Plastics Industry Pipe Association of Australia Limited ACN 086 511 686

Industry Guidelines

POLYETHYLENE PIPE AND FITTINGS COMPOUNDS

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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 end users.

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 ISO13479. *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 20ºC and 80ºC. 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 97.5% 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 3 stress levels 12,0 MPa (20 °C, min 100 h), 11.1 MPa (20 °C, min 2500 h), 4,8 MPa (80 °C, min 5000 h).

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

2.6.2.1 Full Notch Creep Test (FNCT) 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 4131AS/NZS 4131 - That is, perform pressure tests at a minimum of 2 stress levels at test temperatures of 20ºC and 80ºC. 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 97.5% 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 3 stress levels 12,0 MPa (20 °C, min 100 h) , 11.1 MPa (20 °C, min 2500 h), 4,8 MPa (80 °C, min 5000 h).

Pipe material compounds – assessed in accordance with AS/NZS4131

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 2013** (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	EL LENE H5211PC	**Not assessed**	**2008**	**September 2009** (12.5 mm ID)

Pipe material compounds – assessed in accordance with AS/NZS4131

PE 100

Manufacturer	Manufacturing Site	Material	POP013 conformity demonstrated	Date of latest submission	Date of AS/ZS 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**	**November 2014** (DN 16)
	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/ZS 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)
KPIC	Ulsan, South Korea	P600BL	**Yes**	**June 2009**	**May 2009** (DN16)
Qenos	Altona, Australia	GM 5049B	**Yes**	**April 2015**	**May 2006** (25 mm ID)
	Altona, Australia	HDF 193B	**Yes**	**April 2015**	**August 2012** (25 mm ID)
	Altona, Australia	HDF 145B	**Yes**	**April 2015**	**January 2014** (25 mm ID)

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

Note 1: There is no AS/NZS 4020 certificate specific to the Kayan site for P6006 Black. The 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 Yansab site which does have a specific AS/NZS 4020 certificate.

SCG	Rayong, Thailand	EL LENE H1000PC	**Yes**	**January 2013**	**July 2015** (20mm ID)
	Rayong, Thailand	EL LENE H1000PBL Blue	**Not assessed**	**March 2012**	**February 2013** (DN 25)
	Rayong, Thailand	EL LENE H112PC	**Yes**	**August 2015**	**July 2015** (20mm ID)

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/ZS 4020 (sample diameter)
Qenos	Altona, Australia	HCR193B	**Yes**	**September 2016**	**September 2013** (25 mm ID)
LyondellBasell	Wesseling	CRP100RCD Black	**Yes**	**June 2018**	**February 2018** (DN16)

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	October 2011
	CP090507YE Yellow	January 2011
	CP070314PU Purple	March 2012
	CP090320LB Blue	January 2011
	CP101111GY Grey	October 2011
	CP101118GR Green	October 2011
	CP100816BL P Blue	September 2012
	CP090320LB Lt Blue	March 2012
	CP090615BE Cream	November 2012
	CP090730OR Orange	January 2011
MARTOGG	YW1150 Yellow	July 2012
	YW1171 Yellow	July 2012
	WT1406 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	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

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 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 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 ISO9080, as required by AS/NZS 4131, a series of stress rupture pressure tests are performed at 20°C, 60°C and 80°C. ISO9080 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. ISO9080 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 materials listed in POP004. These are realistic, expected performances based on actual test data.

All materials listed in POP004 will, as a minimum, meet the elevated performance nominated in ISO13761 Plastics pipes and fittings – Pressure reduction factors for polyethylene pipeline systems for use at temperatures above 20°C. But in addition there are 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/NZS4131 but also the extended performance of POP013 are identified in Table 1.

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 requirements.

2. MELT FLOW RATE

Stripe and jacket compounds listed in POP004 are required to meet the requirements nominated in AS/NZS4130. In addition to these requirements PIPA has introduced a requirement that must be met before these compounds are listed in POP004. The

[1] The complete definition of MRS according to AS/NZS4131 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.

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 ISO1133.

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 PE 100 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 PE100HSCR.

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.