

## Summary

This JIG Bulletin introduces Dirt Defence Filtration (DDF) in conjunction with Electronic Water Sensor (EWS) technology into the JIG Standards, to supplement the filtration technologies currently accepted by JIG. Entities operating in accordance with JIG standards may start using the tested DDF or DDF+EWS combinations listed below in accordance with the procedures stipulated in this document, which form part of the current JIG standards with immediate effect.

## Background

The aviation industry has worked continuously over the past several years to develop and evaluate new technology to replace Super Absorbent Polymer (SAP)-based filter monitors (FM), without the need for vessel configuration changes (drop-in replacement elements). The ultimate objective remains unchanged: to eliminate SAP-based filtration from all aviation fuel handling applications for the reasons explained in JIG Bulletin 105 and the documents referenced therein.

A joint industry programme designed and funded by JIG, IATA and A4A - the Joint Industry Filtration Field Trial Group - was established in 2018 to conduct field evaluation of new filtration/sensing technology. The scope of this joint field evaluation scheme includes only technology that has successfully completed the required EI qualification testing and technical evaluation for robustness. Progress on the technical and field evaluation of available replacement technologies has been communicated by JIG through regular Technical Newsletters since the onset of the programme.

## Introduction of Dirt Defence Filtration – Electronic Water Sensor combined technology

The field evaluation process that was followed for the combination of the Dirt Defence Filters (DDF) - Electronic Water Sensor (EWS) shown in the table below has been completed. The review of the field evaluation results from the joint industry group has demonstrated that, in the environments in which these systems were tested, they prevent dirt and free water from reaching the aircraft, are durable in mobile applications and have sufficient life for routine operations. It was therefore confirmed by the joint industry group that the tested combinations met the acceptance criteria defined in the field trial protocol. As a result, the joint industry group has recommended the adoption of the tested combinations listed below into the standards. Reference to the JIPL Technical Evaluation Summary: [SUMMARY LINK](#)

**Based on this recommendation, the DDF and EWS combinations listed below are adopted into JIG standards with immediate effect, under the procedures defined in this document.**

Filter/Sensor type	FAUDI Aviation product number
Dirt Defence Element, 2" Qualified to EI 1599 2 <sup>nd</sup> ed.	Model: DDO2.2-xx-2
Dirt Defence Element, 6" Qualified to EI 1599 2 <sup>nd</sup> ed.	Model: DDO6.4-xx-2
Electronic Water Sensor (EWS) conforming to EI 1598 2 <sup>nd</sup> ed.	Model: AFGUARD® Firmware Version: 01.19 or newer

**Note: Users of JIG standards are reminded that JIG do not issue equipment or material approvals. It is the sole responsibility of user companies to decide whether the equipment is acceptable for their use, suitable for their operating environment and conditions and, where it's deemed necessary, subjected to additional field evaluation.**

## Requirements for DDF/EWS – Changes to JIG Standards

Users of JIG standards may use the technologies listed above in the applications shown in Appendix 1 of this document. In Jet fuel applications, models of the tested DDF listed above shall only be used in conjunction with the EWS listed above, as shown in Appendix 1. Users who are planning to implement the technologies listed above shall follow the requirements detailed in Appendices 2-5, which form part of the current JIG standards with immediate effect:

- **Installation:** See Appendix 2
- **Routine Operation:** See Appendix 3
- **Routine Maintenance:** See Appendix 4
- **Documentation and Records:** See Appendix 5

## Process Failure Modes and Effects Analysis (FMEA)

A Failure Modes and Effects Analysis (FMEA) study of this combined filter and sensor technology in fuelling equipment was conducted. The review of results substantiated the end-to-end system functionality and has been used in the development of the operating parameters included in this document.

An FMEA is a qualitative analysis of a system to identify potential failure modes, causes, effects and consequences of those failures. JIG has carried out an end to end (i.e. fueller to wing tip, or hydrant coupler to wing tip) FMEA study for the integration of DDF+EWS technology into hydrant dispensers and fuellers using generic equipment configurations. The design basis used for this study is available on the JIG Website, as an example template ([TEMPLATE LINK](#)). Where DDF+EWS technology will be adopted, an FMEA or similar review should be carried out to establish potential failure modes on each vehicle design being used at a location. For further information see Appendix 2.

Important points to consider for the FMEA are:

- A competent person trained in the FMEA process shall facilitate the study
- Team members shall be selected to provide a broad knowledge of both existing equipment and new equipment e.g. Engineering, Design, Operations & Maintenance.

## Management of Change (MOC)

Operators introducing the DDF+EWS options listed above into their operations shall exercise due diligence in the development and implementation of appropriately authorised Management of Change plans throughout the transition period. The following shall be taken into consideration as a minimum:

- Assess the suitability of this technology at the location by evaluating the historic into-plane fuel cleanliness at the location, using information such as historic filter dP records with FM, FM changeout history, routine drain records etc. Additional information can be sought from the JIPL Technical Evaluation Summary.
- Assess the suitability of equipment on the vehicles that the system is to be connected to and interfaced with (see section on FMEA above and Appendix 2).
- Comply with the installation requirements provided by the EWS manufacturer, and ensure installation works are conducted by trained and competent technicians.

- Update operating manuals, procedures, record forms, training and other documentation as required.
- Ensure relevant personnel receive appropriate training on DDF and EWS technologies and on the required procedures.
- Ensure new operational data plates are attached to the filter vessel.
- Verify max achievable flowrate and ensure that the rated flow of the vessel is not exceeded.
- **Ensure effective segregation of stocks of DDF elements from existing filter element stocks and any other appropriate controls necessary to ensure DDF elements are not inadvertently mixed with FM elements or are not inadvertently mixed within a single filter vessel with FM.**

Particular attention shall be given to operator training to ensure full understanding of the conceptual differences between existing filtration technologies and DDF+EWS combined technology. DDF are not designed to remove free water and for Jet fuel shall be used in conjunction with the EWS listed above, which is designed to detect free water and prevent it from passing downstream. Emphasis should be placed on the DDF+EWS operating procedures, such as the steps required following an EWS system event. Further information on new filtration/sensing technologies can be found in EI 1550.

#### Actions to Implement this Bulletin (See Table 1 for Action Type Codes)

Action Description	Action Type	Effective as of
Entities operating in accordance with JIG standards may use the DDF/EWS technology introduced in this document, in accordance with the requirements detailed in this document.	JS	24 <sup>th</sup> August 2020
Operators introducing the technology introduced in this Bulletin shall establish a risk-based Management of Change plan as explained in this document.	RA	24 <sup>th</sup> August 2020
Operators introducing the technology introduced in this Bulletin should perform their own evaluation prior to full implementation.	RP	24 <sup>th</sup> August 2020

## Appendix 1 – List of Applications where DDF or DDF+EWS technology may be used

The table below includes a list of applications where the tested DDF and DDF+EWS combinations listed in this Bulletin may be used. This table supplements the filtration options currently accepted in the JIG standards.

It is noted that Dirt Defence Filtration technology is considered comparable to Microfilters, with some improved characteristics, e.g. improved mechanical strength (see EI 1550). Therefore, DDF qualified to the latest edition of EI 1599 is an accepted alternative in applications where Microfilters qualified to the latest edition of EI 1590 are currently accepted in JIG standards, without the need for an EWS.

**Table 1 - Applications where DDF or DDF+EWS technology may be used**

JIG Standards	Application	Accepted options
<b>JIG1</b>	Into-plane Jet Fuel	DDF+EWS
	Into-plane Avgas	DDF
<b>JIG2</b>	Loading Jet Fuel	DDF+EWS
	Receipt/Loading Avgas	DDF
<b>JIG4</b>	Into-plane Jet Fuel	DDF+EWS
	Into-plane Avgas	DDF
	Receipt Jet Fuel	DDF
	Loading Jet Fuel	DDF+EWS
	Receipt/Loading Avgas	DDF

## Appendix 2 – Installation and Commissioning

### EWS system assessment and commissioning

Electronic water sensor systems shall conform to the latest EN ISO 13849-1 with a minimum Performance Level (PL) of PL(b). An assessment shall be conducted of the suitability of equipment on the vehicles that the EWS system is to be connected to and interfaced with, as part of the detailed Management of Change (MOC) plan, taking the following into consideration:

- The EWS system shall be installed by trained and competent technicians, in accordance with the installation requirements provided by the equipment manufacturer.
- After installation and before putting vehicles into service with active DDF+EWS, all components in the corresponding safety circuit should conform to the latest EN ISO 13849-1 with a minimum of PL(b), with advice sought from the sensor, the vehicle and/or component manufacturers.
- When newly installed equipment is connected to an existing solenoid valve, an assessment of the reliability of the solenoid valve shall be conducted to ensure this valve is fit for purpose.
- It shall be confirmed that the deadman override does not bypass the EWS system shutdown capability.

It is recommended that a Failure Modes & Effects Analysis (FMEA) or other suitable Process Hazard Analysis (PHA) study in fuelling equipment should be conducted, to evaluate failure modes associated with the integration of the EWS system and associated procedures into a fuelling vehicle equipped with DDF.

The EWS system shall be commissioned by competent technicians, to ensure the EWS system is configured properly, it functions as expected and that no unauthorised bypass routes are allowed by the vehicle design (e.g. by the deadman override design).

### Electronic Water Sensor system requirements

Electronic water sensor (EWS) systems used in conjunction with DDF technology introduced with this Bulletin, shall include the following components:

- an EWS fitted downstream of filtration,
- a compatible controller (PLC) and
- a sensor warning light.

These systems shall be connected to the deadman system to ensure automatic fuel shutdown, under the conditions specified below.

The EWS shall be fitted at a suitable position on the filter outlet. Instructions by the sensor manufacturer shall be followed for the identification of the suitable position for sensor operation and accessibility for routine testing.

A system reset mechanism shall be installed, which shall be controlled by authorised personnel only. This may be an electronic reset with the use of a passcode to reset the system on the controller, a separate key-operated reset mechanism or preferably both. In either case, the reset passcode and the reset key **shall be**

**strictly controlled by authorised personnel only.** The reset mechanism shall be configured such that it prevents a system reset by other means, e.g. by simply disconnecting - reconnecting the sensor cable or using the deadman override.

## EWS Warning Light

The EWS warning light should be blue in colour unless local airport regulations require a different colour. In any case, the same colour shall be used on all vehicles equipped with EWS systems at a location.

The EWS warning light shall be prominently displayed on the fuelling vehicle exterior, enabling a clear, unobstructed view for the fuelling operator at all times during fuelling, in all-weather/light conditions.

The EWS warning light shall be configured as follows:

1. **Standby mode:** Before fuel flow commences, light flashes intermittently in cycles (e.g. flashes on and off twice in 0.5 seconds and then remains off for 2.5 seconds and then the cycle repeats).
2. **Fuelling mode:** When fuel flow commences, light constantly illuminates indicating that the system is operational.
3. **Check Level:** A sensor indication between 15ppm and 30ppm of free water for at least 10 sec shall trigger a slow flashing of the light to prompt the operator to take actions as defined below under Check Level.
4. **Alarm Level:** A sensor indication greater than 30ppm of free water for at least 10 sec or greater than 50ppm of free water for at least 5 sec shall trigger a faster flashing light (faster than Check Level) and shall automatically shut down the fuelling. The operator shall then take actions as defined below under Alarm Level.

In addition to the EWS warning light, the installation of an audible alarm may also be considered.

## Additional considerations

For fuelling equipment fitted with DDF, consideration may be given to the following:

- **An electronic bulk water detector**, such as a device conforming to the latest edition of EI 1592, may be installed at a suitable location upstream of filtration (e.g. vessel drain point). The optimum position of electronic bulk water detectors depends on the filter vessel design and drain pipework configuration. The guidelines provided by the bulk water detector manufacturer shall be adhered to for the identification of the optimum position. Where fitted, bulk water detectors shall have the capability of being function tested externally in accordance with the manufacturer's instructions and at the frequency specified in the current JIG standards for water slug detection devices (JIG1-A6.2.6).
- **A dP limiting device** such as a dP switch fitted on the piston-type dP gauge or other electronic dP monitoring system may be installed on filter vessels fitted with dirt defence filters. Where fitted, dP limiting devices shall be tested in accordance with the current JIG requirements (JIG1-4.10.3).

## Appendix 3 – Operations

### DDF Draining and sampling

**Routinely (all equipment):** For filters fitted with DDF, routine draining (off-ramp for fuelling equipment) shall be carried out under pressure daily, as currently required by the JIG standards.

**Sampling during fuelling operations:** Sampling procedures during fuelling operations shall be carried out as currently required by the JIG standards. For systems fitted with an EWS, a CWD Check as specified in section 5.3 of JIG1 (A7.1 of JIG4), is not required unless the sensor triggers either a Check or an Alarm Level, in which case the actions defined in the following section shall be followed.

### Differential Pressure monitoring and reporting

The current JIG requirements for dP monitoring and recording apply for vessels fitted with DDF.

### EWS operation

EWS systems shall be operated in accordance with the instructions provided by the EWS manufacturer and the requirements detailed below.

**At the beginning of fuelling before fuel flows,** the operator shall check that the system is in standby mode (as described in Appendix 2). If the EWS warning light is not illuminating intermittently (as described in Appendix 2), that might be due to a system fault. The EWS system will not allow fuelling to start in that case and the vehicle shall be withdrawn from service for an investigation by competent technicians.

**When fuel flow commences,** the operator shall confirm that the EWS warning light is constantly illuminated (fuelling mode) indicating that the EWS system is functional, otherwise the fuelling shall not continue and the operator shall return the vehicle to the depot for an investigation by competent technicians.

If the EWS warning light stops illuminating during the fuelling operation due to a system fault, the EWS system will trigger an automatic shutdown of fuelling. The vehicle shall be withdrawn from service for an investigation by competent technicians. If the EWS warning light stops illuminating during the fuelling operation due to a bulb fault, the EWS system will not trigger an automatic shutdown due to the bulb fault. The operator shall return the vehicle to the depot for repair, after the completion of fuelling.

### Check Level Actions

A Check Level indication occurs if the EWS measures free water concentrations of 15-30ppm for more than 10 seconds. If a Check level indication occurs, the fuelling shall be stopped, and the operator shall conduct a Visual Appearance Check followed by a CWD Check on a sample taken downstream of the filter. See Fig.1.

The fuelling shall only recommence if the sample passes the Visual Appearance Check and CWD Check. When the vehicle returns to the depot, the cause of the Check Level indication shall be investigated by competent technicians and the results documented. If the sample fails the Visual Appearance Check or CWD Check, the fuelling operator shall stop the fuelling immediately and follow the actions for an Alarm Level indication (see below).

## Alarm Level Actions

An Alarm Level indication occurs if the EWS measures free water concentrations of 30ppm-50ppm for more than 10 seconds, or >50ppm for more than 5 seconds. When an Alarm Level indication occurs, the EWS system shall automatically shut down the fuelling and the operator shall return the vehicle to the depot and follow the actions described below and shown in Figure 1. The fuelling operator shall inform the location management. Local procedures shall be in place to notify the customer representative, and where applicable, the Hydrant Operating Company.

Site specific procedures shall be developed for use in the event that a second fuelling vehicle is required to complete a fuelling after an EWS system Alarm is triggered. These shall include additional Visual Appearance Checks + CWD Checks and enhanced dP monitoring throughout the subsequent fuelling(s). Consideration should be given to complete the fuelling with a vehicle fitted with other filtration technology (e.g. FWS) or a fueller, where possible. The use of a hydrant flushing vehicle to flush the pit prior to completing a hydrant fuelling should also be considered.

The first vehicle shall return to the depot where an investigation into the cause of the alarm shall be initiated. The actions required before the vehicle is used in a subsequent fuelling are detailed in the following section.

## Checks required after EWS system triggered

As part of the investigation of an EWS system Alarm activation and once the EWS system has been reset by an authorised person, the following actions shall be taken:

- a fuel sample shall be taken from both sides of the filter (inlet and outlet) for a Visual Appearance Check followed by a CWD Check as soon as practically possible after the system shutdown.
- The filter shall be flushed for at least 5 minutes at the maximum achievable flowrate, preferably on a test rig or by recirculation through fuellers if no test rig is available.
- The filter dP at the maximum achievable flowrate shall be checked against the expected dP of the filter and any abnormal variations shall be investigated.

The EWS override system shall be temporarily activated prior to fuel circulation by an authorised person, and in accordance with the manufacturer's recommendations and local written and management control procedures, but only for the time required to complete the fuel circulation procedure described above.

When the process described above is complete, fuel samples shall be taken from both sides of the filter under pressure, for a Visual Appearance Check followed by a CWD Check, before the vehicle returns to service. The vehicle shall be removed from service and support sought from an authorised technician if:

- the fuel sample downstream of the filter fails the Visual Appearance or CWD Check and following additional flushing as described above a satisfactory result cannot be obtained, or
- the above flushing procedure fails to restore the EWS warning light to constantly illuminated (fuelling mode)

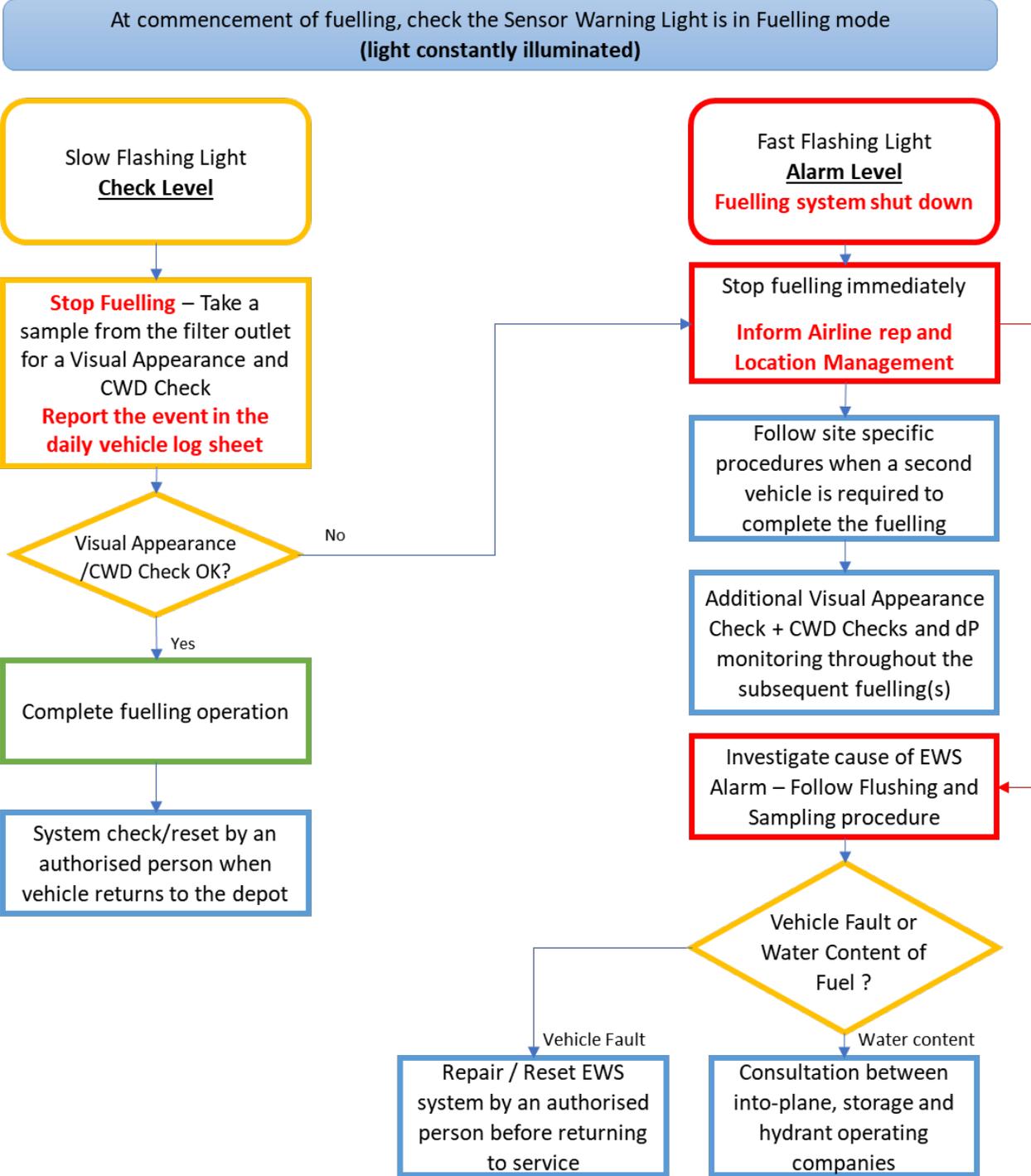
Significant air entrainment in the system may cause an alarm condition so this should be considered in any investigation and addressed in local operating procedures.

Following the investigation of an EWS system activation (Check or Alarm) and before the vehicle returns to service, the system shall be reset by an authorised person.

### Operation of EWS at fixed facilities

Where EWS is used at fixed facilities in conjunction with DDF for jet fuel loading (per Appendix 1), an operating protocol that is consistent with the requirements specified for fuelling operations shall be established and implemented.

Figure 1 – DDF+EWS Operating protocol (Fuelling operations)



## Appendix 4 – New DDF element commissioning and Routine Maintenance

### DDF element commissioning

When new DDF elements have been installed in fuellers and hydrant dispensers, product shall be flushed through the unit either on a test rig or by recirculation on fuellers for at least 5 minutes at the maximum achievable flowrate, preferably back to storage to remove air bubbles, small fibres, etc. Following commissioning of new DDF elements, each hose-end strainer shall then be inspected and cleaned before the unit is returned to service.

When commissioning new filter elements in fuelling equipment fitted with EWS or after other maintenance, there may be air in the system which will trigger the EWS alarm and interfere with the procedure unless overridden. Therefore, the EWS override system shall be temporarily activated by an authorised person, prior to fuel circulation and in accordance with the manufacturer’s recommendations and local written and management control procedures, but only for the time required to complete the fuel circulation procedure described above.

### Reinstatement of equipment fitted with DDF+EWS that has been out of service

The fuel circulation procedure described above shall also be followed for fuelling equipment fitted with EWS that has been temporarily out of service or not used for more than a week, to flush any water accumulated or condensed in the fuelling pipework over the period of dormancy before the vehicle returns to service.

### Routine Testing of EWS

The function of EWS systems and associated on-vehicle systems shall be checked at least every 3 months during fuel circulation on test rig, using the testing equipment supplied by the sensor manufacturer, in accordance with the manufacturer’s instructions. The purpose of this function test is to verify the correct function and response of the system to simulated events generated by the testing equipment. This function test shall also be carried out as part of EWS recommissioning after recertification.

In addition, the certification of newly installed electronic water sensors shall be checked by the manufacturer after 2 years from the date of the original EWS certificate and yearly thereafter or when issues with EWS operation are encountered. After consultation with the sensor manufacturer and in accordance with the manufacturer’s instructions, EWS shall be sent to the manufacturer or manufacturer’s authorised service agent for recertification check and replaced if necessary:

- If they are damaged or malfunction
- If sensors are operated at conditions not recommended by the manufacturer
- If sensors are exposed to high pressure water streams during vehicle washing.

### DDF Inspection and Routine Maintenance

The current JIG requirements for filter inspection and routine maintenance shall be followed for vessels fitted with DDF elements. See Table 2 below.

## DDF element change criteria

DDF elements shall be replaced:

- If the differential pressure reaches 22 psi (1.5 bar) at (or corrected to) the maximum achievable flow rate through the filter vessel as currently installed
- If flow rate falls to unacceptably low levels that cannot be substantiated by an investigation
- If acceptable filter membrane test results (downstream of filtration) cannot be obtained
- If unusual sediment is found downstream of the filter
- If there is a sudden drop in differential pressure without any obvious cause being found
- If elements are contaminated by microbiological growth (MBG) or MBG contamination of elements is suspected
- If filter inspection identifies issues with the condition or structural integrity of elements
- After reaching the 5-year maximum service life recommended by the filter element manufacturer if there is no other cause of concern. Note: JIG has taken the decision to follow the 5-yearly recommendation of the filter element manufacturer, subject to further review when more operational data is available.

## Summary of Routine Test frequencies

**Table 2 – Summary of routine test frequencies for DDF+EWS and associated systems**

	TEST FREQUENCY						Reference
	Daily	Weekly	Monthly	3-monthly	6-monthly	Other	
<b>Fuelling vehicles</b>							
Filter draining	x						A6.2.1
Filter differential pressure	x						A6.2.2
Filter dP graphs		x					A6.2.2
Filter membrane colorimetric test			X				A6.2.3
Double membrane or gravimetric (Fuelling equipment)					x		A6.2.3
Filter internal inspection						Yearly	A6.2.4
Dirt Defence element change						5 years or cause (see above)	Bulletin 130/App4
Electronic water sensor function check (on-site)				x			Bulletin 130/App4
Electronic water sensor recertification (by OEM)						2 years (initial) then Yearly	Bulletin 130/App4
Bulk Water Detectors				x			A6.2.6
dP limiting devices (e.g. dP switches)					x		4.10.3

## Appendix 5 – Documentation and Records

### EWS Data capture

For vehicles fitted with DDF and EWS systems feeding a data capture system, the manufacturer's recommendations for data control and prevention of data loss shall be followed. It is recommended that a data backup is taken on a routine basis and prior to any firmware updates.

The data recorded and retained for each into-plane operation shall include either confirmation that the fuelling was conducted with water below 30 ppm throughout the entire fuelling, or the reason that an interruption to the fuelling occurred (Check or Alarm Level). This shall include the free water levels reported by the EWS system that prompted the fuelling interruption and a record of any associated Visual Appearance Check and CWD Check results. A record shall also be kept when a delivery to a single aircraft was made by two vehicles, in which case the records shall demonstrate that the quality of the overall amount of fuel delivered was within the water specification limits.

This data should be reviewed monthly by site management to validate that all EWS activations (Check or Alarm Level) are being appropriately addressed. Records of all checks performed as part of investigation of an EWS activation (Check or Alarm Level) and actions taken shall be included in vehicle documentation.

For EWS, records should also be kept of the following, to aid an improved understanding of filter performance and other diagnostic activities:

- The peak free water content for the uplift
- The average free water content over the uplift
- Average free water content over the previous 50 fuellings (which can be used in determining filter performance trends)

### Testing of EWS

For vehicles fitted with EWS systems, records shall be kept for:

- Function tests of EWS systems and associated on-vehicle systems carried out on a routine basis; as part of EWS recommissioning; and after EWS recertification
- Valid Certification of EWS supplied by the manufacturer or manufacturer's authorised service agent following periodic recertification. Written confirmation of the EWS satisfactory performance and a test report shall be provided by the testing party.

All records shall be filed in accordance with document retention requirements for at least 3 years.

**Table 1 Action Type Codes**

Action Types	JIG Bulletin Action Type Definition
JS	Change to JIG Standard – to be adopted by JV and/or Operator to continue to meet the JIG Standard(s) (JIG 1, 2, 4, EI/JIG 1530 and the JIG HSSE Management System).
RA	Required Action to implement one off verification or checks outlined in the table of actions.
RP	JIG Recommended Practice which the JV should consider adopting as its own practice (**).
I	Issued for information purposes only.
<p>Note (**) - If the JV agreements require any of the JIG Standards and/or any of the JIG Common Processes as the governing operational standard then adoption of changes to applicable JIG Standards and/or Common Processes should not be considered optional by the JV Board.</p>	

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