



Plastics Industry Pipe Association
of Australia Limited

ACN 086 511 686

Industry Guidelines

POLYETHYLENE PIPE AND FITTINGS COMPOUNDS

ISSUE 16

**Ref: POP004
March 2019**

Pipelines Integrity For a Cleaner Environment



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.

PIPA gives no warranty concerning the correctness of accuracy of the information, opinions and recommendations contained in the guidelines. Users of the guidelines are advised that their reliance on any matter contained in the guidelines is at their own risk.

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 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 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 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 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 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 | SCG HDPE 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/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 | 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/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) |
| 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 | December 2016 (24 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 | July 2015 (20mm ID) |
| | Rayong, Thailand | SCG HDPE H1000PBL Blue | Not assessed | March 2012 | February 2013 (DN 25) |
| | Rayong, Thailand | SCG HDPE 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/NZS 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 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 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 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 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. 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/NZS 4131 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

Striped 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

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 ($\sigma_{20, 50 \text{ years}, 0.975}$), 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.

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 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 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.