Operations Bulletin

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Bulletin 110 Use of Electronic Water Sensors 4th June 2018

Introduction

Electronic sensors qualified against EI 1598[1], monitor the amount of free water and/or particulate matter present in aviation fuel. Recent work, with technology based on scattered light detection, has resulted in the development of water sensors that may be used as an alternative to Chemical Water Detectors (CWD), as explained below.

When inserted into fuel, these water sensors are capable of measuring free water levels both above and below the 30 ppm IATA Guidance Material limit for the free water content of aviation fuel. When fitted into pipework, this technology has the advantage of continually analysing the free water content of the flowing fuel, rather than relying upon periodic representative samples, such as with the use of CWD.

Quantitative electronic water sensors shall not be confused with qualitative electronic bulk water detectors qualified against EI 1592[2], which detect "bulk water" or water slugs that have displaced fuel within a system.

Water sensors qualified for use as an alternative to CWD

Only electronic water sensors that have been qualified against EI 1598 and have been subjected to performance testing on a test rig and in-service field trials over a 12-month period, with supportive data made available, may be used as an alternative to CWD, where CWD checks are mandated in the JIG Standards.

The scope of the field trial shall include testing of reliability and ruggedness of the sensor, to demonstrate any sensitivity to sensor positioning, safe failure modes and an ability to be successfully used and survive the rigors of operational use in a wide variety of climates.

Users may rely on third party performance tests and field trials, where data is made fully available and provides sufficient detail to cover the user's operating environment(s). However, users are encouraged to validate that the sensors operate successfully in their operating environment(s), e.g. via a small-scale trial prior to proceeding to an extended use.

In addition, the sensor system shall conform to the latest ISO 13849 or equivalent standard, as to the design and integration of safety-related parts of control systems including the design of software.

Bulk water detectors qualified against EI 1592 shall not be used as an alternative to CWD.

Installation and Operation of Water Sensors

Electronic water sensors shall be installed in accordance with the installation requirements provided by the manufacturer, and taking into account the suitability of existing equipment on the vehicles that the sensor system will be connected to (see Appendix 1).

Electronic water sensors may be used as an alternative to CWD testing, where required by the JIG Standards, provided that the sensor is located in the appropriate position to meet the sampling requirements outlined in the relevant section of the JIG standards, e.g. for the Visual Check made during fuelling (JIG 1 Section 5.3.1 and 5.3.2 (a)), the sensor shall be installed downstream of the filter.

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When intended to be used as an alternative to CWD during aircraft fuelling, electronic water sensors shall be installed and operated in compliance with Appendix 2 of this Bulletin and in accordance with the protocol illustrated in Figure 1.

Where used as an alternative to CWD during other operations requiring a Visual Check by the JIG standards (e.g. hydrant low point flushing), local procedures and protocols of sensor use shall be developed to meet the existing requirements of the JIG standards for that operation.

It is reminded that an Appearance Check ("Clear and Bright" assessment) of a fuel sample is an integral part of the Visual Check, therefore where such sensors are used in place of a CWD, it is still required to draw a sample for an Appearance Check.

Testing of Water Sensors

The water sensor unit shall be inspected and tested annually in accordance with the manufacturer's instructions. The associated on-vehicle systems shall be tested at least every 3 months in accordance with the manufacturer's instructions for testing.

Qualified Water Sensors

The electronic water sensors listed in Appendix 3 have been qualified against EI 1598 and have been subjected to performance tests and in-service field trials over a 12-month period and may be used as an alternative to CWD testing, in the context of this Bulletin.

Management of Change

Operators who intend to use a qualified water sensor in place of a CWD test kit, shall develop a Management of Change (MOC) plan for the installation, operation and maintenance of the sensors, the update of local operating manuals and procedures and training of the relevant staff, in accordance with this Bulletin, prior to using the sensors in place of CWD testing.

[1] EL 1598 – Design, functional requirements and laboratory testing protocols for electronic sensors to monitor free water and/or particulate matter in aviation fuel.

[2] EL 1592 – Design, functional requirements and laboratory testing protocols for electronic bulk water detectors for use in aviation fuelling.

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

Action Description	Action Type	Effective as of
A qualified water sensor as defined in this Bulletin may be used as an alternative to CWD testing, under the conditions and procedures outlined in this Bulletin and subject to the unanimous agreement by the management committee of the operation or JV and a Management of Change plan for the installation, operation and maintenance of the sensor.	JS	4th June 2018

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).
RP	JIG Recommended Practice which the JV should consider adopting as its own practice (**).
I	Issued for information purposes only.
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.	

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Appendix 1 – Definition of "Sensor System" for the purposes of installation

For the purposes of Installation of Sensor Systems, a risk assessment has also to be made on the existing vehicle components that the water sensor system is integrated into. These include, but are not limited to, the vehicle management system, deadman system and any other directly related components. After installation, all elements are expected to conform to the latest EN ISO 13849-1 or equivalent standard with a Performance Level (PL) agreed between Installer/Supplier and User, but in all cases a minimum of PL (b).

Appendix 2 – Installation and operation of water sensors in aircraft fuelling

Sensor Installation and Indications

Water sensors shall be installed in accordance with the installation requirements provided by the manufacturer.

The water sensor system shall include a sensor, a controller, an indicator lamp (that indicates the system is operational and alerts the fuelling operator when set levels of water are detected) and shall be connected to the deadman system.

The water sensor installation shall provide an alert that is visible to the fuelling operator through the use of a flashing lamp for the following sensor activations (indications for >10 sec):

1. Sensor indication between 15ppm and 30ppm of free water (Alert Level).
2. Sensor indication at or above 30ppm of free water (Alarm Level), giving a different flashing lamp indication from Alert Level, e.g. faster flashing. The software shall prevent further fuelling taking place. An Alarm Level shall also be activated for sensor indications at or above 50ppm of free water for >5sec.

Water Sensor System Operational Procedures – Aircraft fuelling

Water sensors shall be operated in accordance with the operating instructions provided by the sensor manufacturer.

There shall be a lamp that is visible to the fuelling operator, indicating that the water sensor system is active. This shall change to a flashing lamp when a sensor detects free water between 15ppm and 30ppm (Alert Level). For sensor indications at or above 30ppm free water (Alarm Level), the system shall give a different flashing lamp indication to the fuelling operator, e.g. faster flashing, and the sensor shall automatically and immediately stop further fuelling.

Where a CWD is required during aircraft fuelling (e.g. JIG 1 – 5.3.1/5.3.2), that may be replaced by use of water sensors, as illustrated in Figure 1. Where such sensors are in use, it is still required to draw a sample for an Appearance Check.

Laboratory testing and field trials of electronic water sensors has illustrated that it is challenging for sensors to accurately determine water content in fuels flowing at different flow rates, with varying sources of potential signal error, such as cavitation and dirt, which may affect the precision. Therefore, the protocol of use presented in Figure 1 requires that CWD test kits are maintained in stock, to use as a referee method if the water sensor detects water at an Alert level (15-30ppm), as illustrated in Figure1.

Alert Level Actions

When this occurs, the fuelling shall be stopped, and the operator shall conduct a Visual Check (an Appearance Check plus CWD) on a sample taken downstream of the filter, as illustrated in Figure 1.

The fuelling shall only recommence if the sample passes the Visual Check (including CWD). The operator shall revert to the use of CWD, if additional Visual Checks are required for the same fuelling. After the end of that fuelling, the vehicle shall return to the depot for the cause of the Alert Level indication to be investigated.

If the sample fails the Visual Check, the fueling operator shall follow the actions for an Alarm Level indication (see below).

Alarm Level Actions

When this occurs, the sensor system shall automatically and immediately stop further fuelling, as illustrated in Figure 1 (this is expected to be via a link to the deadman).

The fuelling operator shall:

- Stop the fuelling immediately
- Inform the aircraft pilot and/or aircraft operating staff why the fuelling has been stopped
- Inform the fuelling Company Operations Manager, who in turn shall inform the Hydrant Operating Company if applicable
- Return the vehicle to the fuelling depot where an investigation into the cause of the Alarm shall be immediately initiated and the issue then rectified.

It is noted that a significant air entrainment in the system may give an alarm condition, so this would need consideration for any investigation.

Water Sensor Data Recording and Retention

The data recorded and retained for each into-plane operation shall be either:

1. confirmation that the fuelling was conducted with water below 30 ppm for the entire fuelling, or
2. the reason that an interruption to the fuelling has occurred (Alert or Alarm). This shall include the water levels reported by the sensor that prompted the fuelling interruption and a record of any associated CWD test result.

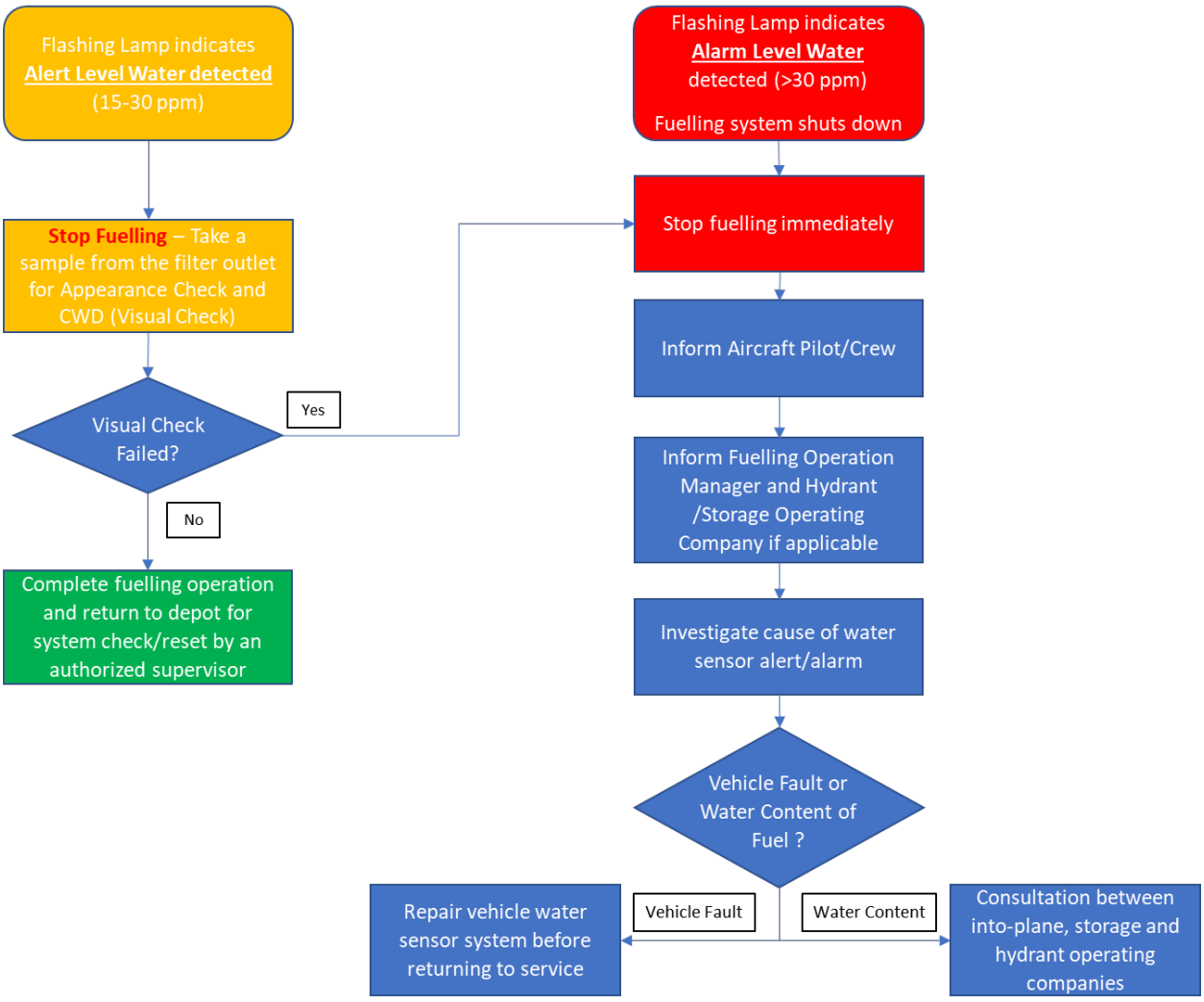
All this data shall be recorded and retained in accordance with the requirements of JIG 1 Section 7.5.

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

- The peak water content for the uplift
- The mean water content over the uplift
- Mean water content over the previous 50 fuellings (which may be useful in determining filter performance trends).

Figure 1 – Procedural flow chart following Alert or Alarm Level Sensor Warning, during aircraft fuelling

After the fuel contained in the vehicle delivery pipework and filter vessel has been displaced, and a 1-litre sample has been taken downstream (outlet side) of the filter for an Appearance Check, in accordance with JIG1 5.3.1 and 5.3.2, the following protocol shall be applied in case of a water sensor activation:



Appendix 3 - Qualified electronic water sensors

The electronic water sensors listed below have been qualified against EI 1598 and have been subjected to performance testing and in-service field trials over a 12-month period and may be used as an alternative to CWD testing, in the context of this Bulletin.

- AFGUARD ™ by Faudi Aviation

Testing of additional electronic water sensors may be undertaken in the near future by other equipment manufacturers. JIG will review and publish information about additional models meeting the criteria outlined in this Bulletin, as they become available.

It shall be noted that the testing protocols in EI 1598 (Annex A) do not include pass/fail criteria, therefore, it is not possible to identify any electronic sensor as having "passed" the EI 1598 performance testing. However, the Energy Institute (EI) does provide an optional independent witnessing scheme for EI 1598 testing on behalf of users and EI 1598 testing of the Faudi Aviation AFGUARD ™ has been witnessed by the Energy Institute.

Users of JIG standards are also reminded of the principles presented in JIG Bulletin 91 regarding equipment approvals. **JIG and the EI do not issue equipment or material approvals** and any claims to this effect are incorrect and should be disregarded. It is the sole responsibility of equipment or material user companies to decide whether the equipment is acceptable for their use, for equipment or material that has been qualified in accordance with a published specification and has also been subjected to a formal review including a period of actual field service evaluation.