

Braided Expandable Sleeving Global Passenger Rail Standards Compliance

Panduit Braided expandable sleeving is made from a polyethylene terephthalate material that is compliant with U.S. and many European fire safety standards for passenger rail rolling stock.

Each section below identifies the applicable Country/Region standards and includes a summary of data gathered from independent lab tests conducted on the braided expandable sleeving. The independent lab test reports are available upon request (see end of document).



French Railway AFNOR Standards (and AFNOR influenced regions)

Codes and Standards

- French Standard AFNOR NF F16 101 Railway Rolling Stock Fire Behaviour and Choice of Materials (Jul. 2008)

Test Methods

- Flammability
 - NF EN 60695-2 Glowing Wire Test at 850 +/- 15 °C and 960 +/- 15 °C
 - NF EN ISO 4589-2 Oxygen Index determination
- Smoke Density
 - NF X 10-702 Smoke Density determination
- Toxicity
 - NF X 70-100 Pyrolysis and combustion gas analysis

Braided Expandable Sleeving (Polyethylene Terephthalate) Test Result Summary

- Test Results Summary – Flame Retardant Braided Expandable Sleeving (Polyethylene Terephthalate)

| Test Method or Standard | Parameter | Result | Classification |
|--------------------------|-------------------------------------|---|-------------------|
| | | T1 @ 2mm diameter | T1 @ 2mm diameter |
| NF EN ISO 4589-2 | OI (Oxygen Index) | 22.48% | I4 |
| NF EN 60695-2 | Glowing Wire @ 850°C | No ignition | |
| | Glowing Wire @ 960°C | Ignition without flame after have removed the glow wire | |
| NF X 10-702 | Dm (Smoke Maximum Density) | 170.7 | F2 |
| | VOF4 (Smoke Opacity @ 4 min.) | 468.0 | |
| NF X 70-100 | ITC (Conventional Toxicity Index) | 39 | |
| NF F16-101 and STM-S 001 | IF (Smoke index - F classification) | 37 | |

The classification of the Flame Retardant Braided Expandable Sleeving Product Line = I4/F2.

Braided Expandable Sleeving Global Rail Standards Compliance

- **Test Results Summary – Standard Retardant Braided Expandable Sleeving (Polyethylene Terephthalate)**

| Test Method or Standard | Parameter | Result | | Classification | |
|--------------------------|-------------------------------------|---------------------|---------------------|---------------------|---------------------|
| | | T1 @ .008" diameter | T2 @ .010" diameter | T1 @ .008" diameter | T2 @ .010" diameter |
| NF EN ISO 4589-2 | OI (Oxygen Index) | 29.5% | 30.2% | I3 | I3 |
| NF EN 60695-2 | Glowing Wire @ 850°C | No ignition | No ignition | | |
| | Glowing Wire @ 960°C | No Ignition | No Ignition | | |
| NF X 10-702 | Dm (Smoke Maximum Density) | 56 | 106 | F2 | F2 |
| | VOF4 (Smoke Opacity @ 4 min.) | 34 | 192 | | |
| NF X 70-100 | ITC (Conventional Toxicity Index) | 49.66 | 27.44 | | |
| NF F16-101 and STM-S 001 | IF (Smoke index - F classification) | 27 | 21 | | |

The classification of the Standard Retardant Braided Expandable Sleeving Product Line = I3/F2.

Italian Railway Standards (UNIFER)

Codes and Standards

- UNIFER Italian Railway Standards

Test Methods

- Flammability
 - EN ISO 11925-2:2002 – Reaction to fire tests-Ignitability of building products subjected to direct impingement of flame – Part 2: Single – flame source test. 30 seconds.

Flame Retardant Braided Expandable Sleeving (Polyethylene Terephthalate) Test Result Summary

- **Test Results Summary**

| Test Method | Run No. | Time to Ignition (s) | Duration of Specimen Flaming (s) | Afterflame Time | Flaming Debris* | Burn to 150mm |
|---------------------|---------|----------------------|----------------------------------|-----------------|-----------------|---------------|
| EN ISO 11925-2:2002 | 1 | 0 | 2 | 0 | None** | No |
| | 2 | 0 | 1 | 0 | Yes | No |
| | 3 | 0 | 1 | 0 | Yes | No |
| | 4 | 0 | 1 | 0 | Yes | No |
| | 5 | 0 | 1 | 0 | Yes | No |
| | 6 | 0 | 1 | 0 | Yes | No |

*Flaming debris is indicated by ignition of the paper beneath the specimen, per the standard.

**The flaming droplet fell outside of the drip pan.

Braided Expandable Sleeving Global Rail Standards Compliance

German Standards (DIN)

Codes and Standards

- German Standard DIN 5510-2: Preventive fire protection in railway vehicles – Part 2: Fire behaviour and fire side effects of materials and parts; Classification, requirements and test methods.

Test Methods

- DIN 54837 (Testing of materials, small components and component sections for rail vehicles – Determination of burning behavior using a gas burner. 07/2008)

Braided Expandable Sleeving (Polyethylene Terephthalate) Test Result Summary

- Test Results Summary – Flame Retardant Braided Expandable Sleeving (Polyethylene Terephthalate)

| DIN 54837 test results: braided expandable sleeving material samples at 0.254mm nominal thickness | | | | | | | |
|---|---|-------------------------------|-----|-----|------|-----|------|
| | | Single value for specimen no. | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | Avg. |
| Flaming at | [s] | 1 | 1 | 1 | 1 | 1 | 1 |
| Afterflame | [s] | 0 | 0 | 0 | 0 | 0 | 0 |
| Glowing | Occurs [s] | – | – | – | – | – | – |
| | Afterglow [s] | – | – | – | – | – | – |
| Flame height | Max. [cm] | 20 | 20 | 20 | 20 | 20 | 20 |
| | Reached at [s] | 4 | 4 | 4 | 4 | 4 | 4 |
| Dripping off of parts | Dripping off | Yes | Yes | Yes | Yes | Yes | Yes |
| | Burning, time [s] | 6 | 15 | 4 | 3 | 4 | 6 |
| Burned length | [cm] | 10,5 | 16 | 16 | 11,5 | 13 | 13 |
| Extinguished | [s] | No | No | No | No | No | No |
| Smoke density | Max. [%] | 2 | 2 | 2 | 3 | 2 | 2 |
| | At time [s] | 8 | 8 | 8 | 6 | 12 | 8 |
| | Integral [%min.] | 1 | 1 | 1 | 1 | 1 | 1 |
| Burn through or melting | [yes/no] | No | No | No | No | No | No |
| Observations | For the testing the samples were not stretched, the end of the samples were clamped on the frame, in the middle the sample was fixed with a wire. | | | | | | |

- DIN 5510/2 Classification: Flame Retardant Braided Expandable Sleeving (Polyethylene Terephthalate)

Classification Requirements According to DIN 5510/2

| Burning Class | Smoke Class | Dripping Class |
|---|------------------------------------|---|
| S1 Test according DIN 53438 required | | |
| S2 Damaged length ≤ 30 cm | | |
| S3 Damaged length ≤ 25 cm, afterflame ≤100s | SR1 not reached – int. > 100% min. | |
| S4 Damaged length ≤ 20 cm, afterflame ≤10s | SR1 Int. ≤ 100% min. | ST1 Burning/falling drops, afterflame of drops > 20 s |
| S5 Damaged length = 0 cm | SR2 Int. ≤ 50% min. | ST2 No dripping/no falling drops |

| | | | |
|--|-----|------|------|
| Flame Retardant Braided Expandable Sleeving Classification (0.254mm nominal thickness) | S-4 | SR-2 | ST-2 |
|--|-----|------|------|

Braided Expandable Sleeving Global Rail Standards Compliance

- **Test Results Summary – Standard Retardant Braided Expandable Sleeving (Polyethylene Terephthalate)**

| DIN 54837 test results: braided expandable sleeving material samples at 0.254mm nominal thickness | | | | | | | |
|---|---|-------------------------------|-----|-----|-----|-----|------|
| | | Single value for specimen no. | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | Avg. |
| Flaming at | [s] | 1 | 1 | 1 | 1 | 1 | 1 |
| Afterflame | [s] | 0 | 0 | 0 | 0 | 0 | 0 |
| Glowing | Occurs [s] | – | – | – | – | – | – |
| | Afterglow [s] | – | – | – | – | – | – |
| Flame height | Max. [cm] | 15 | 15 | 20 | 20 | 20 | 18 |
| | Reached at [s] | 4 | 8 | 8 | 7 | 6 | 7 |
| Dripping off of parts | Dripping off | Yes | Yes | Yes | Yes | Yes | Yes |
| | Burning, time [s] | 1 | 1 | 1 | 1 | 1 | 1 |
| Burned length | [cm] | 8 | 8 | 7 | 7 | 7 | 7 |
| Extinguished | [s] | No | No | No | No | No | No |
| Smoke density | Max. [%] | 1 | 2 | 1 | 2 | 2 | 2 |
| | At time [s] | 5 | 5 | 5 | 5 | 5 | 5 |
| | Integral [%min.] | 1 | 1 | 1 | 1 | 1 | 1 |
| Burn through or melting | [yes/no] | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | For the testing the samples were not stretched, the end of the samples were clamped on the frame, in the middle the sample was fixed with a wire. | | | | | | |

- **DIN 5510/2 Classification: Standard Retardant Braided Expandable Sleeving (Polyethylene Terephthalate)**

Classification Requirements According to DIN 5510/2

| Burning Class | Smoke Class | Dripping Class |
|---|------------------------------------|---|
| S1 Test according DIN 53438 required | | |
| S2 Damaged length ≤ 30 cm | | |
| S3 Damaged length ≤ 25 cm, afterflame ≤100s | SR1 not reached – int. > 100% min. | |
| S4 Damaged length ≤ 20 cm, afterflame ≤10s | SR1 Int. ≤ 100% min. | ST1 Burning/falling drops, afterflame of drops > 20 s |
| S5 Damaged length = 0 cm | SR2 Int. ≤ 50% min. | ST2 No dripping/no falling drops |

| | | | |
|---|-----|------|------|
| Flame Retardant Braided Expandable Sleeving Classification (0.25mm nominal thickness) | S-4 | SR-2 | ST-2 |
|---|-----|------|------|

Braided Expandable Sleeving Global Rail Standards Compliance

- **Test Results Summary – Fray Resistant Braided Expandable Sleeving (Polyethylene Terephthalate)**

| DIN 54837 test results: braided expandable sleeving material samples at 0.2032mm nominal thickness | | | | | | | |
|---|---|-------------------------------|-----|-----|-----|-----|------|
| | | Single value for specimen no. | | | | | |
| | | 1 | 2 | 3 | 4 | 5 | Avg. |
| Flaming at | [s] | 1 | 1 | 1 | 1 | 1 | 1 |
| Afterflame | [s] | 0 | 0 | 0 | 0 | 0 | 0 |
| Glowing | Occurs [s] | – | – | – | – | – | – |
| | Afterglow [s] | – | – | – | – | – | – |
| Flame height | Max. [cm] | 17 | 17 | 20 | 20 | 20 | 19 |
| | Reached at [s] | 5 | 5 | 5 | 5 | 5 | 5 |
| Dripping off of parts | Dripping off | Yes | Yes | Yes | Yes | Yes | Yes |
| | Burning, time [s] | 0 | 0 | 0 | 0 | 0 | 0 |
| Burned length | [cm] | 7 | 8 | 7 | 7 | 7 | 7 |
| Extinguished | [s] | No | No | No | No | No | No |
| Smoke density | Max. [%] | – | – | – | – | – | – |
| | At time [s] | – | – | – | – | – | – |
| | Integral [%min.] | 1 | 1 | 1 | 1 | 1 | 1 |
| Burn through or melting | [yes/no] | No | No | No | No | No | No |
| Observations | For the testing the samples were not stretched, the end of the samples were clamped on the frame, in the middle the sample was fixed with a wire. | | | | | | |

- **DIN 5510/2 Classification: Fray Resistant Braided Expandable Sleeving (Polyethylene Terephthalate)**

Classification Requirements According to DIN 5510/2

| Burning Class | Smoke Class | Dripping Class |
|---|------------------------------------|---|
| S1 Test according DIN 53438 required | | |
| S2 Damaged length ≤ 30 cm | | |
| S3 Damaged length ≤ 25 cm, afterflame ≤100s | SR1 not reached – int. > 100% min. | |
| S4 Damaged length ≤ 20 cm, afterflame ≤10s | SR1 Int. ≤ 100% min. | ST1 Burning/falling drops, afterflame of drops > 20 s |
| S5 Damaged length = 0 cm | SR2 Int. ≤ 50% min. | ST2 No dripping/no falling drops |

| | | | |
|---|------------|-------------|-------------|
| Flame Retardant Braided Expandable Sleeving Classification (0.254mm nominal thickness) | S-4 | SR-2 | ST-2 |
|---|------------|-------------|-------------|

Availability of Independent Lab Test Reports

Copies of test results are available upon request: cs@panduit.com or 800-777-3300.

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