

Australian/New Zealand Standard™

**Rotationally moulded buried, partially  
buried and non-buried storage tanks for  
water and chemicals**



AS/NZS 4766:2020

This Joint Australian/New Zealand Standard™ was prepared by Joint Technical Committee PL-046, Rotationally Moulded Storage Tanks. It was approved on behalf of the Council of Standards Australia on 1 June 2020 and by the New Zealand Standards Approval Board on 3 June 2020.

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- Association of Rotational Moulders Australasia
- Australian Building Codes Board
- Australian Wastewater Treatment Association
- Composites Australia
- Environmental Health Professionals Australia
- Master Plumbers Australia and New Zealand
- Plastics Industry Pipe Association of Australia
- Plastics New Zealand
- Rainwater Harvesting Association of Australia
- WorkSafe New Zealand

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Australian/New Zealand Standard™

**Rotationally moulded buried, partially buried and non-buried storage tanks for water and chemicals**

Originated as AS/NZS 4766(Int):2002.  
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## Preface

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee PL-046, Rotationally Moulded Storage Tanks, to supersede AS/NZS 4766:2006, *Polyethylene storage tanks for water and chemicals*.

The objective of this Standard is to specify requirements for the design and manufacture of storage tanks that are rotationally moulded in one-piece single or multi-layer seamless construction. This includes the following:

- (a) Where the tank is non-buried, ensure secure storage of contents.
- (b) Where the tank is partially buried or buried, ensure secure storage of contents and prevent inflow or infiltration of surface water and soil water.
- (c) Ensure performance and workmanship of the finished tank is adequate for the intended application.
- (d) Ensure tank fittings are suitable for the intended application.
- (e) Specify design criteria and material selection to ensure the above.

The major changes in this edition are as follows:

- (i) Inclusion of buried and partially buried tanks.
- (ii) Changes to design criteria of all tanks.
- (iii) Ability to manufacture with multiple layers of material.

The terms “normative” and “informative” are used in Standards to define the application of the appendices to which they apply. A “normative” appendix is an integral part of a Standard, whereas an “informative” appendix is only for information and guidance.

*This Standard includes a commentary. The commentary directly follows the relevant clause, is designated by “C” preceding the clause number and is printed in italics in a box. The commentary is for information and guidance and does not form part of the Standard.*

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# Australian/New Zealand Standard

## Rotationally moulded buried, partially buried and non-buried storage tanks for water and chemicals

### 1 Scope and general

#### 1.1 Scope

This Standard specifies requirements for the design and manufacture of storage tanks that are rotationally moulded in one-piece single or multi-layer seamless construction.

This Standard applies to tanks for non-buried installation capable of containing water, liquids used in food and beverage manufacture, waste oil treatment, fat, oil and grease, diesel and liquid chemicals at atmospheric pressure.

This Standard also applies to tanks for buried and partially-buried installation capable of containing water, liquids used in food and beverage manufacture, waste oil treatment, fat, oil and grease at atmospheric pressure.

Methods for demonstrating conformance to this Standard are specified in [Appendix A](#).

#### 1.2 Exclusions

This Standard does not apply to the following:

- (a) Portable tanks for the transport of liquids or tanks permanently mounted to vehicles.
- (b) Partially buried or buried liquid chemical and diesel storage tanks.
- (c) Tanks where liquid contents are heated above their flash points.
- (d) Tanks where liquid contents have service temperatures above —
  - (i) 40 °C; or
  - (ii) the rated service temperature of the tank material.
- (e) Tanks where superimposed pressure exceeds 0.25 m head of water, or 2.5 kPa above the maximum recommended fill level.
- (f) Tanks subject to superimposed mechanical forces, such as agitation.
- (g) Installation or dispensing of specific tanks and tank systems, such as the following:
  - (i) Installation and dispensing systems of non-buried diesel storage tanks in accordance with AS 1940.
  - (ii) Installation of septic tanks in accordance with AS/NZS 1546.1.
  - (iii) Installation of wastewater treatment tanks in accordance with AS 1546.3.

#### 1.3 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents for informative purposes are listed in the Bibliography.

AS 1170.4, *Structural design actions, Part 4: Earthquake actions Australia*

AS 2070, *Plastics materials for food contact use*

AS 3600, *Concrete structures*

AS 3688, *Water supply and gas systems — Metallic fittings and end connectors*

AS 4678, *Earth-retaining structures*

AS/NZS 1170.0, *Structural design actions, Part 0: General Principles*

AS/NZS 1170.1, *Structural design actions, Part 1: Permanent, imposed and other actions*

AS/NZS 1170.2, *Structural design actions, Part 2: Wind actions*

AS/NZS 1170.3, *Structural design actions, Part 3: Snow and ice actions*

AS/NZS 1546.1, *On-site domestic wastewater treatment units, Part 1: Septic tanks*

AS/NZS 4020, *Testing of products for use in contact with drinking water*

ISO 527-1, *Plastics — Determination of tensile properties — Part 1: General principles*

ISO 527-2, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics*

ISO 899, *Plastics — Determination of creep behaviour (all parts)*

ISO 1133-1, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method*

ISO 1133-2, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 2: Method for materials sensitive to time-temperature history and/or moisture*

ISO 1183-1, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method*

ISO 1183-2, *Plastics — Methods for determining the density of non-cellular plastics — Part 2: Density gradient column method*

ISO 1183-3, *Plastics — Methods for determining the density of non-cellular plastics — Part 3: Gas pycnometer method*

ISO 6964, *Polyolefin pipes and fittings — Determination of carbon black content by calcination and pyrolysis — Test method*

ISO 8584-1, *Thermoplastics pipes for industrial applications under pressure — Determination of the chemical resistance factor and of the basic stress — Part 1: Polyolefin pipes*

ISO 9080, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*

API 650, *Welded Tanks for Oil Storage*

ASCE/SEI 7-16, *Minimum Design Loads and Associated Criteria For Buildings and Other Structures*

ASTM D543, *Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents*

ASTM D638, *Standard Test Method for Tensile Properties of Plastics*

ASTM D1238, *Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer*

ASTM D1505, *Standard Test Method for Density of Plastics by the Density-Gradient Technique*

ASTM D1693, *Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics*

ASTM D2565, *Standard Practise for Xenon Arc Exposure of Plastics Intended for Outdoor Applications*

ASTM D2837, *Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products*

ASTM D2990, *Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics*

ASTM D3849, *Standard Test Method for Carbon Black—Morphological Characterization of Carbon Black Using Electron Microscopy*

ASTM D4703, *Standard Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets*

EN 1778, *Characteristic values for welded thermoplastics constructions. Determination of allowable stresses and moduli for design of thermoplastics equipment*

EN 13341, *Static thermoplastic tanks for above ground storage of domestic heating oils, kerosene and diesel fuels — Blow moulded and rotationally moulded polyethylene tanks and rotationally moulded tanks made of anionically polymerized polyamide 6 — Requirements and test methods*

NZS 1170.5, *Structural design actions, Part 5: Earthquake actions — New Zealand*

NZS 3101.1, *Concrete structures Standard, Part 1: The design of concrete structures*

## 1.4 Terms and definitions

For the purpose of this document, the following terms and definitions apply.

### 1.4.1

#### **multi-layer construction**

consisting of more than one layer of material

### 1.4.2

#### **polymer “compound”**

hot melt mixed blend of virgin polymer or polymers, additives and pigments

### 1.4.3

#### **polymer “base resin”**

unpigmented virgin polymer in UV stabilized or non-UV stabilized form

### 1.4.4

#### **qualified professional engineer**

engineer who has a relevant degree and is experienced in the design of structural products and applications utilizing polymer plastic materials and computerized finite element analysis (FEA) programs, and has Certified Practicing Engineer (CPEng) status with either the Institution of Engineers, Australia or Engineering NZ or an equivalent registration with a similarly recognized professional body

Note 1 to entry: For partially buried and buried tanks, appropriate experience in the field of geotechnical engineering is necessary, or consultation with an appropriately qualified geotechnical engineer should be undertaken.

### 1.4.5

#### **rated material service temperature**

temperature at which laboratory tests were undertaken in order to determine long and short term characteristics of the polymer material

#### **1.4.6 reduction factor**

$\phi$

de-rating value that takes into consideration reasonable material and process variation, that is applied to long term resin data to provide a design safety margin

#### **1.4.7 service life**

period of time in years in which the tank remains in use as specified by the manufacturer

#### **1.4.8 service temperature**

<ambient temperature> average ambient temperature that the tank is exposed to within a calendar year, for tanks where the stored liquid is at ambient temperature

<stored liquid> maximum temperature of the stored liquid, for tanks where the stored liquid is above ambient temperature

Note 1 to entry: Published meteorological data is used for derivation of the service temperature for tanks where the stored liquid is at ambient temperature. The Bureau of Meteorology provides average annual ambient temperature isothermic information.

#### **1.4.9 shall**

indicates that a statement is mandatory

#### **1.4.10 should**

indicates a recommendation

#### **1.4.11 structural design life**

period of time in years that forms the basis of the structural design

### **1.5 New designs and innovations**

This Standard does not prevent the use of alternative methods of design or construction using rotationally moulded components not specifically referred to, provided that the requirements of [Sections 2, 3, 4](#) and [5](#) are met.

## **2 Materials**

### **2.1 Polyethylene**

This Standard assumes the use of polyethylene materials for the design of rotationally moulded storage tanks.

### **2.2 Compounds**

Compounds shall be manufactured from virgin polymer base resins containing additives and pigments, as required.

### **2.3 Rework of material in compounding**

Post-moulding or post-consumer material in any form, including reground and recycled materials, shall not be used. Only clean and batch traceable beads and powder from a compound or powder

manufacturer's own production in accordance with this Standard shall be reprocessed, provided the following conditions are met:

- (a) The material is being reprocessed into the same grade and colour.
- (b) Reprocessing occurs by feeding the material into virgin material evenly during compounding at a level not exceeding 10 % rework component in the final compound.
- (c) Batches with a rework component shall not be reprocessed again.

## 2.4 Melt flow index (MFI)

When determined in accordance with ISO 1133-1, ISO 1133-2 or ASTM D1238, the melt flow index of the polymer compound shall not deviate by more than 20 % from the value nominated by the compound manufacturer.

## 2.5 Thermal stability of base resin

Polymer base resin used in compounds for tanks shall contain sufficient anti-oxidants to maintain material properties through the compounding and rotational moulding processes.

## 2.6 Carbon black for UV stability

When determined in accordance with ISO 6964, polymer compounds containing carbon black to provide UV stability shall contain  $2.25 \% \pm 0.25 \%$  by mass of carbon black.

When determined in accordance with ASTM D3849, the average particle size of carbon black shall be less than 25 nm.

For water tanks, polymer compounds containing carbon black shall meet the food contact requirements of AS 2070.

## 2.7 UV resistance

### 2.7.1 Application

The requirements of this Section shall apply to base resins where base resins are UV stabilized. Where UV stabilizers are added at the final compounding stage, this Section shall apply to natural (unpigmented) powders.

All UV testing shall be performed on natural (non-pigmented) base resin material to establish a minimum performance level for the material being tested.

### 2.7.2 Exposure to sunlight for non-buried and partially buried tanks

When tested in accordance with ASTM D2565, the polymer compound for tanks, fusion-bonded fittings and welding rods shall contain UV stabilizers such that the natural (non-pigmented) compound will retain 50 % tensile elongation after 8 000 h of exposure in a Xenon-Arc weatherometer.

**C2.7.2** *It is the intention of Committee PL-046 to propose a future amendment to this Standard. The proposed amendment would replace the text in [Clause 2.7.2](#) with the following: "When tested in accordance with ASTM D2565, the polymer compound for tanks, fusion-bonded fittings and welding rods shall contain UV stabilizers such that the natural (non-pigmented) compound will retain 50 % tensile elongation after 12 000 h of exposure in a Xenon-Arc weatherometer."*

### 2.7.3 All other tank types

When tested in accordance with ASTM D2565, the polymer compound for tanks, fusion-bonded fittings and welding rods shall contain UV stabilizers such that the natural (non-pigmented) compound will retain 50 % tensile elongation after 8 000 h of exposure in a Xenon-Arc weatherometer.

### 2.7.4 Alternative test methods

UV testing in accordance with ISO 4892-2 may be conducted as an alternative to ASTM D2565. When testing in accordance with ISO 4892-2, evidence shall be provided to demonstrate that the amount of exposure hours in accordance with ISO 4892-2 is equivalent (or higher) in total energy output to that specified in [Clause 2.7.2](#) or [Clause 2.7.3](#).

## 2.8 Dispersion of additives and pigments

### 2.8.1 General

Compounded powders for rotational moulding that exhibit a uniform colour distribution after the masterbatch has been compounded into the polymer will also exhibit uniform distribution of all other additives including UV light stabilizers that have been compounded into the masterbatch simultaneously with the pigments. The addition of UV light stabilizer additives only via masterbatch into a non-UV stabilized base resin shall not be permitted.

A sample for visual inspection of between 0.5 mm to 1 mm in thickness and a minimum of 40 mm diameter shall be rotational or compression moulded or melted down from production powder to provide a sample sufficiently large to allow inspection under a light source. Colour shall be even through the specimen, without any evidence of agglomeration, blotching or other visual evidence of uneven dispersion.

### 2.8.2 Non-UV stabilized base resins

Anti-oxidants, ultraviolet light stabilizers and pigments, including carbon black, shall be evenly dispersed in the compound for non-UV stabilized base resins. The compounded resin shall be tested for uniformity of dispersion of additive via visual inspection of a specimen manufactured in accordance with [Clause 2.8.1](#).

Anti-oxidants, pigments and ultraviolet stabilizers shall be pre-compounded with a small percentage of a suitable polymer resin into a masterbatch, before this masterbatch is compounded with the (non-UV stabilized) base resin at the prescribed ratio/percentages to ensure the final compound conforms with [Section 5](#) of this Standard. Pigment content, other than carbon black, shall not exceed 2 % of the total mass.

### 2.8.3 UV-stabilized base resins

For UV-stabilized base resins, the compounded resin shall be tested for uniformity of dispersion of the pigments by visual inspection of a specimen manufactured in accordance with [Clause 2.8.1](#).

Anti-oxidants and pigments shall be pre-compounded with a small percentage of a suitable polymer base resin into a masterbatch compound, before this masterbatch is compounded with the UV stabilized base resin at the prescribed ratio/percentages to ensure the final compound conforms with [Section 5](#) of this Standard. Pigment content, other than carbon black, shall not exceed 2 % of the total mass.

## 2.9 Light penetration

Pigment levels in drinking water storage tanks shall be adequate to prevent light penetration, which will promote algal growth.

A light penetration test shall be carried out on a test specimen in accordance with [Appendix B](#). The transmitted light shall be not greater than 500 lx.

## 2.10 Stress-cracking resistance

The polyethylene base resin used in compounds that are intended for use in tanks shall have a stress-cracking resistance of 500 h minimum F50 in accordance with ASTM D1693, Condition A, 100 % Igepal CO-630. The test specimens shall be compression moulded and shall meet the requirements of ASTM D4703 with a minimum platen temperature of 177 °C.

NOTE 1 Advice on the tendency of a chemical to cause stress cracking should be sought from the material supplier.

NOTE 2 The stress-cracking test is not used as an indicator of general chemical resistance of a polymer. The polymer supplier's or moulder's chemical resistance chart should be referred to for information on the resistance of the polymer to specific chemicals or products, or testing of specific products or chemicals should be conducted.

## 2.11 Chemical resistance

The suitability of a polymer base resin used in compounds that are intended for use in chemical storage tanks shall be based on relevant chemical resistance data from base resin manufacturers.

For each chemical storage tank, relevant chemical resistance data demonstrating the tank's suitability for the intended application shall be maintained.

When specified, the compound shall be tested with the intended chemical in accordance with ASTM D543. Specimen dimensions and testing for mechanical properties shall be in the form for tensile testing in accordance with ASTM D638, Type IV.

NOTE 1 Due to the wide range of materials, service conditions and chemical reagents, the suitability of a reagent to be stored in a polymer tank should be by agreement between the parties. Chemical resistance databases should be consulted in this regard.

NOTE 2 Specimens should be cut from compression-moulded plaques. If doubt exists as to the effect of the rotational moulding process (i.e. porosity), rotationally moulded specimens may also be tested.

## 2.12 Materials in contact with drinking water and food

Materials in contact with food shall be in accordance with AS 2070. Materials in contact with drinking water shall be in accordance with AS/NZS 4020, at a surface area to volume ratio of 15 000 mm<sup>2</sup>/L. Pigments and additives based on heavy metals shall not be used.

Testing should be carried out with pigment masterbatch at the intended use add rate.

Additives and pigments shall be tested combined with a base resin. If a material change is made, such as a formulation change, then re-testing shall be required. [Appendix A](#) shall be used to determine what constitutes a material change.

A base resin may be tested by itself (without pigment package) in accordance with AS/NZS 4020 or in combination with a certain pigment masterbatch.

A pigment masterbatch shall be tested with a base resin at the specified use level.

A compound resulting from a combination of any base material that has passed the requirements of AS/NZS 4020, and a pigment masterbatch (within the percentage limits as stated in [Clauses 2.6](#) and [2.8](#)) that has passed the requirements of AS/NZS 4020, shall be deemed to have passed the requirements of AS/NZS 4020.

Test certificates shall state the identity of the manufacturer and the product identification code of the base material.

## 2.13 Mechanical properties of base resin

### 2.13.1 Virgin polymer resins

[Clause 2.13](#) only applies to virgin polymer base resins (see [Clause 2.2](#)).

### 2.13.2 Material test data

Material test data for design analysis shall as a minimum include the following:

- (a) Raw material name and Standard.
- (b) Short and long term physical properties relevant to the expected minimum structural design life of the tank.

Material test data shall be derived from independently verifiable testing. The test data shall be determined on the base resin to be used in the tank at the service temperature.

### 2.13.3 Short term mechanical properties

The following short term mechanical properties shall be provided for the base resin:

- (a) Density determined in accordance with ASTM D1505 or ISO 1183-1, ISO 1183-2 or ISO 1183-3.
- (b) Poisson's ratio determined in accordance with ASTM D638, ISO 527-1 or ISO 527-2.
- (c) Short term yield strength determined in accordance with ASTM D638, ISO 527-1 or ISO 527-2. Strain rate to be adopted ranges between 1.0 mm to 5.0 mm/min.
- (d) Short term tensile modulus determined in accordance with ASTM D638, ISO 527-1 or ISO 527-2. Strain rate to be adopted ranges between 1.0 mm to 5.0 mm/min.

A summary of tests results shall be supplied in the form of a data sheet in a suitable format.

### 2.13.4 Long term mechanical properties

Testing of long term tensile properties shall be undertaken on the base resin using —

- (a) ISO 899 (all parts);
- (b) ASTM D2990; or
- (c) the hydrostatic design basis in accordance with ASTM D2837 for a duration consistent with the minimum structural design life of the tank.

### 2.13.5 Extrapolation of material test data

The minimum duration of long term creep tests shall be 5 000 h.

NOTE The long term creep modulus can be calculated using extrapolation procedures beyond the duration of the test up to the structural design life for a maximum of [1.5](#) log cycles of time beyond the experimental data collected.

The long term creep modulus to be used in the analysis of the tank shall be determined as follows:

$$E_{lt} = \frac{f_s}{(\varepsilon_{lt} A_{2E})}$$

where

|                 |   |                                                                                                                                                                |
|-----------------|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $E_{lt}$        | = | long term creep modulus used in the analysis of the tank based on the required structural design life                                                          |
| $\epsilon_{lt}$ | = | total strain extrapolated from long term creep tests for the required structural design life                                                                   |
| $f_s$           | = | the applied stress adopted during the long term creep test                                                                                                     |
| $A_{2E}$        | = | 1.0, unless the stored liquid is deemed to cause swelling of the polymer material, in which case it shall be determined in accordance with EN 13341:2005 A.2.4 |

### 3 General considerations for structural analysis and design of rotationally moulded tanks

#### 3.1 Structural analysis

Tank design analysis and independent verification should be performed by qualified professional engineer(s) as defined in [Clause 1.4.5](#).

#### 3.2 Design

The design of a tank, its fittings and accessories should consider long term fitness for purpose including service environment and decrease in physical properties of the material due to environmental effects.

Separation of the roof (lid) from the body of the tank after moulding shall be permitted for transport purposes, and, for buried tanks, single rotationally moulded parts such as the tank and riser may be welded together, provided that —

- (a) the design considers this circumstance;
- (b) the structural integrity of the tank is not adversely affected after the roof has been refitted or parts welded together by the manufacturer or its nominated representative in the manner prescribed by the design; and
- (c) the prevention of insect and/or vermin ingress is maintained.

The structural design life of a tank shall be 20 years.

NOTE 1 Tanks should be decommissioned at the end of their service life.

NOTE 2 The service life of a tank may be less than the structural design life.

A tank shall have provision for overflow of contents where required.

The design shall ensure secure storage of contents and prevent inflow or infiltration of surface water and soil water.

### 4 Structural analysis and design of non-buried tanks

#### 4.1 General

This Section specifies the methods required to undertake limit state design of non-buried storage tanks manufactured from polymer.

All tanks in terms of their structural analysis shall be assessed using the finite element analysis (FEA) method. All analysis conducted shall be undertaken using a geometric nonlinear analysis solver (GNA).



Documents

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