PIPA
PLASTICS INDUSTRY PIPE ASSOCIATION OF AUSTRALIA LIMITED

INDUSTRY GUIDELINES

POP004

Polyethylene Pipe and Fittings Compounds

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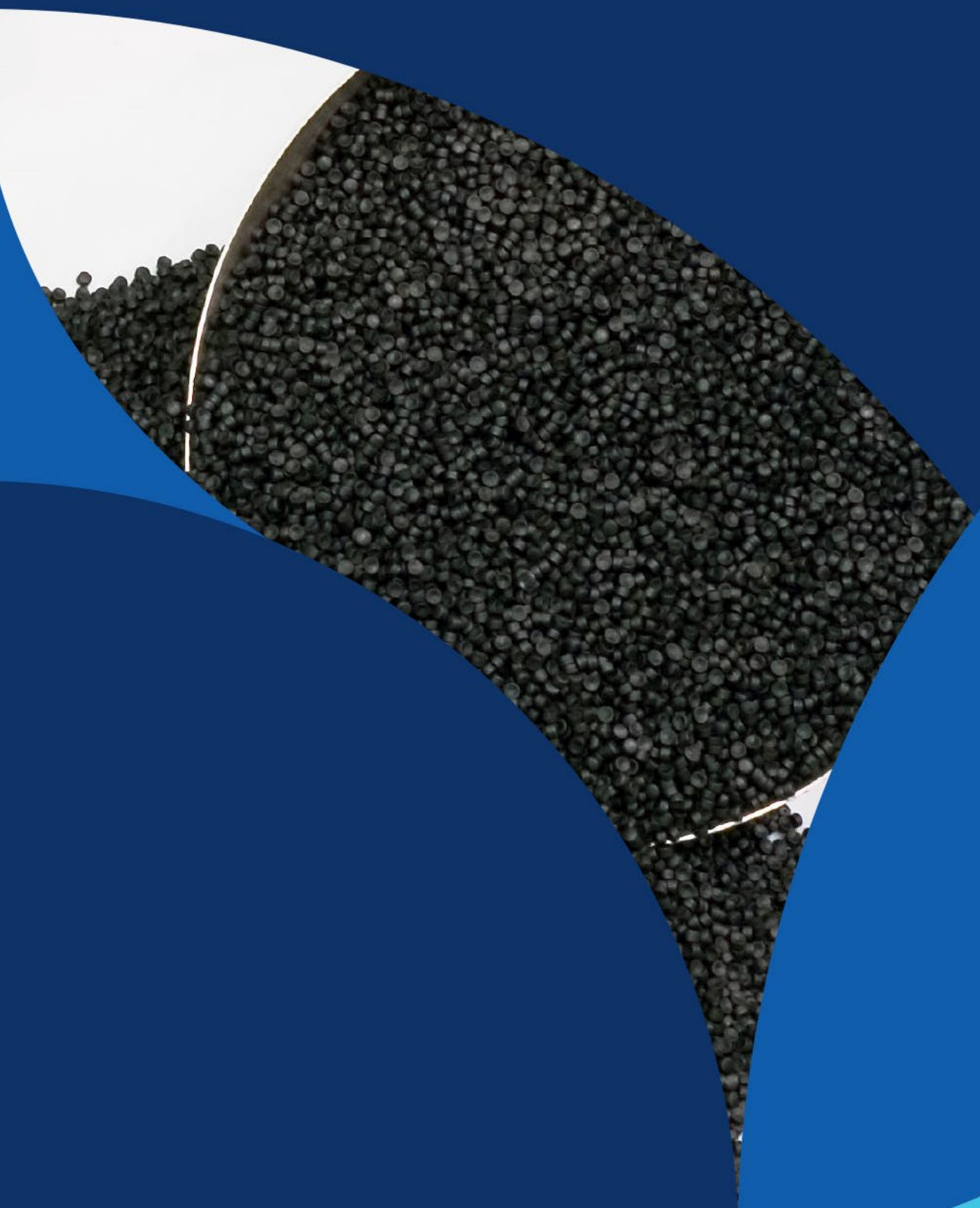

Polyethylene Pipe and Fittings Compounds

1.0 BACKGROUND

This document is a listing of PE pipe compounds evaluated against the requirements of AS/NZS 4131 and stripe and jacket compounds evaluated for use with PE pipe manufactured to AS/NZS 4130. In addition, PE100 pipe compounds with enhanced properties, namely, PE112, High Stress Crack Resistant (PE100 HSCR) and Raised Crack Resistant (PE100-RC).

The relevant Australian Standards are:

(i) AS/NZS 4131, Polyethylene (PE) compounds for pressure pipes and fittings. This Standard specifies requirements for compounds used in the manufacture of pressure pipes.

(ii) AS/NZS 4130, Polyethylene (PE) pipes for pressure applications. This Standard specifies requirements for pipes, and includes stripes and jackets (co-extrusions), plus the relevant compound attributes for these co-extrusions.

Note 1: Pipes conforming to AS/NZS 4130 must be extruded from fully pre-compounded material conforming to AS/NZS 4131.

Note 2: It is recommended that individual pipe manufacturers confirm colour conformity of stripe and jacket compounds when measured on extruded pipes.

The evaluation process is a desktop review where documentation provided by the compound manufacturer is examined by a panel comprised of pipe manufacturing members with appropriate expertise in this field. This evaluation is undertaken at an identified point in time.

In the case of PE100 pipe compounds (including those with enhanced properties including, PE100 HSCR and PE100-RC grades conforming to POP016 and PE112 grades) ongoing retesting is specified for a number of product performance requirements in order to maintain the listing in this document. Ongoing demonstration of conformity is a requirement for PE100 materials as they are used in the most critical applications.

The evaluation is not a formal product certification and there is no audit of the manufacturing site.

2.0 EVALUATION REQUIREMENTS

2.1 ACCEPTED INFORMATION SOURCES

The evaluation process involves the acceptance by PIPA of testing and/or analysis conducted by organisations where these organisations are deemed sufficiently competent and have international recognition.

Accepted organisations are those acceptable to PE100+ (listed on the PE100+ website https://www.pe100plus.com) and PIPA accepted NATA Laboratories in Australia. Additional organisations specifically related to AS/NZS 4020 testing include the Australian Water Quality Centre and Eurofins AMS Laboratories.

Some attributes may be assessed using information provided by the original product manufacturer – for example information relating to carbon black particle size and toluene extract may be provided by the carbon black supplier.

2.2 MANUFACTURERS' DECLARATION

Pipe Compounds: All submissions require a Manufacturers' Declaration that states that the material is fully pre-compounded and in conformity with AS/NZS 4131 and include where necessary any additional performance claims e.g., POP013 or POP016.

Stripe and Jacket Compounds: For stripe and jacket compounds the declaration shall state that the material conforms to AS/NZS 4130 and also meets the additional requirements as required in POP004 e.g., melt flow rate.

2.3 AS/NZS 4020 CERTIFICATION

Conformity with AS/NZS 4020 is a requirement of AS/NZS 4131 for all black, blue, and purple (lilac) compounds. AS/NZS 4131 requires this certification be renewed every 5 years. The POP004 listing contains information about the date of AS/NZS 4020 certification presented at the time of evaluation or provided in subsequent updates by the manufacturer.

Currency of the AS/NZS 4020 certification needs to be confirmed by the resin processor. i.e., the pipe or fitting manufacturer.

The pipe diameters quoted in the listing are the minimum to be used in potable water applications. Diameters smaller than those tested may not be suitable for drinking water applications.

2.4 ADDITIONAL REQUIREMENTS OF POP004

There are references in this document relating to elevated temperature performance and high stress crack resistant PE100 materials (PE100 HSCR and PE100-RC) not included in AS/NZS 4131. Also, there are additional requirements relating to MFR (Melt Flow Rate) and HSCR/RC based materials for stripe and colour compounds not included in the Australian Standards. Detailed explanations of elevated temperature performance, PE100 HSCR, PE100-RC, HSCR and RC based stripe and jacket compounds and MFR are included in the Appendix of this document.

In addition to this document, a supplementary list of additional materials, used in the manufacture of electrofusion and moulded fittings is provided in POP004A.

2.5 MARKET SURVEILLANCE

PIPA reserves the right to:

- Obtain product from the market and undertake conformity testing.
- Consult with Member companies to obtain test information.

Where such testing or information identifies non-conformity PIPA may choose not to list a compound or to delist an existing compound based on the individual circumstances associated with the non-conformity.

2.6 DEMONSTRATING ONGOING CONFORMITY – RETESTING OF PE100 PIPE COMPOUNDS

In order to maintain the listing in this document as a PE100 or PE100 HSCR/PE100-RC pipe compound a selected suite of product performance tests (reduced in scope compared to the initial test requirements and listed below) needs to be carried out by the compound manufacturer every 3 years. Results from these tests, undertaken by accepted information sources must be provided to PIPA within 3 months of the nominated retest period falling due.

2.6.1 Testing required for PE100 Compounds consist of:

Slow Crack Growth Resistance determined using the Notched Pipe Test according to ISO 13479. *Note: for PE100+ listed materials the ISO 13479 test results submitted as part of their current listing within the PE100+ process will be accepted as means of demonstrating conformity with POP004.*

The following tests are to be performed on the material supplied to conduct the Notched Pipe Test in the Slow Crack Growth Resistance above:

- MFR5; MFR21 and FRR 21/5 according to ISO1133
- Carbon Black content according to ISO6964
- Carbon Black dispersion according to AS1462.28 or ISO equivalent
- Density according to ISO 1183
- Thermal stability via OIT according to ISO11357

Hydrostatic Pressure Testing: Either of the options defined in a or b below.

a. In accordance with the note accompanying Table A2 of AS/NZS 4131- That is, perform pressure tests at a minimum of 2 stress levels at test temperatures of 20°C and 80°C. The lowest stress level for each temperature is to correspond to the 2500 h failure time from the original ISO 9080 analysis. Three samples are to be tested at each level. The times to failure of these shall not fall below the calculated 99.5% LPL value for the corresponding stress level as derived from the original classification data. Failure to meet this requirement will mean that the compound has changed sufficiently to require full evaluation.

b. In accordance with CEN/TS 1555-7 and CEN/TS 12201-7 – testing at 2 stress levels 12.0 MPa (20 °C, min 100 h) and 11.1 MPa (20 °C, min 2500 h). In addition, every 8 years a test at 4.8 MPa (80 °C, min 5000 h) shall be carried out.

2.6.2 Testing required for PE100 HSCR/ PE100-RC compounds conforming with POP016 consists of:

Full Notch Creep Test (FNCT) or its accelerated (ACT) form according to POP016

The following tests are to be performed on the material supplied to conduct the FNCT test:

- MFR5; MFR21 and FRR 21/5 according to ISO1133
- Carbon Black content according to ISO6964
- Carbon Black dispersion according to AS1462.28 or ISO equivalent
- Density according to ISO 1183
- Thermal stability via OIT according to ISO11357.

Hydrostatic Pressure Testing: Either of the options defined in a or b below.

a. In accordance with the note accompanying Table A2 of AS/NZS 4131 - That is, perform pressure tests at a minimum of 2 stress levels at test temperatures of 20°C and 80°C. The lowest stress level for each temperature is to correspond to the 2500 h failure time from the original ISO 9080 analysis. Three samples are to be tested at each level. The times to failure of these shall not fall below the calculated 99.5% LPL value for the corresponding stress level as derived from the original classification data. Failure to meet this requirement will mean that the compound has changed sufficiently to require full evaluation.

b. In accordance with CEN/TS 1555-7 and CEN/TS 12201-7 – testing at 2 stress levels 12.0 MPa (20 °C, min 100 h) and 11.1 MPa (20 °C, min 2500 h). In addition, every 8 years, a test at 4.8 MPa (80 °C, min 5000 h) shall be carried out.

Pipe Material Compounds – assessed in accordance with AS/NZS 4131

PE80

MANUFACTURER	MANUFACTURING SITE	MATERIAL	POP013 CONFORMITY	DATE OF LATEST SUBMISSION	DATE OF AS/NZS 4020
Borealis	Finland	ME3441 (Yellow)	Not Assessed	January 2008	December 2019 (16mm ID)
	Finland	ME3444	Not Assessed	January 2008	
Borouge	Ruwais, Abu Dhabi	ME3440	Not Assessed	November 2023	February 2022 (DN32)
	Ruwais, Abu Dhabi	ME3441	Not Assessed	January 2014	
SCGC	Rayong, Thailand	SCGC HDPE H5211PC	Not Assessed	2008	September 2009 (12.5mm ID)

Pipe Material Compounds – assessed in accordance with AS/NZS 4131

PE 100

MANUFACTURER	MANUFACTURING SITE	MATERIAL	POP013 CONFORMITY	DATE OF LATEST SUBMISSION	DATE OF AS/NZS 4020
Lyondell Basell	Wesseling, Germany	CRP 100 Black	Yes	March 2022	April 2023 (DN16)
	SEPC, Saudi Arabia	CRP 100 Black	Yes	February 2010	March 2017 (DN16)
Borealis	Porvoo, Finland	HE3490 – LS-HP	Not Assessed	May 2023	April 2023 (DN20)
	Porvoo, Finland	HE3494 – LS-HP (Blue)	Not Assessed	May 2023	April 2023 (DN20)
Borouge	Ruwais, Abu Dhabi	HE 3490-LS	Yes	October 2022	June 2022 (DN32)
	Ruwais, Abu Dhabi	HE 3490 LS-H	Not Assessed	July 2023	June 2022 (DN32)
	Ruwais, Abu Dhabi	HE 3490 ELS-H	Yes	March 2022	February 2022 (DN32)
	Ruwais, Abu Dhabi	HE3492 LS-H (Orange)	Not Assessed	December 2023	
IRPC Public Company Limited	Rayong, Thailand	P901BK	Yes	October 2011	March 2018 (DN16)

MANUFACTURER	MANUFACTURING SITE	MATERIAL	POP013 CONFORMITY	DATE OF LATEST SUBMISSION	DATE OF AS/NZS 4020
KPIC	Ulsan, South Korea	P600 BL	Yes	December 2023	September 2019 (DN32)
Qenos	Altona, Australia	HDF 193B	Yes	September 2019	July 2019 (25mm ID)
SCGC	Rayong, Thailand	SCGC HDPE H1000PC	Yes	December 2022	November 2020 (18mmID)
	Rayong, Thailand	SCGC HDPE H1000PBL Blue	Not Assessed	March 2012	July 2018 (25mm ID)
	Rayong, Thailand	SCGC HDPE H112PC	Yes	December 2022	November 2020 (18mm ID)
Formosa Plastic Corporation	Kaohsiung, Taiwan	Taisox 8001BL (Black)	Yes	March 2020	February 2018 (24mm ID)

MANUFACTURER	MANUFACTURING SITE	MATERIAL	POP013 CONFORMITY	DATE OF LATEST SUBMISSION	DATE OF AS/NZS 4020
PTT Global Chemical Public Company Limited	Rayong, Thailand	HD8100 MB (Black)	Not Assessed	April 2021	April 2021 (26mm ID)
Hanwha TotalEnergies Petrochemical Co., Ltd.	Republic of Korea	XS10B (Black)	Yes	December 2021	October 2021 (25mm ID)

Pipe Material Compounds – assessed in accordance with AS/NZS 4131 and meeting the requirements of POP016 High Stress Crack Resistance & Raised Cracked Resistance PE100 Materials

MANUFACTURER	MANUFACTURING SITE	MATERIAL	POP013 CONFORMITY	PE 100-RC CONFORMITY	PE 100 HSCR CONFORMITY	DATE OF AS/NZS 4020
Borealis	Porvoo, Finland	HE3490 – LS-HP	Not Assessed	May 2023		April 2023 (DN20)
Borouge	Ruwais, Abu Dhabi	HE3490-ELS-H	Yes	December 2022		February 2022 (DN32)
Borouge	Ruwais, Abu Dhabi	HE3490 LS-H (Orange)	Not Assessed	December 2023		
Hanwha TotalEnergies Petrochemical Co., Ltd	Republic of Korea	XRC20B	Yes		September 2022	December 2021 (25mm ID)
LyondellBasell	Wessling, Germany	CRP100RCD Black	Yes	May 2023		November 2022 (DN16)

Note: PE100 HSCR and PE100-RC materials are equivalent. For more information refer to POP016 High Stress Crack Resistant and Raised Crack Resistant PE100 Materials.

Pipe Material Compounds – assessed in accordance with AS/NZS 4131 and meeting the requirements of POP016 High Stress Crack Resistance & Raised Cracked Resistance PE100 Materials Continued…

MANUFACTURER	MANUFACTURING SITE	MATERIAL	POP013 CONFORMITY	PE 100-RC CONFORMITY	PE 100 HSCR CONFORMITY	DATE OF AS/NZS 4020
LyondellBasell	Wessling, Germany	CRP 100 Resist Black	Yes		February 2023	August 2023 (DN20)
SCGC	Rayong, Thailand	SCGC HDPE H1000PCH	Not Assessed	March 2023		May 2022 (25mmID)
Qenos	Altona, Australia	HCR193B	Yes	March 2023	September 2019	July 2019 (25mm ID)

Note: PE100 HSCR and PE100-RC materials are equivalent. For more information refer to POP016 High Stress Crack Resistant and Raised Crack Resistant PE100 Materials.

Stripe and Jacket materials – assessed in accordance with AS/NZS 4130

PE100

MANUFACTURER	PE 100	DATE SUBMITTED
LYONDELLBASELL ADVANCED POLYOLEFINS	EH6747 U Blue	Prior 2008
	EH5348 U Red	Prior 2008
	EH6574 U Purple	Prior 2008
	EH3748 U Yellow	Prior 2008
	EH0349 U White	Prior 2008
POLYMER DIRECT	SCGC H1000PWI White	February 2012
	SCGC H112PBL Blue	June 2022
	SCGC H112PYL Yellow	June 2022
PRICE PLASTICS	JS070522WH White	June 2022
	JS090507YE Yellow	November 2019
	JS070314PU Purple	September 2022
	JS10111GY Grey	October 2011
	JS10118GR Green	March 2020
	CP100816BL P Blue	September 2012
	JS090320LB Light Blue	September 2022
	JS210801BE Cream	May 2023
	JS090730OR Orange	January 2011
MARTOGG	YW1150 Yellow	July 2012
	YW1171 Yellow	July 2012
	W1406 White	July 2012
	BE2216 Blue	July 2012
	BE2242 Blue	July 2012
	GN1924 Green	July 2012
	RD1938 Red	July 2012
	RD1937 Purple	July 2012

MANUFACTURER	PE 100	DATE SUBMITTED
POLYPACIFIC	POLYCOMP 6030 UVH 5703 Lilac	October 2013
	POLYCOMP 6030 UVH 8388 White	October 2014
	POLYCOMP 6030 UVH 3236 Green	October 2014
	POLYCOMP 6030 UVH 6270 Orange	October 2014
	POLYCOMP 6030 UVH 5714 Purple	April 2010
	POLYCOMP 6030 UVH 4069 Yellow	August 2015
	POLYCOMP 6030 UVH 5719 Cream	August 2015
	POLYCOMP 6030 UVH 6275 Red	August 2015
	POLYCOMP 6030 UVH 7F12 Grey	August 2015
	POLYCOMP 6030 UVH 2340 Dark Blue	November 2015
	POLYCOMP 6030 UVH 2321 Blue	October 2013
	POLYCOMP 6030 UVH 4056 Pale Yellow	October 2013
	POLYCOMP 6030 UVH 2359 Light Blue	July 2017
	POLYCOMP 6030 UVH 6350 Bright Orange	September 2018
	POLYCOMP 6030 UVH 3284 Lime Green	August 2019
	POLYCOMP 6030 UVH 4117 Yellow	August 2019
INFORM PLASTICS	CP111169AHDUVAO PE100 White	March 2017
	CP52902AHDUVAO PE100 Cream	March 2017
	CP21977AHDUVAO PE100 Yellow	March 2017
	CP80882AHDUVAO PE100 Purple	March 2017
	CP42746AHDUVAO PE100 Red	March 2017
	CP72912AHDUVAO PE100 Blue (Bluebell)	March 2017
	CP62548AHDUVAO PE100 Green	March 2017
	CP92965AHDUVAO PE100 Grey	March 2017

Stripe and Jacket materials – assessed in accordance with AS/NZS 4130 and meeting the requirements of POP016 High Stress Crack Resistance & Raised Crack Resistant PE100 Materials

PE 100 HSCR

MANUFACTURER	PE 100 HSCR	DATE SUBMITTED
LYONDELLBASELL	EH41076U (Blue)	August 2021
	EH61075U (Violet)	August 2021
	EH81074U (Bright White)	August 2021
QENOS	HCR193BLU (Blue)	September 2022
	HCR193CRM (Cream)	September 2022
	HCR193WTE (White)	September 2022
	HCR193YLW (Yellow)	September 2022

APPENDIX

ELEVATED TEMPERATURE PERFORMANCE

The majority of PE pipe installations operate at approximately 20°C or lower. It should be noted that 20°C is the temperature at which the minimum required strength (MRS) of the PE compound is defined. The MRS being the lower predicted limit of the hydrostatic strength at a time of 50 years, rounded down[1]. Therefore, for the majority of PE pipelines there is no need to apply any temperature rerating factor when calculating the maximum allowable operating pressure (MAOP). However, there are some polyethylene pipeline applications where temperatures higher than 20°C are encountered- coal seam gas, above ground pipelines and bore water are examples. Because the properties of PE are temperature dependent it is necessary to apply a temperature rerating factor when calculating the MAOP for these higher temperature applications.

To determine the PE material classification according to ISO 9080, as required by AS/NZS 4131, a series of stress rupture pressure tests are performed at 20°C, 60°C and 80°C. ISO 9080 describes the procedure that allows the mathematical relationship between hoop stress, test temperature and time-to-failure to be calculated. It is from this relationship that the temperature rerating design factors in POP013 have been determined. These factors are the ratio of the MRS to the 97.5% lower prediction limit (σLPL) at the given temperature. ISO 9080 also provides explicit rules governing the maximum time to which the failure stress can be extrapolated at any temperature. The longer the pressure tests have been conducted, the longer the extrapolation.

PIPA has used this approach to determine the elevated temperature performance of the several, but not all materials listed in POP004 or POP004A. These are realistic, expected performances based on actual test data.

All materials listed in POP004 and POP004A will, as a minimum, meet the elevated performance nominated in ISO 13761 Plastics pipes and fittings – Pressure reduction factors for polyethylene pipeline systems for use at temperatures above 20°C. But in addition, there are some materials that have sufficient test data confirming they also meet the higher requirements of POP013. Those materials shown to meet not only the requirements of AS/NZS 4131 but also the extended performance of POP013 are identified in this guideline as "POP013 conformity demonstrated – Yes".

It must be understood that the materials that do not have the additional stress rupture data to demonstrate conformity with POP013 are not inferior with respect to POP004 and POP004A requirements.

For materials listed in this guideline that have not demonstrated conformity with POP013 ("Not assessed"), refer to AS/NZS 2033 Tables 3.1 and 3.2 for guidance.

[1] The complete definition of MRS according to AS/NZS 4131 is "The required value of σ_{LPL} for a temperature of 20°C and a time of 50 years ($\sigma_{20,\ 50\ years,\ 0.975}$), rounded down to the next smaller value of the R10 series or the R20 series conforming to ISO 3, ISO 497 or ISO 12162, depending on the value of the σ_{LPL}. The MRS is expressed as a hoop stress in megapascals.

MELT FLOW RATE

Stripe and jacket compounds listed in POP004 are required to meet the requirements nominated in AS/NZS 4130. In addition to these requirements PIPA has introduced a requirement that must be met before these compounds are listed in POP004. The additional requirement relates to the control of Melt Flow Rate (MFR measured at 190°C/5 kg load) for these compounds.

The additional requirement is for MFR of striping and jacketing compounds to be within +/-30% deviation of the MFR value reported for the base polymer grade used in production of the striping or jacketing compound – measured using the test method specified in ISO 1133.

The reason this requirement has been added is that MFR is an industry accepted indication of the molecular weight of a polymer which in turn determines mechanical strength of the product. A change in the MFR value measured on striping and jacketing compounds relative to the MFR value of the starting base polymer would indicate a change in molecular weight and deterioration of mechanical performance of the compound. This could lead to implications for the quality of the final pipe product where striping or jacketing compound had been used. MFR change of +/-30% is considered, based on current industry experience, acceptable to ensure the quality and integrity of the striping and jacketing compound.

HIGH STRESS CRACK RESISTANT & RAISED CRACK RESISTANT PE100 MATERIALS

High Stress Crack Resistant PE100 (PE100 HSCR) and Raised Crack Resistant (PE100-RC) are PE100 materials which offers greater resistance to slow crack growth than regular PE100. This is particularly important where the pipe is prone to damage during installation.

Currently there is no established Australian standard defining high stress crack resistant PE 100 materials and up until recently there was no international standard. As an interim measure to define the parameters characterising PE100 HSCR grades was developed in POP016 "High Stress Crack Resistant & Raised Crack Resistant PE100 Materials." Integration of PE100-RC into international standards is currently in progress with ISO/DIS 4437 "Plastics piping systems for the supply of gaseous fuels - polyethylene (PE) - Part 1-5" being published in September 2020. ISO 4427 "Plastics piping systems for water supply and for drainage and sewer under pressure – polyethylene (PE) - Part 1-5" is currently being updated. The PE100-RC performance requirements are also given in POP016.

PE100 HSCR and PE100-RC materials are equivalent. PE100 HSCR and PE100-RC compounds must conform to both AS/NZS 4131 and the requirements listed in POP016. Compounds meeting all these requirements are identified in POP004 as PE100 HSCR.

HIGH STRESS CRACK RESISTANT & RAISED CRACK RESISTANT PE100 COLOURED COMPOUNDS

Where a coloured stripe or jacket is specified for a PE100 HSCR or PE100-RC pipe it is recommended that the coloured compound meet all the existing requirements for standard PE100 coloured compounds but in addition the base resin must be a material meeting the requirements of POP016.

PE112 MATERIALS

PE pipe compounds falling into the PE112 classification are defined by ISO 12162 (i.e., having a 50-year $\sigma_{LPL} \geq$ 11.2MPa at 20°C) are otherwise only assessed against the standard PE100 performance criteria and, where applicable, the additional requirements of POP013. This approach has been taken as there is no current provision in the relevant ISO or AS/NZS standards for defining the complete set of performance criteria for PE112 compounds. Consequently, pipe compounds with an MRS of 11.2MPa, and proven to meet all other aspects of the PE100 performance criteria, will be listed as PE100 materials.

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Disclaimer

In formulating this guideline PIPA has relied upon the advice of its members and, where appropriate, independent testing.

Notwithstanding, users of the guidelines are advised to seek their own independent advice and, where appropriate, to conduct their own testing and assessment of matters contained in the guidelines, and to not rely solely on the guidelines in relation to any matter that may risk loss or damage.

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