SIPI-Benin

TENDER FOR

SUPPLY OF PE 100 MDPE PIPES AT COTONOU BENIN OF WEST AFRICA

TENDER NO. SIPI/REPL/002/PE

RESONANCE ENERGY PVT LTD

VOLUME II OF II

TECHNICAL VOLUME

INTERNATIONAL COMPETITIVE BIDDING

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Polyethylene pipes for underground networks for natural gas distribution General requirements

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1. SUBJECT AND AREA OF APPLICATION

This specification defines the requirements which must be met by polyethylene (PE)pipes used to construct underground networks for natural gas distribution.

This specification is based on draft standard EN 1555-2, which states the options and defines supplementary requirements arising from specific provisions on safety and historic constraints relating to our networks.

Testing of the pipes is carried out in accordance with the procedures described in document 056-03 "Polyethylene pipes for underground networks for natural gas distribution - Quality control of pipes".

2. REFERENCE STANDARDS AND SPECIFICATIONS

ISO 760: 1978	Determination of water - Karl Fisher method (General method)
ISO 4437: 1997	Buried polyethylene (PE) pipes for the supply of gaseous fuels-Metric Series- Specifications
ISO 6259-3: 1997	Thermoplastics pipes - Determination of tensile properties-Part3: Polyolefin pipes
ISO 3126: 1974	Plastic pipes- Measurement of dimensions
ISO 1183: 1987	Plastics - Methods for determining the density and relativedensity of non-Cellular Plastics
ISO/DIS 1183-3	Plastics - Methods for determining the density of non- cellularplastics – Part 3: Gas pyknometer method
ISO 2505-1: 1994	Thermoplastics pipes - Longitudinal reversion - Part 1:Determination Methods
ISO 2505-2: 1994	Thermoplastics pipes - Longitudinal reversion - Part 2:Determination Parameter.
ISO 1167: 1996	Thermoplastics pipes for the conveyance of fluids- Resistance tointernal Pressure- Test method
EN 728:1997	Plastics piping and ducting systems - Polyolefin pipes and fittings – Determination of oxidation induction time.
EN 1056: 1996	Plastics piping and ducting systems - Plastics pipes and fillings -Method for exposure to direct (natural) weathering.
prEN 1555-1: 2001	Plastics piping systems for the supply of gaseous fuels-Polyethylene (PE)-Part 1: General.
prEN 1555-2: 2001	Plastics piping systems for the supply of gaseous fuels -Polyethylene (PE) – Part 2: Pipes.
EN ISO 12162: 1995	Thermoplastics materials for pipes and fittings for pressure applications-

	Classification and designation-Overall service (design) coefficient.
EN ISO 13479	Polyolefin pipes for the conveyance of fluids - Determination of resistance to crack propagation - Test method for slow crack growth on notched pipes (notch test).
ISO 4440-1: 1994	Thermoplastics pipes and fittings - Determination of melt mass-flow rate - Part 1: Test method.
ISO DIS 9080	Plastics piping and ducting systems - Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation.
ISO 13477: 1997	Thermoplastics pipes for the conveyance of fluids -Determination of resistance to rapid crack propagation (RCP) - Small-scale-steady-state test (S4 test).
IS 14885: 2001or ISO 4437	Polyethylene pipes for the supply of Gaseous Fuels-Specification.

3. DEFINITIONS

3.1. BATCH OF COMPOUND

By batch of compound is meant a homogeneous quantity of PE compound of the same origin and of a particular brand.

The batch must be registered under a single identification number (batch number) which leaves no doubt as to the origin, identity and date of manufacture of the compound.

3.2. BATCH OF PIPES

By batch of pipes is meant a homogenous lot of pipes with identical dimensions, made in a continuous process by the same extrusion machine and from the same batch of compound.

3.3. MINIMUM REQUIRED STRENGTH (MRS 10)

Standardized class of compounds for which the Lower Confidence Limit (LCL) is equal to10.

3.4. PE 100

Standard designation for PE compounds in class MRS 10.

For such PE compounds, the long-term hydrostatic strength – calculated and classifiedaccording to the standardized method (ISO 9080 and ISO 12162) for a temperature of20°C, a period of 50 years and a reliability of 97.5 % – must be at least 10 MPa.

3.5 LOWER CONFIDENCE LIMIT (LCL)

A quantity with the dimensions of stress, in Mega Pascal, which can be considered as a property of the

material under consideration and represents the 97.5% lower confidence limit of the predicted long-term hydrostatic strength at a temperature of 20°C for 50 years with internal water pressure.

3.6 Standard Dimensions Ratio (SDR)

SDR is the quotient of the nominal outside diameter and the nominal wall thickness(expressed rounded to one decimal)

SDR = de/en

de = nominal diameter of pipe

en= nominal thickness of pipe in mm

3.7 Overall Service (Design) Co-efficient (C)

C is an overall co-efficient with a value greater than 1 which takes into considerationservice condition as well as properties of the components of a piping system other thenthose represented in the lower confidence limit. For this specification the minimum of C is 2.0

3.8 Maximum Allowable Operating Pressure (MAOP)

The highest effective pressure of the gas in the pipeline system expressed in bar, which is allowed in continuous use. It takes into account the physical and the mechanical characteristics of the components of the piping system.'

It is given by the equation:

MAOP = (20 X MRS) /(C X (SDR – 1))

4. MATERIAL SPECIFICATION

The PE compounds that are acceptable shall conform to the requirements for PE 100 describedin EN l555-1. In order to be approved, materials shall conform with the technical specification as per clause no.2.

Approved materials are listed in Appendix 1.

Characteristics of PE Compound are given in Appendix 3.

Following are forbidden:

a. use of recycled materials;
b. mixture of different materials;
c. Addition of complementary materials by the pipe manufacturer.

5. CHARACTERISTICS

5.1. RAW MATERIAL

All the characteristics of the PE Compound are in accordance with the provisions of EN 1555-1 or IS 14855 OR ISO 4437 for PE 100 materials and for the limit values listed in the table in Appendix 3.

5.2. PIPES

5.2.1. Physical characteristics

5.2.1.1. Appearance of pipes

The appearance of the pipes is checked in accordance with 6.1.

The pipes must be square cut with smooth trimmed ends.

The internal and external surfaces of the pipes, examined visually without magnification,are uniform and smooth.

The pipes are free of scratches, pits, voids, blisters, occlusions or cracks.

5.2.1.2. Colour

The pipes shall be orange in accordance with the local requirements.

5.2.1.3. Density

Density is measured in accordance with the provisions of 6.2. The measured value must correspond to the data listed in the table in Appendix 3, allowing for possible differences caused by measuring on the pipe instead of granulate.

5.2.1.4. Melt mass-flow rate (MFR)

The melt mass-flow rate MFR (190°C - 5 kg), measured on a sample taken from the pipe in accordance with 6.3., is within the limits stated in the table in Appendix 3: characteristics of PE Compound.

In addition, the discrepancy in absolute value between the MFR measured on a pipe sample and that measured on a sample of raw material may not exceed 20% of the latter.

5.2.1.5. Volatile content

The volatile content, measured on a pipe sample in accordance with Clause 6.4., may not exceed 350 mg/kg.

5.2.1.6. Water content

The water content may be estimated by measuring the volatile content.

If the volatile content, measured in accordance with 6.4., is more than 250 mg/kg, the water content must be ascertained.

The water content, measured in accordance with 6.5., must be 250 mg/kg or less.

5.2.1.7. Thermal stability (OIT)

Thermal stability is measured in accordance with 6.6 on samples taken from the wall at random.

The minimum oxidation induction time at 210°C is 20 minutes. The maximum admissible decrease in the oxidation induction time measured on a pipe sample compared to that measured on the raw material, may not exceed 20% of the latter.

5.2.1.8. Resistance to atmospheric influence

Resistance to atmospheric influence is tested in accordance with 6.7.

The exposure dose corresponds to a total energy of at least 3.5 GJ/m2.

After testing, the pipe sample must meet the specifications laid down in 5.2.1.7 (thermal stability), 5.2.2.2 (resistance to internal hydraulic pressure) and 5.2.2.5 (stress at yield point and elongation to fracture). In the latter test, only elongation to fracture is taken into consideration.

5.2.2. Mechanical characteristics –

5.2.2.1. Internal stresses

Internal stresses are measured in accordance with 6.8. The variation in length between the reference points must be 3% or less.

5.2.2.2. Resistance to internal hydraulic pressure

The tests are carried out in accordance with 6.9. The test specimens taken from a batch of pipes show no leakage in the conditions of temperature, wall stress and test length stated in the tables in Appendix 4: resistance to internal hydraulic pressure.

If, for a given material, during the test at 80°C - 165 hrs. With the highest wall stress σ, fracture occurs before the specified time and is ductile in nature, the tests are repeated with a minimum time of 1,000 hrs. and the corresponding wall stress level as specified in Appendix 4.

5.2.2.3. Resistance to slow cracking (Notch test)

The test is carried out on pipes with a nominal diameter >= 90 using the test method stated at 6.10.

No fracture will occur on the samples for test periods of less than 500 hrs.

5.2.2.4. Resistance to growth of cleavage fractures

Pipes with a diameter >= 90 are tested in accordance with the test described at 6.11. The critical pressure at 0°C is at least 3 bar.

5.2.2.5. Stress at yield point and elongation to fracture

The test is carried out as described at Cl 6.12.

The minimum stress at the yield point is defined in the table “Characteristics of PECompound” (Appendix

3).

Elongation to fracture must be more than 350% for each test specimen.

5.2.3. Dimensional characteristics

The dimensions are measured in accordance with 6.13.

5.2.3.1. Series

The pipes should belong SDR -11 Table

DIA (mm)	SDR	Thickness (mm)
32	11	3
63	11	5.8
90	11	8.2
125	11	11.4
180	11	16.4

5.2.3.2. Length

The length of the pipes is specified in the order. The preferred lengths are defined in 8.2.

The tolerances for rolled pipes are: - 0 / + 0.50 m

5.2.3.3. Mean external diameter Dm

The extreme mean external diameters are stated in ISO 4437.

5.2.3.4. External diameter D – ovalisation

The maximum deviation permitted in relation to nominal diameter de is given ISO 4437. In the eventof dispute regarding the dimensions of rolled pipes, the dimensions shall be reviewed 24 hours after the pipe has been unrolled.

5.2.3.5. Thickness

The thicknesses are given in table A and have been taken from IS 14885 or ISO 4437

5.2.4. Reversion Test

When tested as per Clause 6.14, the value of longitudinal reversion shall not be greaterthan 3% (Specified in IS 14885 or ISO 4437).

5.2.5. Tensile Test

When tested in accordance with Cl. 6.15 at 23+/-10C at a speed of 100 mm/min +/- 10% for specimen thickness below 5 mm and at a speed of 25 mm/min for thickness above 5mm, the value obtained shall be as follows:

Tensile yield strength 15 MPa. MinElongation at Break 350 %, Min

5.2.6. Squeeze off

On all sizes of pipe up to and including 400 mm diameter, strength after squeeze-off and subsequent re - rounding, must be demonstrated by testing as per Cl. 6.16.

5.2.7. Pigment Dispersion

When tested as per Annex E of IS 14885 or ISO 4437 the grading should be <=3.

6. TEST METHODS

6.1 APPEARANCE

The pipes are presented on suitable work surfaces and examined visually.

A suitable artificial lighting system is used to examine their internal appearance.

6.2 DENSITY

The density is tested using the method described in ISO 1183, with the result expressed in kg/m3.

6.3 MELT MASS-FLOW RATE (MFR)

The melt mass-flow rate shall be ascertained in accordance with standard ISO 4440-1 orIS-14885.

6.4 DETERMINATION OF VOLATILE CONTENT

The volatile content is checked using the method described in ISO 4437/IS 14885.

6.5 DETERMINATION OF WATER CONTENT USING KARL FISCHER METHOD

The water content is measured using the Karl Fischer method described ISO 760.

6.6 THERMAL STABILITY (OIT)

The test is carried out in accordance with the minimum oxidation induction time (OIT) of the material from the product shall be >= 20 min when tested as per Annex. D of IS 14885.

6.7 RESISTANCE TO ATMOSPHERIC INFLUENCE

Resistance to atmospheric influence is tested in accordance with the specifications of standard EN 1056.

Artificial exposure is also acceptable, provided it can be proved that the test is equivalentto the natural exposure test.

6.8 INTERNAL STRESSES

Internal stresses are measured using the methods described in ISO 2505 Or Inversion testas per IS 14885.

Table B below states the time depending on the thickness of the pipe and the methodused.

Table B

Wall Thickness (mm)	Time in Minutes	
	Bath	Stove
e < 8	15	60
8<=e<16	30	120
16<=e	60	240

6.9 RESISTANCE TO INTERNAL HYDRAULIC PRESSURE

The test method is that described in ISO 1167.

The test pressure is calculated using the following formula, based on the nominaldiameters and thicknesses.

$$P = 10.\sigma (2.en)/ (de-en)$$

Where

σ = pipe wall stress in MPa de = nominal diameter of pipe

en= nominal thickness of pipe in mmp = test pressure in bar

In the event of dispute, the test pressure shall be calculated on the basis of the diametersand thicknesses measured.

The test specimens taken from a batch of pipes show no leakage in the conditions of temperature, wall stress and test length stated in the tables in Appendix 4: resistance to internal hydraulic pressure.

Fractures at 80°C must be of the cleavage type. The minimum fracture time is defined bythe straight line at 80°C connecting the points specified in the tables in Appendix 4.

If the pressure and/or temperature limits specified are exceeded, this is noted in thereport stating the reason and scale (times and limit values).

If during the minimum specified time the pressure and/or temperature have exceeded the upper limits

determined by the standard, the test is taken into consideration if the cracking time is higher than the specified minimum. Otherwise, the test must be repeated.

On the other hand, the test must be repeated if the pressure and/or temperature fallbelow the lower limits.

6.10 RESISTANCE TO SLOW CRACKING (NOTCH TEST)

The test is carried out in accordance with EN ISO 13479 at 80°C on a notched pipe witha wall stress of 4.6 MPa.

6.11 RESISTANCE TO GROWTH OF CLEAVAGE FRACTURES

Resistance to the growth of cracks is tested using test S4 described in standard ISO13477.

The test temperature is 0°C and the knife speed 20 m/sec.

6.12 STRESS AT YIELD POINT AND ELONGATION TO FRACTURE

The test is carried out in accordance with ISO 6259-3.

In the case of pipes with coextruded yellow lines, all test specimens must be taken suchthat the yellow marking axis coincides with the longitudinal axis of the test specimen.

For thicknesses of less than 12 mm, the test specimens shall be cut using a hollowpunch.

The traction speed is 100 mm/min.

6.13 DIMENSIONS

All dimensions, except for lengths, are measured at a temperature of 23 ➖} 2°C using the methods described in ISO 3126.

6.14 Reversion Test

Shall be tested in according to the procedure given in Annex. C of IS 14885 or ISO 4437

6.15 Tensile Test

Shall be tested according to the procedure given in Annexure J of IS 14885. Or ISO 4437

6.16 Squeeze off

Shall be tested in accordance with Annexure G of IS 14885 or ISO 4437

7. MARKING

The marking is repeated at least once per metre. This marking is done on two diametrically opposite generating lines. The empty space between two technical data is filled by alternate repetition of the word “GAS”.

Marking must be indelible and visible in colour.

The stamping must not affect the quality of the pipe.The minimum height of the characters must be:

• 3 mm for nominal diameters <= 63

• 5 mm for nominal diameters >= 110.

The depth of the marking must be <= 0.1 mm in the case of pipes with a nominaldiameter <= 110 and <= 0.2 mm in the case of pipes with larger diameters.
Manufacturer can go for Inkjet printing.

Marking of the pipes shall include, in the following order, on each generating line:

• the word “GAS”;

• the nominal diameter and the thickness of the wall;

• the SDR series;

• the date of manufacture (year, month, day);

• the work team in Roman numerals;

• the commercial name or code of the resin used (see Appendix 2);

• the code of the extrusion machine;

• the name or style of the manufacturer.

• BIS certification mark of Manufacturer.

Any other marking, either in terms of the application technique or the data specified, must besubmitted to the Company for approval in advance.

8. PACKAGING AND STORAGE

8.1. GENERAL

The manufacturer shall take all necessary action to prevent the pipes from deterioratingduring storage, loading and transport.

The pipes shall be supplied in rolls.

The pipes are fitted with sealing devices at both ends, of a model approved by theCompany.

8.2. LENGTHS

The preferred pipe lengths are given in table C below.

TABLE C

Nominal diameter 'de' (mm)	Preferred length in meters
	Reels
32	200
63	100
90	100
125	50
180	12

8.3. PACKAGING

8.3.1. Packaging of rolled pipes

Each roll includes an adequate number of hoops made from cords or bands of synthetic material, evenly distributed around the whole circumference of the bundle. In each case there must be a hoop less than 0.3 m from each end of the pipes.

The coils shall be supplies in a loose form duly wrapped by black PE film with additional protection of woven jute sack from outside to avoid direct sunlight and transit damage and facilitate out door damage.

8.4. HANDLING AND STORAGE

Immediately after production, pipes shall be handled with great care from the production line to the storage place, in order to avoid any damage such as scratches, notches, superficial wear and tear, holes, dented walls or similar.

If handled by forklift or similar equipment, the metallic forks shall be covered with a soft material in order to avoid any damage to the pipes.

The extremities of the pipes shall not be in contact with the floor while handling.Indoor storage is preferred.

Outdoor storage is permitted at the following conditions:

• Storage periods are not exceeding one month

• Pipes are protected from direct sunlight by a suitable shelter.
• Pipes are stored on a hard storage surface clean from excessive dust, stones, wateretc.

• Pipes are not in contact with the soil, but are supported by soft material such a woodetc.

• Pipes are protected from damages caused by traffic of forklifts, trucks etc.

8.5 SEALS

Prior to execution of the order, the manufacturer must submit to the Company the seals which it intends to use for all the types of pipes ordered.

The seals shall preferably be made of PE or a material which does not adulterate polyethylene. Metal and PVC seals are not permitted. The seals must be able to withstand storage times as guaranteed in 8.6. Of this specification, and also to withstand handling during installation.

They must not be brittle or sharp and the materials, shapes and dimensions thereof must be such that they cannot fully penetrate inside the pipes.

They are of the internal plug type for all pipes supplied in straight lengths, and for pipes rolled in coils or on reels, the seals may be caps.

All seals are fitted with a valve to prevent pressurization or depressurizations of the pipes, depending on climatologically temperature cycles.

In theory, they are placed on the pipes immediately after completion of the manufacturing tests, but before storage of the pipes. In the event of acceptance, the pipe plugs are removed and replaced by the supplier.

The seals cannot be recycled after the pipes have been installed. Their removal on site should not require the use of special tools.

8.5. STORAGE WARRANTY

It must be possible to store the pipes in the open air, protected from direct sunlight, without taking any other special precautions for at least two years from the date of manufacture stated on the pipe.

The storage warranty covers continued conformity of the dimensions, characteristics and performances laid down in this specification.

8.6. DEADLINE FOR SUPPLY

The pipes must be supplied to the user within one month following the date of manufacture.

9. PRODUCT TYPE-APPROVAL

For the purposes of type-approval of the product, the manufacturer is obliged to supply atechnical file as defined in SIPI procedure 056 – 06.

Type-approval of the products is carried out in accordance with the aforementioned procedure.

Any change to the type-approved product, process or manufacturing equipment must benotified to the Company in writing.

Any failure in this respect shall incur withdrawal of type-approval until termination of the contract.

APPENDIX 1

Approved materials

The materials which have passed the "SIPI" approval procedure for PE materials ("056-06") are approved for manufacture of the pipes.

For information, the following materials have been approved to date:

Solvay Eltex TUB 121 (black)	PE 100
or Eltex TUB 125 (orange)	
Borealis HE 3492LSH	PE 100
Total XSC 50	PE 100
Dow BG 10050	PE 100
Lyondell Basell Hostalen CRP 100	PE 100

APPENDIX 2

Code for different raw materials
for PE 100 (Orange Material)

Manufacturer
SOLVAY
BOREALIS /BORAOGE
FINA
DOW
ELENAC
INEOS
Total petrochemicals
Lyondell Basell

*Based on the GERG List

APPENDIX 3

Characteristics of PE Compound

Characteristics	Units	Requirements	Test	Test Method
Conventional density	kg/m3	>=928.4(base Polymer)	230C	IS 7328:19921
		>=928.4(base Polymer)	270C	
Melt flow rate	g/10 min	+/- 20 % of value nominated by compound producer	1900C /5.0 Kg	IS 2530:1963
Thermal Stability	min	>= 20	2000C	Annex D of IS 14855 OR ISO 4437
Resistance to gas Constituents	h	>= 20	800C	Clause 5.5
Pigment Dispersion	Grade	<= 3		Annex E of IS 14855 OR ISO 4437

1) See Explanatory Notes at Annex L

NOTE — Indian testing methods mentioned in IS 7328 and IS 2530 for the determination of conventional density and mass flow rate have been found co-related with ISO/British Standard Testing methods, such as ISO 1183-1983(E), ISO 1133-1991(E), ISO 6964 and BS 2782 Part 8, method 823-A, 823-B, 1978 respectively. The compound shall confirm to the weathering requirements for thermal stability as abov e, hydrostatic strength HS (165 h-80°C) at induced stress 4.6 MPa and 5.5 MPa for PE- 80 and PE-100 material respectiv ely and elongation at break 350 percent minimum after exposure of the test as per Annex F.

APPENDIX 4

Resistance to internal hydraulic pressure

Specification of test parameters

PE 100 materials (MRS1O)

Test type	Minimum Time hours	Type of fracture
200C-б>=12.4 MPa	100	Ductile
400C- б>=5.5 MPa	165	cleavage
800C-б>=5.0 MPa	1000	

If a ductile fracture occurs during the test at 80°C - 165 hrs, the test is repeated for 1,000 hrs at a lower stress level.

Polyethylene pipes for underground networks for natural gas distribution Technical Datasheet

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1.0 REFERENCE AND STANDARD DOCUMENTS

056 - 01	Polyethylene pipes for underground networks for natural gas distribution - General requirements.
056 - 03	Polyethylene pipes for underground networks for natural gas distribution -Quality control of pipes.
056 - 06	Supplementary procedure for type-approval of polyethylene pipes for underground networks for natural gas distribution.
IS 14885 or ISO 4437	Polyethylene Pipes for the Supply of Gaseous Fuels-Specification.

Dn	en	SDR	Coil Length inmeters	Total LengthKm	Approved Material	Weight/ m (Kg/m)
20	3	11	200	1000	E3-N3-F3-D1-H3	0.162
32	3	11	200	240	E3-N3-F3-D1-H3	0.28
63	5.8	11	100	120	E3-N3-F3-D1-H3	1.05
125	7.1	17.6	50	60	E3-N3-F3-D1-H3	4.1
180	10.3	17.6	12	10	E3-N3-F3-D1-H3	8.4

(*) approximate value according to DIN 8074

Manufacturer		**Commercial brand name**	**Code (*)**
SOLVAY	ELTEX	TUB 121/125	E3
BOREALIS /BOROAGE		HE 2490	N3
TOTAL PETROCHEMICAL F3		TOTAL	XSC50
DOW		BG10050	D1
ELENAC	HOSTALEN	CRP100	H7

POLYETHYLENE PIPES FOR UNDERGROUND NETWORKS FOR NATURAL GASDISTRIBUTION QUALITY CONTROL OF PIPES

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1. SUBJECT AND AREA OF APPLICATION

The purpose of this document is to define the test requirements to be met by PE pipes in accordance with the latest version of the SIPI specification listed on reference documents 056 — 01, - 02, - 06.

2. REFERENCE AND ST ANDARD DOCUMENTS

056 - 01	Polyethylene pipes for underground networks for natural gas distribution - General requirements.
056 - 02	Polyethylene pipes for underground networks for natural gas distribution -Technical data sheet.
056 - 06	Supplementary procedure for type-approval ofpolyethylene pipes for underground networks for natural gas distribution.
IS 14885	Polyethylene Pipes for the Supply of Gaseous Fuels-Specification.

3. GENERAL PRINCIPLES

3.1. MANUFACTURER'S RESPONSIBILITY

The manufacturer is totally responsible for the quality of the pipes which he manufactures. Acceptance Test procedures do not absolve him from this responsibility.

In order to ensure that the pipes comply with the specification in every case, tie pipes are tested by the factory control department, which is separate from its production department.

The pipes supplied are guaranteed for one year after commissioning or three years maximum after the date of manufacture.

3.2. QUALITY ASSURANCE

The manufacturer must have a quality assurance system in place as described in standard EN 29001 or EN 29002. The quality manual must be supplied to the Owner/ owner representative Quality Control Department.

The quality assurance system shall be certified by an accredited body.

3.3. SPECIMEN SAMPLE OF GRANULATE

The manufacturer shall supply the Owner/ owner representative Quality Control Department with a kilo of granulate from each batch of material used to manufacture the pipes.

The specimen sample is taken in the presence of the Owner/ owner representative Quality Control Department official if testing takes place during manufacture. A suitable container shall be supplied

to the manufacturer by Owner.

All necessary precautions shall be taken to prevent contamination and deterioration of the granulate during sampling and during subsequent handling of the sample.

4. TESTS

4.1. TESTS CARRIED OUT BY THE MANUFACTURER

4.1.1. General

It is essential to comply with the provisions in the following sections to ensure that the pipes conform to the specification in every case.

All the pipes are individually numbered. This marking is done using an inert product which will not adulterate the quality of the pipes (e.g. lithographic chalk). The pipe number consists of a maximum of three digits. In the case of pipes with a diameter of 90 mm or more, the number is marked on the inside. For rolled pipes and pipes on drums, it is applied on an adjoining label and the marking must not be subject to deterioration.

4.1.2. Individual tests

4.1.2.1. Appearance

The external and internal appearance of each pipe is checked in accordance with thedocument, “Assessment of appearance defects on the internal and external surfaces ofpolyethylene pipes for underground networks for natural gas distribution” (see Appendix 5). A suitable artificial lighting system is used to check the internal appearance.

4.1.2.2. Dimensions

The thickness and average diameter (see Appendix 2), measured in the conditions defined in the specification, are entered in an inspection document which includes the dates of manufacture and the production team, extruder number, code of the material used, pipe number and, if a pipe is declared invalid, the reason for the rejection.

When the manufacturer carries out continuous measurement of the thickness, the recordof the values measured shall include all the details necessary for marking of the pipes.

The, inspection documents and any records shall be supplied to the Owner/ ownerrepresentative official.

4.1.3. Each batch of material

The pipe manufacturer shall ask the raw material manufacturer for a certificate showing:

- melt mass-flow rate;
- water content;
- density;
- carbon black content;

- black quality;
- Thermal stability.

The pipe manufacturer shall carry out the following checks and tests on each batch ofmaterial:

- melt mass-flow rate on resin before use;
- volatile and water content;
- Thermal stability of the resin.

These checks and tests shall be carried out in the conditions laid down in technical specification 056 — 01.

The results are entered in documents showing full identification of the batch of pipe, to besupplied to the Owner/ owner representative official.

4.1.4. Each batch of pipes

For each batch of pipes, the manufacturer shall carry out the following checks and testsin addition to the above-mentioned individual tests:

- Ovalisation;
  - length;
  - melt mass-flow rate on pipe;
  - thermal stability of pipe;
  - internal stresses;
  - resistance to internal hydraulic pressure at 20°C and 80°C;
  - determination of traction characteristics of pipes; tension at yield point at 23°C and elongation to Fracture at 23°C;
  - End-to-end weld ability for pipes with diameters of 110 mm or more.

These checks and tests are carried out in the conditions defined in technical specification056 - 01

The results are entered in documents showing full identification of the batch of pipes andsupplied to Owner/ owner representative.

4.1.5. Type-approval of pipes

When a new material aid/or a new extruder is used, the manufacturer must have theproduct type approved in accordance with the 056 - 06 type-approval procedure.

4.1.6. Special tests

- Resistance to atmospheric influence.

- Resistance to growth of cleavage fractures.
- Resistance to slow cracking (notch test).

If necessary, these tests shall be carried out by mutual agreement in an independentlaboratory.

4.2 FACTORY ACCEPTANCE BY OWNER/ OWNER REPRESENTATIVE QUALITY CONTROL DEPARTMENT OFFICIAL

4.2.1. General

Acceptance tests are carried out in the presence of an official from the Owner/ owner representative Quality Control Department.

All checks and tests are carried out in the conditions laid down in technical specification056 - 01

The results must be in accordance with the provisions specified therein and with theindividual specifications of the order.

On each visit, the manufacturer provides the Owner/Owner's representative free of charge with the facilities and personnel necessary to carry out the tests laid down in the specification. In addition, during execution of the order, the Owner/Owner's representativ e has access to the storage installations for the raw materials before manufacture, the manufacturing and testing installations and the storage areas for the pipes for which Owner/Owner's representative is responsible for testing.

On arrival at the factory for his inspection, Owner/Owner's representative receives a certificate for each batch of pipes presented for acceptance. This document shall be consistent with the specimen in Appendix 3.

In addition, when acceptance relates to part of an order, the supplier must provide the Owner/Owner's representative with a stock list and a history of the stock of pipes intended for CONSULTANT. A specimen of this form is attached to this document: Appendix 4.

Whenever so requested by the Owner/Owner's representative, the manufacturer must be able to provide him with recent test and calibration reports for the measuring instruments and test installations.

4.2.2. Convening notice for acceptance

The acceptance convening procedures are specified in the order.

4.2.3. Acceptance tests.

4.3.2.1. Appearance, dimensions and marking

The number of pipes examined is at least 10 % of the pipes presented for acceptance.The pipes to be examined are placed on work trestles or grids for ease of testing.

Rolled pipes are presented on reels.

4.2.3.2. Checking of characteristics

For each batch of pipes as defined in technical specification 056 - 01 or a constituent partthereof, the minimum samples to be taken are stated in the table in Appendix 1.

4.3 ACCEPTANCE AND REJECTION

4.3.1. Appearance, dimensions and marking

Any failure means that the batch is rejected. It may however be presented again aftersorting, with the agreement of the Owner/Owner's Consultant.

4.3.2 Checking of characteristics

Any result which is not in accordance with the provisions of the specification and the individual specifications of the order shall give rise to a repeat test on at least double thenumber of samples. If the unfavorable result is confirmed, the batch is definitively rejected. If the unfavorable result is invalidated, the batch is accepted.

By way of additional investigation, other analyses or examinations may be carried out bymutual agreement, at the manufacturer's expense.

4.4 DISPATCH WITHOUT ACCEPTANCE

If Owner/Owner's representative decides to waive the acceptance procedures, it reserves the right to ask the manufacturer to carry out the acceptance tests and checks laid down in 4.2.3.

The supplier is obliged to send the Owner/Owner's representative a factory certificate,the stock lists and the acceptance test and check report if these have been requested.

These documents shall contain the order references.

Failure to observe the above procedures shall be sanctioned by refusal to take delivery.

APPENDIX 1 – TABLES OF SAMPLES

Test	Quality criterion as per specification G001-1	Test method As per Specifications G001-1	No of samples per batch	Number of test specimens
Internal stresses	5.2.2.1	6.8	2	3 from the same pipe
Determination of traction characteristics	5.2.2.5	6.12	2	3 from the same pipe
Melt mass flow rate	5.2.1.4	6.3	2	1 from Same pipe
Resistance to Internal hydraulic Pressure -at 200C -at 800C	5.2.2.2	6.9	 1 1	 2 test specimen(+2 reserves)(1) 1 test specimen per pipe 2 test specimen(+2 reserves)(1) 1 test specimen per pipe
Weld ability Traction on welded Pipe Resistance to internal hydraulic pressure -at 200C -at 800C	5.2.2.6 5.2.2.2	6.13 6.9	2(4) 1 1 1	2 section of different pipe welded end to end 1 welded sample(3) See note (2) See note (2)

Resistance to slow cracking of notched pipe	5.2.2.3	. 6.10	4(3)	See note (5)
(Notch test)				
Resistance to growth of cleavage fractures	5.2.2.4.	6.11	4(3)	See note (5)
Thermal stability of PE	5.2.1.7.	6.6	1(3)	See note (5)

Notes

(1) Number of test specimens to be tested: 1 specimen at start of manufacture and 1specimen at end of manufacture per shift basis.

(2) In agreement with the Owner official, these tests on welded test specimens may be included in the series of tests designed to check resistance to internal hydraulic pressure.

(3) Performance of this test is left to the discretion of the Owner/Owner's Representative.

(4) The number of welded samples per batch may be increased to three if the Owner officialhas decided to carry out the traction test on the welded sample.

(5) The taking of samples is left to the discretion of the Owner official, if the manufacturer isnot equipped to carry out these tests properly, they shall be carried out at the Manufacturer's expense in a reputed laboratory chosen by Owner.

APPENDIX 2- DIMENSIONAL REQUIREMENTS

The pipes belong to either series SDR 11 defined below:THICKNESS

Nominal Diameter de	SDR 11		
	en	emin in mm	emax in mm
20	3	3	3.4
32	3	3	3.5
63	5.8	5.8	6.6
90	8.2	8.2	9.2
125	11.4	11.4	12.7
180	**16.4**	**16.4**	**18.2**

MEAN EXTERNAL DIMENSIONS

Nominal Diameter de	MEAN EXTERNAL DIAMETER dm	
	dm min. in mm	dm max in mm
20	20	20.3
32	32	32.3
63	63	63.4
90	90	90.6
125	125	125.8
180	**180**	**181.1**

APPENDIX 3- ASSESSMENT OF APPEARANCE DEFECTS ON INTERNAL AND EXTERNAL SURFACES OF POLYETHYLENE PIPESFOR UNDERGROUND NETWORKS FOR NATURAL GAS DISTRIBUTION

1 PREAMBLE

The internal and external surfaces of the tubes are examined visually with the naked eye,without magnification and under adequate lighting.

2. DESCRIPTION OF MAIN APPEARANCE DEFECTS

2.1. DEFECTS CAUSED BY HANDLING OR STORAGE

2.1.1. Incrustation with foreign matter

Pebbles, sand, glass, filings, wood splinters, etc.

2.1.2 Scratches

Narrow continuous lesions.

2.1.3 Notches

Incisions made by a sharp instrument.

2.1.4 Superficial wear and tear

Surface deterioration resulting from friction against foreign matter.

2.1.5 Holes

Holes in the wall caused by forceful insertion of a generally pointed object (e.g.: nails,probes, screws, etc.).

2.1.6 Dented walls

Permanent distortion of the wall accidentally caused during handling.

2.2 MANUFACTURING DEFECTS[1]

2.2.1. Continuous longitudinal internal lines

Longitudinal marks evenly distributed around the inner circumference of the pipe, caused by fusion of material faces on exit from the extrusion tool. These marks are caused by an incorrect choice of transformation parameters.

2.2.2. Continuous longitudinal lines inside and outside

These do not exceed 0.20 mm in depth.

- They may be caused by the defective condition of the calibrators or the sealing device for the calibration system, in which case they are isolated instances.
- They may be caused by friction of residual deposits attached to parts of the extrusion tool, the calibrators or the sealing plug of the calibration system. In this case, they are generally randomly distributed.

These deposits may consist of waxes, oxidized polyethylene or other products which are released during transformation of the material in the extruder or which are present in the cooling water.

2.2.3. Incrustation with residual matter generated during extrusion

The deposits defined in 2.2.2. Work loose and are crushed in the external wall of the pipes while passing into the calibrator, or adhere to the internal wall of the pipes.

2.2.4. Presence of foreign matter in the polyethylene resulting from contamination of the raw material

This contamination may be caused by all sorts of liquid or solid products (oil, paper. cardboard, plastics, glass, sand, dust, etc.).

2.2.5. Excessive water and volatile contents

2.2.5.1. Porosity

Defects generally caused by volatile matter which occur specifically when the water and volatile contents are too high.

[1] The term extrusion defect covers all defects resulting from the complete pipe manufacturing process.

2.2.5.2. Craters (surface spalling)

Shallow or deep conical cavities the cause of which is difficult to establish, generally the result of water and volatile contents being too high.

2.2.6 Pitting

Defects in the shape of aligned dots, either in clusters or dispersed, which are often connected with carbon black anomalies.

2.2.7 Unfused parts

Molecular polyethylene elements which are totally or partially unfused and located both on the surface and right inside the thickness of the pipe wall.

2.2.8 Cavities

Superficial denting of the external wall, sometimes replicated on the internal wall.

This is the result of distortion caused by a drop of water between the pipe and the calibrator at the intake.

The water comes from the calibrator cooling system and is a common phenomenon if the pressure of the calibrator cooling water is too high.

2.3. DEFECTS CAUSED BY MARKING

2.3.1 Marking too deep

This is caused by incorrect setting of the stamps or the stamp design.

2.3.2 Indentations caused by the tool holding the marking stampsThese are the result of incorrect

settings or wear and tear.

3. ASSESSMENT CRITERIA

3.1. CRITICAL DEFECTS

The following defects are critical:

• Continuous longitudinal internal lines (see 2.2.1.)

• Presence of foreign matter in the polyethylene resulting from contamination of the rawmaterial (see 2.2.4.)

• Porosity (see 2.2.5.1.)

3.2 OTHER DEFECTS

Defects caused by handling or storage

Pipes presenting one of the following defects are classified as defective:

• Incrustation with foreign matter (see 2.1.1.).

• Scratches (see 2.1.2.), the depth of which is more than 10% of the thickness, with alimit of 0.5 mm.

• Superficial wear and tear (see 2.1.4.), where the depth of the marks is more than 10%of the thickness, with a limit of 0.5 mm.

• Notches (see 2.1.3.), the depth of which is more than 10% of the thickness, with alimit of 0.50 mm.

• Holes, the depth of which (see 2.1.5.) is more than 10% of the thickness, with a limitof 0.50 mm

• Dents in the pipe wall (see 2.1.6.).

3.2.2 Manufacturing defects

3.2.2.1 Incrustation with residual matter generated during extrusion, craters, pits, unfusedelements (see 2.2.3., 2.2.5.2., 2.2.6. and 2.2.7.)

A sample may present several of the above defects.

Let p be the depth of the defect and e the nominal thickness of the pipe.Case 1: p>0.1.e

Any pipe which includes one of the above defects where the depth is more than 10% of the nominal thickness of the pipe is always considered to be defective.

Case 2: p <= 0.1.e
For a pipe which contains isolated defects[2],the depth of which is 10% of the nominal thickness or less, each defect is allocated a grade g depending on its largest dimension a, excluding the depth. The value of g in terms of a is defined in Table 1.

Table I

Largest dimension a of defects in mm	Grade
1.0<=a<2.0	5
2.0<=a <3.0	10
3.0<=a<4.0	25
4.0<=a<5.0	50
5.0<=a<6.0	51

Defects, the largest dimension of which is less than 1mm are not taken into account.

[2] A defect is considered to be isolated if the gap between the closest edges of two defects is greater than the largest dimension of the defects. Otherwise, it is a single case defect.

A pipe is considered to be defective when it presents a defect, the largest dimension of which is 6.0 mm or more.

A pipe is considered to be defective when the sum of the products of the grades g multiplied by the number of defects n detected along a length of 100 cm exceeds the value L defined in table 2 in terms of the diameter of the pipe.

Table 2

Nominal diameter de	L=Σ(n.g)
20	20
32	20
63	40
125	40
180	60

3.2.2.2 Continuous longitudinal marks inside and outside, cavities, marking too deep andindentations caused by marking tool.

Pipes presenting the following defects are classified as defective:

• Continuous longitudinal marks on the inside and outside which are 0.20 mmdeep or more (see 2.2.2.).

• Cavities (see 2.2.8.).

• Marking too deep (see 2.3.1.), where the depth is more than 0.20 mm.

• Indentations caused by the marking tool (see 2.3.2.), where the depth is more than 0.20 mm.

4. ACCEPT ANCE CRITERIA FOR BATCHES

4.1. CRITICAL DEFECTS

When a pipe presents one of the defects described in section 3.1., the batch is rejectedNote:

Porosity

Rejection is confirmed if the water or volatile contents measured exceed thecriteria laid down in the technical specification.

4.2 OTHER DEFECTS

The following rules apply to the sampling test[3].

When examining the pipes comprising the sample batch, let n1 be thenumber of defective pipes or rolls

if n1=0 the batch is acceptable;

if 1 <= n1 <3 the batch is acceptable, but the defective pipes or rolls are

Eliminated; if n1>= 3 a second sample is taken from the batch presented following the

Procedures described previously, and the defective pipes orrolls are eliminated.

Sampling: The sample comprises the pipes contained in a whole number of packaging Units (crates or rolls) corresponding to 10% in excess of the total length of pipes presented. Examination of the appearance covers the surfaces of the internal and externalwalls. In the case of pipes rolled on a drum. the appearance is checked for each drum on the sections of pipes in the last layer of rolled coils, as Well as those accessible from the side.

When examining the pipes comprising the second sampling, let n2 be the number of defective pipes or rolls

If n2 = 0 the batch is acceptable;

If 1 <= n2 < 3 the defective pipes or rolls are eliminated;

If n2 >= 3 the batch is rejected. It may be sorted and, if necessary, the balance of the sorting operation may be presented again for testing.