



## QUALIFICATION TEST REPORT RBK-ILS-125 TUBING

**Tested in accordance with 108-120003, Revision A**

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## QUALIFICATION TEST REPORT

|  |  |
|--|--|
| <b>PRODUCT</b>   | <b>RBK-ILS-125, Dual Wall, Black Tubing</b>  |
| <b>SPECIFICATION</b>   | <b>108-120003, Revision A</b>  |
| <b>REPORT NUMBER</b>   | <b>501-120291</b>  |
| <b>QUALIFICATION DATE</b>  | <b>October 06, 2022</b>  |
| <b>TUBING BATCH NUMBERS</b>  | <b>RBK-ILS-125-NR1-0-50MM, LOT# 22TR1264T<br/>RBK-ILS-125-NR3-0-65MM, LOT# 22TR1423T</b> |
| <b>TUBING MANUFACTURING SITE</b>   | <b>Czech Republic</b>  |
| <b>QUALIFICATION LABORATORIES</b>  | <b>Trutnov CZ and Swindon UK</b>   |
| <b>LAB BOOK / TSL NUMBER REFERENCE /<br/>PROJECT NUMBER<br/>IF AVAILABLE</b> | <b>TuTSL Number - 220062<br/>TNT Number - 2961</b>                                       |

### CONCLUSION

The test results in the following table show that the product meets all the requirements of 108-120003, Revision A specification.

### APPROVAL

Report approved electronically via PDM link.

## RBK-ILS-125 Tubing Qualification Report



| Test   | Requirement  | Results                 |                         |
|--|--|-------------------------|-------------------------|
|  |  | NR1                     | NR3                     |
| Dimensions, mm<br>ASTM D2671-21                    |  |                         |                         |
| Supplied Inside Diameter                           | 5.75 Min.  | 6.65                    | --                      |
|  | 11.0 Min.  | --                      | 11.70                   |
| Recovered Inside Diameter                          | 1.25 Max.  | 1.09                    | --                      |
|  | 2.40 Max.  | --                      | 2.03                    |
| Recovered Jacket Inside Diameter                   | 2.65 Max.  | 2.37                    | --                      |
|  | 4.65 Max.  | --                      | 4.31                    |
| Recovered Total Wall                               | 1.15 Min.  | 1.40                    | --                      |
|  | 1.80 Min.  | --                      | 1.97                    |
| Recovered Jacket Wall                              | 0.60 Min.  | 0.66                    | --                      |
|  | 0.80 Min.  | --                      | 0.98                    |
| Longitudinal Change, %<br>ASTM D2671-21            | 0 to -10   | -4                      | -7                      |
| Inner Wall Flow                                    | Total blocking (in at least one area of the splice length) | Pass                    | Pass                    |
| Split Resistance<br>10 mins. ± 30 sec. @ 200 ± 5°C |  |                         |                         |
| Size NR1 use a 3/16" Mandrel OD                    | No splitting @ 200°C                                       | Pass                    | Pass                    |
| Size NR3 use a 3/8" Mandrel OD                     |  |                         |                         |
| Strain Relief, N *<br>Followed by test for:        | 50 Min.  | Pass                    | Pass                    |
| Insulation Resistance, Ohms                        | 2.00 x 10 <sup>8</sup> Min.                                | 5.80 x 10 <sup>10</sup> | 3.80 x 10 <sup>10</sup> |
| Flammability<br>ISO 6722-1:2011                    | Self-extinguishing within 30 seconds                       | Pass<br>(0 seconds)     | Pass<br>(0 seconds)     |

\* Tested in Swindon.

## RBK-ILS-125 Tubing Qualification Report



| Test  | Requirement                               | Results                 |                         |
|---|---|-------------------------|-------------------------|
|   |   | NR1                     | NR3                     |
| Scrape Abrasion, cycles *<br>ISO 6722-1:2011                                | NR1 500 Min.<br>NR3 5,000 Min.            | > 1,000<br>--           | --<br>> 6,000           |
| Heat Ageing Long Term *<br>3,000 hrs. @ 125 ± 3°C<br>Followed by tests for: |   |                         |                         |
| Visual  | No cracking of tubing jacket              | Pass                    | Pass                    |
| Insulation Resistance, Ohms   | 2.00 x 10 <sup>8</sup> Min.               | 3.96 x 10 <sup>8</sup>  | 3.83 x 10 <sup>8</sup>  |
| Tensile Strength, MPa<br>ISO 37:2019  | 10.0 Min.                                 | 18.6                    | 19.5                    |
| Ultimate Elongation, %<br>ISO 37:2019                                       | 250 Min.                                  | 476                     | 499                     |
| 2% Secant Modulus, MPa<br>ASTM D882-18                                      | 137 Min.                                  | 344                     | 276                     |
| Volume Resistivity, Ohm-cm<br>ASTM D2671-21                                 | 1.00 x 10 <sup>12</sup> Min.              | 2.04 x 10 <sup>15</sup> | 4.25 x 10 <sup>15</sup> |
| Thermal Indentation *<br>ISO 6722-1:2011                                    | Minimum of 40% residual<br>wall thickness | Pass<br>(86,91)         | Pass<br>(86,90)         |
| Copper Mirror Corrosion<br>ASTM D2671-21                                    | No corrosion of the copper<br>mirror      | Pass                    | Pass                    |
| Dielectric Strength, MV/m<br>IEC 60243-1:2013                               | 16.0 Min.                                 | 20.7                    | 21.3                    |
| Specific Gravity<br>ISO 1183-1:2019   | 1.20 Max.                                 | 1.18                    | 1.15                    |
| Water Absorption, %<br>ISO 62:2008  | 0.50 Max.                                 | 0.10                    | 0.14                    |

\* Tested in Swindon.

## RBK-ILS-125 Tubing Qualification Report



| Test  | Requirement                  | Results                 |                         |
|---|------------------------------|-------------------------|-------------------------|
|   |                              | NR1                     | NR3                     |
| Sequential Test Results *   |                              |                         |                         |
| Insulation Resistance Test, Ohms  | 2.00 x 10 <sup>8</sup> Min.  | 4.70 x 10 <sup>9</sup>  | 7.90 x 10 <sup>9</sup>  |
| Cold Impact<br>4 hrs. @ -40 ± 2°C<br>ISO 6722-1:2011<br>Followed by tests for:                            |                              |                         |                         |
| Visual  | No cracking of tubing jacket | Pass                    | Pass                    |
| Insulation Resistance, Ohms   | 2.00 x 10 <sup>8</sup> Min.  | 1.25 x 10 <sup>10</sup> | 1.20 x 10 <sup>9</sup>  |
| Accelerated Heat Ageing<br>168 ± 2 hrs. @ 130 ± 5°C<br>Followed by tests for:                             |                              |                         |                         |
| Visual  | No cracking of tubing jacket | Pass                    | Pass                    |
| Insulation Resistance, Ohms   | 2.00 x 10 <sup>8</sup> Min.  | 4.30 x 10 <sup>10</sup> | 1.84 x 10 <sup>10</sup> |
| Thermal Shock<br>1 hr. ± 5 mins. @ 130 ± 5°C/30 ± 2 mins. @ 0 to 5°C (5 cycles)<br>Followed by tests for: |                              |                         |                         |
| Visual  | No cracking of tubing jacket | Pass                    | Pass                    |
| Insulation Resistance, Ohms   | 2.00 x 10 <sup>8</sup> Min.  | 7.69 x 10 <sup>8</sup>  | 1.24 x 10 <sup>10</sup> |
| Temperature Humidity Cycling<br>Followed by test for:   |                              |                         |                         |
| Insulation Resistance, Ohms   | 2.00 x 10 <sup>8</sup> Min.  | 4.00 x 10 <sup>9</sup>  | 1.60 x 10 <sup>9</sup>  |
| Mechanical Vibration **<br>IEC 60068-2-6<br>Followed by test for:   |                              |                         |                         |
| Insulation Resistance, Ohms   | 2.00 x 10 <sup>8</sup> Min.  | 4.70 x 10 <sup>10</sup> | 1.54 x 10 <sup>10</sup> |

\*\* Tested in Shanghai.

## RBK-ILS-125 Tubing Qualification Report



| Test  | Requirement                        | Results                 |                         |
|---|------------------------------------|-------------------------|-------------------------|
|   |                                    | NR1                     | NR3                     |
| Sequential Test Results *   |                                    |                         |                         |
| Flex Test (Ambient)<br>Followed by test for:  |                                    |                         |                         |
| Insulation Resistance, Ohms   | 2.00 x 10 <sup>8</sup> Min.        | 5.90 x 10 <sup>9</sup>  | 2.50 x 10 <sup>9</sup>  |
| Voltage Withstand   | No breakdown at 1kV after 1 minute | Pass                    | Pass                    |
| Fluid Compatibility<br>30 ± 2 mins. @ 23 ± 2°C<br>Followed by tests for:                            |                                    |                         |                         |
| Diesel Fuel<br>Insulation Resistance, Ohms  | 2.00 x 10 <sup>8</sup> Min.        | 8.70 x 10 <sup>10</sup> | 2.37 x 10 <sup>10</sup> |
| Brake Fluid DOT 4<br>Insulation Resistance, Ohms  | 2.00 x 10 <sup>8</sup> Min.        | 4.00 x 10 <sup>10</sup> | 8.00 x 10 <sup>9</sup>  |
| Engine Cleaner GUNK Degreaser<br>Insulation Resistance, Ohms  | 2.00 x 10 <sup>8</sup> Min.        | 1.16 x 10 <sup>11</sup> | 5.30 x 10 <sup>10</sup> |
| Petrol (without oxygen compounds),<br>ISO 1817 Liquid C<br>Insulation Resistance, Ohms              | 2.00 x 10 <sup>8</sup> Min.        | 3.80 x 10 <sup>10</sup> | 1.55 x 10 <sup>10</sup> |
| Screen Wash (50% Isopropanol / 50%<br>Distilled Water by vol)<br>Insulation Resistance, Ohms        | 2.00 x 10 <sup>8</sup> Min.        | 7.80 x 10 <sup>10</sup> | 2.50 x 10 <sup>9</sup>  |
| Carwash Detergent (1% Teepol / 99%<br>Distilled Water by vol)<br>Insulation Resistance, Ohms        | 2.00 x 10 <sup>8</sup> Min.        | 2.06 x 10 <sup>10</sup> | 6.10 x 10 <sup>9</sup>  |
| Battery Acid<br>Insulation Resistance, Ohms   | 2.00 x 10 <sup>8</sup> Min.        | 4.10 x 10 <sup>10</sup> | 5.90 x 10 <sup>9</sup>  |
| Engine Coolant (50% Ethylene Glycol /<br>50% Distilled Water by vol)<br>Insulation Resistance, Ohms | 2.00 x 10 <sup>8</sup> Min.        | 9.30 x 10 <sup>10</sup> | 1.81 x 10 <sup>10</sup> |

## RBK-ILS-125 Tubing Qualification Report



| Test  | Requirement                 | Results                 |                         |
|---|-----------------------------|-------------------------|-------------------------|
|   |                             | NR1                     | NR3                     |
| Sequential Test Results *   |                             |                         |                         |
| Fluid Compatibility<br>30 ± 2 mins. @ 100 ± 3°C<br>Followed by tests for: |                             |                         |                         |
| ISO 1817 Oil No.1 (IRM 901)<br>Insulation Resistance, Ohms                | 2.00 x 10 <sup>8</sup> Min. | 1.70 x 10 <sup>11</sup> | 5.60 x 10 <sup>10</sup> |
| Automatic Transmission Fluid Dextron VI<br>Insulation Resistance, Ohms    | 2.00 x 10 <sup>8</sup> Min. | 2.13 x 10 <sup>11</sup> | 7.20 x 10 <sup>10</sup> |

\* Tested in Swindon.

## RBK-ILS-125 Tubing Qualification Report



| Key Equipment Used       |  |                 |                         |
|--------------------------|--|-----------------|-------------------------|
| Equipment Name           | Equipment Model                          | Calibration No. | Calibration Expire Date |
| Micrometer               | Digital micrometer with center 0-25 mm   | QL M5675        | 09/2023                 |
| Caliper                  | Digital                                  | QL M5671        | 10/2022                 |
| Ruler                    | 300 x 30 x 1 mm                          | M5724           | 10/2022                 |
| Stopwatch                | TM 44                                    | E4906           | 04/2024                 |
| Stopwatch                | Fisherbrand                              | E4897           | 11/2022                 |
| Pin Gauge set # 2        | Meyer Gage Company Inc. -- 1,52-7,70 mm  | M5668           | 07/2026                 |
| Pin Gauge set # 3        | Meyer Gage Company Inc. -- 7,72-12,70 mm | M5687           | 09/2026                 |
| Microscope               | MicroVu, SOL 161                         | M5848           | 10/2022                 |
| Thermocouple             | FLUKE 52 II + FLUKE 80PK-25              | E4885           | 10/2022                 |
| Tensile Machine #1       | Instron 3345                             | M5869           | 08/2023                 |
| Tensile Machine #2       | Instron 3345                             | M5870           | 08/2023                 |
| High Resistance Meter    | Keysight B2987A                          | E4991           | 05/2023                 |
| Glass Thermometer        | 0 - 360°C                                | E4941           | 10/2023                 |
| Dielectric Tester        | Hypotronic, 7100-2D149-5B                | E4929           | 09/2024                 |
| Analytical Scale         | Ohaus AX224                              | M5801           | 04/2023                 |
| Temperature Sensor #4    | MAC -- 00-80-A3-B1-96-1C                 | E4873           | 03/2023                 |
| Temperature Sensor #12   | MAC -- 00-80-A3-B1-88-A8                 | E4881           | 09/2023                 |
| MKIV RBK Processor       |  | 16G0133         | 01/2023                 |
| IR tester (Norma)        |  | 56927 AA        | 02/2023                 |
| H5KS - TX0252 Tensometer |  | WCTEN16         | 03/2023                 |
| Oven AT30                |  | 89/04/113       | 02/2023                 |



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| Key Equipment Used                       |                    |                 |                         |
|--|--------------------|-----------------|-------------------------|
| Equipment Name                           | Equipment Model    | Calibration No. | Calibration Expire Date |
| Digital Thermometer                      |                    | 03002908        | 12/2022                 |
| Scales (PC4400)                          |                    | TS15            | 04/2023                 |
| Stop Clock                               |                    | ASC06           | 12/2022                 |
| Oven AT03                                |                    | B516-0279       | 02/2023                 |
| Laser Gauge                              |                    | 54197           | 01/2023                 |
| Binder MKFT740                           |                    | 16-02297        | 03/2023                 |
| Oven AT04                                |                    | 1155-0018A      | 02/2023                 |
| Oven AT29                                |                    | B521.0511       | 02/2023                 |
| HEMS Climate Chamber (HCC07)             |                    | 54260018220070  | 03/2023                 |
| Keithley 2750 Digital Multimeter (HDL02) |                    | 4370524         | 08/2023                 |
| Vibration Machine                        | STI THV-1000-6000H | E-00524         | 11/2022                 |
| Digital Caliper                          |                    | CLE89           | 11/2022                 |
| HV Cage (HV11)                           |                    | 6TE1051         | 08/2023                 |
| Oven AT33                                |                    | 2306D           | 03/2023                 |
| Thermometer                              |                    | 73001798        | 02/2023                 |
| Stop Clock                               |                    | ASC01           | 12/2022                 |
| Stop Clock                               |                    | ASC03           | 12/2022                 |