OPTIMISING ELECTRONIC WATER SENSOR SYSTEMS (EWS) IN AVIATION REFUELLING OPERATIONS

Reducing Nuisance Alarms While Enhancing Fuel Quality Assurance

Electronic Water Sensor Systems (EWS) have changed how aviation fuel quality can be monitored during refuelling. Unlike traditional Chemical Water Detection (CWD) methods, which assess a single fuel sample, EWS technology continuously monitors the fuelling process and provides a quantitative measurement of free water levels.

This increased visibility has brought clear benefits, but it has also introduced a new operational challenge. Many operators have experienced warning and alarm events that interrupt refuelling even though subsequent checks do not confirm high-water contamination. Based on field experience from thousands of AFGUARD® installations worldwide, many of these events appear to be linked to the way the system is operated, how the equipment is configured, or how filtration media behave under changing flow conditions.

This paper explains the operating principles of EWS technology, examines the most common causes of warning and alarm events, and provides practical recommendations to reduce unnecessary shutdowns while maintaining a high level of aviation fuel safety.

1. INTRODUCTION

The aviation industry prioritises the delivery of clean, dry fuel to aircraft. Historically, Chemical Water Detection (CWD) tests have been used as a primary method for verification. These tests remain important, but they assess only a small fuel sample and provide a qualitative result: either above or below the 30 ppm threshold.

Electronic Water Sensor Systems provide a different approach. An EWS continuously monitors the fuelling process using an EI 1598 qualified electronic water sensor, providing a real-time quantitative measurement of free water content between 0 and 50 ppm. The system shall be integrated with a PLC that converts the sensor output into operational signals, including warning and alarm conditions and, where configured, automatic shutdown of the refuelling process.

The technology was introduced into industry standards in 2020 as an accepted filtration solution when used with Dirt Defence Filters (DDF). In practice, this gives operators a more detailed view of fuel quality conditions during refuelling than periodic sampling alone can provide.

2. UNDERSTANDING EWS ALARMS

A early misconception is that every EWS alarm indicates a significant water contamination event.

Operational experience from thousands of AFGUARD® installations worldwide suggests a more nuanced picture. In reported cases, warning and alarm events have not been linked to confirmed high-water contamination requiring emergency intervention. Subsequent CWD checks have returned results below the 30 ppm criterion or IATA limit.

This distinction matters because EWS systems can detect conditions that would usually remain invisible when only conventional sampling methods are used. Because the sensor continuously monitors the fuelling process, it may react to short-duration events that a periodic sample would not capture. These can include air bubbles, condensation-related moisture, temporary water release from filtration media or changes caused by flow behaviour.

Operators should therefore view EWS alarms as signals that require investigation and context. An alarm should never be ignored, but it should also not automatically be interpreted as evidence that water contaminated fuel has been delivered.

3. COMMON CAUSES OF EWS WARNINGS AND ALARMS

3.1 Entrained Air and Air Bubbles

One frequent cause of nuisance alarms is the presence of air bubbles in the fuel stream. In observed cases, air bubbles passing through the sensor may be interpreted as water droplets and trigger a warning or alarm condition.

Air can enter the system in different ways. It may be drawn into a vessel when flushing or sampling is carried out without maintaining system pressure. It can also be introduced after vessel draining, during filter element replacement, following rapid deadman shutdown events on hydrant dispensers or through automatic air eliminators. Low fuel levels in refuellers can also create suction-side air entrainment, while Product Recovery Tank transfer systems may draw in air if pumps continue running after the minimum fuel level has been exceeded or fuel has been depleted.

Recommended Mitigation Measures

- Install soft-seat non-return valves on air eliminator outlets.
- Ensure flushing and sampling activities are conducted under pressure.
- Maintain adequate minimum ullage levels in refuellers.
- Verify low-level controls and transfer pump protection within product recovery systems.
- Train operators on correct procedures following maintenance and draining activities.

3.2 Condensation-Related Events

Temperature fluctuations can allow condensation to form, particularly when equipment remains parked overnight or is used infrequently. Moisture may accumulate inside vessels, pipework or on sensor surfaces. During the first fuelling of the day, this moisture can be mobilised and whilst only temporary, may be detected by the EWS.

Recommended Mitigation Measure

- Improve draining and flushing procedures.
- Ensure flushing is conducted from the lowest points in the system.
- Rotate fleet utilisation to reduce extended idle periods.
- Extend EWS PLC start-delay settings where this is supported by operational data.
- Train operators to fully open fuelling valves before activating the deadman control, so the start-delay function can work as intended.

3.3 Sampling and Draining Practices

Correct sampling procedures play an important role in preventing avoidable EWS alarms. Water naturally accumulates at the lowest points within a vessel. If flushing or sampling is performed from unsuitable locations, accumulated water may remain in the system and later become dispersed into the fuel flow.

Sampling and draining should therefore be conducted from the designated vessel drain points. Operators also need to understand the difference between upstream and downstream sampling locations, particularly when working with different vessel designs.

Best Practice Recommendations

- Follow applicable sample procedures as detailed in operating standards.
- Use vessel drain points rather than pipework connections.
- Ensure operators understand upstream and downstream sampling locations.
- Verify that flushing procedures remove accumulated water from all low points.

3.4 Water Retention and Release in Dirt Defence Filters

A less intuitive cause of EWS warnings involves the behaviour of Dirt Defence Filter (DDF) elements. Under low-flow conditions, filter media can retain low levels of water. When flow rates increase, or when the retained water capacity is exceeded, this moisture can be released back into the fuel stream.

Laboratory testing has shown that DDF elements can retain measurable quantities of water for extended periods during lower-flow operation. When exposed to higher flow rates, the retained water is flushed from the element, and the filtration media is effectively regenerated.

This released water is not newly introduced contamination. It is water that has already been captured from the fuel and is later released under changing hydraulic conditions.

Recommended Mitigation Measures

- Avoid significantly oversizing filter vessels.
- Match element count to realistic maximum operating flow requirements.
- Periodically operate equipment at higher flow rates where operationally feasible.
- Implement recirculation programmes where required.
- Ensure vehicles regularly reach representative operating flows to support filter media regeneration.

4. DATA-DRIVEN EWS MANAGEMENT

One of the main advantages of EWS technology is the availability of operational data. Modern EWS installations generate continuous records of water readings, warnings and alarms. Over time, this data helps operators understand whether alarms follow a recognisable pattern, such as a specific vehicle, time of day, first fuelling of the day or flow condition.

Rather than treating every alarm as an isolated event, organisations would be well advised to adopt a structured review process.

Key Parameters to Monitor

- Time of day
- Ambient conditions
- First fuelling compared with subsequent fuellings
- Aircraft type changes
- Flow-rate variations
- Vehicle surge events
- Duration of elevated water readings
- Warning sequences preceding an alarm

Monthly review of EWS records can help operating companies adjust PLC settings where appropriate, support operational improvements and provide objective evidence during inspections and audits.

5. THE FUTURE OF FUEL QUALITY MONITORING

The aviation industry is making greater use of real-time fuel quality data. Continuous monitoring provides more information than traditional periodic sampling and gives operators a clearer view of what happens during the refuelling process.

As EWS data becomes more widely used, operators may be able to apply more refined alarm logic that considers not only the measured water level, but also how long the condition lasts and under which flow conditions it occurs. This could help reduce unnecessary operational interruptions while maintaining strong safety margins.

Continuous downstream monitoring may also support more performance-based filtration maintenance strategies. Operators can use actual operating data alongside existing inspection and maintenance requirements, helping them understand how filtration systems perform in service and where closer attention may be needed.

6. CONCLUSION

Electronic Water Sensor Systems are an important development in aviation fuel quality monitoring. They provide continuous measurement during refuelling and

can reveal fuel-system conditions that conventional periodic sampling may not detect.

Operational experience suggests that many warning and alarm events are not caused by confirmed high-water contamination. In many cases, the cause can be traced to air ingress, condensation, sampling practices, equipment configuration or water retention and release within filtration media.

By understanding these root causes and applying practical mitigation measures, operators can reduce nuisance alarms while retaining the safety and quality benefits of continuous fuel monitoring. EWS data also gives the industry an opportunity to improve how fuel quality is understood, reviewed and managed during refuelling operations.

ABOUT SEFISO | FAUDI AVIATION

sefiso | FAUDI Aviation develops filtration, sensor and fuel quality monitoring solutions for aviation fuel handling. Its portfolio includes AFGUARD® Electronic Water Sensor Systems and technologies supporting performance-based filter life management.