3.5 respectively.

Equivalence

The National Regulator considers that the design and construction of Polyethylene vessels up to 13m in measured length which:

- are not novel vessels;
- are fitted only with outboard motors for propulsion;
- operate only in areas C, D or E; &
- operate in water temperatures not less than 10°C and air temperatures not normally greater than 40°C

in accordance with either AS 4132 (as permitted by GES 2010/02), ISO 12215 or Lloyds SSC rules as modified below, is at least as effective in meeting the required outcomes listed above as the deemed to satisfy solution set out in clause 3.2.2 of NSCV Part C3, provided the following conditions are satisfied:

Consistency of standard applied

The same standard must be used for the calculation of design pressures, through to the required scantlings. Differing standards may not be used for the calculation of design pressures and resulting scantlings.

Design Pressures Stresses and Deflections

Design pressures, stresses and deflections, may be calculated in accordance with:

- AS 4132.1 & 4132.2 (as permitted by GES 2010/02); or
- ISO 12215; or
- Lloyds SSC rules.

Deflections

The acceptance criteria for deflections in the selected standard may be modified as follows:

- a limiting deflection of span / 50 may be used for hull plating
- a limiting deflection of span / 75 may be used for all other locations.

Equivalence - cont

Allowable Stresses - Static Loading

The allowable stresses for static loading is to be calculated on the basis of the long term allowable stress for the material where:

1. Allowable tensile stress is equal to 0.33 x the yield stress of the material

   $\sigma_{AY}=0.33\times F_Y$

2. Allowable compressive stress is equal to 0.33 x the yield stress of the material, modified by the slenderness ratio, in accordance with the rule set being used.
3. Allowable shear stress is equal to 0.15 x the yield stress of the material.

   $\sigma_{AS}=0.15\times F_Y$

Allowable Stresses - Dynamic Loading

Allowable stress for dynamic loading is to be calculated by multiplying the allowable static stress by a factor of 1.8.

Welding schedule

A welding schedule is to be developed for the vessel by the designer, specifying the type and dimensions of welds to be used. DVS 2202-1 may be used as guidance for the development of this welding schedule.

Qualification of welders

Fabricators undertaking welding are to be tested and qualified in accordance with a recognised standard for the welding such as DVS 2212-1. A record of personnel qualification is to be kept by the yard and sighted by the surveyor.

Welding Inspection

All welds are to be visually inspected for imperfections and subjected to in situ impact testing where appropriate. DVS 2207-1 & 2207- 4 may be used as guidance for inspection and testing welds.

Butt Welds

For full penetration butt welds:

- The assumed strength of the weld is to be taken as the lesser of

  $F_{Yt}=0.83\times F_Y$; and

  $F_{Yt}=0.83\times F_{uw}$.

  Where:

  F_{Yt} is the assumed strength of the weld

  F_Y is the yield stress of the parent material; and

  F_{uw} is the yield stress of the weld material.

- The allowable stresses in butt welds is to be taken as no greater than:

  In Tension $=0.6\times F_{Yt}$

  In Compression $=0.6\times F_{Yt}$

  In Shear $=0.45\times F_{Yt}$

Where:

F_Y is the assumed strength of the weld

Note: Partial penetration butt welds are not to be used.

Equivalence - cont

Location of butt welds

1. Generally butt welds in plating are to be located a distance of 15% to 30% of the plating span from the nearest supporting member.
2. Butt welds in any final panel of plating, terminating at an edge such as shipside, are to be located a distance of 70% to 80% of the plating span from the termination.
3. Butt welds of structural members generally are to be located a distance of 15% to 30% of the span of the member, away from any intersection with a supporting member.
4. Butt welds if required in structural members that terminate are to be located a distance of 70% to 80% of the span of the member away from the termination point.
5. Any welds outside these areas are to be treated as simply supported rather than continuous for the purposes of analysis.

Fillet Welds

- The allowable stresses in fillet welds is to be taken as no greater than:

$$= 0.33 \times F_Y$$

Where

F_Y is the yield stress of the parent material

- For fillet welds of equal leg length, the maximum permissible longitudinal shear stress is to be taken as no more than

$$\sigma_l = 0.33 \times \frac{(F_Y \times t_w)}{\sqrt{2}}$$

Where:

P_l is the permissible longitudinal shear flow

t_w is the leg length of the weld

F_Y is the yield stress of the parent material

- For fillet welds of equal leg length, the maximum permissible transverse shear stress is to be taken as no more than

$$\sigma_t = \sqrt{1.5} \times P_l$$

Where

P_t is the permissible transverse shear flow

Table 1 provides an example of the permissible loads for fillet welds where the parent material has a yield stress of 24 Mpa.

Table 1: Permissible loads for fillet welds where F_y = 24 Mpa

Weld size (mm)		Permissible load in weld (N/mm)	
Leg Length	Throat Thickness	Longitudinal (Pl)	Transverse (Pt)
4	2.8	22.4	27.4
6	4.2	33.6	41.2
8	5.7	44.8	54.9
10	7.1	56.0	68.6
12	8.5	67.2	82.3
14	9.9	78.4	96.0
16	11.3	89.6	109.8
18	12.7	100.8	123.5
20	14.1	112.0	137.2

Equivalence - cont

Intermittent welds

- The required length and spacing of intermittent welds is to be based on calculation of predicted shear stress for each case

Welding in way of end connections

Double continuous welding is required in way of end connections for all members that terminate or cross with other members. The length of these welds is to be equal to:

- the web depth of the smaller stiffening member, extending either side of a stiffer crossing.
- twice the height of the stiffening member, extending from either end of the stiffener, if the stiffener is sniped and / or un-bracketed at ends.
- the height of the stiffening member plus the leg length of the attached bracket, if the stiffener is bracketed.

However; in no case may the length of these welds be taken as less than 10% of the stiffener span, or in the case of bracketed connections the length in way of the bracket if that is greater.

See Figure 1 for guidance.

Figure 1: Example stiffening members required double continuous weld zones

Sourced from Lloyds: https://www.amsa.gov.au/domestic/vessels-operations-surveys/documents/NRIP00003.pdf