


| Annex to Solar Keymark Certificate - Summary of EN ISO 9806:2013 Test Results  |  |  |                      |                                    | Licence Number   |                         | 011-7S406 F               |                          |       |       |      |
|--|--|--|----------------------|------------------------------------|--|-------------------------|---------------------------|--------------------------|-------|-------|------|
|  |  |  |                      |                                    | Date issued  |                         | 2018-07-31                |                          |       |       |      |
|  |  |  |                      |                                    | Issued by  |                         | TÜV Rheinland Energy GmbH |                          |       |       |      |
| Licence holder   |  | Vaillant GmbH  |                      |                                    | Country  |                         | Germany                   |                          |       |       |      |
| Brand (optional)   |  | auroTHERM  |                      |                                    | Web  |                         | www.vaillant-group.com    |                          |       |       |      |
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| Collector Type   |  |  |                      |                                    | Flat plate collector, glazed   |                         |                           |                          |       |       |      |
| Collector name   | Gross area (A <sub>G</sub> )<br>m <sup>2</sup> | Gross length<br>mm   | Gross width<br>mm    | Gross height<br>mm                 | Power output per collector<br>G <sub>b</sub> = 850 W/m <sup>2</sup> ; G <sub>d</sub> = 150 W/m <sup>2</sup><br>ϑ <sub>m</sub> - ϑ <sub>a</sub> |                         |                           |                          |       |       |      |
|  |  |  |                      |                                    | 0 K  | 10 K                    | 30 K                      | 50 K                     | 70 K  | 100 K |      |
|  |  |  |                      |                                    | W  | W                       | W                         | W                        | W     | W     |      |
| VFK 145/2 V  | 2.51   | 2 033  | 1 233                | 80                                 | 1 858  | 1 766                   | 1 561                     | 1 326                    | 1 061 | 606   |      |
| VFK 145/2 H  | 2.51   | 1 233  | 2 033                | 80                                 | 1 858  | 1 766                   | 1 561                     | 1 326                    | 1 061 | 606   |      |
| Power output per m <sup>2</sup> gross area   |  |  |                      |                                    | 741  | 705                     | 623                       | 529                      | 423   | 242   |      |
| Performance parameters test method   |  | Steady state - indoor  |                      |                                    |  |                         |                           |                          |       |       |      |
| Performance parameters (related to AG)   |  | η <sub>0,hem</sub>   | a <sub>1</sub>       | a <sub>2</sub>                     |  |                         |                           |                          |       |       |      |
| Units  |  | -  | W/(m <sup>2</sup> K) | W/(m <sup>2</sup> K <sup>2</sup> ) |  |                         |                           |                          |       |       |      |
| Test results   |  | 0.741  | 3.491                | 0.015                              |  |                         |                           |                          |       |       |      |
| Incidence angle modifier test method   |  | Quasi dynamic - outdoor  |                      |                                    |  |                         |                           |                          |       |       |      |
| Bi-directional incidence angle modifiers   |  | No   |                      |                                    |  |                         |                           |                          |       |       |      |
| Incidence angle modifier   |  | Angle  | 10°                  | 20°                                | 30°  | 40°                     | 50°                       | 60°                      | 70°   | 80°   | 90°  |
| Transversal  |  | K <sub>θT, coll</sub>  | 1.00                 | 0.99                               | 0.97   | 0.95                    | 0.90                      | 0.82                     | 0.66  |       | 0.00 |
| Longitudinal   |  | K <sub>θL, coll</sub>  | 1.00                 | 0.99                               | 0.97   | 0.95                    | 0.90                      | 0.82                     | 0.66  |       | 0.00 |
| Heat transfer medium for testing   |  | Water-Glycole  |                      |                                    |  |                         |                           |                          |       |       |      |
| Flow rate for testing (per gross area, A <sub>G</sub> )  |  | dm/dt  | 0.020                | kg/(sm <sup>2</sup> )              |  |                         |                           |                          |       |       |      |
| Maximum temperature difference for thermal performance calculations  |  | (ϑ <sub>m</sub> -ϑ <sub>a</sub> ) <sub>max</sub>   | 100                  | K                                  |  |                         |                           |                          |       |       |      |
| Standard stagnation temperature (G = 1000 W/m <sup>2</sup> ; ϑ <sub>a</sub> = 30 °C)   |  | ϑ <sub>stg</sub>   | 200                  | °C                                 |  |                         |                           |                          |       |       |      |
| Effective thermal capacity, incl. fluid (per gross area, A <sub>G</sub> )  |  | C/m <sup>2</sup>   | 5.66                 | kJ/(Km <sup>2</sup> )              |  |                         |                           |                          |       |       |      |
| Maximum operating temperature  |  | ϑ <sub>max, op</sub>   | 199                  | °C                                 |  |                         |                           |                          |       |       |      |
| Maximum operating pressure   |  | p <sub>max, op</sub>   | 1000                 | kPa                                |  |                         |                           |                          |       |       |      |
| Testing laboratory   |  | TÜV Rheinland Energy GmbH  |                      |                                    |  | www.tuv.com/solarenergy |                           |                          |       |       |      |
| Test report(s)   |  | 21221150_EN_P_145-2V; 21221150_EN_R_145-2V<br>21221150_EN_P_145-2H; 21221150_EN_R_145-2H |                      |                                    |  | Dated                   |                           | 29.05.2013<br>29.05.2013 |       |       |      |
| Comments of testing laboratory   |  | Datashet version: 5.01, 2016-03-01   |                      |                                    |  |                         |                           |                          |       |       |      |
| The collector tests were performed according to EN 12975-2:2006. The performance parameter related to 2.352 m <sup>2</sup> aperture area would be η <sub>0,hem,a</sub> =0.790; a <sub>1a</sub> =3.721 and a <sub>2a</sub> =0.016 |  |  |                      |                                    |  TÜVRheinland®<br>Genau. Richtig.                         |                         |                           |                          |       |       |      |
|  |  |  |                      |                                    | TÜV Rheinland Energy GmbH<br>Am Grauen Stein<br>51105 Köln   |                         |                           |                          |       |       |      |
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|   |                       |                    |
|---|-----------------------|--------------------|
| <b>Annex to Solar Keymark Certificate<br/>Supplementary Information</b> | <b>Licence Number</b> | <b>011-7S406 F</b> |
|   | <b>Issued</b>         | <b>2018-07-31</b>  |

| Annual collector output in kWh/collector at mean fluid temperature $\vartheta_m$ , based on EN ISO 9806:2013 test results  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
|--|---------------|---|-------|-------|-------------------------|-------|------|-------------------------|-------|------|-------------------------|-------|------|
| Standard Locations   |               | Athens  |       |       | Davos                   |       |      | Stockholm               |       |      | Würzburg                |       |      |
| Collector name   | $\vartheta_m$ | 25°C  | 50°C  | 75°C  | 25°C                    | 50°C  | 75°C | 25°C                    | 50°C  | 75°C | 25°C                    | 50°C  | 75°C |
| VFK 145/2 V  |               | 2 863   | 2 009 | 1 271 | 2 166                   | 1 468 | 888  | 1 594                   | 1 025 | 601  | 1 730                   | 1 100 | 634  |
| VFK 145/2 H  |               | 2 863   | 2 009 | 1 271 | 2 166                   | 1 468 | 888  | 1 594                   | 1 025 | 601  | 1 730                   | 1 100 | 634  |
|  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
|  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
|  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
|  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
|  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
|  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
|  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
|  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
|  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
|  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
|  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
|  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
|  |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |
| Annual output per m <sup>2</sup> gross area  |               | 1 142   | 801   | 507   | 864                     | 585   | 354  | 636                     | 409   | 240  | 690                     | 439   | 253  |
| Fixed or tracking collector  |               | Fixed (slope = latitude - 15°; rounded to nearest 5°) |       |       |                         |       |      |                         |       |      |                         |       |      |
| Annual irradiation on collector plane  |               | 1765 kWh/m <sup>2</sup>                               |       |       | 1714 kWh/m <sup>2</sup> |       |      | 1166 kWh/m <sup>2</sup> |       |      | 1244 kWh/m <sup>2</sup> |       |      |
| Mean annual ambient air temperature  |               | 18.5°C  |       |       | 3.2°C                   |       |      | 7.5°C                   |       |      | 9.0°C                   |       |      |
| Collector orientation or tracking mode   |               | South, 25°  |       |       | South, 30°              |       |      | South, 45°              |       |      | South, 35°              |       |      |
| The collector is operated at constant temperature $\vartheta_m$ (mean of in- and outlet temperatures). The calculation of the annual collector performance is performed with the official Solar Keymark spreadsheet tool Scenocalc Ver. 5.01 (March 2016). A detailed description of the calculations is available at <a href="http://www.solarkeymark.org/scenocalc">www.solarkeymark.org/scenocalc</a> |               |   |       |       |                         |       |      |                         |       |      |                         |       |      |

| Additional Information  |               |    |
|---|---------------|----|
| Collector heat transfer medium  | Water-Glycole |    |
| Hybrid Thermal and Photo Voltaic collector  | No            |    |
| The collector is deemed to be suitable for roof integration   | Yes           |    |
| The collector was tested successfully according to EN ISO 9806:2013 under the following conditions: |               |    |
| Climate class (A, B or C)   | B             | -- |
| Maximum tested positive load  | 5400          | Pa |
| Maximum tested negative load  | 3500          | Pa |
| Hail resistance using steel ball (maximum drop height)  | -             | m  |

| Energy Labelling Information |   |  |  |
|------------------------------|---|--|--|
|                              | Reference Area, $A_{sol}$ (m <sup>2</sup> ) | Data required for CDR (EU) No 811/2013 - Reference Area $A_{sol}$  |  |
| VFK 145/2 V                  | 2.51  | Collector efficiency ( $\eta_{col}$ )  | 58 %                                     |
| VFK 145/2 H                  | 2.51  | Remark: Collector efficiency ( $\eta_{col}$ ) is defined in CDR (EU) No 811/2013 as collector efficiency of the solar collector at a temperature difference between the solar collector and the surrounding air of 40 K and a global solar irradiance of 1000 W/m <sup>2</sup> , expressed in % and rounded to the nearest integer. Deviating from the regulation $\eta_{col}$ is based on reference area ( $A_{sol}$ ) which is aperture area for values according to EN 12975-2 or gross area for ISO 9806:2013. |  |
|                              |   | Data required for CDR (EU) No 812/2013 - Reference Area $A_{sol}$  |  |
|                              |   | Zero-loss efficiency ( $\eta_0$ )  | 0.741 --                                 |
|                              |   | First-order coefficient ( $a_1$ )  | 3.49 W/(m <sup>2</sup> K)                |
|                              |   | Second-order coefficient ( $a_2$ )   | 0.015 W/(m <sup>2</sup> K <sup>2</sup> ) |
|                              |   | Incidence angle modifier IAM (50°)   | 0.90 --                                  |
|                              |   | Remark: The data given in this section are related to collector reference area ( $A_{sol}$ ) which is aperture area for values according to EN 12975-2 or gross area for ISO 9806. Consistent data sets for either aperture or gross area can be used in calculations like in the regulation 811 and 812 and simulation programs.  |  |