For dissemination to all filter monitor purchasers/users **EI17/074 rev 1**

Filtration bulletin, November 2017

Purpose

The purpose of this bulletin is to explain to current users and purchasers of filter monitor systems, the other filtration options covered by EI specifications that may be considered as potential alternatives (element retrofit or vessel/system replacement).

Background

All fuel is filtered as it is delivered to aircraft (a mandatory requirement of industry operating standards). The filter technology used can differ, but for jet fuel deliveries either a filter/water separator (FWS) or filter monitor is typically used.

Specifications for selected aspects of design and laboratory performance (first article testing) for filter monitors used in aviation fuel handling have been developed by Industry specialists and published by the Energy Institute (as EI 1583). Filter monitors use superabsorbent polymer (SAP) to remove low levels of free water from aviation fuel and provide a shut down response in the event of excessive water being present in fuel. They are designed for single use only and once the elements have reached a differential pressure of above 1 bar (22 psi) they are required to be changed. Filter monitors are also required to be changed after one-year service life, regardless of their condition or fuel throughput.

EI 1583 was first issued in 1987 and subsequent editions have added further design criteria and first article tests. As of 3 November 2017 the current edition is the 7th.

The scope of EI 1583 is limited to the following:

- 50 mm (two-inch) nominal diameter elements with fuel flow from their outside to their inside. Typically fitted into dedicated filter monitor vessels and mainly used for into plane operations
- 150 mm (six -inch) nominal diameter elements with fuel flow from their outside to their inside. May be used in dedicated vessels or as an alternative in filter/water separator (FWS) vessels.
- 150 mm (six -inch) nominal diameter elements with fuel flow from their inside to their outside. May be used in dedicated vessels or as an alternative in FWS vessels.

If operated correctly, within their qualified operating parameters, all filtration types should provide suitable protection to ensure the fuel delivered to aircraft is clean and dry. It is not envisaged that the filtration unit be the cause of contamination. However, filter monitors deploy cross-linked super absorbent polymer that may be susceptible to mobilisation if it is activated by water and then subjected to high differential pressure.

Recent reports of aircraft fuel contamination events and laboratory testing of filter monitor elements have led to concerns about the stability of the SAP in filter monitor elements and the risk that it may pose to aircraft operations.

The way forward

Key industry stakeholders, meeting under the auspices of IATA, have agreed that a transition is required to the global use of filtration/sensing technology that does not contain SAP. For further information see Appendix A.

The EI supports this position and has stated that it will not be maintaining or updating EI 1583 beyond its current 7th edition and will withdraw the specification by no later than 31st December 2020, see Appendix B. The statement also draws user and manufacturer attention to implications for filter monitor elements of nominal diameters outside of the scope of 1583 (but which may be marketed with reference to it).

Currently there is no like-for-like retrofit option, qualified to an EI specification, to replace two-inch nominal diameter filter monitors with filters that do not contain SAP in existing filter monitor vessels. In the near future it is anticipated that up to three different technology types may be offered in two-inch element format that could retrofit into existing filter monitor vessels. The first that is likely to be available is a dirt defence filter.

Currently, replacing a two-inch filter monitor vessel for a filtration system of another technology type will require the use of a larger vessel.

It may be possible to convert some vessels currently housing six-inch filter monitor systems to filter/water separators. In the near future there may also be different technology types in six-inch element format that could retrofit into existing filter monitor vessels

Appendix C explains the filtration options that are currently provided by EI specifications (including two currently being prepared) that may be considered as replacements and/or retrofits for filter monitors. Whether or not the options are available commercially is also stated. Whether or not the approaches are deemed satisfactory by organisations that publish operational standards (e.g. A4A, JIG) is not included. The order that technology is included in the list is not intended to imply any EI preference or endorsement of the technologies.

Appendix C also provides some schematic diagrams to illustrate the options that may become available to users.

Short term actions for filter monitor users

The following actions are recommended to all users of filter monitor systems in aviation fuel handling:

- Initiate planning for replacement of filter monitor systems with alternative technology in all fuel handling systems (fixed facilities and mobile applications), e.g.
  - EI 1581 6th ed filter/water separator
  - EI 1590 microfilter with an EI 1598 electronic sensor
  - EI 1599 dirt defence filter with an EI 1598 electronic sensor
  - EI 1588 water barrier system
- Where it is impractical to immediately replace a filter monitor system, ensure that the elements used are compliant with EI 1583 7th edition.
- Replace all filter monitor elements operating at or above 15 psi at maximum achievable flow rate.
- Ensure DP switches are fitted to all into-plane filter monitors and set them to 15 psi.
- Clean hose end strainers as part of filter monitor commissioning and the routine hose end strainer check (e.g. monthly).
- Change all hose end strainers in use with monitors to 100 mesh.
- Review filter monitor operations and ensure they follow manufacturer's recommendations and good practice at all times (e.g. never expose a filter monitor system to fuel containing fuel system icing inhibitor, never operate a system outside of its qualified performance envelope; never move a system that is at high DP onto a lower flow rate application to extend service life). For further information see EI 1550 *Handbook on equipment used for the maintenance and delivery of clean aviation fuel*. Report any abnormalities experienced in operation or found during filter inspections.
- Ensure that filtration systems used for defuelling operations are FWS Category M only.

Appendix A - IATA SAP Special Interest Group communication to all users of filter monitor filtration systems

Representatives of airlines, engine and airframe manufacturers, aviation fuel filter manufacturers and the EI have been meeting as an IATA Special Interest Group to share information relating to the presence of super-absorbent polymer (SAP) in engine/fuel system components.

The Special Interest Group is aware of eight incidents since April 2010, where the presence of SAP in engine/airframe fuel system components has been confirmed by those involved. More than one engine manufacturer, airframe manufacturer and location have been affected.

The SAP involved in these events can only come from filter monitors, qualified to the industry specification, EI 1583.

It has not been possible for these events to be investigated sufficiently to explain SAP migration mechanisms. To date, the Special Interest Group has been unable to identify any significant fuel handling irregularities at the locations implicated in the events. However, work undertaken by the Special Interest Group has identified SAP migration mechanisms within normal operating parameters, that were previously unknown.

Engine and airframe OEMs have not identified a level of SAP that is acceptable in aviation fuel. Filter monitor manufacturers and SAP manufacturers have confirmed that it is not possible to guarantee that no SAP will pass downstream of filter monitor elements when in service.

It is the collective opinion of the Special Interest Group that the continued use of filter monitor filtration systems in aviation fuel handling is incapable of reliably meeting the aircraft and engine operating requirements.

It is the position of the Special Interest Group that filter monitors shall be phased out of all aviation fuel handling systems.

The Special Interest Group activity will be concluded with the issue of a data summary and proposed roadmap for adoption by the industry.

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Appendix B – Energy Institute statement on filter monitors

27 November 2017

The EI has received data demonstrating that filter monitor elements qualified to the requirements of EI 1583 Laboratory tests and minimum performance levels for aviation fuel filter monitors, 6th or 7th editions may not be fit-for-purpose due to their release of super-absorbent polymer, particularly at differential pressures above 15 psi (caused by water injection into fuel; below their rated flow).

Users of this technology for into-plane fuelling applications shall review this with their filter monitor suppliers as a matter of urgency and implement measures to mitigate the risk of SAP migration.

The EI is supportive of the IATA SAP Special Interest Group position statement that filter monitors shall be phased out of all aviation fuel handling systems.

EI will not be maintaining or updating EI 1583 beyond its current 7th edition and will withdraw the specification by no later than 31st December 2020. Until then, only modifications to existing qualified elements that reduce the level of SAP migration will be eligible for an EI qualification test witness. EI is focusing all available resources on supporting the development of alternative technologies to replace filter monitors.

Manufacturers who provide filter monitor elements in nominal diameters outside of the scope of EI 1583 (which covers only two inch out to in flow format and six inch in to out and out to in flow formats) shall investigate their propensity for SAP migration at elevated differential pressure (caused by water-wetting) and communicate the risk to all element users.

Appendix C Equipment options for filter monitor retrofit/replacement

The following tables illustrate the filtration options currently provided by EI specifications, not commercial availability. Their order is not intended to imply any preference.

Table C.1 – For mobile equipment currently fitted with a two-inch filter monitor system

Technology Type	**Performance Specification**	**Contaminant capability** (demonstrated via lab testing)	**Retrofit for existing filter monitor vessels?**	**User considerations**	**Readiness Level**
Microfilter, two inch nominal diameter	EI 1590	Low loading of particulate matter, at a specified micron rating. No capacity for dispersed free water or bulk water	**Yes**, for two inch filter monitor vessels	– Technology proven to provide particulate matter protection (in larger diameter format) – May not generate DP rise to alarm condition in presence of bulk water – Could be used in conjunction with quantitative electronic sensor (EI 1598 2nd ed) to provide dispersed free water measurement (but not removal) – Could be used in conjunction with qualitative bulk water detector (EI 1592) to provide bulk water alarm	No qualified products on market
Dirt defence filter, two inch nominal diameter	EI 1599	Low loading of particulate matter. No capacity for dispersed free water or bulk water	**Yes**, for two inch filter monitor vessels	– May not generate DP rise to alarm condition in presence of bulk water – Could be used in conjunction with quantitative electronic sensor (EI 1598 2nd ed) to provide dispersed free water measurement (but not removal) – Could be used in conjunction with qualitative bulk water detector (EI 1592) to provide bulk water alarm	One product recently qualified, another model (not qualified) is commercially available.

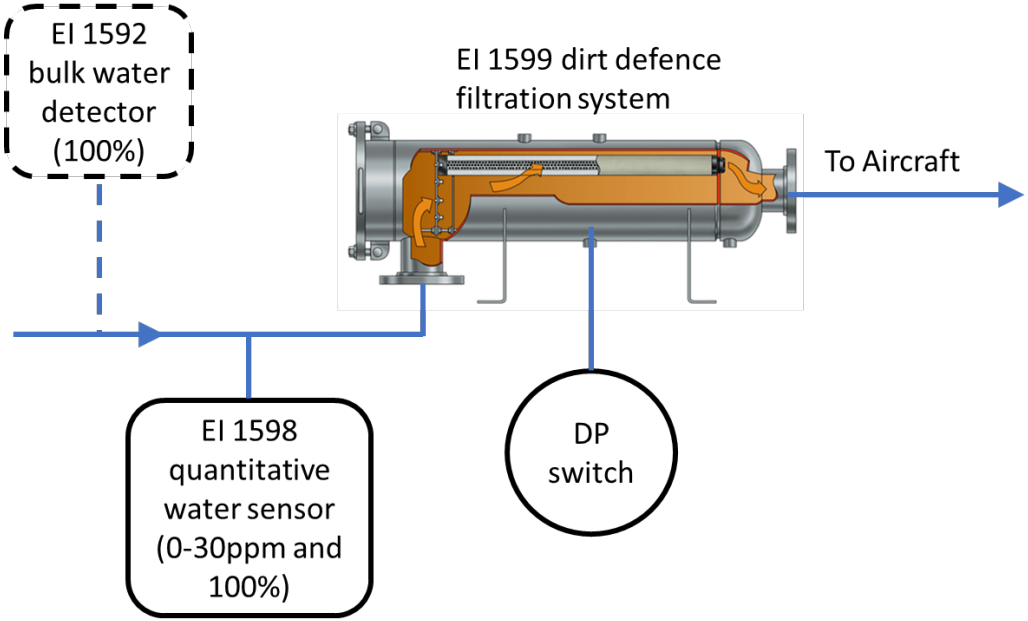
Technology Type	**Performance Specification**	**Contaminant capability** (demonstrated via lab testing)	**Retrofit for existing filter monitor vessels?**	**User considerations**	**Readiness Level**
Water barrier filter, two inch nominal diameter	EI 1588 (in prep, due 1Q 2018)	Low loading of particulate matter. High capacity for dispersed free water and bulk water	**Yes**, for two inch filter monitor vessels	– Laboratory testing to date highlights that the technology provides an effective barrier to passage of free water (dispersed and bulk) – Unproven technology in the field – May be susceptible to surfactant disarming – May be susceptible to fine particulate matter blockage – Could be used in conjunction with quantitative electronic sensor (EI 1598 2nd ed) or qualitative bulk water detector (EI 1592) to provide additional safeguard	No qualified products on market
Filter/water separator (Type S-M), two inch nominal diameter	EI 1581 6th edition	Low loading of particulate matter and low capacity for dispersed free water	**No**. Requires replacement of a two inch monitor vessel with a larger one (may be possible for six inch monitor vessel following conversion).	– May not generate DP rise to alarm condition in presence of bulk water – Requires operational procedures/system design to manage the free water removed from fuel – May be susceptible to water removal performance degradation due to build-up of surfactants (coalescer disarming) – Can be used in conjunction with quantitative electronic sensor (EI 1598 2nd ed) or qualitative bulk water detector (EI 1592) to provide bulk water alarm	No qualified products currently on market

Technology Type	**Performance Specification**	**Contaminant capability** (demonstrated via lab testing)	**Retrofit for existing filter monitor vessels?**	**User considerations**	**Readiness Level**
Filter/water separator (Type S), six inch nominal diameter	EI 1581 6th edition	High loading of particulate matter and intermediate capacity for dispersed free water	**No.** Requires replacement of a two inch monitor vessel with a larger one	– Proven to provide contaminant protection – Requires operational procedures/ system design to manage the free water removed from fuel – May not generate DP rise to alarm condition in presence of bulk water – May be susceptible to water removal performance degradation due to build-up of surfactants (coalescer disarming) – Can be used in conjunction with quantitative electronic sensor (EI 1598 2nd ed) or qualitative bulk water detector (EI 1592) to provide bulk water alarm	Qualified products on market for 10+ years

Notes:
For further details of design, performance and testing requirements for **quantitative** particulate matter and/or free water sensors, see EI 1598 *Design, functional requirements and laboratory testing protocols for electronic sensors to monitor free water and/or particulate matter in aviation fuel* 2nd edition, and the user guide to sensors, EI 1570 *Handbook on electronic sensors for the detection of particulate matter and/or free water during aircraft refuelling*.
For further details of design, performance and testing requirements for **qualitative** bulk water detectors, see EI 1592 *Design, functional requirements and laboratory testing protocols for electronic bulk water detectors for use in aviation fuelling*.

For dissemination to all filter monitor purchasers/users

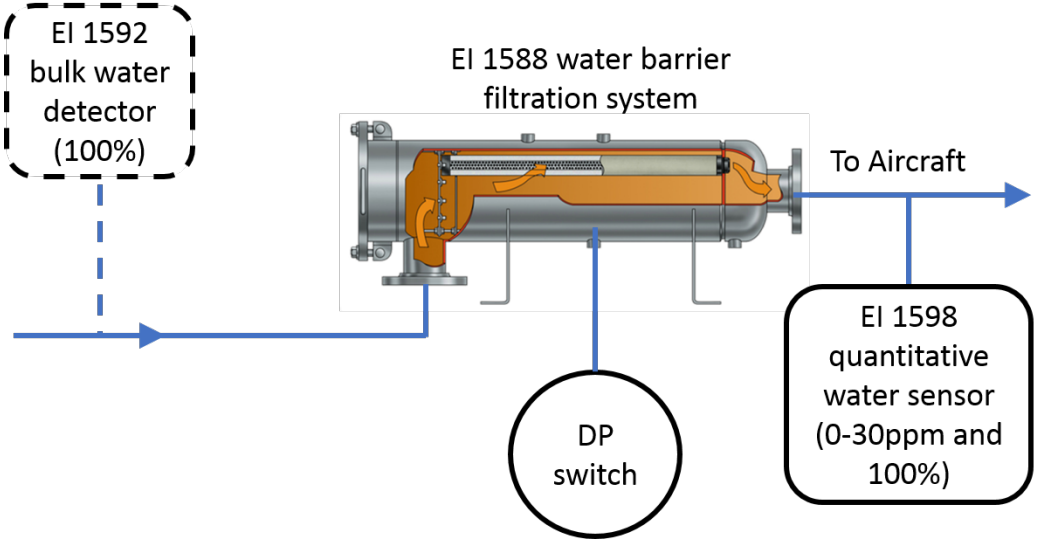
Example of application of dirt defence filter (EI 1599)



Key points to consider

- One model of two-inch element has been qualified to EI 1599, another is commercially available (yet to be qualified to EI 1599).
- Application intended to be dry fuel systems (where current filter monitor life is typically one year)
- Particulate removal performance is tested to be at least the same as a two-inch filter monitor system.
- No free water removal performance is tested by EI 1599, but some water resistance/removal may be evident.
- Protection against free water needs to be provided by an associated electronic sensor.
- Flow rates the same as a two-inch filter monitor system.
- No industry position on maximum service life of elements in clean systems
- Current lack of field trial data shared within industry
- May be possible for manufacturers to offer six-inch versions in both flow formats (in-to-out introduced by EI 1599 2nd edition).

Example of application of water barrier filtration system (EI 1588)



Key points to consider

- New EI specification, 1588 is in development. No models are commercially available for aviation fuel handling applications, or have been subjected to qualification testing.
- Flow rates the same as a two-inch filter monitor system.
- No industry position on maximum service life of elements.
- No field evaluation data available.
- May be possible for manufacturers to offer six-inch versions both flow formats (not currently covered by draft of EI 1588).
- Coalesced free water required to be drained from the vessel and managed by the operation/design of facility.
- Could be used in conjunction with quantitative electronic sensor (EI 1598 2nd ed) or qualitative bulk water detector (EI 1592) to provide additional safeguard.

Table C.2 – For equipment currently fitted with a six-inch filter monitor system

Technology Type	Performance Specification	Contaminant capability (demonstrated via lab testing)	Retrofit for existing filter monitor vessels?	User considerations	Readiness Level
Filter/water separator (Type S), six inch nominal diameter	EI 1581 6th edition	High loading of particulate matter and intermediate capacity for dispersed free water	**Yes.** Possible for six inch monitor vessel after conversion. May have to reduce flow rate.	– Proven to provide contaminant protection – Requires operational procedures/ system design to manage the free water removed from fuel – May not generate DP rise to alarm condition in presence of bulk water – May be susceptible to water removal performance degradation due to build-up of surfactants (coalescer disarming) – Can be used in conjunction with quantitative electronic sensor (EI 1598 2nd ed) or qualitative bulk water detector (EI 1592) to provide bulk water alarm	Qualified products on market for 10+ years

Technology Type	Performance Specification	Contaminant capability (demonstrated via lab testing)	Retrofit for existing filter monitor vessels?	User considerations	Readiness Level
Filter/water separator (Type S-M), six inch nominal diameter	EI 1581 6th edition	Intermediate loading of particulate matter and low capacity for dispersed free water	**Yes.** May be possible for six inch monitor vessel following conversion. May have to reduce flow rate	– Proven to provide contaminant protection – Requires operational procedures/ system design to manage the free water removed from fuel – May not generate DP rise to alarm condition in presence of bulk water – May be susceptible to water removal performance degradation due to build-up of surfactants (coalescer disarming) – Can be used in conjunction with quantitative electronic sensor (EI 1598 2nd ed) or qualitative bulk water detector (EI 1592) to provide bulk water alarm	Qualified products on market for 10+ years (as Type S-LW)
Microfilter, six inch nominal diameter	EI 1590	High loading of particulate matter at a specified micron rating No capacity for dispersed free water or bulk water	**Yes.** May be possible for six inch filter monitor vessels following conversion.	– Proven to provide particulate matter protection – May not generate DP rise to alarm condition in presence of bulk water – Could be used in conjunction with quantitative electronic sensor (EI 1598 2nd ed) to provide dispersed free water measurement (but not removal) – Could be used in conjunction with qualitative bulk water detector (EI 1592) to provide bulk water alarm	Qualified products on market for 18 years

Technology Type	Performance Specification	Contaminant capability (demonstrated via lab testing)	Retrofit for existing filter monitor vessels?	User considerations	Readiness Level
Dirt defence filter, six inch nominal diameter	EI 1599	Intermediate loading of particulate matter. No capacity for dispersed free water or bulk water	**Yes**, for six inch filter monitor vessels (out-to-in flow format or in-to-out flow format)	– May not generate DP rise to alarm condition in presence of bulk water – Could be used in conjunction with quantitative electronic sensor (EI 1598 2nd ed) to provide dispersed free water measurement (but not removal) – Could be used in conjunction with qualitative bulk water detector (EI 1592) to provide bulk water alarm	No qualified products on market
Notes: For further details of design, performance and testing requirements for **quantitative** particulate matter and/or free water sensors, see EI 1598 *Design, functional requirements and laboratory testing protocols for electronic sensors to monitor free water and/or particulate matter in aviation fuel* 2nd edition, and the user guide to sensors, EI 1570 *Handbook on electronic sensors for the detection of particulate matter and/or free water during aircraft refuelling*. For further details of design, performance and testing requirements for **qualitative** bulk water detectors, see EI 1592 *Design, functional requirements and laboratory testing protocols for electronic bulk water detectors for use in aviation fuelling*.					