



Plastics Industry Pipe Association
of Australia Limited

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Industry Guidelines

POLYETHYLENE PIPE AND FITTINGS COMPOUNDS

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Pipelines Integrity For a Cleaner Environment



Disclaimer

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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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POLYETHYLENE PIPE AND FITTINGS COMPOUNDS

1. 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.

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 PE100 HSCR grades conforming to POP016) 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. 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 and POP004A

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

2.6.1.1 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.*

2.6.1.2 The following tests are to be performed on the material supplied to conduct the Notched Pipe Test in 2.6.1.1:

- 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

2.6.1.3 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 compounds conforming with POP016 consists of:

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

2.6.2.2 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

2.6.2.3 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

PE 80B

Manufacturer	Manufacturing site	Material	POP013 conformity	Date of latest submission	Date of AS/NZS 4020 (sample diameter)
LyondellBasell	Wesseling, Germany	GM 5010 T3	Not assessed	October 2007	May 2007 (DN 16)
Borealis	Finland	ME3441 (Yellow)	Not assessed	January 2008	December 2019 (16 mm ID)
	Finland	ME3444	Not assessed	January 2008	
Borouge	Ruwais, Abu Dhabi	ME3440	Not assessed	2003	April 2017 (DN32)
	Ruwais, Abu Dhabi	ME3441	Not assessed	January 2014	
Qenos	Altona, Australia	MD 0898	Not assessed	April 2015	August 2012 (25 mm ID)
SCG	Rayong, Thailand	SCG HDPE H5211PC	Not assessed	2008	September 2009 (12.5 mm ID)

Pipe material compounds – assessed in accordance with AS/NZS 4131

PE 100

Manufacturer	Manufacturing site	Material	POP013 conformity demonstrated	Date of latest submission	Date of AS/NZS 4020 (sample diameter)
LyondellBasell	Wesseling, Germany	CRP 100 Black	Yes	December 2007	February 2018 (DN 16)
	SEPC, Saudi Arabia	CRP 100 Black	Yes	February 2010	March 2017 (DN 16)
	Wesseling, Germany	CRP 100 Blue	Not assessed	December 2007	May 2007 (DN 16)
	SEPC, Saudi Arabia	CRP 100 Blue	Yes	April 2011	February 2011 (DN 16)
Borealis	Stenungsund, Sweden	HE3490-LS-H	Yes	October 2011	April 2015 (DN 16)
	Porvoo, Finland	HE3494-LS-H (Blue)	Not assessed	October 2012	January 2020 (DN 20)
	Stenungsund, Sweden	HE3490-DS-H	Not assessed	August 2018	September 2018 (DN 20)

Manufacturer	Manufacturing site	Material	POP013 conformity demonstrated	Date of latest submission	Date of AS/NZS 4020 (sample diameter)
Borouge	Ruwais, Abu Dhabi	HE 3490-LS	Yes	March 2009	April 2017 (DN32)
	Ruwais, Abu Dhabi	HE3490 LS-H	Not assessed	September 2011	Sept 2016 (32 mm ID)
	Ruwais, Abu Dhabi	HE3492-LS-H (Orange)	Not assessed	September 2013	

IRPC Public Company Limited	Rayong, Thailand	P901BK	Yes	October 2011	March 2018 (DN 16)
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KPIC	Ulsan, South Korea	P600BL	Yes	June 2009	May 2009 (DN16)
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Qenos	Altona, Australia	GM 5049B	Yes	April 2015	May 2006 (25 mm ID)
	Altona, Australia	HDF 193B	Yes	September 2019	July 2019 (25 mm ID)
	Altona, Australia	HDF 145B	Yes	April 2015	November 2018 (26 mm ID)

Manufacturer	Manufacturing site	Material	POP013 conformity demonstrated	Date of latest submission	Date of AS/NZS 4020 (sample diameter)
Sabic	Saudi Yansab and Saudi Kayan	P6006 Black	Yes	June 2013	March 2013 (DN32 - see Note 1)
	Saudi Kayan	P6006AD	Yes	March 2017	March 2017 (DN32)

Note 1: There is no AS/NZS 4020 certificate specific to the Saudi Kayan site for P6006 Black. The Saudi Kayan site has been listed on the basis that all other data meets the requirements of AS/NZS 4131 and a Manufacturer's Declaration that all feedstock, additives and processing is the same as the Saudi Yansab site which does have a specific AS/NZS 4020 certificate.

SCG	Rayong, Thailand	SCG HDPE H1000PC	Yes	January 2013	November 2020 (18mm ID)
	Rayong, Thailand	SCG HDPE H1000PBL Blue	Not assessed	March 2012	July 2018 (25mm ID)
	Rayong, Thailand	SCG HDPE H112PC	Yes	August 2015	November 2020 (18mm ID)

Formosa Plastics Corporation	Kaohsiung, Taiwan	Taisox 8001BL (Black)	Yes	March 2020	February 2018 (24mm ID)
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Sinopec International (Australia) Pty Ltd	Shanghai, China	YGH041T (Black)	Not assessed	September 2020	July 2017 (DN 32)
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Pipe material compounds – assessed in accordance with AS/NZS4131 and meeting the requirements of POP016 High Stress Crack Resistant PE100

PE 100 HSCR

Manufacturer	Manufacturing site	Material	POP013 conformity demonstrated	Date of latest submission	Date of AS/NZS 4020 (sample diameter)
Qenos	Altona, Australia	HCR193B	Yes	September 2019	July 2019 (25 mm ID)
LyondellBasell	Wesseling	CRP100RCD Black	Yes	June 2018	February 2018 (DN16)
		CRP 100 Resist Black	Yes	May 2020	December 2018 (DN20)

**Stripe and Jacket materials – assessed in accordance with AS/NZS4130
PE 80B**

Manufacturer	PE 80B	Date submitted
A SCHULMAN	EH5376 U Red	Prior to 2008
	EH5305 U Purple	Prior to 2008
	EH3435 U Yellow	Prior to 2008
GENERAL POLYMERS	BE1439 Blue	Prior to 2008
	YW641 Yellow	Prior to 2008

Stripe and Jacket materials – assessed in accordance with AS/NZS4130

PE 100

Manufacturer	PE 100	Date Submitted
LYONDELLBASELL	CRP 100 Blue	April 2011
A SCHULMAN	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
GENERAL POLYMERS	BE1438 Blue	October 2008
	YW738 Yellow	April 2010
	BE1975 Blue	April 2010
	YW987 Yellow	October 2008
	RD1659 Lilac	October 2008
	RD1705 Dark Lilac	October 2008
	WT1231 White	October 2008
HILM PTY LTD (IWP Trading)	HP600YE Yellow	November 2014
	HP600SK Blue	November 2014
POLYMER DIRECT	PSD 1165 White	February 2012
	H1000PWI White	February 2012
	PSD 1041 Purple	February 2012

Manufacturer	PE 100	Date Submitted
PRICE PLASTICS	CP070522WH White JS070522WH White CP090507YE Yellow JS090507YE Yellow CP070314PU Purple CP090320LB Blue CP101111GY Grey JS10118GR Green CP100816BL P Blue CP090320LB Light Blue JS090320LB Light Blue CP090615BE Cream CP090730OR Orange	October 2011 November 2019 January 2011 November 2019 March 2012 January 2011 October 2011 March 2020 September 2012 March 2012 November 2019 November 2012 January 2011
MARTOGG	YW1150 Yellow YW1171 Yellow WT1406 White BE2216 Blue BE2242 Blue GN1924 Green RD1938 Red RD1937 Purple	July 2012 July 2012 July 2012 July 2012 July 2012 July 2012 July 2012 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	October 2014
	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

Manufacturer	PE 100	Date Submitted
POLYPACIFIC	POLYCOMP 6030 UVH 4117 Yellow	August 2019

Manufacturer	PE 100	Date Submitted
INFORM PLASTICS	Purple 80882 AHDUVAO	March 2017
	Blue 72912 AHDUVAO	March 2017
	Green 62548 AHDUVAO	March 2017
	Grey 92965 AHDUVAO	March 2017
	Cream 52902 AHDUVAO	March 2017
	Red 42746 AHDUVAO	March 2017
	White 11169 AHDUVAO	March 2017
	Yellow 21977 AHDUVAO	March 2017

APPENDIX

1. 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 down¹. Therefore, for the majority of PE pipelines there is no need to apply any temperature derating 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 derating 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 derating design factors in POP013 have been determined. These factors are the ratio of the MRS to the 97.5% lower prediction limit (σ_{LPL}) 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 ($\sigma_{20, 50 \text{ years}, 0.975}$), 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.

2. 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.

3. HIGH STRESS CRACK RESISTANT PE100 MATERIALS (PE100 HSCR)

High Stress Crack Resistant PE100 (PE100 HSCR) is a PE100 material which offers greater resistance to slow crack growth than regular PE100. This is particularly important where the pipe is prone to damage during installation.

There are currently no established national or international standards that define high stress crack resistant PE100 materials. As an interim measure there is a need to provide guidance to define the parameters that characterise PE100 HSCR grades. PIPA document POP016 sets out the performance requirements that will be used to define PE100 HSCR material during this interim period.

PE100 HSCR 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.

4. HIGH STRESS CRACK RESISTANT PE100 COLOURED COMPOUNDS

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