**QUALITY INSPECTION COMMITTEE REPORT**

**FOR**

**HDPE PIPES AND FITTINGS**

**MANUFACTURING AT**

**……. (PRIVATE) LIMITED,**

**……, , SRI LANKA.**

**SUPPLYING AND LAYING OF TREATED WATER TRANSMISSION MAINS AND CONSTRUCTION OF THREE TREATED WATER SUMPS AT KALLUNDAI, PUNGUDUTIVU AND POONAKARY.**

**Contract No. PEIC/JKWSSP/TWTM/2014/02**

**Eng. U.C. Pathiranage, AGM (P&D –Documentation)**

**Eng. A.S.Kaluarachchi, AGM (P&D)**

**Eng. T.Barathithasan, PD (JKWSSP)**

**Eng. R.Balendra, SE (JKWSSP)**

**Eng. M.Mathavan, PE (JKWSSP)**

**May 2017**

**Table of Content**

1. INTRODUCTION ……………………………………………………………….. 03

2. HDPE FACTORY INSPECTION ……………………………………………….. 03

2.1 Location and description of the factory ………………………………………….. 03

2.2 Description of the Factory ……………………………………………………….. 03

2.3 Officials Met During the Pre Shipment Inspection ……………………………… 04

2.4 Manufacturing Standards ……………………………………………………….. 05

2.5 Raw Materials ……………………………………………………………………. 05

3. Manufacturing Process …………………………………………………………… 06

4. Inspection & Testing of HDPE Pipes & Fittings ………………………………… 07

4.1 Participation of Third Party Inspection Agency …………………………………. 07

4.2 Inspection & Testing Procedure …………………………………………………. 07

4.3 Calibration of Test Equipment …………………………………………………… 07

4.4 Markings …………………………………………………………………………. 07

4.5 General Characteristics …………………………………………………………... 08

4.5.1 Appearance ……………………………………………………………… 08

4.5.2 Colour …………………………………………………………………… 08

4.6 Geometrical Characteristics ……………………………………………………… 08

4.6.1 Mean Outside Diameter ………………………………………………….. 08

4.6.2 Ovality …………………………………………………………………… 09

4.6.3 Wall Thickness …………………………………………………………… 09

4.6.4 Length of Straight Pipes …………………………………………………. 10

4.7 Physical Characteristics ………………………………………………………….. 11

 4.7.1 Elongation at Break Test …………………………………………………. 11

4.7.2 Longitudinal Reversion …………………………………………………… 12

4.7.3 Melt Mass Flow Rate …………………………………………………….. 13

4.7.4 Oxidation Induction Time ……………………………………………….. 15

4.7.5 Material Density ………………………………………………………….. 16

4.7.6 Tensile strength of butt fusion joints…………………………………….. 18

4.8 Mechanical Characteristics ………………………………………………………. 19

4.8.1 Hydrostatic Pressure Test at 80°C for 165 hours ………………………… 19

4.8.2 Hydrostatic Pressure Test at 20°C for 100 hours ………………………… 20

5. Inspection Team Certified Checklist ………………………………………….. 20

6. Conclusion ………………………………………………………………………. 20

7. Recommendation ………………………………………………………………... 21

**Annexures**

|  |  |  |
| --- | --- | --- |
| Annex 1 | **-** | Copy of ISO 9001:2008 / SLS ISO 9001:2008 Quality Management System Certificate issued by SRI LANKA STANDARDS INSTITUTION. (Certificate No – QSC 00664)  |
| Annex 2 | **-** | Copy of Product conformity certificate ISO 4427:2007 - Part 2 & 3 issued by Bureau Vertas Lanka (Pvt.) Ltd; (Certificate No – FA-SRL.C.8.14.016 for FACTORY APPROVAL for dia DN20 to DN500) |
| Annex 3 | **-** | Copy of Product conformity certificate ISO 4427:2007 - Part 2 & 3 issued by Bureau Vertas Lanka (Pvt) Ltd (Certificate No – FA-SRL.C.8.14.016 for TYPE APPROVAL for dia DN20 to DN500) |
| Annex 4 | **-** | Copy of SLS 1498:2015 Certificate for PE pipes of PE100, PN10, SDR17 63 mm and 225 mm, PE100, PN112.5, SDR13.6 32 mm and PE100, PN16, SDR11, 20 mm dia issued by SRI LANKA STANDARDS INSTITUTION. (Permit No – 1535) |
| Annex 5 | **-** | Copy of SLS 1499:2015 Certificate for PE pipes of PE100, PN10, SDR17 63 mm and 225 mm dia issued by SRI LANKA STANDARDS INSTITUTION. (Permit No – 1567) |
| Annex 6 | **-** | Copy of BS 6920-1:2000 and or 2014 certificate of conformity issued by Water Regulation Advisory Scheme (WRAS) (Approval no – 1505535) |
| Annex 7 | **-** | Copy of test results of Chemical composition of the PE raw material from raw material supplier |
| Annex 8 | **-** | Calibration certificates |
| Annex 9 | **-** | NWSDB inspection reports |
| Annex 10 | **-** | Inspection Team Certified Checklist  |
|  |  |  |

**1. INTRODUCTION**

As per the letter dated 19/04/2017 of Actg. Addl. GM (WSP), the following inspection team of National Water Supply & Drainage Board was appointed to carryout Factory Inspection of production of Polyethylene pipes and fittings for Supplying and Laying of Treated Water Transmission Mains And Construction of Three Treated Water Sumps At Kallundai, Pungudutivu And Poonakary, under Jaffna - Kilinochchi Water Supply and Sanitation Project manufactured by S-lon Lanka (Private) Limited, No 135, Ratamada Para, Singak Kuliya, Sadalankawa, Sri Lanka.

Eng. U.C. Pathiranage - AGM (P&D –Documentation)

Eng. A.S.Kaluarachchi - AGM (P&D)

Eng. T.Barathithasan - Project Director (JKWSSP)

Eng. R.Balendra - Senior Engineer (JKWSSP)

Eng. M.Mathavan - Project Engineer (JKWSSP)

The inspection team inspected the manufacturer’s factory, manufacturing process, quality control systems and witness the tests carried out by the manufacturer with the presence of the nominated accredited independence inspection agency for the purpose of determining mechanical properties, dimensions hydrostatic pressure tests and leak tightness in conformity with ISO 4427:2007 standard for HDPE blue coloured pipes and fittings on randomly selected PE pipes and fitting samples from pipes and fittings.

The details of the inspection carried out at the manufacturing facilities of the S-lon Lanka (Private) Limited are given in this report.

**2. HDPE FACTORY INSPECTION**

**2.1 Location and description of the factory**

The HDPE production facilities of the S-lon Lanka (Private) Limited is located in Sadalankawa, Sri Lanka and the factory address is M/s. S-lon Lanka (Private) Limited, No 135, Ratamada Para, Singak Kuliya, Sadalankawa, Sri Lanka.

**2.2 Description of the Factory**

The S-lon Lanka (Pvt.) Ltd; HDPE pipes and fittings factory consists of 2 HDPE production lines.



**Figure 2.2 - S-lon Lanka (Private) Limited, Factory**

The team commenced the Factory inspection on 27th April 2017 carried out tests during the period of 27th April 2017 to 19th May 2017. During the inspection, period only 225 mm Diameter HDPE pipes and fittings were available at the for testing and carry out the testing up to 225 mm Dia.

The inspected 225 mm dia HDPE pipes and the fittings were manufactured by the same manufacturer S-lon Lanka (Private) Limited. All fittings were fabricated fittings and the fittings were fabricated from the HDPE pipes produced at the same factory.

**2.3 Officials Met During the Factory Inspection**

During the inspection, the inspection team had meetings and discussions with the following officials of the S-lon Lanka (Private) Limited and the representative from Inspection Agency.

Dr. K.D. Kotian, Technical Director, S-lon Lanka (Pvt.) Ltd;

Mr. M.Shabbir Ahmed, Factory Director, S-lon Lanka (Pvt.) Ltd;

Mr. Priyasantha Fernando, Quality Control Manager, S-lon Lanka (Pvt.) Ltd;

Mr. L.S. Perera – Factory Manager, S-lon Lanka (Pvt.) Ltd;

 Mr. S. Rogers, Sales Manager – S-lon Lanka (Pvt.) Ltd;

Mr. H.M.A.W. Herath, Inspection Engineer, Bureau Vertas Lanka (Pvt.) Ltd;

**2.4 Manufacturing Standards**

The Inspection team verified the following certificates produced by of M/s S-lon Lanka (Pvt.) Ltd; with the originals during the inspection.

* ISO 9001:2008 / SLS ISO 9001:2008 Quality Management System Certificate issued by SRI LANKA STANDARDS INSTITUTION (Certificate No – QSC 00664, valid until 14/09/2018) - **Annex 1**
* Product conformity certificate ISO 4427:2007 - Part 2 & 3 issued by Bureau Vertas Lanka (Pvt) Ltd (Certificate No – FA-SRL.C.8.14.016 dated 30/09/2014 for FACTORY APPROVAL for dia DN20 to DN500, Valid until 29/06/2017) – **Annex 2**
* Product conformity certificate ISO 4427:2007 - Part 2 & 3 issued by Bureau Vertas Lanka (Pvt) Ltd (Certificate No – FA-SRL.C.8.14.016 dated 23/09/2014 for TYPE APPROVAL for dia DN20 to DN500, Valid until 29/06/2017) – **Annex 3**
* SLS 1498:2015 Certificate for PE pipes of PE100, PN10, SDR17 63 mm and 225 mm, PE100, PN112.5, SDR13.6 32 mm and PE100, PN16, SDR11, 20 mm dia issued by SRI LANKA STANDARDS INSTITUTION. (Permit No – 1535, valid until 01/06/2017) – **Annex 4**
* SLS 1499:2015 Certificate for PE pipes of PE100, PN10, SDR17 63 mm and 225 mm dia issued by SRI LANKA STANDARDS INSTITUTION. (Permit No – 1567, valid until 26/06/2017) – **Annex 5**
* BS 6920-1:2000 and or 2014 certificate of conformity issued by Water Regulation Advisory Scheme (WRAS) (Approval no – 1505535, valid until May 2020) – **Annex 6**

**2.5 Raw Materials**

The raw materials required for the manufacturing of HDPE pipes and fittings are sourced from M/s. National Petrochemical Industrialization Marketing Company, Saudi Arabia.

On request by the inspection team the certificate of analysis for Chemical composition of the PE raw material TASNEE 100 Blue from the raw material supplier is attached as **Annex 7**.

**Figure 2.5 - HDPE raw material**

**3. Manufacturing Process**

PE compounds are stored in 25 kg Bags and physically fed into the PE extrusion machines. Colour of the PE Raw material is blue which is fulfill the NWSDB requirement. Additional colour pigments are not added during the HDPE production. The 225 mm diameter pipes are finished to 12.0 m lengths in order to stack in 12 m containers. The rolling and cutting is done at the end of the extrusion and cooling process.

The production facility has a testing laboratory which is capable to carry out all the tests which are specified in the ISO 4427:2007 such as;

* Test to verify Geometrical Characteristics

Length

Out of Roundness (Ovality)

Mean Outside Diameter

* Test to verify Physical Characteristics

Melt mass flow rate

Elongation at beak

Longitudinal reversion

Tensile strength of but fusion joints

Material density

* Test to verify Mechanical Characteristics

Hydrostatic pressure testing

**4. Inspection & Testing of HDPE Pipes & Fittings**

The S-lon Lanka (Private) Limited provided all reasonable facilities and assistance including access to documents and production data to the inspection team, to perform the factory inspection at their factory.

**4.1 Participation of Third Party Inspection Agency**

The inspection Engineer from the inspection agency, M/s. Bureau Vertas Lanka (Pvt) Ltd, Mr. H.M.A.W. Herath, was present during factory inspection.

**4.2 Inspection & Testing Procedure**

The inspection team carried out the tests for randomly selected HDPE pipes & fittings together with the factory quality control team in accordance to ISO 4427:2007 standards.

**4.3 Calibration of Test Equipment**

During the inspection it was observed that all the test equipment have been labeled giving calibrated date and the validity date of calibration. The manufacturer submitted the summary of calibration status for each measuring equipment along with the calibration certificates. The copies of the calibration certificates provided by the manufacturer are annexed as **Annex 8**.

**4.4 Markings**

The team found the markings indicated on HDPE pipes and fittings were in accordance with the contract specifications.

 As an example following markings were printed on 225 mm PE pipes.

“s-lon ISO 4427 PE100 225 x 13.4 MM SDR 17 PN10 JKWSSP –NWSDB WATER”

 **Figure 4.4: Pipe Markings**

**4.5 General Characteristics**

 **4.5.1 Appearance**

The inspection team observed the appearances of 225 mm diameter HDPE pipes and fittings at factory premises of M/s. S-lon Lanka (Pvt.) Ltd.; manufactured for the contract. The appearances without magnification of the internal and external surfaces of pipes were generally smooth, free from cavities and other surface defects. Hence, satisfy the Contract requirement.

 **4.5.2 Colour**

The colour of pipes has been specified in the contract as “Blue” and the 225 mm diameter pipes and fittings produced for the contract are of “blue” colour.

**4.6 Geometrical Characteristics**

To determine the geometrical characteristics the dimensional checks were carried out for samples of 225mm diameter pipes & Fittings.

 The dimensional checks were carried out in accordance to the ISO 3126:2005.

 **4.6.1 Mean Outside Diameter**

The inspection team checked the direct measurement using a π–tape to obtain the mean outside diameter of 225 mm diameter pipes and fittings and found the results lies within the range of the dimension given in the Table 1 of ISO 4427:2007. The details of the inspection team certified measurements for mean outside diameter for pipes and fittings are given in **Annex 9** and **Annex 10**.

 **Figure 4.6.1: Measuring the Diameter**

 **4.6.2 Ovality**

The Ovality of the 225 mm diameter PE pipes and fittings were calculated based on the measured values of diameter and found within the range of valves given in Table 1 of ISO 4427:2007 specified ovality. The details of the inspection team certified ovality values are given in **Annex 9 and Annex 10**.

**Figure 4.6.2 – Ovality Measurement**

**4.6.3 Wall Thickness**

The wall thickness of 225 mm diameters PE pipes and fittings samples were checked by using a calibrated Vernier Caliper and found to be within the range of values given in Table – 2 of ISO 4427:2007. The details of inspection team certified measurements are given in **Annex 9**.

**Figure 4.6.3 - Wall Thickness**

**4.6.4 Length of Straight Pipes**

Lengths of the randomly selected 225 mm diameters PE pipes were checked and found to be satisfied. The inspection agency certified results are given in **Annex 9.**

 **Figure 4.6.4 - Length of Straight Pipes**

**4.7 Physical Characteristics**

 **4.7.1 Elongation at Break Test**

The Elongation at break tests were carried out for 225 mm pipes according to the test method stated in ISO 6259 for test speed of 10mm/mint by using a universal tensile testing machine.

A specimen calculation to find the % elongation of pipe sample is given below;

 Elongation = {(b-a) / a} x 100%

 Original length = a, length at break = b,

For 225 mm; a = 50mm

A punching mark was established on the samples at 50mm distance and then sample was subjected for elongation by applying load by the machine at speed of 25 mm/mint.

Sample was stretched to the maximum length that the machine can reach, but the samples were not failed. The testing terminated as the test piece almost reaching machine limit without failure. At this time, the machine produced the test results. Results are tabulated below;

|  |  |  |  |
| --- | --- | --- | --- |
| **Specimen Label** | **Pipe diameter****(mm)** | **Maximum Load****(N)** | **Elongation****%** |
| 01 | 225 |  |  |
| 02 | 225 |  |  |
| 03 | 225 |  |  |
| 04 | 225 |  |  |
| 05 | 225 |  |  |
|  |  |  |  |

**Figure 4.7.1 Test for Elongation at Break**

As 400% is greater than required elongation (350%) the samples tested satisfy the requirements of ISO 4427:2007.

The results obtained thorough the INSTRON data logger is annexed as **Annex 9**.

**4.7.2 Longitudinal Reversion**

The Longitudinal Reversion tests were carried out for samples of 225 mm diameter pipes according to the method stated in ISO 2505.

Three circumferential marks marked on 100mm apart on the test pieces of length 200mm, at equal distances from the two ends. The pipe test pieces were placed in an oven at a 110°C temperature for 2 hours’ time. Then the samples were kept outside the oven until sample reached the room temperature. A marked length of this portion of pipe is measured, before and after heating. The reversion is calculated as a percentage of the change in length in relation to the initial length.

 **Figure 4.7.2: Longitudinal Reversion test**

The inspection team observed the surface appearance of the test pieces after heating and not changed due to heating.

 According to the standards requirement is reversion should be less than 3%.

 The results obtained for longitudinal reversion test is tabulated below;

|  |  |  |  |
| --- | --- | --- | --- |
| **Pipe diameter(mm)** | **L (mm)** | **L (mm)** | **% Longitudinal Reversion** |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

For all the samples tested reversion is less than 3%. Hence satisfy the ISO 4427 code requirements.

 The inspection team certified results are given in **Annex 9**.

**4.7.3 Melt Mass Flow Rate**

Melt flow rate measures the rate of extrusion of thermoplastics through an orifice at a prescribed temperature and load. The Melt Flow Rate (MFR) tests were carried out for 225 mm diameter pipe samples by using a calibrated Melt Flow rate Tester.

As per ISO 1133 the weighed raw material (TASNEE 100 blue) was loaded into the barrel of the melt flow apparatus, and weight specified for the material (5kg) was applied to a plunger and the melted material was forced to extrude. The extrudate was recorded for 240 seconds.

 **Figure 4.7.3 : Melt Mass Flow Rate Test**

The MFR was estimated at 190 deg. C with 5kg load and MFR values were calculated in g/10 min.

 The specimen calculation for MFR for 225 mm is given below;

Melt Flow rate = (600/t x weight of extrudate)

T = time of extrudate in seconds

Melt flow rate = g/10 min

 Number of samples selected = 4

 Total weight of four samples = 0.3980 g

 Average weight of samples = 0.0975 g

Time of extrudate in seconds = 240

 MFR = Avg. weight x 600/240

 = 0.0975 x 600/240

 = 0.2438g/10min

Total requirement is MFR should not be more than 20% of value nominated by raw material supplier. The value nominated by the raw material supplier is 0.23g/10mint and hence the requirement is MFR value 0.28 g/10 mints.

The MFR results obtained for pipes and fittings are tabulated in the Table given below.

**MRF Results**

|  |  |  |  |
| --- | --- | --- | --- |
| **Specimen**  | **Required MFR Value****g/10min** | **Tested MFR Values****g/10min** |  |
| 01 | < 0.28 |  |  |
| 02 | < 0.28 |  |  |
| 03 | < 0.28 |  |  |
| 04 | < 0.28 |  |  |

Therefore the samples tested satisfy the ISO 4427:2: 2007 code requirement.

.

**4.7.4 Oxidation Induction Time**

Oxidation Induction Time (OIT) is a relative measure of stabilized materials resistance to oxidative decomposition which measures the level of thermal stabilization. The Tests were carried out in accordance to the ISO 11357.

Determinations of OIT were carried out for samples of 225 mm pipes.

The Equipment used was fully automated Deferential Scanning Colorimeter (model DSC 60 Plus) and the results were plotted by the software through a computer. The measurement was carried out in an oxygen atmosphere at a temperature 2000C to assure that decomposition begins within a reasonable time. The test samples were heated in an inert atmosphere (nitrogen) to temperature above the melting point of the sample. At a constant temperature (isothermal) the sample atmosphere is switched from insert to oxidative. The amount of time elapsing until the exothermal oxidation of the sample begins is the oxidation induction time. As per the code requirements, after switching from Nitrogen to Oxygen, the OIT should be greater than 20 minutes.

**Figure 4.7.4: Oxidation Induction test**

 The normalized Heat flow graphs obtained as tests records are given in **Annex 9**.

According to the graph results the OIT of all the test samples were greater than 20 minutes. Hence satisfy the requirements.

**4.7.5 Material Density**

The determinations of material density were carried out for samples of 225 mm pipe.

The tests were carried out in accordance to the ISO 1183 using immersion method.

The test specimens were weighed in air then weighed when immersed in distilled water at 230C using a sinker and wire to hold the specimen completely submerged as required.

 **Figure 4.7.5: Material Density Test**

 The results obtained for density test is tabulated below;

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Pipe diameter (mm)** | **Mass in Air a (g)** | **Mass in water b(g)** | **Density (g/cm2)** | **Density kg/m3** |
| 225 |  |  |  |  |
| 225 |  |  |  |  |

Density was calculated based on the following formula.

 Density = a/(a-b+c)

 a = Weight of sample in air

 b = Weight of sample + wire + sinker in distilled water

 c = Weight of wire + sinker in in distilled water

= 2.0180 g

According to the results the calculated Density values of all the test samples were greater than 0.93 kg/m³. Hence satisfy the requirements.

The inspection team certified results are given in **Annex 9**.

**4.7.6 Tensile strength of butt fusion joints**

The Butt-fused PE pipe joints shall be prepared in accordance with the instruction specified in the relevant standards (ISO 4427:2007 and ISO 11414)

Each test piece complied with ISO 13953:2001 (E), Table 1, Type “A” Test piece. Dimensions of the Test piece complied with the Following requirement.

A – Overall Length (Min) = 180 mm

B – Width at ends = 80 ± 3 mm

C – Length of narrow parallel sided portion = Not Applicable

D – Width of narrow portion = 25 ± 1 mm

E – Radius = 10 ± 0.5 mm

G – Initial distance between grips = 90 ± 5 mm

H – Thickness = Full wall Thickness

I – Diameter of the traction holes = 20 ± 5 mm

Visual appearance for cross section of the samples found satisfactory with homogeneous grips along the Butt-Fusion Joint.

During the tensile test of the Butt-Fusion sample, all six numbers of the samples broke out the joint and ductile manner. Therefore all samples performed satisfactory.

**Figure 4.7.6: Tensile strength of butt fusion joints**

**4.8 Mechanical Characteristics**

**4.8.1 Hydrostatic Pressure Test at 80°C for 165 hours**

According to the ISO 4427:2007 pressure test for duration of 165 hours at 80 deg. C at stress of 5.4 MPa performed in a water bath for samples of 225 mm pipe.

The tests were carried out in accordance to the ISO 1167.

The samples found satisfactory with no deformation such as no swelling, no leakages or no busting observed. Therefore all samples performed satisfactory.

The manufacturer’s test equipment is fully automated machine with the facility to continuously record (plot) the pressure from the start of the test until the completion. And the inspection team were able to see the pressure at any time in the computer or in the digital display of hydrostatic testing machine. Upon completion of the test the lab staff were able to print the continuous record of the pressure over the test period.

**Figure 4.8.1 - Hydrostatic Pressure Test at 80°C for 165 hours**

**4.8.2 Hydrostatic Pressure Test at 20°C for 100 hours**

According to the ISO 4427:2007 pressure test for duration of 100 hours at 20 deg. C at stress of 12.4 MPa performed in a water bath for samples of 225 mm pipe & Fitting.

The tests were carried out in accordance to the ISO 1167.

The samples found satisfactory with no deformation such as no swelling, no leakages or no busting observed. Therefore all samples performed satisfactory.

**Figure 4.8.2 - Hydrostatic Pressure Test at 20°C for 100 hours**

**5. Inspection Team Certified Checklist**

 The inspection Team certified factory inspection check list attached as **Annex -10**.

**6. Conclusion**

Based on the observations made during the inspection such as sourcing of raw materials, production process, quality control procedures, the results of the dimensional, physical and mechanical characteristics tests carried out in selected samples during the inspection, it is recommended that the inspected 225 mm dia pipes & Fittings are in conformity with the requirement of the ISO 4427:2007 standard which is one of the standards specified in the Specification for the manufacturing of HDPE pipes and fittings.

**7. Recommendation**

The inspection team recommends that the HDPE 225 mm dia. blue coloured pipes manufactured by the S-Lon Lanka (Private) Limited, Sri Lanka and fittings fabricated at the same factory using the same blue coloured pipes at their factory located at No 135, Ratameda Para, Singak Kuliya, Sadalankawa, Sri Lanka for Jaffna Killinochchi Water Supply and Sanitation Project is manufactured in accordance with ISO 4427:2007 standards.

**……………………………... ……………………………..**

**Eng. U. C. Pathiranage Eng. A. S. Kaluarachchi**

**AGM (Planning & Designs –Documentation) AGM (Planning & Designs)**

**……………………………... ……………………………..**

**Eng. T. Barathithasan Eng. R. Balendra**

**Project Director (JKWSSP) Senior Engineer (JKWSSP)**

**……………………………..**

**Eng. M. Mathavan**

**Senior Engineer (JKWSSP)**