

Reinforced Heat Shrinkable closures

Test Report (Non-Pressurized)



31, Wonso-ro 37beon-gil, Wonnam-myeon, Eumseong-gun, Chungcheongbuk-do, Republic of Korea Tel : 82-43-877-9621 Fax : 82-43-877-9620 Email: sales_ikorea@naver.com

Specification of Heat Shrinkable Splice Closure



1. Heat shrinkable reinforced raw material requirements: Non Pressurized

No.	Type of Test	Test methods and conditions	Measured Values	Check Result
1-1	Temperature Indicating Paint Conversion	The Sleeve Cover is placed in oven at 300°C for 5min.	The paint should Convert or disappear	The paint should disappear
1-2	Tensile strength	Test method:EN-ISO527-2 After shrinking with test speed 50mm/min	≥20N/mm²	24N/mm²
1-3	Ultimate Elongation	Test method:DIN 53455 After shrinking	≥250%	265%
1-4	Tensile Strength After Thermal Aging	Test Method:ISO 188 168hours at (150±2)°C	≥18N/mm² ≥350%	21N/mm² 408%
1-5	Burst Strength	Clamping Procedure:ISO3303 -Fully Recovered Material Method	Min.3000N	4150N
		-Un-recovering Material	Min.2000N	2320N
1-6	Thermal Ageing -Burst Strength	Test Time:168hrs ISO3303/A Test Temperature:(150±2)°C -Fully Recovered material	Min.3000N	3890N
1-7	Carbon Content For uv resistance of outer layer	Heating Rate:20°C/min ISO7111 Gas Flow Rate:300cc/min Inert Gas:Nitrogen Oxidation Medium:Oxygen	Min.2~3%	2.52%
1-8	Resistance to Split propagation	200°C/15min	Split propagation ≤5mm	4.5mm
1-9	Corrosive Effect	Test Method:ASTM D2671 Method A at 120°C for 16hrs	non Corrosive	non Corrosive
1-10	Dielectric Strength	IEC 243 Jumps in steps of:2KV every 20 seconds	≥12KV/mm	18KV/mm
1-11	Fungus Resistance	Test Method:ISO 846 Method A	Max Rate 1	
1-12	Stress Crack Resistance	Test Method:ASTM 1693 Method B Immersion for 30Days	No Cracking	No Cracking

Specification of Heat Shrinkable Splice Closure



		in Igepal 10%		
1-13	Tightness of the laminate	Test pressure 200K pa (absolute) Test Duration:12hrs Test Done on unshrunk Sleeve with no adhesive	Must pass the tightness test	
1-14	Deformation and compression Test	Test Method: ISO 3303 Method A sleeve as delivered	Must pass the tightness test F≥1000N Test Point 30mm	
1-15	Water Absorption	DIN 53495 Method 3 sample stored for 24hrs in water at (23±2)°C The sleeve should be as delivered	≤0.1%	0.15%
1-16	Thermo chromic conversion	Color conversion At 300°C in oven after 5 min.		Passed
1-17	Tensile strength		Min 140Kg/cm²	145 Kg/cm²
1-18	Hardness		50-70 Shore D	63 Shore D
1-19	Impact Brittleness		<-40°C	-42.5°C
1-20	Volume resistivity		Min 10ą² Ohm cm	Passed



2. Adhesive Raw Material Requirements: Non Pressurized

No.	Type of Test	Test methods and conditions	Measured Values	Check Result
2-1	Water absorption	EN ISO 62 Method 1	≤0.5%	0.30%
2-2	Fungus Resistance	ISO 846, Method A	Max.Rate 1	
2-3	Environmental Stress Cracking	ASTM D1693 48hrs at 50°C in Air oven	No Cracking	No Cracking
2-4	Peel Strength	Test Temp.(23±2)°C on PE Cable Sheath on pb on AL At 60°C on PE sheathed Cable	≥200N/25mm ≥120N/25mm ≥120N/25mm ≥100N/25mm	265N/25mm 199N/25mm 225N/25mm 152N/25mm
2-5	Peel Strength Temperature Cycling	Temperature Cycle:-30°C to 60°C Cycle Duration:12hrs -2hrs from -30°C to 60°C -4hrs at 60°C -2hrs from 60°C to -30°C No.of cycles:14 on PE cable sheath test temperature:(23±2)°C	≥180N/25mm	229N/25mm
2-6	Peel strength after storage in water	168hrs at (23±2)°C Remaining in water test temperature 23°C	≥180N/25mm	221N/25mm
2-7	Peel strength after storage in chemicals	Sample remaining in the Following Solutions: For 24hrs: NA ₂ SO ₄ 0.1N NAOH 0.1N H ₂ SO4 0.1N NACL 0.1N ASTMOIL ASTMD 396 NO.1 ON PE cable sheath at (23±2)°C	≥180N/25mm ≥180N/25mm ≥180N/25mm ≥180N/25mm	≥247N/25mm ≥251N/25mm ≥260N/25mm ≥249N/25mm
2-8	Corrosive Effect	ASTM D 2671, Method A Duration of Test : 16h At A Temperature of 120°C	No Corrosion	No Corrosion
2-9	Shear strength	ISO 4587 Test Temperature (23±2)°C	≥40Kg/25cm²	49.3Kg/25cm²



2-10	Softening point	100±10°C	105.8°C
2-11	Environmental resistance (thermal ageing)	Min 8 Kg/25 cm²	9.8 Kg/25cm²
2-12	Water resistance	Min 8 Kg/25 cm²	12.4 Kg/25 cm²
2-13	Corrosive effect	No corrosion	No corrosion



3. Functional Requirements: Non Pressurized

No.	Type of Test	Test methods and conditions	Requirement	Check Result
3-1	Appearance		No Defects which will adversely affect product performance	None
3-2	Tightness	Test Temperature: (27±2)°C Test Time : 30 minutes Gas Pressure : 100kPa	No Continuous Emission of bubbles	None
3-3	Installation with a blue flame	Installation Temp: (23±2)°C Torch: Borrmann 20or30 or Equivalent Gas pressure: 150 kPa	No Splitting Tightness	None
3-4	Longitudinal shrinkage	Installation Temp: (23±2)°C Substrate: Maximum Application Diameter	<5% shrinkage	3.8% shrinkage
3-5	Flexibility	Force=500N(max) at 45° Duration=5min. 2 directions at 10x D from closure	no leakage during test or subsequent tightness test. 100 kpa/15min.	None
3-6	Split Propagation	Substrate: Maximum Edge cut: Application Diameter For oven Option: 5mm Perpendicular Time: 15mins Temperature: (200±2)°C	Split Propagation≤5mm	None
3-7	Torchability	Installation temp: (23±2)°C Torch: Borrmann 20or30 or Equivalent Gas pressure: 150 kPa Local Overheating: Yellow tip, 10secs	Tightness As in No. 3.2	None



4. Mechanical : Non Pressurized

No.	Type of Test	Test methods and conditions	Requirement	Check Result
4-1	Axial Tension	Test Temp.Range:(-15to+45)±2°C Load: D*/50x1000N (1000±10)N Max Test Time: 24hrs Each Cable	Tightness As in No. 3.2	None
4-2	Bending	Test Temp.Range: (-5to+45)±2°C Bend: 45°or300mm Displacement Force: Max.500N Clamp At : 10xD*(Min.250mm) Duration : 2Cycles/Cable	Tightness As in No. 3.2	None
4-3	Blunt Blade	Test Temp.Range: $(-15to + 45)\pm 2^{\circ}C$ Blunt Blade Wt: (6000 ± 50) gmDrop Height: $<0^{\circ}C-30$ cm, $\geq 0^{\circ}C-90$ cmSite of impact: 90° from seam No.of Impacts: 1	Tightness As in No. 3.2	None
4-4	Impact	Test Temp.Range: (-15to+45)±2°C Impact tool: Steel Ball Weight: (1000±10)gm Drop Height: 2m Site of Impact: 90° from seam No.of Impacts: 1	Tightness As in No. 3.2	None
4-5	Ladder Test	Test Temp.Range: (-5to+45)±2°C Load: 800N Clamp at: 10xD*(Min.250mm) Load Application: 2hrs	Tightness As in No. 3.2	None
4-6	Static Load	Test Temp.Range: (-15to+45)±2°C Time: 5minutes Load: (1000±10)N Area: 5 cm² ±10% No.Application: 2	Tightness As in No. 3.2	None
4-7	Torsion	Test Temp.Range: (-5to+45)±2°C Torque: Max.50Nm or 90° Rotation Clamp At: 10xD*(Min.250mm) Duration: 5cycles/cable	Tightness As in No. 3.2	None



4-8	Vibration	Test Temp.Range: (+1-to+45)±2°C Vibration: 10Hz, Sinusoidal Amplitude: 3mm (6mm peak-to-peak) Clamping: 10xD* Distance: (min:250mm) Test Time: 10days	Tightness As in No. 3.2	None
4-9	Electrical continuity	Temperature Cycle:-30°C to 60°C Cycle Duration:10hrs -2hrs from -30°C to 60°C -3hrs at 60°C -2hrs from 60°C to -30°C -3hrs at-30°C No.of cycles:5	Current 100mA	100mA
4-10	Water Electrical continuity	Temperature Cycle:-30°C to 60°C Cycle Duration:12hrs -2hrs from -30°C to 60°C -4hrs at 60°C -2hrs from 60°C to -30°C -4hrs at-30°C No.of cycles:10	Current 100mA	100mA



5. Environmental : Non Pressurized

No.	Type of Test	Test methods and conditions	Requirement	Check Result
5-1	Environmental Temperature Cycling	High Temperature: (60±2)°C Low Temperature: (-40±2)°C Dwell Time: 2.5hrs Transition time: 1.5hrs Cycle Duration: 10hrs Number of cycles: 10	Tightness As in No. 3.2	None
5-2	Freeze/Thaw	Test Temperature: ICE-Water/Water-Ice Number of Cycles: 20 Frequency: 2 per Day	Tightness As in No. 3.2	None
5-3	Resistance to Aggressive Media	Test Temperature: (23±2)°C Test Media: pH2, pH12 Diesel for Cars Petroleum Jelly Test Time: 30Days	Tightness As in No. 3.2	None
5-4	Resistance to Stress Cracking	Test Temperature: (50±2)°C Test Pressure: Test Medium: 10% Igepal Test Time: 7Days	Tightness As in No. 3.2	None
5-5	Moisture Vapor transmission	Test Temperature: (23±2)°C	Maximum 18 µg m/hr	9 μg m/hr



6. TEST PROCEDURE

6.1 Testing Method

All test specimen shall be conditioned at room temperature ($23\pm2^{\circ}C$) for 24hrs at least before test, and all temperatures allowance shall be $\pm2^{\circ}C$

6.2 Heat shrinkable closure (except Adhesive)

Unless otherwise specified, the test shall be done on unrecovered, cross linked, uncoated material, and all tests are performed at room temperature $(23\pm3^{\circ}C)$, other stipulated temperatures shall be held at $\pm 2^{\circ}C$. For pressurized closures the test pressure must be 100kPa and for non pressurized closures the test pressure should be 70kPa. For the duration of the test, continuously regulated pressure must be connected to the closure assembly.

6.2.1 Burst Strength

The method shall be ISO 3303 Method A.



6.2.2 Thermal Ageing

Samples shall be conditioned for 168hours at $150\pm2^{\circ}c$ in an air circulating oven. After conditioning, the samples shall be remove form the oven, cooled to ambient temperature, and subjected to the burst strength as per section 1.2.2

6.2.3 Carbon Content For UV resistance of outer layer The method shall be ASTM D-1603 latest issue.



- 6.2.4 Resistance to split propagation
- 6.2.4.1 A rectangular specimen, 50mm wide and 150mm long (in the shrink direction), shall be cut from the unrecovered material as material as delivered. (Uncoated)
- 6.2.4.2 An indelible line(unaffected by the recovery process) shall be drawn parallel to and 5mm from a long-edge.
- 6.2.4.3 A perpendicular cut shall be made approximately half-way long the same edge to the line.
- 6.2.4.4 The sample shall be clamped at both ends and held rightly so that no shrinking may occur during resting.
- 6.2.4.5 The test assembly shall be placed in an air-circulation oven at 175±2°c for 15minutes. After removal from the oven and cooling to room, temperature, the sample shall be inspected for cut propagation.
- 6.2.5 Corrosive Effect
 The method shall be ASTM D2671 97 Method A.
 Condition: Copper mirror / Test Temperature: 120±2°c / Test Time: 16hrs
- 6.2.6 Dielectric Strength The method shall be IEC 60243-1



6.2.7 Fungus Resistance



The method shall follow in principle of ASTM G-21 latest issue.

- 6.2.8 Tightness of the laminate
- 6.2.9 Water absorption Refer to the ISO 62 Method 1.
- 6.2.10 Visual inspection Sleeves should be free from flaws, defects, pinholes, and cracks.

6.3 Hot melt raw material

Unless otherwise specified, all tests shall be done on test plaques made up according to the procedure described in ISO 293. The thickness of the plaques shall be 2.0 ± 0.3 mm. They shall be pressed at a temperature of $140\pm5^{\circ}$ C and shall be cooled below 50°C before removal from the mould. Unless otherwise specified, all tests are performed at room temperature($23\pm3^{\circ}$ c), other stipulated temperatures shall be held at $\pm2^{\circ}$ c.

6.3.1 Water absorption

The water resistance shall be determined by measuring the adhesive peel strength as in Section 8.1 after immersion of the sample for 168 hours in water at $27\pm5^{\circ}$ c.

6.3.2 Fungus Resistance

The fungus resistance shall be determined in accordance with ASTM G-21 or lasts issue.

6.3.3 Peel strength

The adhesive peel strength shall be determined by the rolling drum peel test method. The test samples shall consist of uncoated sleeves of appropriate size and a sheet of adhesive under test, installed on straight cylindrical substrates in the form of polyethylene cable jackets. The sheet of adhesive shall be approximately 1mm thick. The sample preparation and jacket bonding techniques are described in 2-5.

The specimen shall remain at room temperature for one day before cutting the samples into 25mm wide sections as illustrated in figure 1. Exposure to any specified medium shall be done at this stage.

The specimen shall be placed in a tensile testing machine, with the specimen around the positioning mandrel and the free end of the specimen inserted into the tensile testing machine jaw as illustrated in figure 2. The holding fixture shall be constructed so that the joke is free to rotate during testing. The test samples shall be preconditioned at the test temperature for a period of 20 minutes. Testing shall be with a jaw separation speed of 50mm per minute. Readings of peel strength shall be taken at every 12.5mm of jaw separation after an initial separation of 25mm. The average of five readings shall define peel strength.





<Figure 1>

6.3.5 Corrosive Effect

The method shall be ASTM D2671 97 Method A. Condition: Copper mirror / Test Temperature : 120±2°c / Test Time : 16hrs



6.3.6 Shear strength

Specification of Heat Shrinkable Splice Closure



Refer to the ISO 4587.



6.4.1 Installed product

6.4.2. Appearance

Free from flaws, defects, pinholes cracks, inclusion

6.4.3 Tightness

The tightness of installed closures shall be checked by pressurizing to 70kPa for non pressurized Closures and 100kPa for pressurized closures for a period of 15 minutes while immersed in water at room temperature. A sample shall be considered tight if there is no continuous stream of air bubbles escaping from it.



6.4.4 Flexibility



6.4.5 Split propagation

A 5mm long clean cut shall be made approximately half-way along and perpendicular to one sleeve edge prior to installation(approved torch or oven) onto a cylindrical, smooth wooden or aluminum tubing mandrel. Then mandrel outer diameter shall be the maximum usable diameter

of the product as indicated by the applicable installation instructions. After installation is complete there shall be no significant propagation of the cut, as determined by examination with the naked eye.

6.4.6 Torch ability

Immediately after installation of a sleeve according to the applicable installation instructions, with an approved torch set at a gas pressure of 150kPa, the tip of a yellow flame shall be allowed to impinge on an area of the sleeve for 10 seconds. The sleeve shall then be subjected to the tightness test as described in section 3.2

6.4.7 Axial Tension.

The test temperature shall be in the range -15°C to 45°C. An axial tensile force of D/45x1000N, with a maximum of 1000±10N shall be applied on each individual cable protruding from the



specimen (D is the cable outside diameter in mm). Each cable shall be tested individually for 24hours. After completing the test samples shall be subjected to the tightness test as described in section 3.2



6.4.8 Bending

The test temperature shall be in the range -5° C to 45° C. The specimen shall be clamped on a smooth, flat, horizontal surface. A bending force of maximum 500N shall be applied at a distance of 10 x D, minimum 250mm, from the sleeve edge on each extending cable to deflect the cable to an angle of maximum of 45° (or a maximum deflection of 300mm from the horizontal) at the point of application of the force.(D is the cable outside diameter)

Each cable shall be tested individually. A bending cycle shall consist of one excursion of the cable (s) from the neutral position in one direction to the limit specified, maintained for 5 minutes, returned to the neutral position and bent in the opposite direction to the limit specified, maintained for 5 minutes and returned to the neutral position. After 2 cycles per cable, samples shall be subjected to the tightness test as described in section 3.2

6.4.9 Impact

The test temperature shall be in the range -15°C to 45°C. Installed specimens shall be placed on a smooth, flat, horizontal surface. The rail shall be rotated 90°C from the point of impact.

A steel ball weighing 1Kg shall be suspended at a height of 2 meters above the centre of the test specimen. Then weight shall be allowed to fall under gravity, striking the test specimen at the apex of curvature, within 30 seconds of preconditioning. After inspection with the naked eye, samples shall be subjected to the tightness test as described in section 6.4.2 for test pressure refers to the item.

6.4.10 Ladder



The test temperature shall be between -5 and 45° C. Installed samples shall be clamped at a distance of 10 x D. Where D is the cable diameter, from the sleeve ends. The minimum distance shall be 250mm. In the case of more than one cable, the largest diameter shall be used for the calculation and cables shall be clamped together. The test set-up shall be arranged so that sample displacement cannot exceed 300mm. A load of 800N shall be applied to the sleeve by means of a die its mid-point. After two hours the load shall be removed, the sample rotated 180° along its longitudinal axis, re-clamped and the procedure repeated. After completing the test, samples shall be subjected to the tightness test as described in section 3.2

6.4.11 Static Load

The test temperature shall be in the range -15°C to 45°C. A static Load of 1000±10N shall be placed in the centre of the joint closure 90° from the seam, using a circular compression die of 5Cm² surface area. The load shall be applied for 5 minutes, then removed, the sample turned through 180°, and the load reapplied for an additional five minutes. After completing the test, samples shall be subjected to the tightness test as described in section 3.2

6.4.12 Torsion

The test temperature shall be in the range -5° C to 45° C. The specimen shall be clamped rigidly. Extending cables shall be gripped at a distance of 10 x D from the sleeve edge (D is the cable outside diameter). Each cable shall be tested individually.

A torsion cycle shall consist of each cable being subjected to a torsion stress in one direction of 50Nm maximum or an angle of maximum 90° for a period of 5 minutes. The cable shall be returned to its original position and the same maximum torsion then applied in the opposite direction for 5 minutes. The cable shall then be returned to its neutral position. After 5 cycles per cable, samples shall be subjected to the tightness test as described in section 3.2

6.4.13 Vibration

The test specimen shall be between 10 and 45°C. A test specimen shall be mounted on a vibration

apparatuses with the cables rigidly clamped at distances of $10 \times D$, minimum 250mm, from each end of the sleeve. D is the cable outer diameter ; in the case of more than one cable the outer diameter of the largest cable is used.

The centre point of the sample shall be subjected to a sinusoidal vibration with a frequency of 10Hz and an amplitude of 3mm(6mm peak-to-peak) for a period of 10days. After completing the test, samples shall be subjected to the tightness test described in section 3.2

6.5 Environmental Test

6.5.1 Environmental Temperature cycling

The test specimen shall be inserted in or pulled out from the temperature cycling chamber at 23°c



During the test, the regulated pressurized air shall be supplied continually. The air shall be dry air or nitrogen with dew point not be higher than -40°c.

The pressure drop of supplied air is checked by locking the valve on occasion during the test. But the pressure drop which is caused by temperature is not considered as a leakage.

After completion of the test as prescribed, the specimen shall be pull out when chamber is maintained at 23°c and the specimen shall be subjected to the tightness test described in 3.2 Test condition is same as below drawing.





6.5.2 Freeze / Thaw

The installed specimen shall be placed at least 5cm below the water surface. The water bath shall be temperature cycled so that the water changes. Alternately from the complete solid to the complete liquid state. The frequency of cycling shall be two cycles per day.

Sample shall be pressurized during the test with an internal regulated pressure of 40 ± 2 kPa. After completing the number of cycles the specimen shall be submitted to the tightness test described in section 3.2

6.5.3 Resistance to Stress Cracking



The installed specimen shall be submerged in a 10% solution of Igepal, maintained at (50±2°c) whilst under an internal pressure of 40 kPa.

After 7days, samples shall be inspected for cracking visible to the naked eye, then subjected to the tightness test as described in section 3.2

6.5.4 Moisture Vapor transmission

The test sample prepared shall be connected to the measuring system with suitable stainless steel tubing and connectors and shall be fully immersed in a water at room temperature. Dry air shall be continuously purged through the samples at a continuously purged through the samples at a constant rat of 10cc9mm. For the duration of the test. The sampling gas stream shall be analyzed every 24hours for water content by means of a hygrometer and flow meter or other suitable arrangement until a constant rate of permeation is achieved. This shall be recorded as the water vapor permeability rate.

6.5.5 Immersion test

The closure shall be submerged to a depth of 1 meter in a bath of 0.2 grams of sodium fluorescent per liter of 5% salt water at room temperature for 10 days. The cable ends shall be long enough to extend above the water level. Remove the closure from the bath, dry the outside surface completely. Carefully disassembly the closure examining the splicing

bundle with on ultraviolet light source for traces of the fluorescent water.

7. TEST STANDARD

7.1 ISO 62

(ASTM D 570) Test Method to determine the water absorption of plastic materials

7.2 ISO 188

Test Method to determine the thermal aging or heat resistance off vulcanized rubbers

7.3 ISO 527-2

Determination of tensil properties

7.4 ISO 846

Plastic-Determination of behavior under the action of fungi and bacteria

7.5 ISO 1408

Determination of carbon black content, pyrolytic method

7.6 ISO 3303

Methods of test for coated fabrics

7.7 IEC 243

Recommended Methods of test for electric strength of solid insulating materials

7.8 ASTM D 1693

Test Method for Environmental Stress-Cracking of Ethylene Plastics

7.9 ASTM D 396



Standard Specification for Fuel Oils

7.10 ASTM D 2565

Standard Practice for Xenon-Arc Exposure of Plastics Intended for Outdoor Applications

7.11 ASTM D 2671

Test Method for the determination of the corrosive effect



8. TEST MACHINERY



1. Heat Cycle Test Machine



2. Heat Storage Test





4. Torsion Test Machine



5. Flection Test Machine



6. Vibration Test Machine



3. Universal Test

Machine

7. Pressure Time Test Machine



8. Axial compression Test Machine



Corrosion Test Machine



13. Low-Temperature Tester



14. Softening Point

Tester



11. Model

15. Axial Test

Machine





16. Impact Test

Machine

