Bilag 1A: Forsyningernes krav til plastrørsledninger

RPE: 2021-08-13

KLAR-forsyning	Kerteminde	Skanderborg	Svendborg	Lemvig
Egen dimensioneringspraksis **Gravitationsledninger** Hovedledning minimum Ø200 mm Stikledninger er ø160 (vurderes for større byggerier) SN=ringstivhed [kN/m2] Skelbrønde for regnvand skal udføres med blå opføringsrør, således at fejltilslutninger undgås. **Trykledninger** Fuldsvejste PE ledninger, minimum SDR 11 SDR11 betyder f.eks. at rørets diameter er ca. 11 gange rørvæggens tykkelse	**Generelt** INSTA-CERT certificeret (mærket med Nordic Poly Mark og DS) anses for at opfylde de stillede krav **Fleksible ledninger** Generelt gælder, at der skal anvendes ledninger i befæstede arealer PVC SN8 og i ubefæstede arealer PVC SN4. Der anvendes som udgangspunkt PVC-S rør, glatte rør (ikke ultra). Ledninger og formstykker af PVC, PE og PP-rør skal overholde krav svarende til INSTA-CERT certificering (mærket med Nordic Poly Mark) samt DS/EN 1401-01 for PVC og PE-rør og DS/EN 1852 for PP-rør. PVC flerlagsrør accepteres ikke. Alle PE-trykrør skal opfylde kravene i DS/EN 12201 del 1, 2 og 3 og skal desuden være DS-mærkede.	**Plastmaterialer** Alle plastledninger og formstykker skal være minimum SN8. Ledninger og formstykker skal overholde kravene til INSTA-CERT Nordic Poly Mark eller tilsvarende certificeringsordning som dokumenterer samme tekniske kvalitet og egenskaber. Stive lige PP og PE gravitationsrør skal være i henhold til EN 13476-3, med minimums godstykkelse på 1 % af rørets indvendige diameter, dog minimum 3 mm. Buede PE gravitationsrør skal være PE-100 SDR 17 rør med svejsede samlinger. Indvendige vulster skal være fjernet. PE trykrør trykrør skal være i henhold til EN 12201. PE-100 SDR 17 med svejste samlinger. Indvendige vulster skal være fjernet. **Spildevandsledninger** Hovedledninger udføres i glatte PVC rør (EN1401), eller PP struktur rør (EN 13476-3) i dimension ø200 mm op til 1.000 boliger. Stikledninger udføres i plast i dimension ø160 mm op til 500 boliger. Trykledninger udføres i PE med beskyttelseskappe i farven rødbrun (EN 12201), dimension ø90 mm op til ø400 mm. **Regnvandsledninger** Hovedledninger udføres i glatte PVC rør (EN 1401), eller PP struktur rør (EN 13476-3) i dimension ø200 mm op til ø1200 mm. øvrige dim. skal testet efter de samme standarder. Stikledninger udføres i plast i dimension ø160 mm for enkelt-parceller for beboelse.	**Krav stilles i udbudsmaterialer** **Gravitationsledninger af plast** udføres som rødbrune glatteuPVC-rør eller rør i materialet PP/PE og hvis intet er nævnt altid som SN 8-rør. Gummiringe skal være godkendt af rørleverandøren. Rør og formstykker skal være produceret efter angivne standarder. **Trykledninger** udføres i materialet PE100 og i trykklasse Pn10 med mindre andet fremgår af projektbeskrivelsen. PE-rør skal overholde kravene i DS/EN 12201 og DS/EN ISO 9080.	**Krav til rør der er udfærdiget i forbindelse med rammeaftaler** Har en forventning om at leverandøren levere et godt produkt Bruger standart produkter, uden vi har haft et kritisk blik for produkterne der leveres

Dimension / mm	Materiale
< ø200 - Stikledninger til skelbrønde/rotte-spærrebrønde: ø160 - Stikledninger til vejbrønde: ø110	Glatte pvc / pp – klasse S / SN8 Massive homogene rør
≥ ø200 og < ø600	pvc / pp – klasse S / SN8
≥ ø600	PEH eller beton – Klasse S / SN8

Fælles bemærkning:
Der er krav til rørene, men umiddelbart ingen interne krav til kontrol af rørene. Korrekt ringstivhed, SDR, gældende godkendelse?

RPE: 2021-08-13

KLAR-forsyning

Totalopgørelse 31/12 2018

Dimension (mm)	Land Længde (m)	By Længde (m)	City Længde (m)	Længde (pct.)
Samlet	173822	402230	14921	
Små:	114580	179010	3159	50
Specificerede:				
Ø200-Ø500	34920	156277	9098	34
Ø500-Ø800	18292	41069	2096	10
Ø800-Ø1000	4012	12625	464	6
Ø1000-Ø1200	1708	8030	4	2
Ø1200-Ø1600	310	5219	100	1

Kerteminde

De rør der anvendes mest er Ø100 – Ø160 glat PVC rør, glat pakning i muffe.

Skanderborg

Opgørelse for rørledninger anlagt 2001-2021:

Dimension (mm)	Længde (km)	Længde (pct.)
Ø110	2,26	24
Ø160	38,71	
Ø200	62,73	64
Ø250	16,56	
Ø300	0,29	
Ø315	12,32	
Ø400	6,99	
Ø450	8,9	
Ø500	5,82	9
Ø560	1,9	
Ø600	4,96	
Ø700	3,09	
Ø800	2,43	1,8
Ø900	0,53	
	167,49	

Ved nyanlæg:
For spildevand udgør Ø200 mm PVC ca. 90% af hovedledningerne, og alle nye stikledninger er i Ø160 mm PVC.
Næsten alle spildevandsbrønde udføres i plast.
Ved regnvand udføres næsten alle større ledninger og brønde i beton.

Svendborg

Opgørelse 2011-2020

	Dimension (mm)	Længde (m)	Længde (pct.)
Trykledning	Ø50	11307	66
	Ø63	15578	
	Ø75	1921	
	Ø90	2804	
	Ø110	4268	
Gravitation	Ø160	6499	34
	Ø200	14526	
	Ø250	5215	
	Ø315	1674	
		63792	

Lemvig

De meste anvendte rør til spildevand er Ø110 til Ø160. PVC (Glat rør) til gravitation. På trykledninger er materialet polyethylen trykklassen PN10.

Konklusion: De mest anvendte rør vurderes ud fra ovennævnte at være Ø200

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Plastrør til fremtidens forsyningsledninger

Fastlæggelse af krav og dokumentation som sikrer funktion og grønne værdier

VUDP ID nr.: 13-2020

Bilag 2:

Testmetoder for plastrør

1

TEKNOLOGISK INSTITUT

Testmetoder for plastrør

Denne præsentation har sigte på at belyse formål, baggrund og gennemførelse af de test, som i dag indgår ved dokumentation af plastrør og deres samlinger

Gennemgangen tager afsæt i den gennemgang af test, der fremgår af DANVA Vejledning 54' side 15 – 30, og er illustreret med eksempler fra de testmuligheder, som findes på Teknologisk Institut.

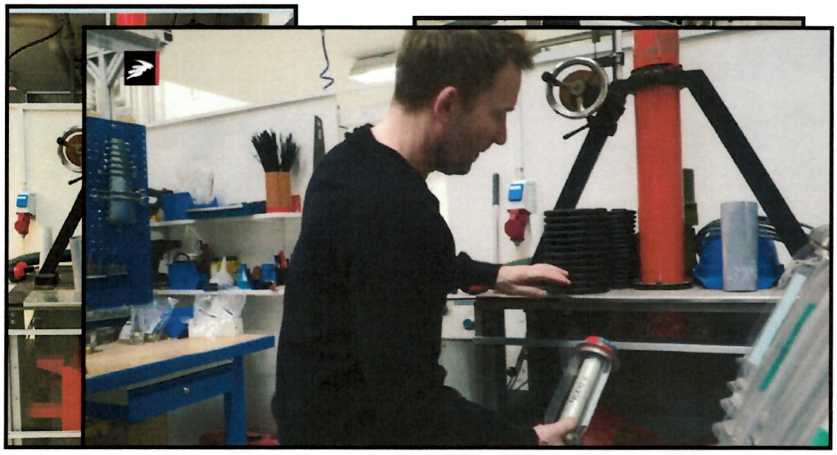
Beskrivelse/egenskaber
Produktcertificering:
Typeprøvning tredjepart
Intern kontrol
Ekstern kontrol tredjepart
Materialer:
Densitet, PE/PP/PVC-U
Smelteindeks, PE/PP
Termisk stabilitet, PP/PE
K-værdi, PVC-U
Blødgøringstemperatur, PVC-U
Langtidstrykstyrke
Produkt:
Dimensioner
Udseende
Mærkning
Overfladebeskaffenhed
Dimensionsstabilitet
Termisk stabilitet
Slagprøvning
Stivhed
Trykprøve
Methylenklorid, PVC-U
Vejrbestandighed
Systemet:
Samlingers tæthed
Modstand mod kombineret jordbelastning og høj temperatur (BLT) (rør i jord)
Cyklustest ved forhøjet temperatur (rør i bygning)
Toksiske krav

2

TEKNOLOGISK INSTITUT

Testmetoder for plastrør

Slagtest



Testens formål, baggrund og gennemførelse:

Slagtest er test af materialets evne til at modstå slag/stød og anvendes til at forudsige dets opførsel under faktiske forhold. Mange materialer fejler pludselig under slag/stød, ved fejl, revner eller hak.

Slagtest for plastrør gennemføres med ophængte vægte af given vægt afhængig af rørdimension, og falder fra en given højde ligeledes afhængig af rørdimensionen.

Anvendte standarder for slagtest af plastrør er EN /ISO 3127 og EN/ISO 11173, der dækker test ned til -20 °C, hvor plasten er meget sprød.

3

TEKNOLOGISK INSTITUT

Testmetoder for plastrør

Temperaturcyklustest

1500 cyklusser a'
- **1 min. med 93°C,**
- **1 min. pause**
- **1 min. med 15 °C, og**
- **1 min. pause**

Gælder for:
Trykløse rør af PE/PP og PVC

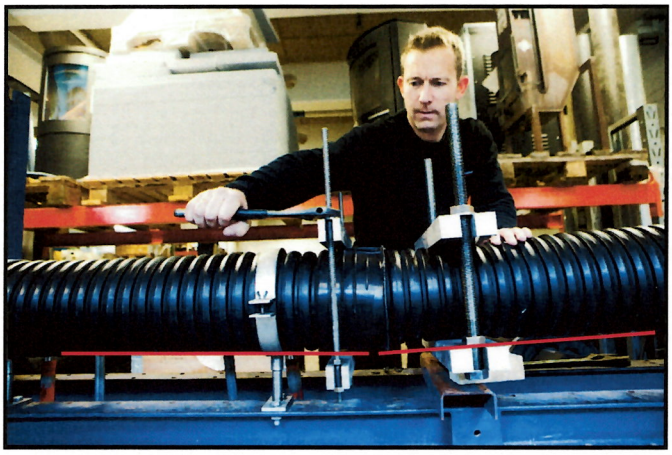
Formål:
En stresstest hvor rørene efter 1500 cyklusser skal bestå krav til tæthed og nedbøjning af det vandrette rør.

4

TEKNOLOGISK INSTITUT

Testmetoder for plastrør

Samlingers tæthed



Gælder for:
Trykløse rør af PE/PP og PVC

Formål:
At simulere de belastninger og påvirkninger som røret bliver udsat for, når de er lagt i jorden.

Gennemførelse:
Samlingen afvikles 2°. Spidsende deformeres 15% og muffen 10%

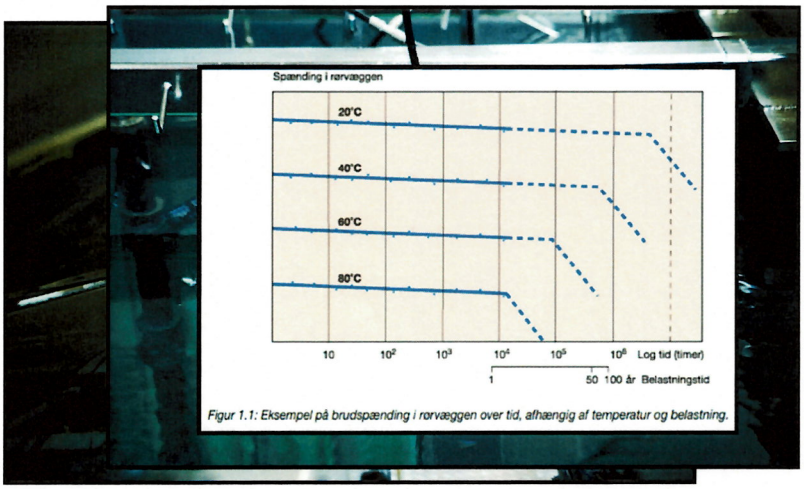
15 minutter med:
- 0,05 bar
- 0,5 bar
- -0,3 bar (vakuum)

5

TEKNOLOGISK INSTITUT

Testmetoder for plastrør

Levetidstrykprøvning



Figur 1.1: Eksempel på brudspænding i rørvæggen over tid, afhængig af temperatur og belastning.

Gælder for:
For trykløse og trykbærende rør af PE/PP og PVC

Formål:
At påvise levetiden af rørene.

PE100	PP	PVC
1000h ved 80°C	1000h ved 95°C	1000h ved 60°C
165h ved 80°C	140h ved 80°C	
Samtidigt med indvendig trykbelastning		

6

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Ekstern kontrol tredje part

Inspektion

7

Bilag 3: Standarder med genanvendelsespotentiale for plastrør

Danske marked Source: Business expert input

EN Standard		Own reprocessed material (same EN)	External non-virgin material with agreed specification	External non-virgin material from pipes and fittings (covered by an EN) with agreed specification	Danish volume (estimate)	Recycling potential, external material with agreed specification	Blocking stones
PVC-U material							
EN 1452-1:2010	PVC Water pressure	100%	0%	0%	500	0	Blybekendtgørelsen
prEN 1401-1:2019	PVC-U Sewer pipes	100%	20%		7000	1400	Blybekendtgørelsen
EN 1329-1:2014	PVC Soil & Waste	100%	20%	100%	0,5	0	Blybekendtgørelsen
EN 13476-2	PVC Structured wall sewer pipes (A)	100%	100%	100%	2500	2500	Blybekendtgørelsen
EN 13476-3	Structured wall sewer pipes (B)	100%	0%	100%	0	0	Blybekendtgørelsen
prEN 13598-2	Manhole and chambers	100%	100%		2500	2500	Blybekendtgørelsen
prEN 17152	Storm Water boxes	100%	100%		0	0	Blybekendtgørelsen
Total					12500,5	6400	Blybekendtgørelsen
PP material							
EN 1852	PP Solid Wall sewer pipes	100%	0%	100%	4000	0	Standard
EN 1451	PP Soil & Waste	100%	0%	100%	1000	0	Standard
EN 14758	PP-MD Sewer pipes	100%	0%	0%	2500	0	Standard
EN 13476-2	PP Structured wall sewer pipes (A)	100%	0%	100%	0	0	Standard
EN 13476-3	PP Structured wall sewer pipes (B)		0%		6000	0	Standard
prEN 13598-2	Manhole and chambers	100%	100%		4000	4000	Inkc. Shaft pipes
prEN 17152	Storm Water boxes	100%	100%		3500	3500	N/A
Total					21000	7500	
PE material							
EN ISO 15875	PEX pipes				3000	0	Technical and Hygenic requirements
EN ISO 21003	Multilayer H&C pipes				1500	0	Technical and Hygenic requirements
EN 1555	PE Gas pipes				1000	0	Technical and Hygenic requirements
EN 12201	PE Water pressure	0%	0%		12000	0	Technical and Hygenic requirements
EN 12666	PE Solid Wall sewer pipes	100%	0%	100%	0	0	Standard
prEN 1519	PE Soil & Waste	100%	0%	100%	200	0	Standard
EN13476	PE Structured wall sewer pipes (A)	100%	0%	100%	2000	0	Standard
EN13476	PE Structured wall sewer pipes (B)	100%	0%	100%	500	0	Standard
prEN 13598-2	Manhole and chambers	100%	100%		500	500	N/A
Total					20700	500	

PE and PP Recycled material - not covered by EN							
DIN, BS, factory standard	Storm Water pipes		100%		3000	3000	N/A
DIN, BS, factory standard	Cable duct pipes		100%		2000	2000	N/A
Factory and customer standard	Optoduct (typicall Ø40mm)				3000	0	N/A
Factory and customer standard	Micro ducts, fiber to the homes				1500	0	N/A
Total					9500	5000	

Grand Total					63700,5	19400,1

30%

Table 4 – Characteristics that require type testing (TT) of the pipe, including coextruded pipes and pipes with peel-able layer per compound designation by the pipe manufacturer

Change of production method is not regarded relevant for pipes in accordance with this standard.

Charac-teristic [g]	Reference to part and clause of EN 12201	3rd part type testing frequency			Number of test pieces a)	Number of measure-ments per test piece
		New designation / first compound / first SDR	Change of compound with same designation	Extension (New size groups and/or SDR series)		
Effect on water quality	2 –5.3. / 8.2	National regulations	National regulations		National regulations	
Appearance	2 – 5.1	Pipes from the samples for the testing specified below are checked.			1	1
Colour	2 – 5.2				1	1
Geometrical character-istics	2 – 6 (for coex pipes see also annex B.2)				1	1
Hydrostatic strength 20 °C; ≥ 100 h b)	2 – 7.2	1 diameter / size group, but at least two diameters shall be tested	1 diameter from size group 1 or 2	1 diameter of the new size group or of the largest size group with the new SDR	3 for size group 1 and 2 and 1 for size group 3 and 4	1
Hydrostatic strength 80 °C; ≥ 1000 h b)	2 – 7.2	1 diameter / size group, but at least two diameters shall be tested	1 diameter from size group 1 or 2	1 diameter of the new size group or of the largest size group with the new SDR	3 for size group 1 and 2 and 1 for size group 3 and 4	1
Elongation at break c)	2 – 7.2	1 diameter / size group, but at least two diameters shall be tested	1 diameter from size group 1 or 2	1 diameter of the new size group or SDR	Shall conform to EN ISO 6259-1	1
Oxidation induction time d)	2 – 8.2 (for coex pipes see also annex B.4)	Once / size group	1 diameter from size group 1 or 2	1 diameter of the new size group or of the largest size group with the new SDR	3	1
Change of melt mass flow rate (MFR)	2 – 8.2 (for coex pipes see also annex B.4)	Once / size group	1 diameter from size group 1 or 2		1	1
Marking e)	2 – 11					
Fitness for purpose for butt fusion jointing carried out at -5°: Pressure test Hydrostatic strength 80°C/1000 h i)	5 - .2.2.2	Once per size group 1 or 2	Once per size group 1 or 2		1	1
Fitness for purpose for butt fusion jointing carried out at -5°: Tensile test f) i)	5 - 4.2.2.2	≥ DN 90	≥ DN 90		1	As ISO 13953

Table 4 – continue

Charac-teristic [g]	Reference to part and clause of EN 12201	3rd part type testing frequency			Number of test pieces a)	Number of measure-ments per test piece
		New designation / first compound / first SDR	Change of compound with same designation	Extension (New size groups and/or SDR series)		
Longitudinal reversion Wall thickness ≤ 16 mm	2 – 8.2	1 diameter / size group, but at least two diameters shall be tested		1 diameter of the new size group or SDR	3	1
Additional tests for coextruded pipes						
Delamination	2 – B.6	No delamination shall occur during all tests of the co-extruded pipe				
Integrity of the structure after deflection	2 – B.7	1 diameter/size group	1 diameter/size group	1 diameter/size group	3	1
Additional test for non-black pipes with peel-able layer g)						
Resistance to weathering h)	2 –C.3	1 diameter/peel-able layer compound	one diameter /peel-able layer compound		1	1

a The number of test piece(s) given in the Table are the minimum. All test pieces shall pass the relevant tests.

b Successful testing on the lowest SDR pipe will validate pipes in the same size group having the same or a higher SDR i.e. the same or thinner wall thickness.

c The number of test pieces and the test piece shape shall conform to EN ISO 6259-1 and ISO 6259-3 respectively. The test pieces are taken from the circumference of one pipe sample.

d Samples to be taken from the inner wall surface.

e Products for type testing do not need to be marked as requested in the referred standard. The manufacturer shall mark such products according to his quality plan in a clear way so traceability to all necessary data for the material used, processing parameters etc. is secured. This marking shall be reflected in the report.

f For a manufacturer only applying for size group 1 the tensile test is not applied.

g All characteristics except marking are applicable for the base pipe of peel-able layer pipe without layer. Appearance, colour, resistance to weathering and marking are applicable to peel-able layer pipes including the layer.

h Weathering of the base pipe is assessed in accordance with EN 12201-1:2011. The weathering of peel-able layer pipe with the layer is assessed by testing three test pieces for elongation at break/three test pieces for hydrostatic strength/one sample for decohesion of an electrofusion joint.

i The butt fusion shall be carried out without misalignment.

Table 5: Characteristics of pipes that require type testing

Characteristic	Reference to clauses and tables of EN 13476		Third part type testing frequency				Number of test pieces	Number of measure-ments per test piece
	Part 2	Part 3	New	Change of design (only changes influencing the jointing and/or performance of the pipe)	Change of material a) e)	Extension (New size group or new SN)		
PVC, PE and PP content	4.2.1 4.3.1 4.4.1	4.2.1 4.3.1 4.4.1	One calculation / recipe / compound				-	-
K-value, PVC EN ISO 13229 Min. 64.0 Intermediate layer foamed pipes Type A1 min. 56.0			Once / recipe / compound		Once / recipe / compound		-	-
Resistance to internal pressure b)	4.2.2 - Table 1 4.3.2 - Table 2 4.4.2 - Table 3 as applicable	4.2.2 - Table 1 4.3.2 - Table 2 4.4.2 - Table 3 as applicable					3	1
Melt mass flow rate PP and PE	4.3.2 - Table 2 4.4.2 - Table 3 as applicable	4.3.2 - Table 2 4.4.2 - Table 3 as applicable					1	1
Thermal stability PP and PE							1	1
Compound density PE	4.4.2 - Table 3	4.4.2 - Table 3					1	1
Appearance	6	6	Pipes from which samples for testing as specified below and in Table 7 is taken				1	1
Colour	6	6						
Dimensions Pipe diameter and wall thickness; socket depth, wall thickness and diameters For foamed pipes Type A1 see also Table 0 in this SBC	7.2 - Tables 5, 6 and 7	7.2 - Tables 5, 6 and 7						
Creep Ratio	9.1 - Table 14	9.1 - Table 14	One size from smallest size group / recipe / compound d)		One size from smallest size group / recipe / compound d)		3 for size group 1. 1 for size group 2 and 3.	1
Vicat softening temperature (VST) PVC only	8.1.1 - Table 8	8.1.1 - Table 8	Once / recipe		Once / recipe		2	1

Table 5: Characteristics of pipes that require type testing (continued)

Characteristic	Reference to clauses and tables of EN 13476		Third part type testing frequency				Number of test pieces	Number of measurements per test piece
	Part 2	Part 3	New	Change of design (only changes influencing the jointing and/or performance of the pipe)	Change of material a) e)	Extension (New size group or new SN)		
Impact resistance at -10°C. Staircase method. Size group 1, 2 and 3.	Annex H	Annex H	1 diameter/ size group, but at least two diameters shall be tested	Once / size group	1 diameter/ size group, but at least two diameters shall be tested	1 diameter/ new size group and/or stiffness class	20	1
Impact resistance at -10°C. Staircase method. Size group 4.	Annex K	Annex K						
Ring stiffness	9.1 - Table 14	9.1 - Table 14					3	1
Ring Flexibility	9.1 - Table 14	9.1 - Table 14					3	1
Tensile strength of seam, spirally wound pipes	9.1 - Table 14	9.1 - Table 14		Once / size / compound/ recipe			3	1
Longitudinal reversion, type A only	8.1.1 - Table 8 8.2.1 - Table 10 8.3.1 - Table 12 as applicable	n.a.		Once / size group			3	1
Resistance to dichloromethane at a specified temperature; PVC only	8.1.1 - Table 8	8.1.1 - Table 8					3	1
Resistance to heating – Oven test. Type B pipes only	n.a.	8.1.1 - Table 8 8.2.1 - Table 10 8.3.1 - Table 12 as applicable		Once / size group			3	1
Sealing ring	4.5	4.5	One evaluation / ring material	One evaluation / ring material	One evaluation / ring material			
Marking according to clause 5 in this SBC	11 - Table 18	11 - Table 18	c)			c)		

a) For definition of change of material, see 8.1.1, 8.1.2 or 8.1.3 as applicable for PVC-U, PP or PE respectively.
b) To be tested in pipe form with an optional diameter. Accredited reports from raw material manufacturer can be used.
c) Products for type testing do not need to be marked as requested in the referring standard. The manufacturer shall mark such products according to his quality plan in a clear way so traceability to all necessary data for the material used, processing parameters etc. is secured. This marking shall be reflected in the report.
d) Not applicable for size group 4.
e) Test results are only valid for the tested material grade combination in the inner and outer layer.

Bilag 4C: Pressure pipe application-PE100 long term performance

2021-11-17

Borealis, Lars Höjer

Pressure pipe application – PE100 long term performance
Within the application are standardised procedures applied to evaluate (and classify) the long-term performance.

For PE100 this include a pipe testing program running up to one year, which involve a significant number of pipe specimens, tested at different temperatures and stress levels. Why? Because in real life service, pressure pipes are exposed to three mechanical/chemical phenomena with potential negative impact on pipe service life:

- mechanical load
- crack propagation
- oxidation

So the full picture has to be documented, hence the complexity. The SEM evaluation is addressing all three phenomena described above. And the SEM evaluation is the base for the classification (example: PE100).

So how to do a performance prediction after mixing in recycled content?

- Short term mechanical load (=short term pressure testing) and OIT will in itself alone not answer the performance question (in pressure pipe application)
- Crack resistance and oxidation resistance will influence too
- OIT is primarily a tool to understand the resistance to high heat exposure (i.e. during processing and welding, i.e. not the long term resistance to oxidation in service life application.)
- On speculation basis I expect that the recycled content may cause negative impact on the crack resistance, as microscopic contaminants and inhomogeneity may serve as stress concentration points, fostering accelerated slow crack growth (SCG), which ultimately may cause premature brittle failure in real life pipe application.

A service life prediction can't be done from the limited data given in the report.

The topic is important and knowledge building around recycled content is both needed and welcome, why I welcome the efforts spent.

Best regards

Lars Höjer

Borealis,

Application Technology Manager
Pipe

OCEANIX

rHDPE 111-001 Black

Polyethylene

PLASTIX

ORIGIN OF END-OF-USE POLYMERS

OceanIX is our range of **high-quality post-consumer recycled (PCR)** raw materials originating from **end-of-life maritime gear** that would otherwise end up in our oceans or on landfill, sourced for preventive action to eradicate plastic pollution, and suitable to be used at 100% or in a blend.

RECYCLING STEPS

Rough Sorting; Fine Fractioning/Homogenisation; Metal Detection; Shredding; Washing; Separation; Compounding; Extrusion

SELECTED PROCESSING SUITABILITY

Most suitable: Extrusion (e.g.: sheets; fibres; films; pipes; tubes); Thermoforming; Blow Moulding (e.g.: bottles); Roto Moulding

Possible: Injection Moulding; 3D Free Form Injection Moulding; 3D Print

COMPLIANCE

REACH ; RoHS ; Recycling Norms (European Norm: EN15344:2007 and Spanish Norm: PNE53978)

TECHNICAL DATA [1]

PHYSICAL PROPERTIES	METHOD / INFO	CONDITIONS	VALUE	UNITS/COMMENTS
Melt Flow Index, MFI	ISO 1133-1	230 0 C, 2,16 kg	0,60 to 0,95	g/10 mins
Density	ISO 1183-1-Method A	Immersion	0,94 to 0,96	g/cm3
Shape		Visual inspection	Regular shaped granules	
Color		Visual inspection	Black	
Color variation	CIELab	D65/10°	> 3	Range of measured ΔE
Odour		Sensory Evaluation	Minor	
Recycled Plastics Content (PCR)			97	%
Filtration Level		Mesh Size	300	µ
Contamination	No. of defects on extruded film		n/a	defects/dm2
Other Polymers	DSC and FT-IR Analysis		-	%
MECHANICAL PROPERTIES (AT 23°C)				
Tensile strength [2]	ISO 527-1/2		19 to 23	N/mm2 (MPa)
E-modulus [2]	ISO 527-1/2		> 600	N/mm2 (MPa)
Flexural Modulus	ISO 178		n/a	N/mm2 (MPa)
Charpy Impact Strength	ISO 179-1	Notched	16-20	kJ/m2
THERMAL PROPERTIES				
Melting Point	ISO 11357-1/3		132 to 140	°C
ASH CONTENT	ISO 3451-1		< 2,0	%

[1] Testing Frequency: 1 composite sample per 12-hour shift. A composite sample is comprised of an increment from each Big Bag of 1000kg.
[2] Performed on injection moulded samples type 1B.

Material handling: rHDPE granules need normally not to be dried. However, condensation of atmospheric moisture inside the packing may occur due to fluctuating temperatures and high humidity upon storage. Plastix recommends that the material is pre-dried to remove possible condense moisture, which could be done normally with 2 hours drying at 80°C or according to our customers' normal pre-drying procedure for HDPE.

ECO FOOTPRINT

By sing OceanIX rHDPE and with reference to Plastix' Life Cycle Assessment (LCA) you are saving our planet for 1650 kg equivalent emissions in comparison with similar virgin plastic material, every time you use 1000 kg OceanIX rHDPE, improving CO_2 emission savings by a factor 1 : 5,5. Depending on your application, the percentage of OceanIX rHDPE used and the end of life option for your own product, you could even further increase the CO_2 and resource savings.
By using OceanIX rHDPE as your prevailing Green Plastics raw material choice you directly contribute to further closing the material loops, reducing landfilling, marine pollution and loss of valuable resources.

Laboratory Capabilities:
Our Laboratory is equipped with state-of-the-art instruments for polymer analysis.

Mechanical properties: Tensile & Impact Testing
Physical properties: MFI & Density, CIELab Colour Analysis
Thermal Properties: DSC, Oxidative Decomposition Analysis
Chemical Properties: FTIR, Ash Content, Heavy Metal Detection by XRF Analysis

PLASTIX' Quality and Environmental Management System is certified by FORCE Certification A/S according to ISO 9001 and ISO 14001.

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Version 7.0/2021

Bilag 5B: Plastix: TDS_OceanIX_rHDPE 110-001 Green

OCEANIX

rHDPE 110-001 Green

Polyethylene

PLASTIX

ORIGIN OF END-OF-USE POLYMERS

OceanIX is our range of **high-quality post-consumer recycled (PCR)** raw materials originating from **end-of-life maritime gear** that would otherwise end up in our oceans or on landfill, sourced for preventive action to eradicate plastic pollution, and suitable to be used at 100% or in a blend.

RECYCLING STEPS

Rough Sorting; Fine Fractioning/Homogenisation; Metal Detection; Shredding; Washing; Separation; Compounding; Extrusion

SELECTED PROCESSING SUITABILITY

Most suitable: Extrusion (e.g.: sheets; fibres; films; pipes; tubes); Thermoforming; Blow Moulding (e.g.: bottles); Roto Moulding

Possible: Injection Moulding; 3D Free Form Injection Moulding; 3D Print

COMPLIANCE

REACH ; RoHS ; Recycling Norms (European Norm: EN15344:2007 and Spanish Norm: PNE53978)

TECHNICAL DATA [1]

PHYSICAL PROPERTIES	METHOD / INFO	CONDITIONS	VALUE / RANGE	UNITS/COMMENTS
Melt Flow Index, MFI	ISO 1133-1	190°C, 2,16 kg	0,6 to 0,9	g/10 mins
Density	ISO 1183-1-Method A	Immersion	0,94 to 0,96	g/cm3
Shape		Visual inspection	Regular shaped granules	
Color		Visual inspection	Green	
Color variation	CIELab (Reference 'Pure White')	D65/10°	22 to 33	ΔE to L*,a*,b*=100,0,0
Odour		Sensory Evaluation	Minor	
Recycled Plastics Content (PCR)			98	%
Filtration Level	Opening/Aperture		300	µ
Contamination	No. of defects on extruded film		n/a	defects/dm2
Other Polymers	DSC and FT-IR Analysis		-	%
MECHANICAL PROPERTIES (AT 23°C)				
Tensile strength [2]	ISO 527-1/2		20 to 25	N/mm2 (MPa)
E-modulus [2]	ISO 527-1/2		> 600	N/mm2 (MPa)
Flexural Modulus	ISO 178		n/a	N/mm2 (MPa)
Charpy Impact Strength	ISO 179-1/1eU b	Unnotched	110 to 130	kJ/m2
THERMAL PROPERTIES				
Melting Point	ISO 11357-1/3		132 to 140	°C
ASH CONTENT	ISO 3451-1		< 1,5	%

[1] Testing Frequency: 1 composite sample per 12-hour shift. A composite sample is comprised of an increment from each Big Bag of 1000kg.
[2] Performed on injection moulded samples type 1B.

Material handling: rHDPE granules need normally not to be dried. However, condensation of atmospheric moisture inside the packing may occur due to fluctuating temperatures and high humidity upon storage. Plastix recommends that the material is pre-dried to remove possible condense moisture, which could be done normally with 2 hours drying at 80°C or according to our customers' normal pre-drying procedure for HDPE.

ECO FOOTPRINT
By sing OceanIX rHDPE and with reference to Plastix' Life Cycle Assessment (LCA) you are saving our planet for 1650 kg equivalent emissions in comparison with similar virgin plastic material, every time you use 1000 kg OceanIX rHDPE, improving CO_2 emission savings by a factor 1 : 5,5. Depending on your application, the percentage of OceanIX rHDPE used and the end of life option for your own product, you could even further increase the CO_2 and resource savings.
By using OceanIX rHDPE as your prevailing Green Plastics raw material choice you directly contribute to further closing the material loops, reducing landfilling, marine pollution and loss of valuable resources.

Laboratory Capabilities:
Our Laboratory is equipped with state-of-the-art instruments for polymer analysis.

Mechanical properties: Tensile & Impact Testing
Physical properties: MFI & Density, CIELab Colour Analysis
Thermal Properties: DSC, Oxidative Decomposition Analysis
Chemical Properties: FTIR, Ash Content, Heavy Metal Detection by XRF Analysis

PLASTIX' Quality and Environmental Management System is certified by FORCE Certification A/S according to ISO 9001 and ISO 14001.

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Version 12.0/2021

OCEANIX

rPPC 211-001 Black

Polypropylene

PLASTIX

ORIGIN OF END-OF-USE POLYMERS

OceanIX is our range of **high-quality post-consumer recycled (PCR)** raw materials originating from **end-of-life maritime gear** that would otherwise end up in our oceans or on landfill, sourced for preventive action to eradicate plastic pollution, and suitable to be used at 100% or in a blend.

RECYCLING STEPS

Rough Sorting; Fine Fractioning/Homogenisation; Metal Detection; Shredding; Washing; Separation; Compounding; Extrusion

SELECTED PROCESSING SUITABILITY

Most suitable: Injection Moulding; 3D Print; Extrusion (e.g.: sheets; fibres; films; pipes; tubes); Thermoforming; 3D Free Form Injection Moulding

Possible: Blow Moulding (e.g.: bottles); Roto Moulding

COMPLIANCE

REACH ; RoHS ; Recycling Norms (European Norm: EN15345 and Spanish Norm: PNE53972)

TECHNICAL DATA [1]

PHYSICAL PROPERTIES	METHOD / INFO	CONDITIONS	VALUE	UNITS/COMMENTS
Melt Flow Index, MFI	ISO 1133-1	230°C, 2,16 kg	2,5 to 4,5	g/10 mins
Density	ISO 1183-1-Method A	Immersion	0,92 to 0,94	g/cm3
Shape		Visual inspection	Regular shaped granules	
Color		Visual inspection	Black	
Color variation	CIELab (Reference 'Pure White')	D65/10°	86 to 89	ΔE to L*,a*,b*=100,0,0
Odour		Sensory Evaluation	Minor	
Recycled Plastix Content (PCR)			96	%
Filtration Level	Opening/Aperture		200	µ
Contamination	No of defects on extruded film		n/a	defects/dm2
Other Polymers	DSC and FT-IR Analysis	HDPE	≈30	%
MECHANICAL PROPERTIES (AT 23°C)				
Tensile strength [2]	ISO 527-1/2		26 to 36	N/mm2 (MPa)
E-modulus [2]	ISO 527-1/2		> 800	N/mm2 (MPa)
Flexural Modulus	ISO 178		n/a	N/mm2 (MPa)
Charpy Impact Strength	ISO 179-1	Notched	3,1 to 6,1	kJ/m2
THERMAL PROPERTIES				
Melting Point	ISO 11357-1/3		161 to 167	°C
ASH CONTENT	ISO 3451-1		< 2,5	%

[1] Testing Frequency: 1 composite sample per 12-hour shift. A composite sample is comprised of an increment from each Big Bag of a 1000kg.
[2] Performed on injection moulded samples Type 18.

Material handling: rPPC granules need normally not to be dried. However, condensation of atmospheric moisture inside the packing may occur due to fluctuating temperatures and high humidity upon storage. Plastix recommends that the material is pre-dried to remove possible condense moisture, which could be done normally with 2 hours drying at 80°C or according to our customers' normal pre-drying procedure for PP.

ECO FOOTPRINT

By using OceanIX rPPC and with reference to Plastix' Life Cycle Assessment (LCA) you are saving our planet for 1675 kg equivalent emissions in comparison with similar virgin plastic material, every time you use 1000 kg OceanIX rPPC, improving CO_2 emission savings by a factor 1 : 5,7. Depending on your application, the percentage of OceanIX rPPC used and the end of life option for your own product, you could even further increase the CO_2 and resource savings.
By using OceanIX rPPC as your prevailing Green Plastics raw material choice you directly contribute to further closing the material loops, reducing landfilling, marine pollution and loss of valuable resources.

Laboratory Capabilities:
Our Laboratory is equipped with state-of-the-art instruments for polymer analysis.

Mechanical properties: Tensile & Impact Testing
Physical properties: MFI & Density, CIELab Colour Analysis
Thermal Properties: DSC, Oxidative Decomposition Analysis
Chemical Properties: FTIR, Ash Content, Heavy Metal Detection by XRF Analysis

PLASTIX' Quality and Environmental Management System is certified by FORCE Certification A/S according to ISO 9001 and ISO 14001.

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Version 12.0/2021

OCEANIX

rPPC 210-001 Green

Polypropylene

PLASTIX

ORIGIN OF END-OF-USE POLYMERS

OceanIX is our range of **high-quality post-consumer recycled (PCR)** raw materials originating from **end-of-life maritime gear** that would otherwise end up in our oceans or on landfill, sourced for preventive action to eradicate plastic pollution, and suitable to be used at 100% or in a blend.

RECYCLING STEPS

Rough Sorting; Fine Fractioning/Homogenisation; Metal Detection; Shredding; Washing; Separation; Compounding; Extrusion

SELECTED PROCESSING SUITABILITY

Most suitable: Injection Moulding; 3D Print; Extrusion (e.g.: sheets; fibres; films; pipes; tubes); Thermoforming; 3D Free Form Injection Moulding

Possible: Blow Moulding (e.g.: bottles); Roto Moulding

COMPLIANCE

REACH ; RoHS ; Recycling Norms (European Norm: EN15345 and Spanish Norm: PNE53972)

TECHNICAL DATA

PHYSICAL PROPERTIES [1]	METHOD / INFO	CONDITIONS	VALUE / RANGE	UNITS/COMMENTS
Melt Flow Index, MFI	ISO 1133-1	230 °C, 2,16 kg	2,6 to 4,5	g/10 mins
Density	ISO 1183-1-Method A	Immersion	0,91 to 0,93	g/cm^3
Shape		Visual inspection	Regular shaped granules	
Color		Visual inspection	Green	
Color variation	CIELab (Reference 'Pure White')	D65/10°	72 to 82	ΔE to L*,a*,b*=100,0,0
Odor		Sensory Evaluation	Minor	
Recycled Plastics Content (PCR)			98	%
Filtration Level		Mesh Size	200	µ
Contamination	No of defects on extruded film		n/a	defects/dm2
Other Polymers	DSC and FT-IR Analysis	HDPE	≈30	%
MECHANICAL PROPERTIES (AT 23°C) [1]				
Tensile strength [2]	ISO 527-1/2		27 to 36	N/mm^2 (MPa)
E-modulus [2]	ISO 527-1/2		> 900	N/mm^2 (MPa)
Flexural Modulus	ISO 178		n/a	N/mm^2 (MPa)
Charpy Impact Strength	ISO 179-1	Notched	4,0 to 6,5	kJ/m^2
THERMAL PROPERTIES [1]				
Melting Point	ISO 11357-1/3		160 to 166	°C
ASH CONTENT [1]	ISO 3451-1		< 1,5	%

[1] Testing Frequency: 1 composite sample per 12-hour shift. A composite sample is comprised of an increment from each Big Bag of a 1000kg.
[2] Performed on injection moulded samples Type 18.

Material handling: rPPC granules need normally not to be dried. However, condensation of atmospheric moisture inside the packing may occur due to fluctuating temperatures and high humidity upon storage. Plastix recommends that the material is pre-dried to remove possible condense moisture, which could be done normally with 2 hours drying at 80°C or according to our customers' normal pre-drying procedure for PP.

ECO FOOTPRINT

By using OceanIX rPPC and with reference to Plastix' Life Cycle Assessment (LCA) you are saving our planet for 1675 kg equivalent emissions in comparison with similar virgin plastic material, every time you use 1000 kg OceanIX rPPC, improving CO_2 emission savings by a factor 1 : 5,7. Depending on your application, the percentage of OceanIX rPPC used and the end of life option for your own product, you could even further increase the CO_2 and resource savings.
By using OceanIX rPPC as your prevailing Green Plastics raw material choice you directly contribute to further closing the material loops, reducing landfilling, marine pollution and loss of valuable resources.

Laboratory Capabilities:
Our Laboratory is equipped with state-of-the-art instruments for polymer analysis.

Mechanical properties: Tensile & Impact Testing
Physical properties: MFI & Density, CIELab Colour Analysis
Thermal Properties: DSC, Oxidative Decomposition Analysis
Chemical Properties: FTIR, Ash Content, Heavy Metal Detection by XRF Analysis

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Version 3.0/2022

PROVICE

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To: Plastix A/S
From: Tomas Sander Poulsen, Provice
Date: 16. march 2022
Subject: Carbon Footprint for OceanIX® - Executive summary

Background
This memo summarizes the *carbon footprint* for Plastix' Green Plastics branded under the Trademark OceanIX®.

The carbon footprint is extracted from an LCA-screening conducted during Q1-2022 and developed according to the ISO 14040-14044 standard for Life Cycle Assessment. The SimaPro LCA-software is the applied tool for the LCA-calculations. Background information and data is described in a separate document.

The LCA-screening is based on Plastix' actual production data and the results are presented as average figures for OceanIX®.

Unit and system
The LCA-screening comprise the following life cycle phases (cradle to gate):

1. Transport of plastic waste/input supply
2. Plastix production (energy, waste, additives)
3. Electricity and district heat production
4. Waste disposal

The carbon footprint represents *1 ton OceanIX® (rPPC or rHDPE) ready for sale.* While there are no differences in the production of OceanIX® rHDPE or OceanIX® rPPC the carbon footprint is representative for both polymer types.

The carbon footprint is calculated for these two product types:

- Basic OceanIX® with no compounded polymer additives
- Standard OceanIX® with 2% compounded polymer additives

Results
The carbon footprint for Basic OceanIX® rPPC and rHDPE is *126 kg CO_2 equivalents/ton.*

The carbon footprint for Standard OceanIX® rPPC and rHDPE is *168 kg CO_2 equivalents/ton.*

The reference carbon footprint for Virgin PP is 1,980 kg CO_2 *equivalents/ton.*
The reference carbon footprint for Virgin HDPE is 1,992 kg CO_2 *equivalents/ton.*

On that background, it can be concluded that:

- The Carbon Footprint for Basic OceanIX® is **93,64% less** than Virgin PP
- The Carbon Footprint for Basic OceanIX® is **93,68% less** than Virgin HDPE
- The Carbon Footprint for Standard OceanIX® is **91,52% less** than Virgin PP
- The Carbon Footprint for Standard OceanIX® is **91,57% less** than Virgin HDPE

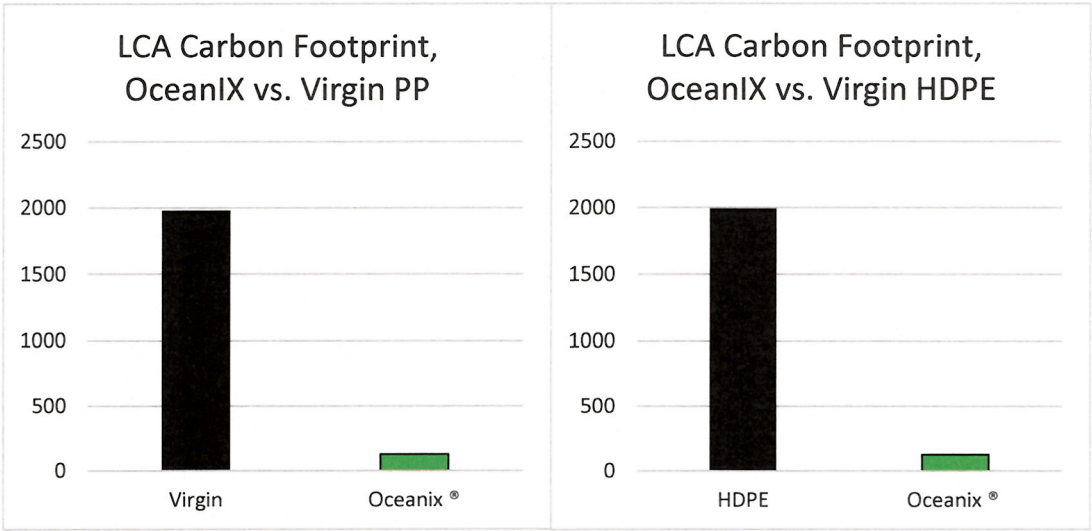

Figure 1: Basic OceanIX® rPPC/rHDPE carbon footprint vs. Virgin PP and HDPE (kg CO_2/ton)

In relation to both Basic OceanIX® and Standard OceanIX® the three largest CO_2 contributions come from transporting input supply to gate, waste incineration of production waste and diesel consumption from exterior moving equipment.

The CO_2-emissions from Plastix' energy consumption (electricity and district heating) is absolutely marginal. Plastix uses 100% certified green electricity (CO_2 compensated) and district heating is produced on biogas which is a CO_2-neutral energy source.

TECHNICAL DATA SHEET

The data should be regarded as indicative and should not be used for specification work. Aage Vestergaard Larsen A/S assumes no legal responsibility for the precision or correctness of the test results.

Ref: 853

PP COPO RE 001 MIXED COLOUR

ID: 47118
quantity:

Material: Polypropylene copolymer
Colour: mix colour
Application: - Extrusion

Regenerated raw material

Physical properties.

Mechanical properties

Charpy notched impact strength	**(+23 degrees)**	**62 P Partial break**	**Kj/m^2**	**ISO 179 /1eA**
E-mod	**(1 mm/min; +23 degrees)**	**1250**	**Mpa**	**ISO 527-2**
Elongation at Break	**(50 mm/min; +23 degrees)**	**> 100**	**%**	**ISO 527-2**
Tensile stress at break	**(50 mm/min; +23 degrees)**	**21**	**Mpa**	**ISO 527-2**
Tensile stress at Yield	**(50 mm/min; +23 degrees)**	**29**	**Mpa**	**ISO 527-2**

Other properties

Density	**(+23 degrees)**	**0,913**	**g/cm^3**	**ISO 1183**

Rheological properties

Melt Flow Rate	**(230 degrees; 2,16 kg)**	**0,7**	**g/10 min**	**ISO 1133**

Thermal properties

OIT	**(210 degrees)**	**14**	**min**	**EN 728:1997**

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EMTELLE

Laboratorierapport EN12201 PE100 rør med Plastix rHDPE 111-001 Black

Rør er produceret i Insta-Cert godkendt PE100 råvare blandet i forskellige forhold med Plastix rHDPE 111-001 Black.

Lot	Blanding
66113	75% regenerat - 25% PE100
66112	50% regenerat - 50% PE100
66111	25% regenerat - 75% PE100

Efterspurgte tests af rør udført i henhold til EN 12201 og under normale procedurer godkendt under Emtelle's Insta-Cert certifikat 2042. På Lot 66111 er der ændret procedure i forhold til antal timer, efter forespørgsel fra projektleder.

Resultater:

Lot	Dimensionskontrol OD [mm]	Dimensionskontrol gods [mm]	Dimensionsstabilitet
66113	110,7	6,63-6,90	1,36 %
66112	110,7	6,63-6,90	1,50 %
66111	110,7	6,63-6,87	1,63 %

Lot	Tryktest 80°	Yield styrke [Mpa]	Brud-forlængelse [%]	OIT [min]
66113	15 timer 11 min	24,7	409 – intet brud	24,1 (202,0°)
66112	95 timer 28 min	24,1	409 – intet brud	26,9 (202,2°)
66111	165 +135 timer (intet brud)	25,5	409 – intet brud	47,4 (202,3°)

25-10-2021

Kim Aakermann – Chemical Engineer

Sdr. feld.

Emtelle Head Office
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UK

+ 44 (0) 1450 364 000

info@emtelle.com

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Test report

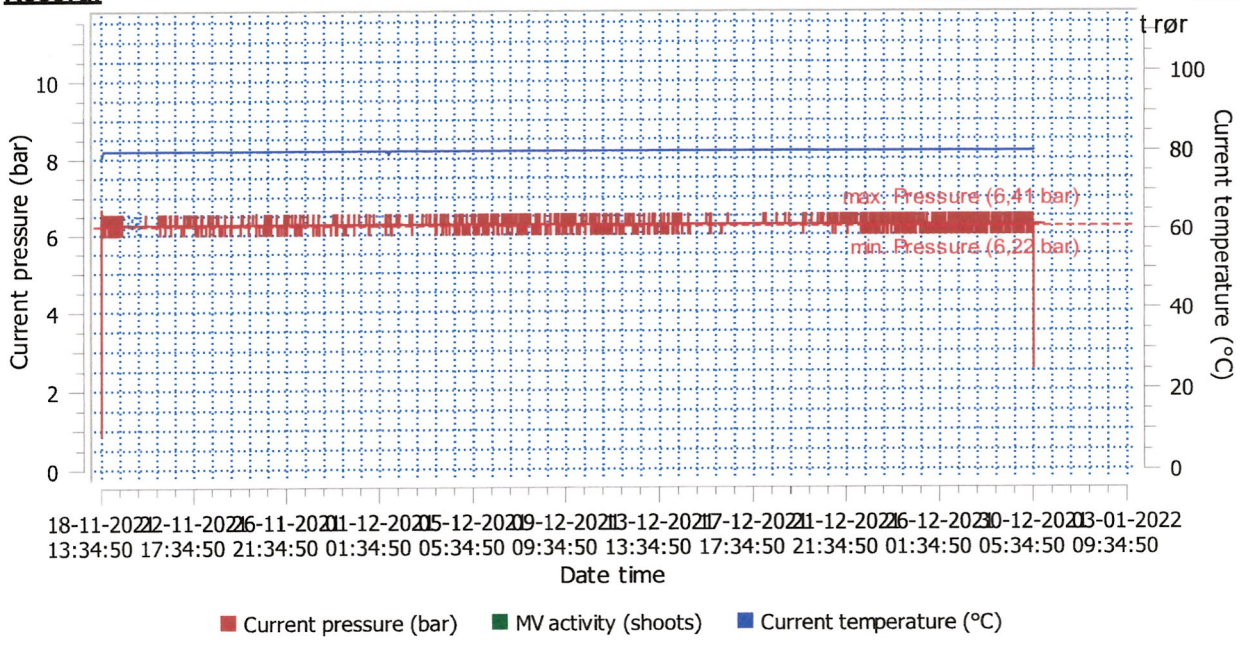
Test-Id	**2021110033/000**
Order number	-
Customer	Rene regenerat rør
Set pressure	6,28 bar
min. Pressure	6,22 bar
max. Pressure	6,41 bar
Conditioning time	0:0:0 h:m:s
Set temperature	80,0 °C
Start date	18-11-2021 13:34
Timecounter start	0:0:0 h:m:s
End date	30-12-2021 05:55
Time counter	1.000:0:26 h:m:s
Pressurize time	60,00 sec
Status	End

Set pressure
6,28 bar

Hoop stress (σ)	0,00 N/mm²
Wall thickness (min)	0,00 mm
Outer diameter	0,00 mm

Testing Respons

Record: Customer Connection (numl



Events:	**Start date**	**End date**	**Description**

Test report

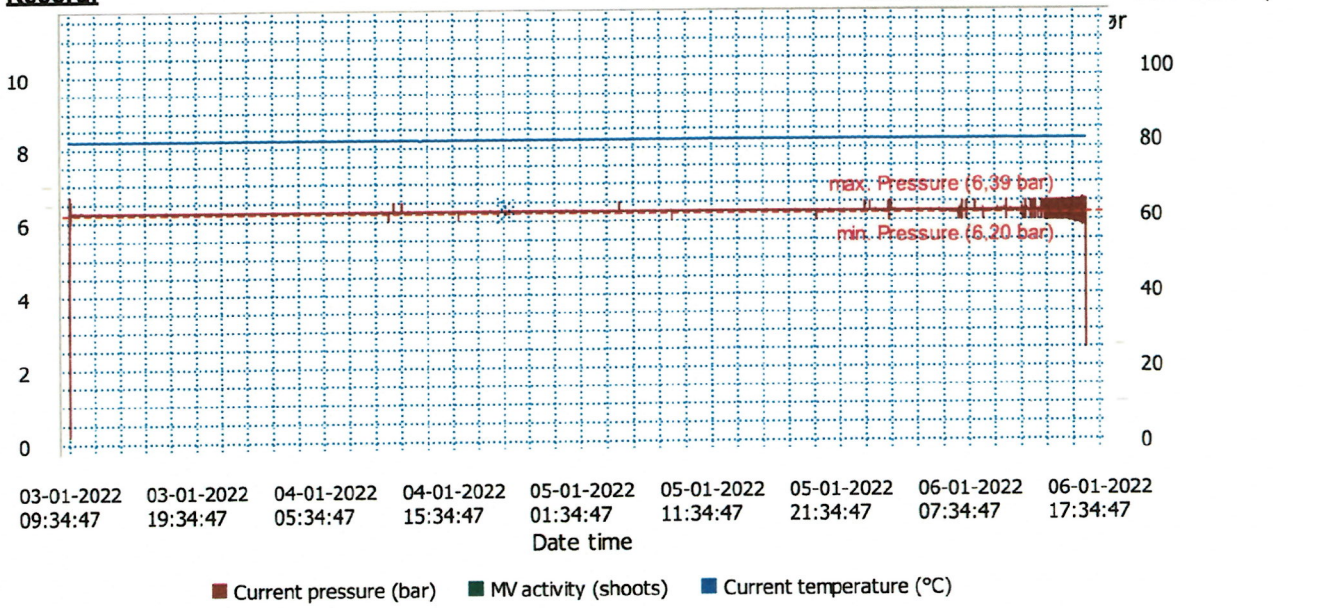
Test-Id	**2022010001/000**
Order number	-
Customer	Rene regenerat rør
Set pressure	6,26 bar
min. Pressure	6,20 bar
max. Pressure	6,39 bar
Conditioning time	0:0:0 h:m:s
Set temperature	80,0 °C
Start date	03-01-2022 09:34
Timecounter start	0:0:0 h:m:s
End date	06-01-2022 16:32
Time counter	78:44:29 h:m:s
Pressurize time	84,00 sec
Status	Broken

Set pressure
6,26 bar

Hoop stress (σ)	0,00 N/mm²
Wall thickness (min)	0,00 mm
Outer diameter	0,00 mm

Testing Respons

Record: Customer Connection (numb



Events:	**Start date**	**End date**	**Description**

DANISH
TECHNOLOGICAL
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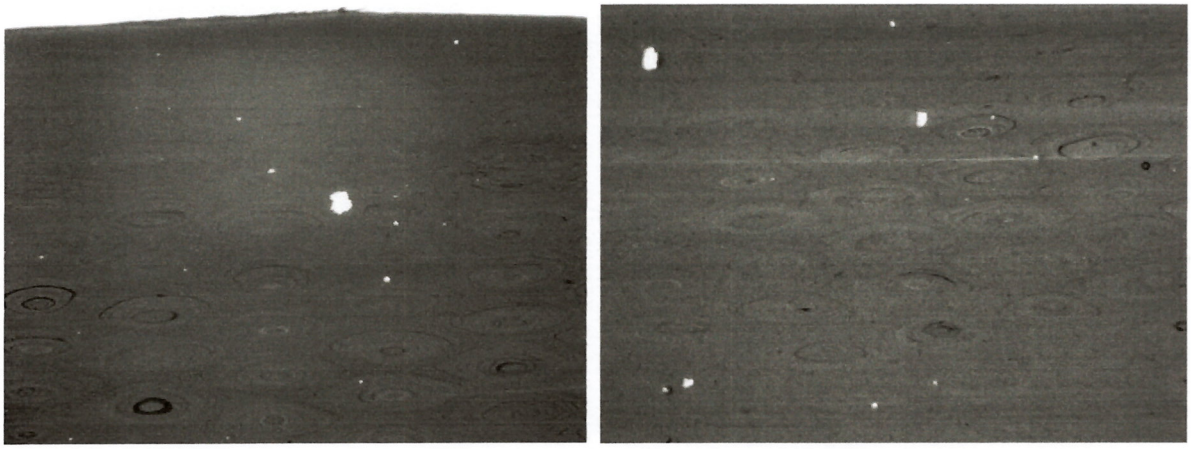
15. November 2021
ANCA/FHGS

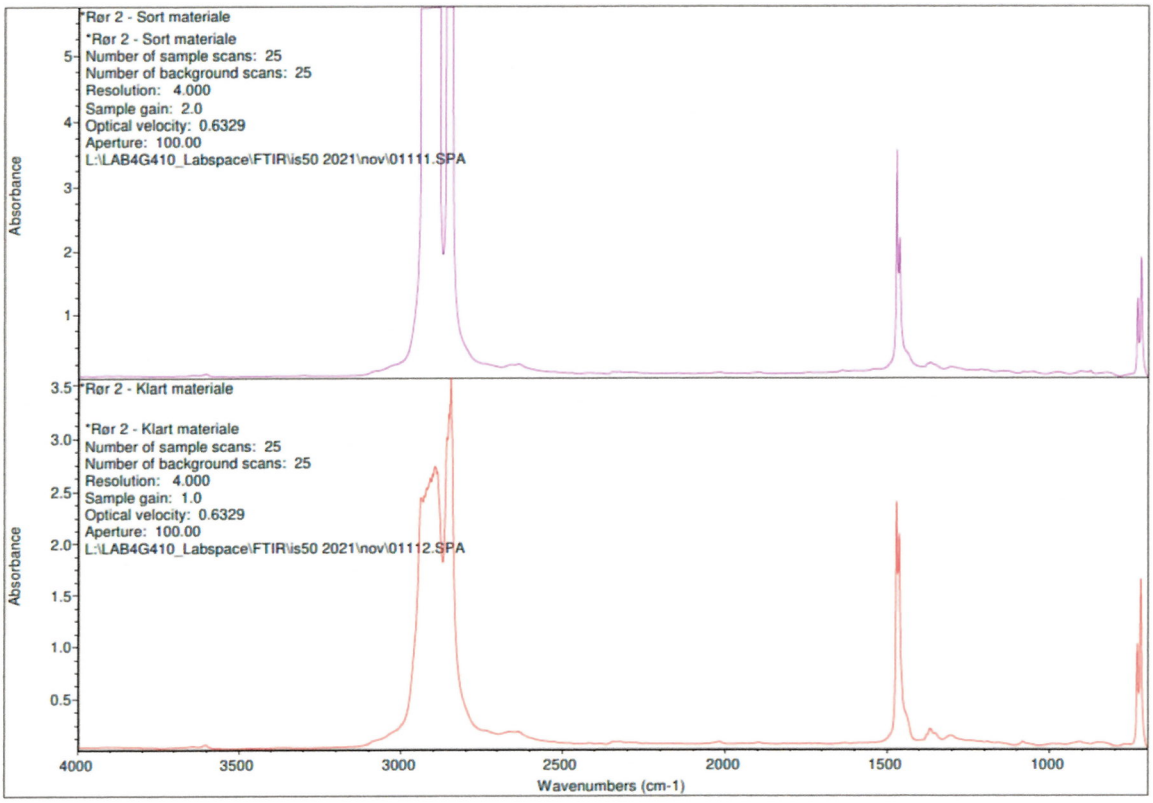
Project 2008614-02, Failure analysis of two pipe samples

Two PE pipe segments produced with 50% and 25% recyclate from PE fishnets was sent to analysis due to failure after pressure loading at the Danish Technological Institute, Installation and Calibration.

From both pipe segments thin sections were made and analyzed using microscope.
It was found that the material is highly inhomogeneous, as seen on the photos below.
The circular pattern is most likely due to insufficient compounding prior to extrusion.
In addition, the thin section photos reveal the presence of voids and foreign objects.



FTIR analysis was performed on both the black areas and the opaque material.
It was found that both materials are identified as PE. However, the opaque material relatively has a higher concentration of CH_3 groups, which could indicate higher level of branching.



In conclusion, the pipe wall shows clear signs of being a blend of two different PE materials, which leads to significantly reduced quality of the pipe.
As we are not familiar with the production process, it is difficult to recommend how to alleviate this, but achieving a homogeneous blend before extrusion considered imperative for the quality of the pipe.

Kind regards

Anders Ask Carton
Consultant, Plastics and Packaging
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anca@teknologisk.dk

Bilag 6D: Uponor – Test PE-trykrør

Lemvig Vand
Havnen 8
7620 Lemvig
Att. Isa Schipperheijn

uponor

Inspection Certificate type 3.1 according to DS/EN 10204

Certificate no. 1144

Product	:	110 x 6,6mm PN10 SDR 17 PE-afløbsrør med 8 brune striber - 21 x 12 m.
Production batch no.	:	1030638
Your order no	:	VUDP 1,0 **Batch no.:** : 1511191;
Raw material	:	70% PE100 + 30 % Plastix RHDPE 111-001 Black
Product Standard	:	Produceret efter principperne i EN 12201
Pipe marking	:	UPONOR PE -VUDP 1,0- 110 x 6,6 SDR 17 -99- 1030638. (2) 25-02-22
Comments	:	Projekt VUDP, Lemvig Vand. * Hvis test var blevet udført ved 200 °C vil test værdierne være omkring 15 min højere end angivet. ** Materialet er svejsbart. Brud sker i rør. *** Både 165t og 1000t test bestået. Trykprøvningen fortsat til brud. Brudtype sprødbrud.

Property	Reference	Method	Unit	Requirement	Result
MFR - Raw material (BRT)	EN ISO 1133	190/5	g/10 min.	0,2 - 0,4	0,59
OIT - Raw material (BRT)	ISO 11357-6	210 °C	min.	≥ 20	21,1
MFR – Pipe (PVT)	EN ISO 1133	190/5	g/10 min.	Changing of MFR by processing less than ± 20%	0,60
OIT – Pipe (BRT)	ISO 11357-6	210 °C	min.	≥ 20	18,8 - 16,9 -19,4 = 18,4*
Dimension control	EN 12201	Measured immediately after production	mm	Od. : 110,0 – 110,7 e : 6,6 – 7,4 Ova. : ≤ 2,2	Od. : 110,5 – 110,6 e : 6,7 – 7,2 Ovalitet. : ≤ 0,7
	Internal specification		m	Length : ≥ 6,0	Length : 6,04 – 6,05
Hydrostatic Strength (PVT)	EN ISO 1167	80 °C / 5,4 MPa	Hour	≥ 165	499***
Hydrostatic Strength (PVT)	EN ISO 1167	80 °C / 5,0 MPa	Hour	≥ 1000	1141***
Tensile test (PVT)	ISO 6259 1+3	50 mm/min	%	≥ 350	552-633-414-626-**207** **= 486,4**
Longitudinal reversion	EN ISO 2505	110 °C / 1 h	%	≤ 3	≤ 1,1
Tensile strength for butt fusion joint	DS/ISO 13953	5 mm/min Type A		Brudtype: Normal / Sprød	Normal brud**
Tensile strength for butt fusion joint	DS/ISO 13953	5 mm/min Type A	N/mm	-	22,8 - 24,4

Middelfart, Date 11-03-2022 / Opdatering 19-05-2022.

We hereby certify, that the product delivered complies with the terms of order confirmation.

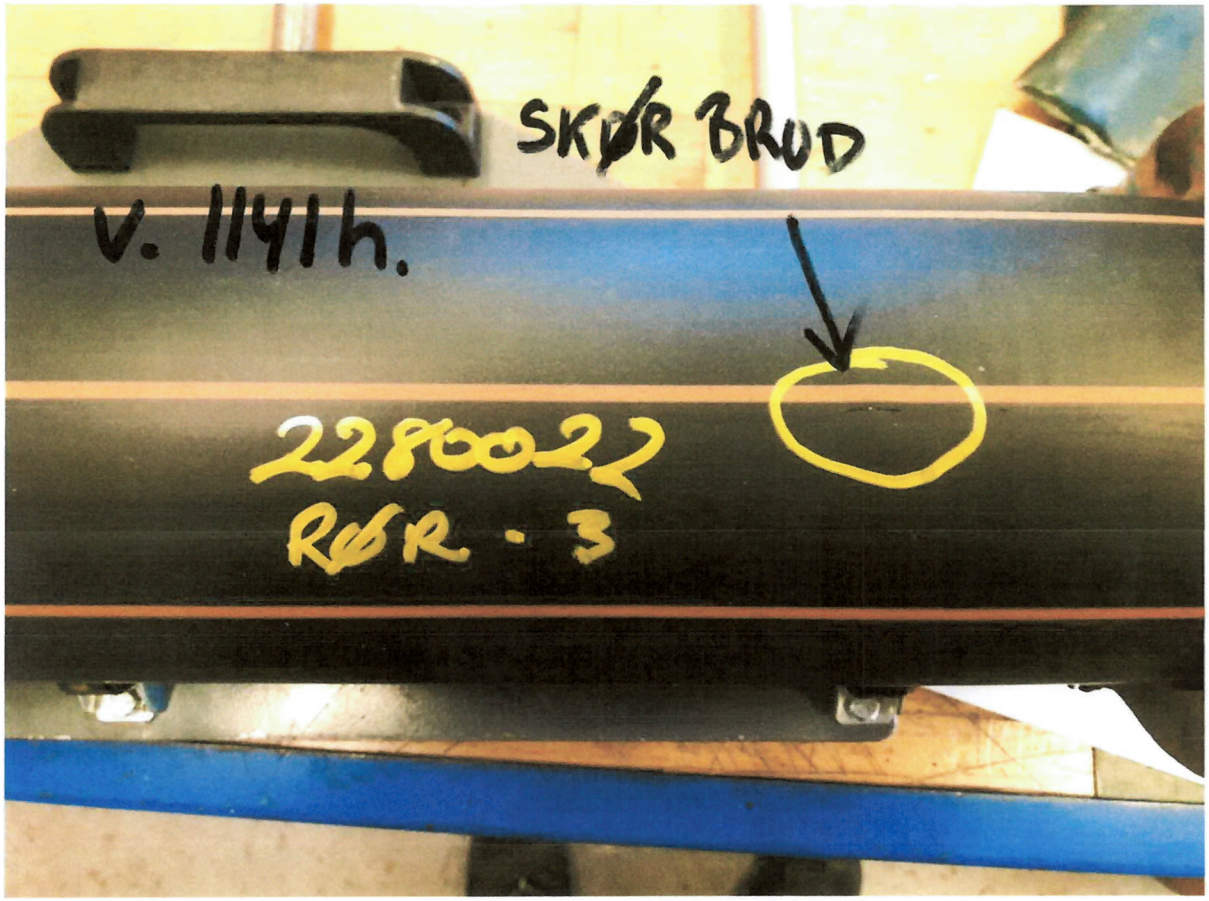
Uponor Infra A/S

This Test Report has been created electronically and is valid without signatures.

MANAGEMENT SYSTEM CERTIFICATION
DNV·GL
ISO 9001 = ISO 14001
ISO 50001

Uponor Infra A/S
Pipefactory
Lollandsvej 35
DK-5500 Middelfart
T +45 64 41 22 02
F +45 46 40 53 51
W www.uponor.dk
CVR-nr. 35383107
Bank: Danske Bank A/S

Bilag 6E: Uponor – Sprødt brud PE-trykrør



wavin orbia

Testrapport – Kvalitetssikringsafdelingen (QA)

Emne:	Ø200 mm PP afløbsrør SN8 med 10% genanvendt materiale
Dato:	2021-11-10
Udarbejdet af:	MIWA
Rekvirent:	LJB

Table 1

7.2, tables 5 in DS EN13476-2 and INSTA SBC 13476 - Dimensions

Item id. 1

Sample No. 1		**A1**	**A2**	**A3**	**Requirement**	**B1**	**B2**	**B3**	**Requirement**
Outside diameter	d_{em}	200.5			min. 200.0 max. 200.5				
Wall thickness pipes and fittings	$e_{4,min.\ inner-layer}$	0.92			min. 1.0				
	$e_{min.\ outer-layer}$	0.80			min. 0.6				
	e_c	7.46 7.81			min. 6.9 max. 7.8				
Requirements met	**Yes**								
	No	X							

Test conditions
Test method: EN ISO 3126:2005
Test temperature: 22°C
Test equipment: DINOCAM – 1603 – 1133

Table 2

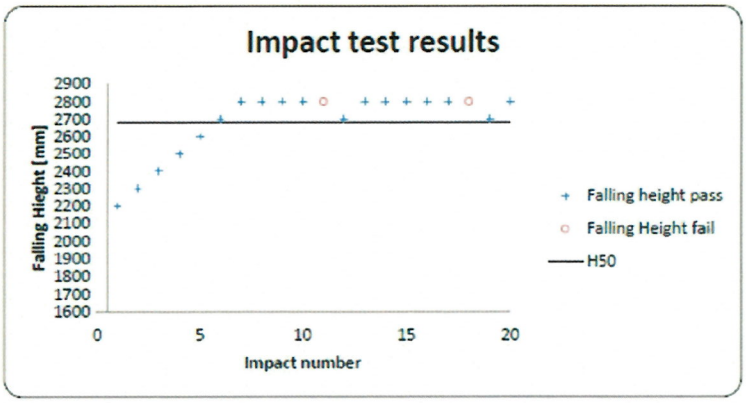
Annex H - Impact resistance, staircase method

Impact resistance. Staircase method EN ISO 11173:2017

Pipe ID	ID 1 (22 PP 200X6,9 SN8 UD)	Manufacturer:	Wavin SE
Referring standard	13476-2	Date of test:	08-11-2021
Falling weight	10,00 kg	Operator:	MIWA
Striker type	D90		
Test temperature	-10 °C		
Conditioning	1 h		

Number of impacts, preliminary test	10		
Number of impacts, main test	20	Number of passes, main test	18
Sum of fall heights, main test	53700 mm	Number of failures, main test	2

	Result	Requierements		Requirement met?
H50 mm	2685 mm	min.	1000	YES
Number of failures below 500 mm	0	max.	1	YES
		Are both requirements met?		YES



Special failure criteria observed:
None

Any factors or incidents observed, that may have affected the results:
None

ID1. Sample number 1-4 was cut into 30pieces of 200mm.
Test conditions
Test method: EN ISO 11173:2017
Number of test samples for preliminary test: 10
Test equipment: 100061 – 4471003 – 1912,4

OBS. Der er valgt et lod på 10,0 kg, for at opnå brud under test, hvor der efter standarden, skal bruges et lod på 8,0 kg.

Table 3

8.1.1, table 8 – Longitudinal reversion

Item Id.	Sample No.	Test temperature °C	Test duration min.	Reversion mm	Reversion %	Appearance after test OK	Appearance after test Not OK
1	4	150	60	0.31	0.31	X	
1	4	150	60	0.37	0.31	X	
1	4	150	60	0.39	0.31	X	

ID1. Sample number 4 were cut into 3pieces of 200mm.
Requirements
Reversion ≤ 5%
The pipes shall show no delamination, cracks, or bubbles.

Test conditions
Test method: EN ISO 2505:2006, method B
Conditioning time: 2 h
Conditioning temperature: 22°C
Conditioning medium: Air
Test equipment: 1599 – 100066 – 1922

Table 4

9.1, table 14 - Ring stiffness

Item Id.	Sample No.	Position °	Deflection mm	Deflection %	Load N	Result kN/m²	Ring stiffness kN/m²	Requirement	Requirement met Yes	Requirement met No
1	1	0	5.553	3	806.7	9.370	9.359	≥8	X	
1	1	120	5.553	3	811.7	9.428				
1	1	240	5.553	3	801.7	9.281				

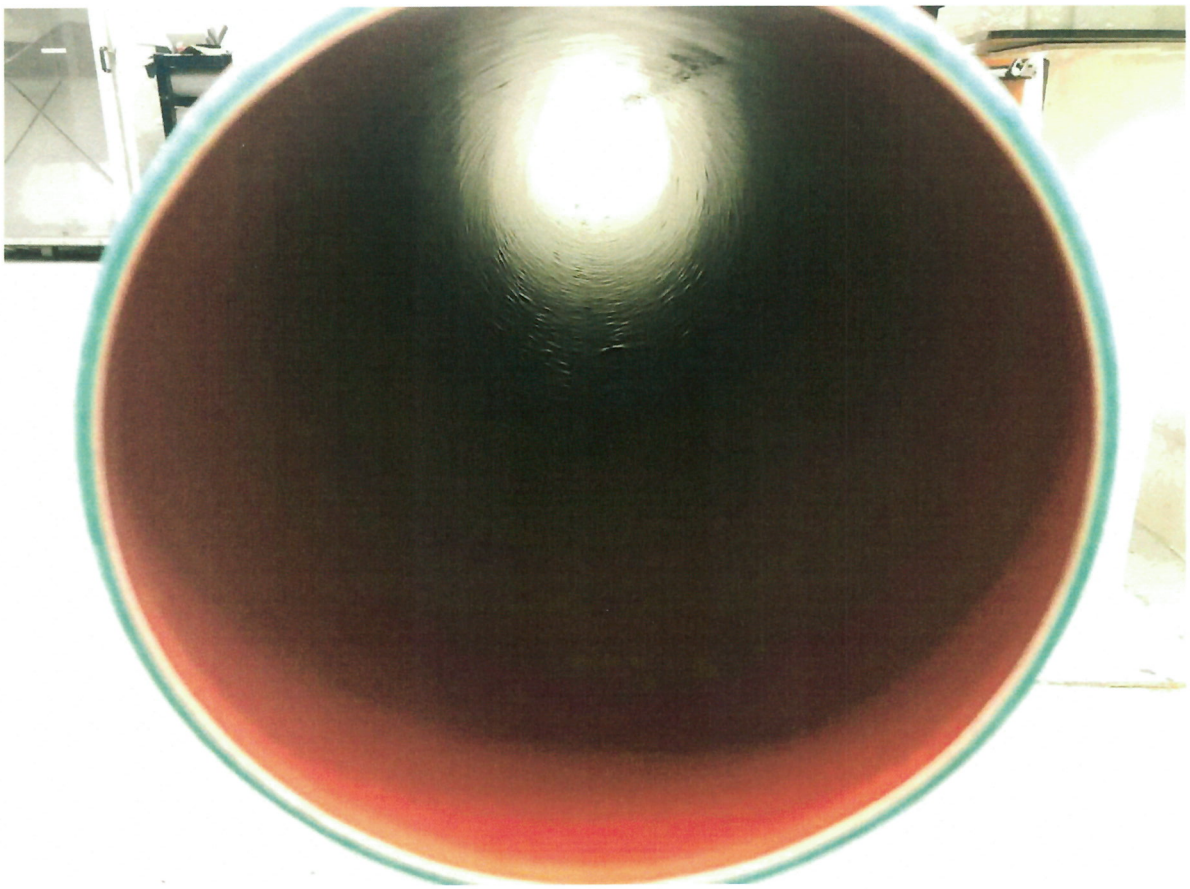
ID1. Sample number 1 was cut into 3pieces of 300mm.
Test conditions
Test method: EN ISO 9969:2016
Test temperature: 22°C
Test equipment: H50KTW-0032 – 2961,7 – 1603 – 4620 – 2933,1

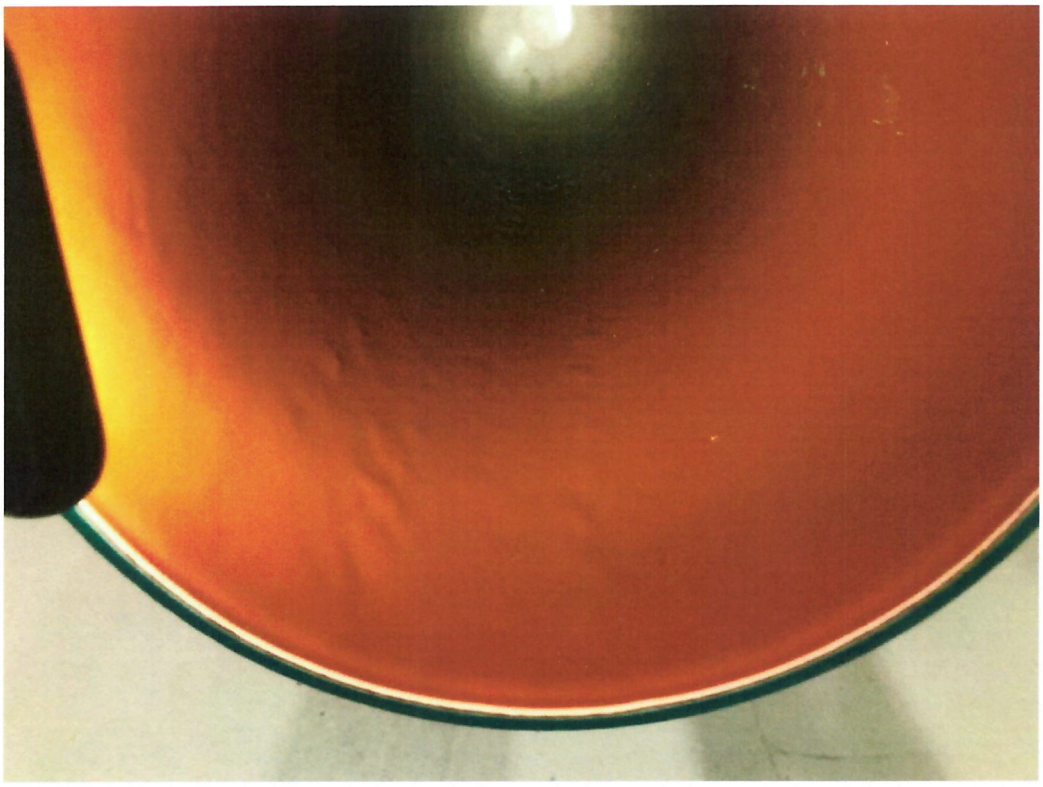
Table 5						
4.1 - Material						
Rodding tee						
Characteristics	**Unit**	**Raw material**	**From sample**	**Requirement**	**Requirement met**	
					Yes	**No**
Thermal stability	min		23	>8	X	
Test conditions, thermal stability Test method: EN ISO 11357-6:2018 Test equipment: METTLER TOLEDO – 47.125.02 – 110057						

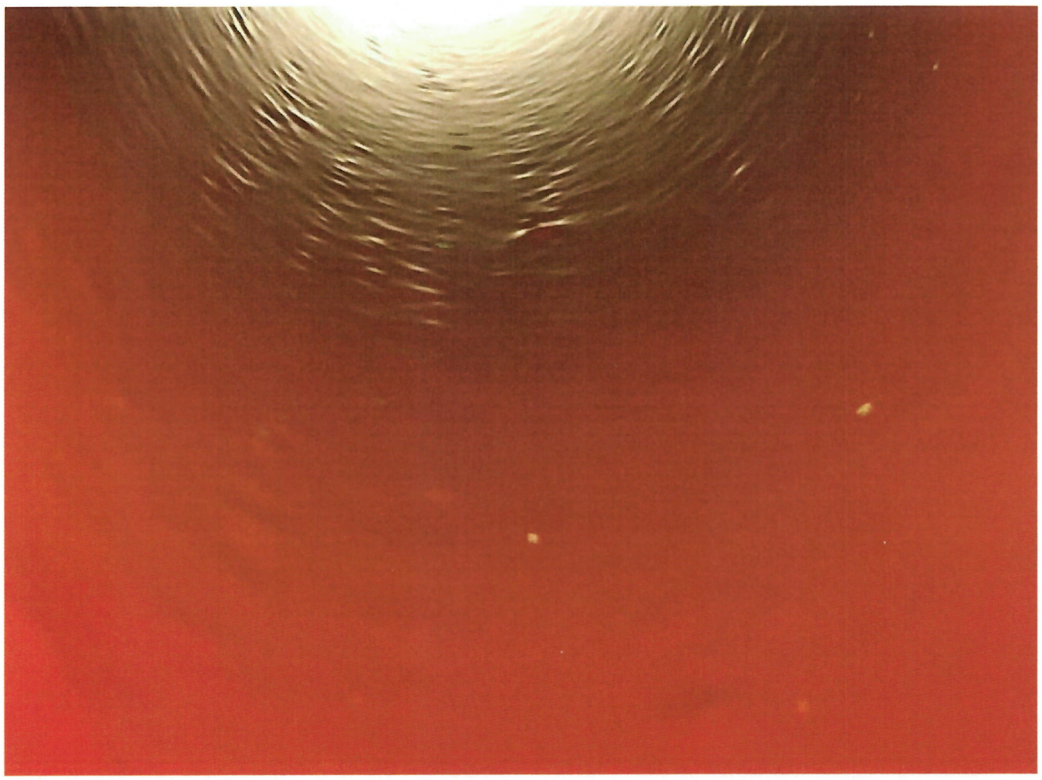
Konklusion:

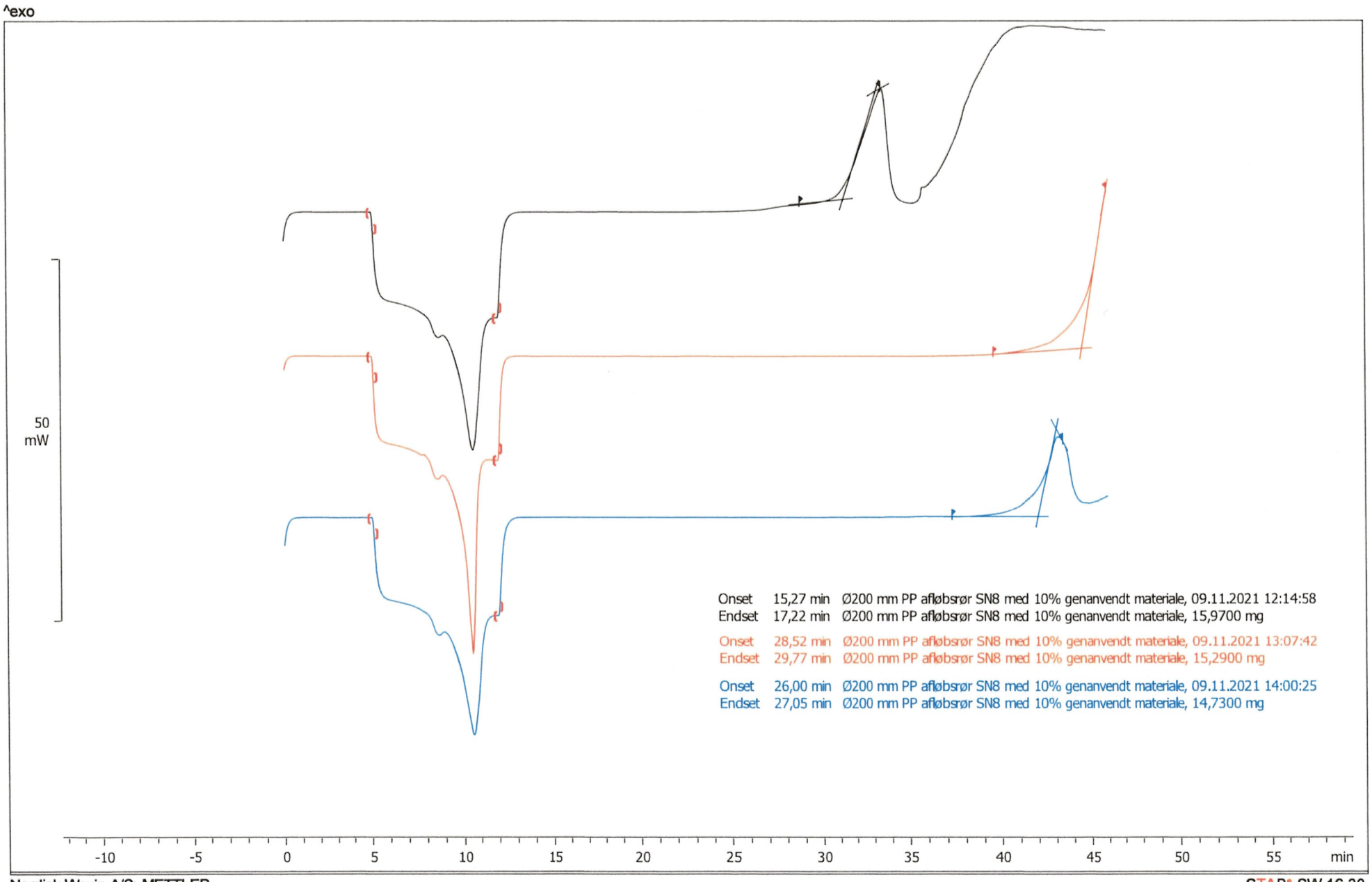
Godstykkelsen på inderlaget af røret, er under minimumskravet på 1.0 mm (0.92 mm), og godstykkelsen overstiger maksimumkravet med 0.01 mm.

Yderligere skal det nævnes, at overfladen på indersiden af røret er ujævn i forhold til den normale kvalitet hos Wavin.








^exo
50
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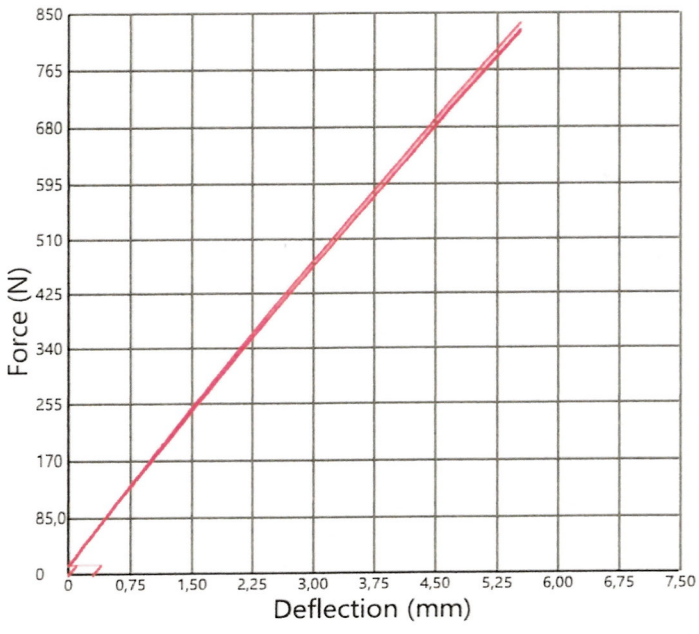
min
Onset 15,27 min Ø200 mm PP afløbsrør SN8 med 10% genanvendt materiale, 09.11.2021 12:14:58
Endset 17,22 min Ø200 mm PP afløbsrør SN8 med 10% genanvendt materiale, 15,9700 mg
Onset 28,52 min Ø200 mm PP afløbsrør SN8 med 10% genanvendt materiale, 09.11.2021 13:07:42
Endset 29,77 min Ø200 mm PP afløbsrør SN8 med 10% genanvendt materiale, 15,2900 mg
Onset 26,00 min Ø200 mm PP afløbsrør SN8 med 10% genanvendt materiale, 09.11.2021 14:00:25
Endset 27,05 min Ø200 mm PP afløbsrør SN8 med 10% genanvendt materiale, 14,7300 mg
Nordisk Wavin A/S: METTLER
STAR® SW 16.30

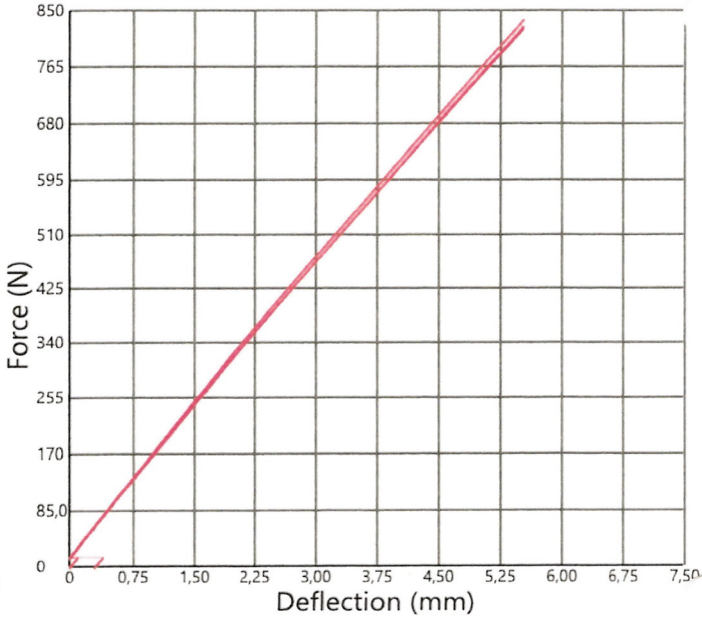
wavin orbia

Determination of Ring Stiffness - DS/EN/ISO 9969

Varetekst:	Ø200 mm PP SN8 UD med 10 % genanvendt materiale	Vægt:	4,27
Vare Nr.:	-	Måleværktøj:	2961,7 - 1603 - 4620 - 2933,1
Farve:	Rød	Rørets alder:	23
Dato:	10-11-2021 08:01	Contact Load:	13,9 N
Operator:	MIWA	Contact Speed:	5,00 mm/min
Temperature [C]:	22,3	Test Speed:	5,00 mm/min
Materiale:	PP	Deflection Limit:	5,55 mm
SN Klasse:	8		

Direction	Inside mm	Length mm	Force at 3% Strain N	Pipe Deflection at 3% mm	Pipe Ring Stiffness at 3% kN/m²	Ultimate Force N
0 - Degrees	185,1	300,0	806,7	5,553	9,370	825
120 - Degrees	185,1	300,0	811,7	5,553	9,428	835
240 - Degrees	185,1	301,0	801,7	5,553	9,281	822
Average			806,7	5,553	9,359	





Testrapport – Kvalitetssikringsafdelingen (QA)

Emne: Ø200 mm PP afløbsrør SN8 med genanvendt materiale i kernelaget

Dato: 2022-04-13

Udarbejdet af: ANPE

Rekvirent: LJB

Test methods and requirements in accordance with: **EN 1852-1:2018** **INSTA-CERT SBC EN 1852-1 May 2018**		**Test site**	**Table No.**	**Requirements met**	
				Yes	**No**
Description and identification of the tested samples		Nordisk Wavin	Table 1		
5.4, table 1	Resistance to internal pressure	Nordisk Wavin	Table 2	X	
5.5	Thermal stability	Nordisk Wavin	Table 3	X	
7.3 & 7.4 tables 2, 3, 5, 6 & 7	Dimensions, fittings	Nordisk Wavin	Table 4	X	
8.1.1, table 8	Ring stiffness	Nordisk Wavin	Table 5	X	
9.1, table 11	Longitudinal reversion	Nordisk Wavin	Table 7	X	
12.2 table 15	Marking of pipes	Nordisk Wavin	Table 8	X	

Table 1			
Description and identification of the tested samples			
Photo	**Type of fitting**	**Type of connection**	**Nominal diameter**
	Pipe	Ring seal joint	200

Table 1

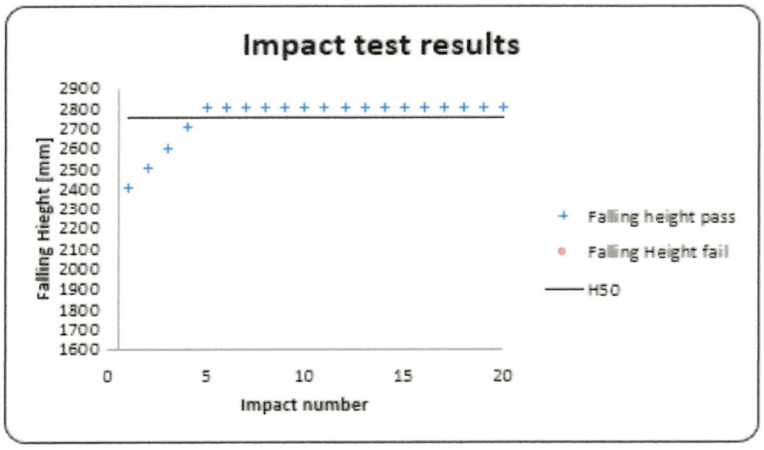
Annex H - Impact resistance, staircase method

Impact resistance. Staircase method EN ISO 11173:2017

Pipe ID	200 PP genanvendt materiale		Manufacturer:	Wavin Sweden
Referring standard	13476-2		Date of test:	12-04-2022
Falling weight	8,00	kg	Operator:	ANPE
Striker type	D90			
Test temperature	-10	°C		
Conditioning	1h			

Number of impacts, preliminary test	10			
Number of impacts, main test	20		Number of passes, main test	20
Sum of fall heights, main test	55000	mm	Number of failures, main test	0

	Result		Requierements		Requirement met?
H50 mm	**2750**	**mm**	min.	1000	**YES**
Number of failures below 500 mm	**0**		max	1	**YES**
			Are both requirements met?		**YES**



Special failure criteria observed:

None

Any factors or incidents observed, that may have affected the results:

None

Test conditions
Test method: EN ISO 11173:2017
Number of test samples for preliminary test: 10
Test equipment: 100061 – 4471003 – 1911,4

Table 2

8.1.1, table 8 – Longitudinal reversion

Test temperature °C	Test duration min.	Reversion mm	Reversion %	Appearance after test OK	Appearance after test Not OK
150	60	0.54	0.54	X	
150	60	0.55	0.55	X	
150	60	0.40	0.40	X	

Requirements
Reversion ≤ 5%
The pipes shall show no delamination, cracks, or bubbles.

Test conditions
Test method: EN ISO 2505:2006, method B
Conditioning time: 2 h
Conditioning temperature: 22°C
Conditioning medium: Air
Test equipment: 1599 – 100066 – 1922

Table 3

9.1, table 14 - Ring stiffness

Position °	Deflection mm	Deflection %	Load N	Result kN/m²	Ring stiffness kN/m²	Requirement	Requirement met Yes	Requirement met No
0	5,532	3	658,3	7,659	7,772	≥8	X	
120	5,532	3	696,7	8,132				
240	5,532	3	646,7	7,523				

Test conditions
Test method: EN ISO 9969:2016
Test temperature: 22°C
Test equipment: H50KTW-0032 – 1603 – 1413

Table 2						
5.5 - Thermal stability						
Material	**Sample No.**	**Mass of sample mg**	**Test temperature °C**	**OIT measured minutes**	**Requirements met**	
					Yes	**No**
PP fra Aage Vestergård Larsen (kernelaget)	1	15.17	200		X	
	2	16.72	200		X	
	3	16.71	200		X	
Test conditions Test method: EN ISO 11357-6:2018 Sampling carried out from: Requirement: OIT ≥8 minutes Test equipment: Mettler Toledo DSC 820 - 110057						

Konklusion:

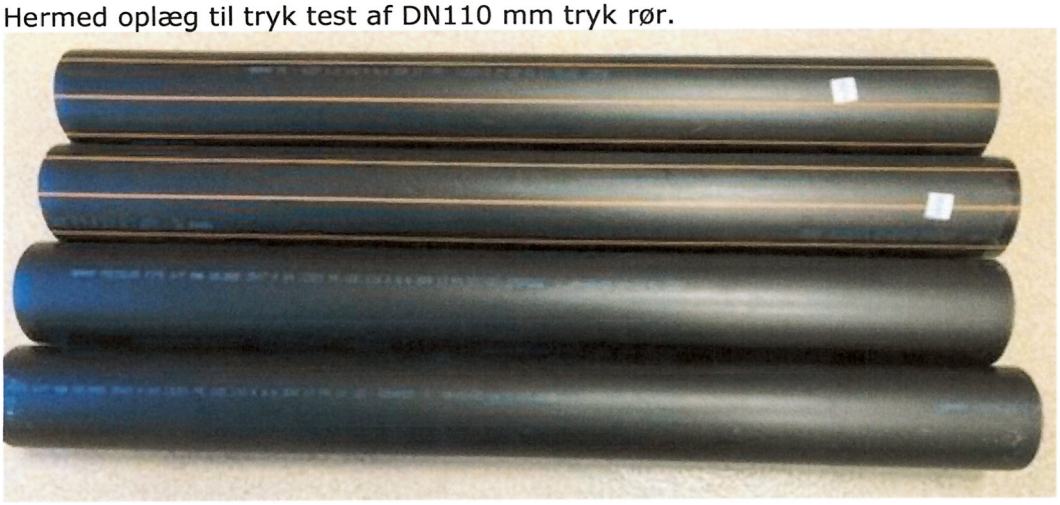
Indre skindlag overholder ikke godstykkelsen på min. 1,0mm. Ydre diameter er 0,1mm for stor.

Den manglende godstykkelse på det indre skindlag kan have indvirkning på stivheden, som er i gennemsnit 7,8 kN/m2, hvilket ikke overholder kravet på 8 kN/m2.

Bilag 8: Revnetest for Uponor-trykrør (PE)

For at undersøge en mulig langsom revneudvikling for Uponor-trykrør Ø 110 mm gennemføres maj 2022 – maj 2023 den efterfølgende beskrevne test på Teknologisk Institut.

Hermed oplæg til tryk test af DN110 mm tryk rør.



Rør 1: Referencerør, PE100 materiale, dimension 110x6,6 mm SDR17

Rør 2: 30% fiskegarn + 70% PE100 materiale, dimension 110x6,6 mm SDR17

Standard: EN ISO 15494:2018 Plastrørssystemer til industriel anvendelse, polyethylen (PE– Metrisk serie til specifikation af rørledningsdele og rørledningssystemet)

Formål: At teste styrken og evt. revnedannelse for rør 1 og 2 med PE100 styrkekravene (hoop stress) i EN ISO 15494

De 2 rørtyper tryk testes i 1 år, med 80°C vand, Hoop stress (MPa) tages fra PE100 referencekurve i EN ISO 15494

Test parametre: 4,8 MPa, 80°C, 8760 h (Der benyttes en trykstation til hver rør type)