



Referenced standards and concepts under development: EI 1598 2nd Edition (electronic sensors), EI 1599 2nd Edition (dirt defence filter), EI 1588 (water barrier filter), no EI-Specification (water containment filter)

Technology highlights

- Dirt Defence Filter plus AFGUARD®, likely to be the only option available to meet deadline of December 2020
- Specification EI 1599 and EI 1598 covers qualification and performance requirements
- Filter material contains no SAP and has been used for into-plane operations for decades
- No modifications to vessel housings or flow rates for Dirt Defence Filter installation
- Proactive and free-of-charge training for organizations to understand and evaluate filtration and sensing technologies
- Operational safety through continuous real-time monitoring
- Dirt Defence Filter under JIG field trials
- Available as soon as EI 1599 is adopted into standards

Reliability

Following over 1000 successful implementations of AFGUARD® on numerous locations worldwide, with demonstrated evidence of safety and reliability, FAUDI Aviation has gained years of expertise and a strong organizational commitment to “doing the right thing”.

For more than 10 years, the electronic water sensor AFGUARD® has been deployed in commercial applications for the automatic detection and measurement of water content in aviation fuels. The AFGUARD® sensor is qualified to EI 1598 2nd Edition and accepted for use as an alternative to Chemical Water Detectors (CWD) by the Joint Inspection Group (JIG), refer to JIG Technical Bulletin 110. Several tests under various environmental conditions testify to the reliability and functionality of the sensor.

Signals from AFGUARD® are transmitted to registers or PLCs which record and store data on water content and performance of filter elements installed. Comprehensive data will be made available to guarantee functional safety and reduce downtimes. With the real-time availability of information new approaches in the organization, preventative maintenance and thus new services are made possible.



„Industry acceptance of concept of sensor measurement rather than water removal.“

Special Interest Group, September 2019

Versatility

In December 2017, FAUDI Aviation first introduced a filtration system solution – Dirt Defence Filters plus AFGUARD® - as an alternative to filter monitor elements to the market. Since then, FAUDI Aviation has been working according to the industry’s roadmap to progressively phase out filter monitors.

Dirt Defence Filters both 2” and 6” models are qualified to specification EI 1599 2nd Edition and have successfully passed the EI additional robustness testing phase 1 for new technology (See Appendix 1). Since July, Dirt Defence Filter in conjunction with AFGUARD® are under joint field trial evaluation in real conditions at global sites. We expect to see a positive outcome of the field trials by the second quarter of 2020.

The FAUDI Aviation Dirt Defence Filter elements (2” and 6” models) are an efficient and reliable alternative to filter monitor elements. The filter material contains no SAP and is has been used in into-plane operations for decades. With a service life of up to 5 years, this filtration technology offers a high quality yet low cost solution when compared to other technologies. Our findings demonstrate protection from solids and degrees of water. There is no better or more economical filter material.

There are several aspects that should be considered for when deciding which retrofit option is best. In conjunction with the AFGUARD® sensor, a safe, economical and field-proven solution is provided. The cost and reliability of any other technology should be proportional to the benefit it provides.

Preparation and planning are the most important tasks to retrofit to whatever drop-in solution is going to be available (for more information on the development status of other products please see Annex 2).

Safety remains the number one priority.



„What happens after December 31, 2020? ” [...] Mitigate your operational risk ALARP (as low as reasonably practicable).

Lufthansa Group, September 2019

“AFGUARD® will support every filtration solution to verify filter performance.”

FAUDI Aviation, December 2019

Built around ITP operations

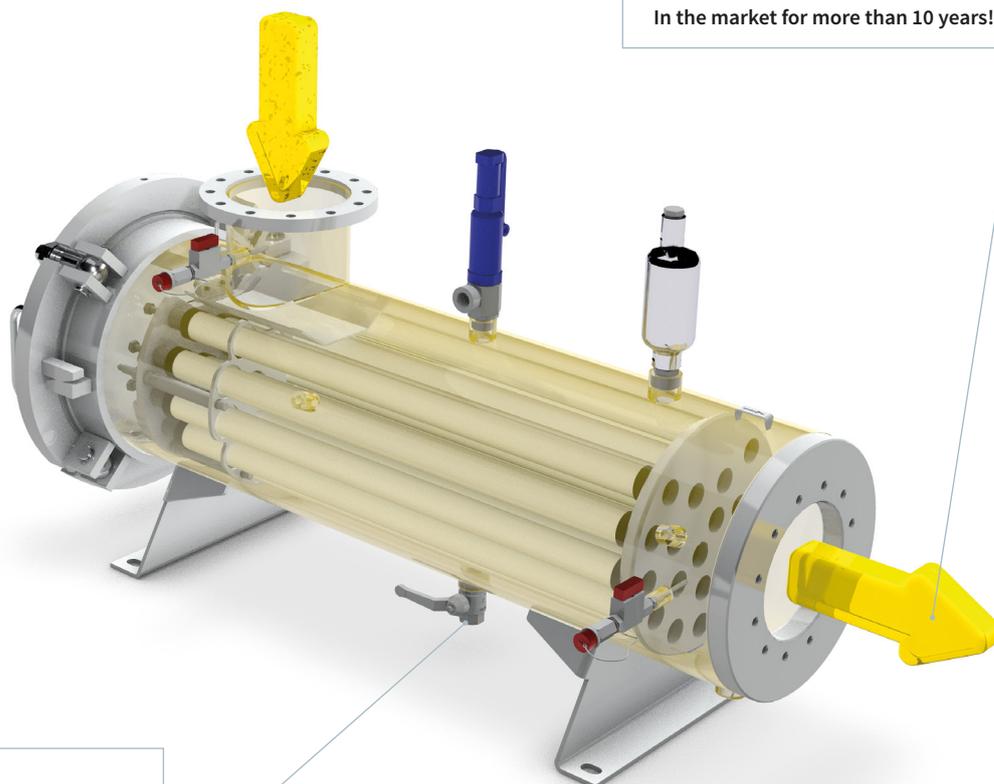
- Ideally suited to interchange filter monitor elements
- No changes required to the vessel
- Identical nominal diameters and flow rates for 50 mm (2 inch) and 150 mm (6 inch)
- Service lifetime of up to five years
- Dirt Defence Filter elements readily available
- Focus on performance, robustness and simple operation with maximum safety
- Qualification in accordance to international standards
- Investment protection due to sensor compatibility with products and interfaces from other manufacturers
- No SAP material or related absorbent filter material



AFGUARD®

Electronic sensor for detection of free water in aviation fuel. The AFGUARD® sensor is qualified for use as an alternative to Chemical Water Detectors (CWD) by the Joint Inspection Group (JIG).

In the market for more than 10 years!



SLUGGUARD®

Sensor to distinguish between aviation fuel and water. The SLUGGUARD® is qualified to EI 1592.

Transparency

FAUDI Aviation shares the idea to work with others to translate knowledge into initiatives that benefit organisations. Rather than becoming a bottleneck for knowledge, we share it freely and proactively. Rather than cultivating reliance on our own skills, we seek to train others to become more effective and less dependent. Through continuous teaching, we aim to help organisations to stay competitive in today’s global marketplace.

The FAUDI Aviation approach to customer support is a worldwide service network. A very important challenge is to ensure availability and continuity in the provision of these services, and to avoid any potential operational failures and interruptions.

The FAUDI Aviation electronic water sensors can help to avoid such incidents and prevent the need for costly and time-consuming unplanned down-time and thus increase productivity.

“[...] We tested the solution AFGUARD® plus DDO ourselves and decided that this is the most feasible and sound solution...”

Shell Aviation, September 2019

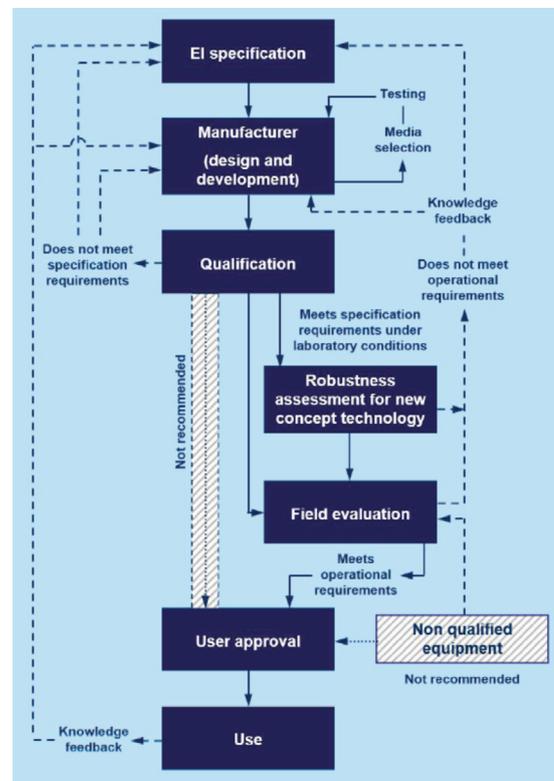
Innovation guarantees safety

Our purpose is to ensure safety in aviation through clean dry fuel. Our promise is to develop innovations that help our customers optimize the quality of their product and the safety and efficiency of their processes.



Annex 1: Recommended Process by the Industry

A4A, together with IATA and the Joint Inspection Group (JIG), developed a precise evaluation process for new into-plane filtration technologies. This process is designed to evaluate whether the new technology meets the operational and safety needs of commercial aviation and does not introduce additional risk to the fueling process or to the aircraft.



Unique since 2012: FAUDI Aviation has been manufacturing a FWS system that utilises 50 mm (2 inch) nominal diameter coalescer elements. The coalescers are qualified to EI 1581 6th Edition, Category C, commercial fuels and Category M, military fuels, Type S-M. They are available for immediate deployment. EI robustness testing or industry field trials are not required since coalescing is not a new technology. This filter water separator is comparably lightweight and small in diameter. The FWS system can be deployed with AFGUARD® as an alternative to Chemical Water Detectors (CWD) and to monitor the coalescer and separator in case of disarming.

Status of Technologies
Status as of 01 Nov 2019

JIG
jigonline.com

| Technology | Supplied by | Robustness | Field Trials | Evaluation | Adopted in Standards |
|---|------------------|---|---------------------|------------|----------------------|
| FWS (EI 1581) | 1 (2") 3 (6") | | | | 2" & 6" |
| Dirt Defence (EI 1599) with EI1598 sensor | 2 | Faudi: Done Facet: Under Review | In progress (Faudi) | Ongoing | Estimated in 2020 |
| Water Barriers (EI 1588) | 1 | In progress (Parker Velcon) | | | |
| Water Sensors (EI 1598) | 1 | | | | Adopted (Faudi) |
| Water Holding (Spec not available) | 0 | Under development by Facet – No specification available yet | | | |
| Hydrophobic DDF (Spec not available) | 0 | Under development by Faudi – No specification available yet | | | |

*number of suppliers with qualified models

Prepared by Antonis Christodoulakis 3

Source: JIG Status Chart, November 2019

Status - Dirt defence filters

energy institute

| Technology Overview | Specification | Qualification/Testing | Robustness Assessment | |
|--|---|---|---|---------------------------|
| | | | Laboratory | Airport fuel conditioning |
| <ul style="list-style-type: none"> Dirt removal only (not designed to remove free water) Elements designed to retrofit into existing filter monitor vessels (identical end caps and dimensions) Same flow rate Can only be deployed with a quantitative electronic sensor for free water measurement | EI 1599 2 nd edition (2017) Retrospective electrostatic test incorporated into 1599 2 nd edition by addendum, 4 Feb 2019 | FACET 50 mm DD-2xx (April 2018) Electrostatic testing complete | Testing complete Awaiting final sign-off by EI AFFC | Not necessary |
| | | FAUDI 50 mm DD.O2-770-2 (Nov 2017) Electrostatic testing complete | Testing complete AFFC statement of suitability for field trial | Not necessary |
| | | FAUDI 150 mm DDO6.x-xx-2 (Jan 2018) Electrostatic testing complete | Testing complete AFFC statement of suitability for field trial | Not necessary |
| | | ParkerVelcon Model in development Qualification not scheduled | To be done after successful qualification | Not necessary |

Source: IATA Aviation Fuel Forum, November 2019

Dirt defence filter + 1598 sensor



| Technology Overview | Specification | Qualification/Testing | Robustness Assessment | |
|---|---------------|--|---|---------------------------|
| | | | Laboratory | Airport fuel conditioning |
| <ul style="list-style-type: none"> Pairing of a model of dirt defence filter with a model of quantitative electronic sensor for free water measurement (ppm) | N/A | N/A | FACET 50 mm (DD-2xx) and FAUDI AFGUARD® Testing complete Awaiting final sign-off by EI AFCC | Not necessary |
| | | N/A | FAUDI 50 mm (DD.O2-770-2) and FAUDI AFGUARD® Testing completed. AFCC statement of suitability for field trial | Not necessary |
| | | N/A | FAUDI 150 mm (DDO6.x-xx-2) and FAUDI AFGUARD® Testing completed. AFCC statement of suitability for field trial | Not necessary |
| | | Combination of all qualified dirt defence filters with ParkerVelcon WIF sensor | To be done when sensor is qualified to EI 1598 | Not necessary |

Source: IATA Aviation Fuel Forum, November 2019

New concept retrofit filter #1



| Technology Overview | Specification | Qualification/Testing | Robustness Assessment | |
|--|---|--|---|---|
| | | | Laboratory | Airport fuel conditioning |
| <ul style="list-style-type: none"> Dirt removal Dispersed water removal Bulk water shutdown Elements designed to retrofit into existing filter monitor vessels (identical end caps and dimensions) Same flow rate | Concept being developed by FACET EI AFCC working with Facet on means to demonstrate stability of element. Not sufficiently progressed to justify development of EI specification at this time | To be done after development of EI specification | To be done after successful qualification | To be done after successful laboratory robustness testing |

Source: IATA Aviation Fuel Forum, November 2019

Status – Water barrier filter



| Technology Overview | Specification | Qualification/Testing | Robustness Assessment | |
|--|---|---|---|--|
| | | | Laboratory | Airport fuel conditioning |
| <ul style="list-style-type: none"> Dirt removal Dispersed water removal Bulk water shutdown Elements designed to retrofit into existing filter monitor vessels (identical end caps and dimensions) Same flow rate | EI 1588 1 st edition (2018) Retrospective electrostatic test incorporated into 1588 1 st edition by addendum, 4 Feb 2019 | ParkerVelcon qualification accepted by EI AFFC (May 2019) | Testing completed, 13-17 May '19. AFFC statement of suitability for airport fuel conditioning | Conditioning x2 sets at Pittsburgh; x2 sets at Atlanta (vehicle test rigs). Report awaited |
| | | FACET model in development | To be done after successful qualification | To be done after successful laboratory robustness testing |

Source: IATA Aviation Fuel Forum, November 2019

Status – Quantitative electronic sensor (for free water)



| Technology Overview | Specification | Qualification/Testing | Robustness Assessment | |
|---|---|---|--|---------------------------|
| | | | Laboratory | Airport fuel conditioning |
| <ul style="list-style-type: none"> Optical device to measure dispersed water droplets in ppm and detect bulk water Can only be deployed into-plane with a filtration system | EI 1598 2 nd edition (2012) + 12 Jul 2019 addendum | FAUDI AFGUARD® with Firmware 01.19 (Dec 2018) | Stand-alone testing not necessary (but see next slide) | |
| | | ParkerVelcon WIF (Water in Fuel) In development 1598 testing not scheduled | Stand-alone testing not necessary (but see next slide) | |

Source: IATA Aviation Fuel Forum, November 2019