PIPA
PLASTICS INDUSTRY PIPE ASSOCIATION OF AUSTRALIA LIMITED

INDUSTRY GUIDELINES
POP016
Raised Crack Resistant & High Stress Crack Resistant PE 100 Materials

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Raised Crack Resistant and High Stress Crack Resistant PE 100 materials

All PE 100 pipe materials must meet minimum slow crack growth performance requirements to Australian and International standards. PE 100 materials with enhanced resistance to slow crack growth were first developed in the 2000s. These pipe materials are suited to those installations where there is an increased risk of external surface damage or point loads, such as some trenchless installations or open trench installations without optimum embedment materials.

In 2009, the requirements for these materials were documented in a publicly available specification, PAS 1075 – Pipes Made of Polyethylene for Alternative Installation Techniques: Dimensions, Technical Requirements and Testing.

As there is no Australian Standard, and until recently no International Standard which defines higher stress crack resistant materials, PIPA developed POP016 as an interim measure. The first version dated May 2017 recognised these materials as High Stress Crack Resistant PE 100 and used the designation PE 100 HSCR. The technical requirements for PE 100 HSCR were based on, but not identical to PAS 1075.

Since then, PAS 1075 has been withdrawn, the technical requirements for higher stress crack resistant PE 100 materials have been standardised and the designation PE 100-RC adopted for these materials. PE 100-RC material requirements are now incorporated in EN 1555, ISO 4437 and in progress in EN12201 and ISO 4427.

High Stress Crack Resistant (PE 100 HSCR) and Raised Crack Resistant (PE 100-RC) are PE 100 materials which offer enhanced resistance to slow crack growth than regular PE 100.

PE 100 HSCR and PE 100-RC materials are considered to be equivalent and interchangeable.

Currently listed on POP004 Polyethylene Pipe and Fittings Compounds there are PE 100 materials that conform to PE 100 HSCR and/or PE 100-RC requirements. With the development of the PE 100-RC International Standards it is intended that PE 100-RC will supersede PE 100 HSCR as Australia moves to align with international practices. This means there will be no new listings and no further re-conformity of materials to PE 100 HSCR. The current listings on POP004 will remain until they reach the timeframe of reconformity assessment. At this time, Raised Crack Resistant PE compounds will need to demonstrate conformity with the PE 100-RC requirements if they haven't already.

Refer to Appendix A for PE 100 HSCR requirements.

RAISED CRACK RESISTANT PE 100-RC

EN and ISO have now defined the performance criteria for PE 100-RC materials (raised crack resistant). Minimum mechanical requirements of PE100 and PE 100-RC are the same in the ISO standards with exception of the Slow Crack Growth resistance (SCG). Due to the same MRS (minimum required strength), the dimensions of pipes related to outer diameter, wall thickness and SDR are the same for PE100 as for PE 100-RC.

PE 100-RC compounds must conform to both AS/NZS 4131 and the requirements listed in Table 1 below. Compounds meeting all these requirements will be identified in POP004 as PE 100-RC.

Table 1
PE 100-RC Compound Performance

TEST	STANDARD	SAMPLE	MINIMUM PERFORMANCE
Accelerated Notched Pipe Test (ANTP) (Note 1& 2)	ISO/DIS 13479-2020	Solid wall DN110 SDR11 pipe	>300 hrs @ 80°C & 9.2 Bar. Water in nonylphenol (See Note 3)
Accelerated Full Notch Creep Test (AFNCT)	ISO 16770	Compression moulded plate	≥550 h at an interpolated reference tensile stress of 4 MPa or ≥300 h at an interpolated reference tensile stress of 5 MPa @90°C & lauramine oxide (See Note 4).
Strain Hardening Test (SHT)	ISO 18488	Compression moulded tensile test bar	<Gp> ≥53MPa @80°C, sample thickness = 300µm
Crack Round Bar Test (CRB)	ISO 18489	Round bar 14mm diameter	≥1.5 x 10^6 cycles at an interpolated stress range ($\Delta\sigma_o$) 12.5 MPa @23°C in air, sinusoid 10Hz

NOTES:

1. This requirement correlates to a test on DN110 SDR11 PE 100-RC pipe in accordance with ISO 13479, at a test pressure of 0.92 MPa at 80°C, water-in-water, with no failure in a test period of 8,760 hours.
2. Studies are still being undertaken for the selection of an alternative detergent. PE100+ Association recommends the following as an interim measure:

- To accept existing ANPT test reports (obtained in Arkopal N100) until the end of 2025,
- As alternative to consider existing NPT test reports (1 year testing at standard condition in water) valid until end of 2025 for existing PE 100-RC materials, in case no recipe change took place (also applicable to new materials that cannot be testing in Arkopal N100 solution anymore).
- For more information, please refer to the PE100+ Association website

3. Nonylphenol ethoxylate (CAS number 9016–45–9) with a trade name of Arkopal N100 is used for this test with a concen-tration for testing of 2%. aqueous solution. It is noted that Arkopal N100 is currently unavailable in certain markets. It is intended that Lauramine oxide (Dehyton PL) will replace Arkopal N100 in the accelerated notch pipe test.

4. Lauramine oxide (CAS number 85408–49–7) is commercially available as Dehyton PL. The dilution of the lauramine oxide in the product shall be taken into account when calculating the concentration of 2 wt%. For example, when Dehyton PL is used, it is already diluted to 30 wt%. Therefore, 6,67 wt% of Dehyton PL is needed to obtain 2 wt% lauramine oxide.

REFERENCED STANDARDS

AS/NZS 4131 - Polyethylene (PE) compounds for pressure pipes and fitting

EN 1555 – Plastics piping systems for the supply of gaseous fuels – Polyethylene (PE) – Part1-5

EN 12201 – Plastics piping systems for water supply, and for drainage and sewerage under pressure – polyethylene (PE) – Part 1-5

EN 12814-3:2014 - Testing of welded joints in thermoplastics semi-finished products. Tensile creep test

DIN PAS 1075 (2009-04) **-** Pipes made from polyethylene for alternative installation techniques - Dimensions, technical requirements and testing

ISO 4427- Plastics piping systems for water supply and for drainage and sewer under pressure – polyethylene (PE) - Part 1-5

ISO/DIS 4437- Plastics piping systems for the supply of gaseous fuels - polyethylene (PE) - Part 1-5

ISO 13479:2009 – Polyolefin pipes for the conveyance of fluids -- Determination of resistance to crack propagation -- Test method for slow crack growth on notched pipes

ISO 16770 Plastics **-** Determination of environmental stress cracking (ESC) of polyethylene - Full-notch creep test (FNCT)

ISO 18488 – Polyethylene (PE) materials for piping systems – Determination of Strain Hardening Modulus in relation to slow crack

ISO 18489 – Polyethylene (PE) materials for piping systems – Determination of resistance to slow crack growth under cycling loading – Cracked Round Bar test method

APPENDIX A

High Stress Crack Resistant PE 100 HSCR

Prior to the International Standards Organisation (ISO) defining the nomenclature to describe this range of PE 100 materials PE 100 HSCR has been applied.

PE 100 HSCR compounds must conform to both AS/NZS 4131" Polyethylene (PE) compounds for pressure pipes and fittings" and the requirements listed in Table 1below. Compounds meeting all these requirements will be identified in POP004 "Polyethylene Pipe and Fittings Compounds" as PE 100 HSCR.

Table A1

PE 100 HSCR Compound Performance

TEST	STANDARD	SAMPLE	MINIMUM PERFORMANCE
Notched Pipe Test (NTP)	ISO 13479-2009	Solid wall SDR11 pipe	>5,000 hrs
Full Notch Creep Test (FNCT) See Note 1	ISO 16770-2004	Compression moulded plate	>8,670 hrs at 80°C or by correlated acceleration testing procedure as specified in Note 1
2 Notch Creep Test (2NCT) see Note 3	EN 12814-3:2014	Solid wall pipe	>3,300 hrs at 80°C or by correlated accelerated testing procedure as specified in Note 3
Point Load Test (PLT) see Note 2	DIN PAS 1075 2009	Solid wall pipe 110 SDR 11 pipe	>8,760 hrs at 80°C or by correlated acceleration testing procedure as specified in Note 2

NOTES:

1. The FNCT can be undertaken in its long-term or accelerated (ACT) form ie: Long-term: time to failure > 8760 hrs; 80°C; 4 N/mm^2 tensile stress, 2% Arkopal N-100 surfactant. Accelerated: time to failure > 400 hrs; 90°C; 4 N/mm^2 tensile stress, 2 % NM 5 surfactant and 90°C.
2. Point Load test can be undertaken in its long-term or accelerated (PLT+) form ie: Long-term: time to failure > 8760 hrs; 80°C; 4 N/mm^2 tensile stress, 2% Arkopal N-100 surfactant. Accelerated: time to failure > 450 hrs; 90°C; 4N/mm^2 tensile stress, 2 % NM 5 surfactant.
3. The 2 Notch Creep Test can be undertaken in its long term or accelerated (2NCT+) form ie: Long-term: time to failure >3300hrs; 80°C, 4N/mm^2 tensile stress, 2% Arkopal N-100 surfactant. Accelerated: time to failure >195hrs; 90°C; 4N/mm^2 tensile stress, 2% NM5 surfactant.

PIPA
PLASTICS INDUSTRY PIPE ASSOCIATION OF AUSTRALIA LIMITED

PO Box 957 North Lakes Q 4509
E plasticspipe@pipa.com.au
P +61 (0) 459 919 437
pipa.com.au

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