



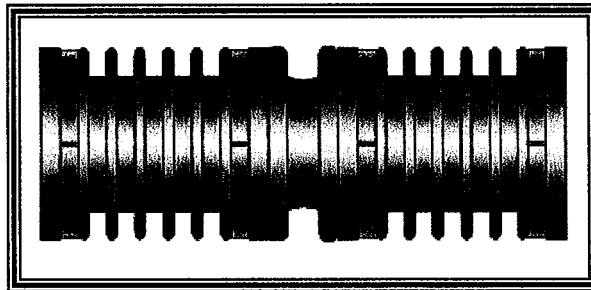
Technical Data Package

R. W. Lyall & Company, Inc.

LYCOFIT[®]

PE Mechanical Fittings

Polyamide 11 & Polyamide 12



Registered Patents in the U.S. and in many other countries.

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**Technical Data Package
LYCOFIT® Mechanical Fitting**

June, 2011
LIT-LCTDP-1D

MANUAL DEFINITION:

This Technical Data Package outlines and summarizes testing performed on the LYCOFIT® coupling and Mechanical Tapping Tee¹ products. Design Qualification testing was performed on product manufactured from Rilsan® Polyamide 11, a homopolymer resin by ARKEMA (previously known as Atofina Chemicals/Elf Atochem). The validation testing of PA12 material was performed on product manufactured by UBE as Ubesta 3035 LU1. The attached data describes the material properties for both PA11 (PA32312) & PA12 (PA42316). Test results are summarized for design qualification and supplemental testing data from parts molded from RILSAN® PA11 (PA32312) and validation testing of product molded from Ubesta 3035 LU1 PA12 (PA42316).

All test data included in this technical Data Package has been compiled from testing performed by the R.W. Lyall & Company Laboratory unless otherwise noted. All of the required testing has been completed and summarized according to the requirement and test type. The location of testing and or supplier of data are noted in each section.



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1.0 Requirements for the Categorization of Mechanical Fittings as described in ASTM D2513-99, Category 1, and requirements from the Code of Federal Regulations Title 49 Part 192.281 and 192.283 are tested by the following test methods:


- Tensile Strength test ASTM D638-86
- Hydrostatic Quick Burst ASTM D1599-88
- Sustained Pressure test ASTM D1598-86

1.1 The quantities listed in the matrix below represent the number of joints tested. All of the joints tested meet or exceed the requirements of ASTM D2513-99 Category 1, and Code of Federal Regulations Title 49 Part 192.281 and 192.283.

Coupling Size & Type	Pullout Resistance * ASTM D638		Hydrostatic Quick Burst** ASTM D1599		Sustained Pressure*** ASTM D1598	
	PE Pipe Material		PE Pipe Material		PE Pipe Material	
	PE -2406	PE -3408	PE-2406	PE-3408	PE-2406	PE-3408
½" CTS .090 Coupling	6	6	6	6	6	6
½" IPS SDR 9.3 Coupling	6	6	6	6	6	6
¾" CTS .090 Coupling	6	6	6	6	6	6
¾" IPS SDR 11 Coupling	6	6	6	6	6	6
1" CTS .099 -.102 Coupling	6	6	6	6	6	6
1" IPS SDR 11 Coupling	6	6	6	6	6	6
1 ¼" CTS .090 Coupling	6	6	6	6	6	6
½" +3/4" CTS, ½" IPS 3 Way Tee	6	6	6	6	6	6
¾" +1IPS 1" + 1 ¼" CTS 3 Way Tee	6	6	6	6	6	6
½" CTS .090 Stub End	6	6	6	6	6	6
1" CTS .099-.102 Stub End	6	6	6	6	6	6
¾" IPS X 1/2" CTS	6	6	6	6	6	6
¾" IPS X ½" IPS	6	6	6	6	6	6
1" IPS X ½" CTS	6	6	6	6	6	6
1" IPS X ¾" IPS	6	6	6	6	6	6
1" CTS .099 X ½" CTS	6	6	6	6	6	6
1 ¼" X ½" CTS .090 Tapping Tees	6	6	6	6	6	6
1 ¼" X ½" CTS .090 Tapping Tees	6	6	6	6	6	6
1 ¼" X 1" CTS .099 -.102 Tapping Tee	6	6	6	6	6	6
2" X ½" CTS .090 Tapping Tee	6	6	6	6	6	6
2" X 1" CTS .099 -.102 Tapping Tee	6	6	6	6	6	6

The above testing was performed by the R.W. Lyall & Company Laboratory on parts molded of PA11.

- * Pullout resistance testing was performed at 0.2" per minute rate of pull, at minimum yield of 30% pipe elongation.
- ** Hydrostatic Quick burst testing was performed with ductile failures always in the pipe between 60-70 seconds.
- *** Sustained Pressure test was performed at 73° F for 1000 hours.

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2.0 Supplemental Test Data for Elevated Temperature Stress Rupture ASTM D1598 at 60° C, 80° C and 90° C

This non-mandatory test data is used to further evaluate long-term performance of the Lycofit fitting design

The "X" designates number of hours on test to date, and the numbers represent quantities of joints on test. Many of these parts remain on test unless there has been a failure in the pipe. In all testing performed to date, no brittle failures have occurred in the Lycofit coupling, nor has failure occurred due to leakage.

Lycofit Rilsan 11																		
Summary of Stress Rupture Test Data																		
Couplings Size and Type	60C Stress Rupture Test Summary*						80 C Stress Rupture Test Summary**						90C Stress Rupture Test Summary***					
	Hours on Test						Hours on Test						Hours on Test					
	Under 640	640 to 999	1000 to 1999	2000 to 3999	4000 to 5999	Over 6000	Under 640	640 to 999	1000 to 1999	2000 to 3999	4000 to 5999	Over 6000	Under 640	640 to 999	1000 to 1999	2000 to 3999	4000 to 5999	Over 6000
PE 2406		PE 3408		PE 2406		PE 3408		PE 2406		PE 3408		PE 2406		PE 3408		PE 3408		
1/2" CTS .080 Coupling			X			6			X					X				4
1/2" CTS .090 Coupling				X			6								X			6
1/2" CTS .090 Coupling																		2
1/2" IPS SDR 9.3 Coupling			X			6			X						X			6
3/4" CTS .090 Coupling							6			X					X			6
1" CTS .090 Coupling			X			6				X					X			6
1" CTS .090 Coupling			X			4	6											4
1" CTS .099 102 Coupling									X							X		6
1" CTS .099 102 Coupling				X		6				X					X			6
1" IPS SDR 11 Coupling			X			2	2			X					X			8
1" IPS SDR 11 Coupling			X			6				X					X			6
1 1/4" CTS .090 Coupling				X					X						X			4
1 1/4" CTS .090 Coupling			X			6			X						X			24
1/2" CTS .090 Stub End						2	2			X						X		6
1" CTS .099-.102 Stub End																X		2
1/2" CTS .090 X 1" CTS .099-.102 Reducer											X							
1 1/4" X 1/2" CTS .090 Tapping Tee										X								
1 1/4" X 1/2" CTS .090 Tapping Tee										X								
1 1/4" X 1/2" CTS .099-.102 Tapping Tee									X									
1 1/4" X 1/2" CTS .099-.102 Tapping Tee										X								
1 1/4" X 1" CTS .099-.102 Tapping Tee										X								
1 1/4" X 1" CTS .099-.102 Tapping Tee										X								
2" X 1/2" CTS .090 Tapping Tee				X			6			X							X	6
2" X 1/2" CTS .090 Tapping Tee										X								
2" X 1" CTS .099-.102 Tapping Tee										X								6
2" X 1" CTS .099-.102 Tapping Tee										X								

The above testing was performed by the R.W. Lyall and Company Laboratory on parts molded of PA11.

- * Tested in water with internal pressures equivalent to a hoop stress in the PE pipe of 950 psi.
- ** Tested in water with internal pressure equivalent to a hoop stress in the PE pipe of 700 psi.
- *** Tested in water with internal pressure equivalent to a hoop stress in the PE pipe of 580 psi.



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3.0 Supplemental Mechanical Joint Testing

Thermal Cycle Test
Constant Tensile Load joints tested.

The number represents the quantity of joints tested.

Thermal Cycle testing consists of samples subjected to -20°F for 10 hours, 73° for 10 hours, 140°F for 10 hours. This constitutes one cycle, and is repeated for 10 complete cycles.

Constant Tensile Load Joint Test consists of samples subjected to an axial load that produces a minimum total axial stress of 1320 PSI on the Polyethylene pipe. The internal pressure is 60 psi, total test duration is 1000 hours minimum.

In all test performed no pullout or leakage of the joint occurred.

Coupling Size & Type	Thermal Cycle		Constant Tensile Load Joint Test	
	PE Pipe Material		PE Pipe Material	
	PE -2406	PE -3408	PE -2406	PE-3408
½" CTS .090 Coupling		12	6	6
½" IPS SDR 9.3 Coupling	12	6		
¾" CTS .090 Coupling		12		
¾" IPS SDR 11 Coupling	12	6		
1" CTS .090 Coupling	12	6	6	6
1" CTS .099 -102 Coupling		12	6	6
1" IPS SDR 11 Coupling	16	10		
1 ¼" CTS .090 Coupling	6	6		

The above testing was performed by the R.W. Lyall & Company Laboratory on parts molded of PA11.

3.1 PA12 (PA42316) Validation Testing

Stress Rupture Testing (ASTM D1598):

Test # 2007003 – 4 IPS Tapping Tee, 1 CTS Spin Weld Spigot & Completion Sleeve (CS), 1 CTS Stub End Cap & CS

80°C, 570 psi hoop stress, 1000 hrs

Results: Pass

Test # 2007004 – 1 CTS Spin Weld Coupling, 1 CTS Stub End Cap & CS, 1 CTS X ½ CTS Reducing Coupling

80°C, 570 psi hoop stress, 1000 hrs

Results: Pass

Thermal Cycle Testing

Test # 2007006 – 4 IPS Tapping Tee, 1 CTS Spigot & CS, 1 CTS Stub End Cap & CS

ASTM F1924 Section 6.2.3 revised to 10 cycles between -20°F & 176°F.

Results: Pass

Test # 2007007 – 1 CTS Spin Weld Coupling, 1 CTS Stub End Cap & CS, 1 CTS X ½ CTS Reducing Coupling

ASTM F1924 Section 6.2.3 revised to 10 cycles between -20°F & 176°F.

Results: Pass

Constant Tensile Load Joint Test (ASTM F1588)

Test # 2007005 – 1 CTS Spin Weld Coupling

ASTM F1924 Section 6.2.4 – Axial Tensile stress of 1320 psi under internal pressure > 4 psig for ≥1000 hours.

Results: Pass - 1872 hours and taken off test with no failures.

Tensile Test

Test # 2006081 – 1 CTS Spin Weld Coupling

ASTM F1924 Section 6.2.2 – Axial Elongation at > 25% without pull out of the joint.

Results: Pass

Supplemental Testing

-20°F Crush Test

Test# 2010014 – 6 IPS Tapping Tee Top, 2 IPS Tapping Tee Top, 2 IPS CS

Crush at a rate of < 1"/minute until inner wall is coincident without brittle failure

Test for Ductile Behavior of As Converted Component

Results: 0% failure



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4.0 Material Properties

4.1 PA12 (PA42316) / PA11 (PA32312) Natural Gas Grade

	UBESTA 3035 UF	PA 11
Melting point, F	351	361-369
Density, g/ml	1.02	1.03
Moisture absorption, %	1.5	1.9
Tensile stress @ yield, psi	6607	5800
Elongation @ yield, %	10	10
Tensile strength, psi	7776	7542
Elongation, %	254	300
Hoop stress, psi	6896	7500
Flexural modulus, psi	231,000	145,000
HDT @ 66 psi, F	293	293
Long term hydrostatic stress, psi		
τ73 F	3150	2500
τ140 F	2000	1600
τ180 F	1600	1250

PA11 data provided by Elf Atochem (ARKEMA) technical data sheet and testing at Nicor Technologies;
PA12 data provided by UBE from testing at GTI from one lot of material.

Material Requirements as per ASTM D 2513-09 and F2785-09

Property	D2513 REQ'D	PA32312 REPORTED	F2785 REQ'D	PA42316 REPORTED
Melt point °C	185-195	187	170-195	178
Specific gravity	1.03-1.06	1.03	1.00-1.06	1.02
Tensile strength, min PSI	6961	7542	5076	7832
Elongation, min	200%	300%	150%	254%
Flex modulus, min PSI	130,536	145,000	145,040	210,018
Izod impact resistance, min J/M	55	64-99	25	40-78
HDT, min °C	40	47	35	50



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Tensile Properties of PA11 and PA12

	PA11 (PA32312)	PA12 (PA42316)
Tensile stress@ yield, PSI ASTM D638	5657	6672
Elongation@ yield ASTM D638	14%	10%
Tensile strength, PSI ASTM D638	6237	7832
Elongation@ break ASTM D638	240%	254%
Apparent tensile stress@ yield, PSI ASTM D2290	7397	6972
Hoop stress, PSI	7542	6817

Tensile testing performed at GTI on polyamide 11 & 12 are presented in the tables above as reported by UBE Industries, Ltd. These results may vary from other reported values because of variations in material grades, lots and testing labs.



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5.0 Chemical Resistance and Exposure Data

A= Good - material is unaffected

B= Limited- The extent of attack depends on conditions and can range from swelling to dissolving

Chemical Resistance	
Chemical	Affect on PA11 – PA12
Acetic Acid 10%	A
Acetic Acid 50%	B
Acetone	A
Butane	A
Butyl Alcohol	A
Ethanol	A
Ethylene Glycol	A
Fatty Acid Esters	A
Gas (Coal)	A
Gasoline	A
Glycol	A
Hydrochloric Acid 10%	A
Hydrochloric Acid 20%	B
Isopropyl Alcohol	A
Methane	A
Methanol	A
Methyl Acetate	A
Methyl Ethyl Ketone	A
Methyl Isobutyl Ketone	A
Propane	A
Soap Solution	A
Sodium Chloride	A
Toluene	A
Urea	A
Water	A
Water (Sea)	A



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Chemical Resistance and Exposure Data Continued...

5.1 RILSAN® PA11

The following exposure data was generated with assembled Lycofit Couplings fully immersed in the listed chemical or reagent.

Lycofit Rilsan Coupling Exposure		
Chemical or Reagent	Exposure Time (hours)	Results
Lye	4000	Unaffected
Bleach	4000	Unaffected
Sulfuric Acid 100%	3000	Material Degraded
Ph 4.01 Buffer	3300	Unaffected
Ph 7.0 Buffer	3300	Unaffected
Ph 10.0 Buffer	3300	Unaffected
Portland Cement & H2O	768	Unaffected
Portland & Sand Wet 5:1	672	Unaffected
Portland & Sand Wet 10:1	672	Unaffected
Portland & Sand Wet 20:1	672	Unaffected
Portland & Sand Wet 50:1	672	Unaffected
Permasoil & H2O	696	Unaffected
Permasoil & Sand Wet 5:1	696	Unaffected
Permasoil & Sand Wet 10:1	696	Unaffected
Permasoil & Sand Wet 20:1	696	Unaffected
Permasoil & Sand Wet 50:1	696	Unaffected

The above testing was performed by the R.W. Lyall and Company Laboratory.



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5.2 PA12 (PA42316)

Chemical	Requirement			Test Results		
	Wt. Change.	Yield Strength, Change	Relative Viscosity, Change	Wt. Change	Yield Strength, Change	Relative Viscosity, Change
Mineral Oil	+0.5%, max	-12%, max	±3%	0%	0%	<±3%
Tertiary-butyl Mercaptan (5%)	+0.5%, max	-12%, max	±3%	0%	-1%	<±3%
Methanol	+5%, max	-35%, max	±3%	+2.3%	-31%	<±3%
Ethylene Glycol	+0.5%, max	-12%, max	±3%	0%	-1%	<±3%
Toulene (15%)	+7%, max	-40%, max	±3%	+2.3%	-27%	<±3%

The Chemical Resistance Requirements of ASTM F2785-09 and results of testing performed at GTI and Jana Laboratories on polyamide 12 are presented in the tables above as reported by UBE Industries, Ltd.



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