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MICROBMONITOR®2

Technical Guidance

Routine Monitoring of Aviation Fuels in Supply and Distribution Facilities, Airport Depots and Into-plane Operations with MICROBMONITOR®2

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BACKGROUND

MicrobMonitor2 enables on-site or laboratory testing in accordance with ASTM and IP Standard Methods (ASTM D7978 and IP613 - Determination of the viable aerobic microbial content of fuels and associated water - Thixotropic Gel Culture Method).

Microbial growth may occur wherever any water accumulates in aviation fuel tanks and systems. Only very small quantities of water are required; films of water less than 1mm thick are sufficient to support microbial growth. When heavy microbial growth occurs, fuel quality is affected and fuel may become off specification. Microbial growth can also disarm Filter Water Separators and can cause corrosion of fuel tanks, pipelines and fuel system components such as gauging equipment. If microbiologically contaminated fuel is uplifted onto aircraft then there is a possibility for serious operational problems, including fuel tank corrosion, clogging of engine fuel filters and malfunction of fuel quantity indicator systems.

Prevention of microbial growth is a key safety requirement in the aviation fuel supply chain. It is best accomplished by rigorous attention to prevent water entering fuel systems, by designing and operating systems so that they do not accumulate water and by routine removal of water from tank bottoms and pipeline and system low points. It is also important to regularly maintain filters and to change filter elements at the first signs of microbial growth. Further information on ensuring the quality of aviation fuel at airports is provided in ATA 103 *Standards for Jet Fuel Quality Control at Airports* and the Joint Inspection Group (JIG) Guidelines *for Aviation Fuel Quality Control & Operating Procedures for Into-plane Fuelling Services (JIG 1), Airport Depots* (*JIG 2*) and *Smaller Airports* (*JIG 4*). Information is also contained JIG Bulletin 83 *Microbial Monitoring Strategies Oct 2015* and associated Technical Information Document *Part 1* Microbial Monitoring Strategies Oct 2015. JIG Guidelines are endorsed by IATA. Additional guidance relevant to aviation fuel supply from the refinery up to delivery to the airport s is available in EI/JIG Standard 1530 *Quality Assurance Requirements for the Manufacture, Storage and Distribution of Aviation Fuels to Airports* and in API Recommended Practice 1595 *Design, Construction, Operation, Maintenance, and Inspection of Aviation Pre-Airfield Storage Terminals.* Further information for aircraft operators can be found in the IATA *Guidance Material on Microbiological Contamination in Aircraft Fuel Tanks.*

Even when all reasonable measures are taken to keep water out of fuel systems, there may still be a risk of microbial growth. This is why IATA, EI, JIG and API recommend routine microbiological monitoring to ensure systems remain free of contamination. JIG mandates semi-annual microbial testing of vehicles used for de-fuelling. JIG also recommends routine microbial monitoring throughout the aviation fuel supply chain. JIG guidance states that microbial monitoring can be used as an alternative to quarterly visual inspections of product recovery tanks and as a means to evaluate extending main storage tank cleaning frequency. The frequency of microbial monitoring should be monthly, quarterly or annually depending on the risk of microbial contamination at the facility. This risk will initially be assessed by at least quarterly monitoring over a period of 1 year. API 1595 takes a slightly different approach and mandates a six monthly test of aviation fuel pre-airfield storage tank bottoms. ATA 103 recommends microbial testing where there are indications of microbial growth.

The **Microb**Monitor2 test is recommended by IATA and leading aircraft manufacturers (including Boeing and Airbus) for monitoring aircraft fuel tanks, JIG recommends that microbiological test kits recommended by IATA are used for monitoring microbial contamination in aviation fuel at airports and supply and distribution facilities. This Technical Guidance document provides information on using the **Microb**Monitor2 test kit to monitor for microbial contamination in aviation fuel supply, storage and distribution facilities, airport depots and into-plane operations including;

- When, where and how to take samples
- How to conduct the test for aviation fuel samples and associated water
- How to interpret test results
- Appropriate actions when contamination is detected.

We endeavour to ensure the advice offered in this Technical Guidance document is, at time of publication, consistent with the current recommendations provided in the various industry standard guidance documents referenced above. Some of the industry standard documents recommend seeking advice from specialists in the use of field testing kits and interpretation of results when contamination is detected and this Technical Guidance thus provides additional recommendations to those provided in the Industry Standards.

SAMPLING - WHEN AND WHERE

Guidance on where and when to take samples is given in the tables on page 3 for **Supply & Distribution Facilities** and for **Airport Depots and Into-plane Operations.** This guidance is based on JIG Guidelines although in some cases the recommendations we provide are more rigorous (e.g. although not specified by JIG, in our experience it is useful to routinely test filter drain line samples in facilities at risk of microbial growth).

The tables suggest appropriate samples for **routine monitoring** (highlighted in green) and also additional samples which might be taken as part of an

investigation when microbial contamination is detected or suspected. For routine monitoring, the frequency of sampling and testing should be based on the perceived risk and/or any previous experience of microbial growth problems.

Consider facilities to be "**high risk**" if at any time in the previous 2 years, heavy microbial contamination has been detected at any sampling location on more than one occasion or if significant microbial growth has been observed during inspection of tanks or filters.

Consider facilities to be "**moderate risk**" if there has been a single incident of heavy microbial contamination detected at any sampling location in the previous 2 years and/or if the facility operates under conditions which may be conducive to microbial growth (e.g. facilities in hot, humid environments, facilities where water or dirt is known to ingress or accumulate in tanks, facilities which are ship fed and facilities undergoing engineering works such as hydrant installation or repairs).

Facilities which do not operate under conditions specifically conducive to microbial growth can be considered "**low risk**" if no samples have shown heavy contamination and there have been no other indications of microbial growth in the previous 2 years. Ongoing testing is required for 2 years after return of a facility to low/acceptable levels of contamination and some limited sampling and testing of these facilities (e.g. annually) might be advisable after this period.

Category A and **Category B** shown in comments column of the tables refers to the appropriate microbial contamination limit values which should be applied to the sample and is explained further in the section on Interpretation of Test Results (see page 6 and 7). Usually, most microbial contamination will be present in the tank bottom, particularly in any free water at the fuel water interface; growth will normally be detected here first before it spreads into the fuel and affects bulk fuel quality. Therefore, for routine monitoring, it is best to test low point, dead bottom or drain line samples as these will provide the earliest and most consistent indication of contamination. When sampling storage tanks, drain or bottom samples should be taken after any standard product settling time has been applied and immediately before tank release.

HOW TO SAMPLE

It is important to be consistent in the procedure used for sampling and testing. Appropriate sampling procedures are described in the Energy Institute *Guidelines for the investigation of the microbial content of petroleum fuels and for the implementation of avoidance and remedial strategies* (Energy Institute, London) and ASTM D 7464 *Standard Practice for Manual Sampling of Liquid Fuels, Associated Material, and Fuel System Components for Microbiological Testing* (ASTM International, PA, USA).

Sampling equipment and sampling valves should be clean and, if possible, decontaminated by rinsing or wiping with a 70% alcohol solution (ensure all residues of alcohol evaporate before taking the sample or it will affect the test result). Particular attention should be paid to the cleanliness of any rubber or plastic hoses attached to the ends of sampling points as these can harbour dirt and microbial growth (and consequently cause false positive test results). Ideally, sterile sampling containers should be used but in practice it is usually sufficient to use clean previously unused containers. A **Microb**Monitor sampling kit, including sterile bottles and alcohol wipes, is available from ECHA Microbiology. It is a good idea to rinse sampling equipment (e.g. bottom samplers, bacon bombs and all level samplers) with fuel from the tank or system to be sampled before taking the sample for test.

Most fuel supplier guidelines on routine microbiological monitoring advise that when sampling from drain lines, the sample point should be flushed completely clear of water and verified “water free” using a chemical detector capsule, if one is available, before taking the sample for microbiological test. Alternatively, for purposes of investigating a suspected microbiological incident, it may be appropriate to take the sample as soon as the contents of the drain line have been flushed away (i.e. sample the first product/water to come from the tank or filter vessel); samples taken in this way may give a higher microbiological test result as it is more likely that microbes associated with water in the bottom of the tank will be recovered. It is important that a sampling protocol suitable to the objectives of the test is adopted and that sampling is conducted using a consistent procedure to enable comparison of test results of samples taken from different tanks or at different times. To improve the representation of the system sampled it is preferable to take samples of about 1 litre in volume; this will enable easier visual observation of the sample for water, dirt, particulates and suspected microbial growth. However, only a very small volume of sample is actually required for the **Microb**Monitor2 test.

Once fuel samples have been taken, any microbes present will tend to slowly die and it is important to test samples as soon as possible; if samples are to be returned to a laboratory or other facility for testing then ideally the test should be conducted within 48 hours. Samples will give increasingly less reliable results as they get older. Alternatively, part or all of the **Microb**Monitor2 test procedure can be conducted at the sampling location as described below (see **Testing on-site**).

TESTING

For full details on the procedure for conducting a **Microb**Monitor2 test refer to the Instruction for Use provided with the test. A quick reference guide to the test procedure for aviation fuels is shown on the following page. An aliquot of 0.5 ml of fuel (or 0.01 ml of water) sample is added to the gel in the **Microb**Monitor2 test bottle; the bottle is shaken to disperse the sample and the gel is then tapped into a flat layer. The bottle is incubated (usually for 4 days at 25°C) and then the number of microbial colonies which grow is counted or estimated.

The **Microb**Monitor2 test can be used to test fuel phase and/or water phase in samples. However, because water phase may not always be recovered in samples, for the purposes of consistency in routine monitoring, we recommend that fuel phase from above any water phase or interface present is always tested, after allowing water to settle out.

In some circumstances, for example when investigating contamination sources or assessing the extent of microbial growth in a tank or system, it may also be informative to assess the microbial content in any free water present in the sample. Water phase will usually contain substantially higher numbers of microbial cfu than fuel phase and a different interpretation of results is required.

Testing Fuel: Shake the sample by hand for approximately 30 seconds and then allow it to stand for 12 min ± 1 min. If the depth of the fuel phase in the sample is less than 6 cm then allow a settling time of 2 min per cm. Using the syringe provided, draw 0.5 ml fuel from approximately 3 cm below the surface of the fuel phase of the sample and transfer to the **Microb**Monitor2 and complete the test as described in the Instructions for Use. If there is less than 6 cm depth of fuel, draw sample from approximately halfway down the fuel phase. The transfer of visible interfacial particulate, water droplets or emulsion in the aliquot to be tested shall be avoided. If the sample is not in a container that enables the use of the syringe to remove an aliquot for test from 3 cm below the surface of the fuel then it should be transferred to a suitable, sterile container, avoiding transfer of visible interfacial particulate, water droplets or emulsion.

Testing Associated Water: If an assessment of microbial content of free water phase is required, after completion of the fuel phase analysis, allow the sample to stand until water phase has settled to the bottom of the sample. To enable ready access to water phase, it may be necessary to first decant off some fuel phase from the sample. Use the syringe to remove water from the bottom of the sample and transfer to a separate small, sterile container. Avoid transferring any of the fuel with the water. Once water has been removed from any fuel, invert the container containing the water three times to homogenise the water prior to sampling. Immediately after inverting the container transfer 0.01ml water to the **Microb**Monitor2 test bottle using the sterile "loop" provided.

Testing on site

To avoid delays in testing, the first stages of the **Microb**Monitor2 test procedure can be conducted on-site at the sampling location in one of two ways;

- Add 0.5 ml of fuel sample (or 0.01 ml water) to the **Microb**Monitor2 test bottle on-site. Then return the test bottle to a laboratory or other suitable facility and complete the remaining part of the test procedure (shake the gel, tap into a flat layer then incubate). If using this procedure, it does not matter whether the test bottles are agitated during transport and it is not necessary to keep them flat. However, the test should be returned to the test facility and shaken and incubated within 6 hours of the sample being added to the test bottle. Transport time can be extended if tests are kept cool (2 to 8°C).

OR

- Add 0.5 ml of fuel sample (or 0.01 ml water) to the **Microb**Monitor2 test bottle and then shake and make the gel form a flat layer, as per test instructions. Then return the test bottle to a laboratory or other suitable facility for incubation. If using this procedure, the test

  bottle should be kept flat during transport and should not be agitated excessively. Providing the gel is not agitated, it does not matter how long it takes to return the test bottle to the incubation facility. However, if the temperature during transportation is lower than the recommended incubation temperature (25°C) then it may take longer for colonies to develop and the incubation time should therefore be extended by a time equivalent to the transportation time.

OTHER USEFUL TESTS

Visual examination of drain line and bottom samples can provide indication that heavy microbial growth is occurring. Presence of discoloured water (brown or black), a lacy interface between the fuel and water layers or organic debris in the fuel or water layer are all indications of likely microbiological activity. Soft brown or black sludge or spotting in tanks and filter vessels and "leopard" spotting on coalescer filter elements in Filter Water Separators are other indicators of microbial growth.

Another useful and simple test is to measure the pH of any water in tanks using indicator papers. Significant acidity (e.g. pH 5 or lower) is a possible indicator of microbial activity.

How to Test **Aviation** Fuel with **MICROB**MONITOR®**2**; Supply & Distribution, Airport Depots and Into-plane Operations

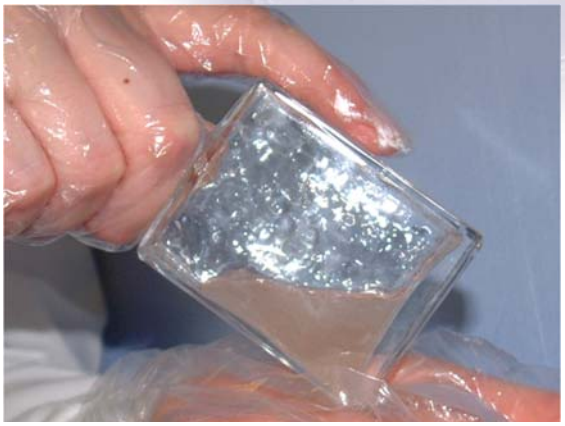
1. Shake sample and then allow to stand. If free water is present determine whether to test fuel/oil or water.

2. Break and discard the plastic seal on the **Microb**Monitor2 bottle. Remove the cap and place on a clean surface. Don't touch the inside of the cap or bottle neck. Using the supplied loop (0.01ml) or syringe (for other volumes), transfer the required volume of sample to the MicrobMonitor2 bottle and replace the cap.

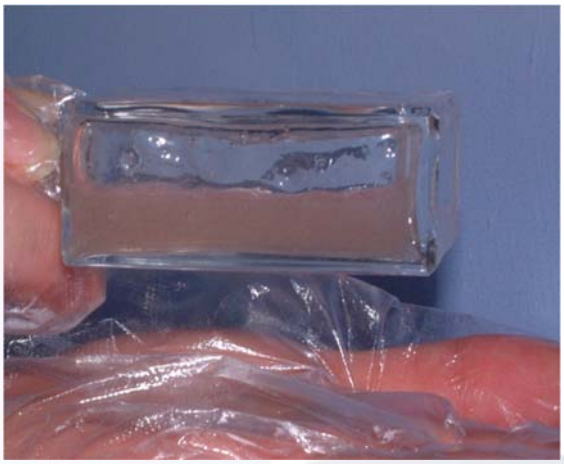
3. Tap the bottle to break up the gel.

4. Shake vigorously for 30 seconds. Ensure gel is not lumpy and sample is fully dispersed.

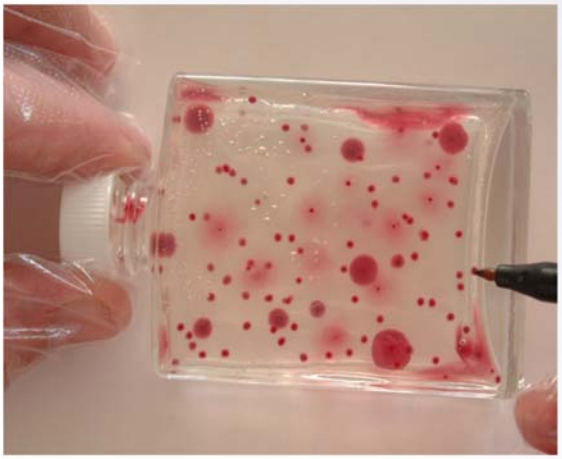
5. Flick the gel into the bottom of the bottle.



6. Tap the bottle to make a flat layer of gel. Lay the bottle flat (with gel layer at the bottom) in a warm dark place and incubate at 25˚C (± 3˚C) for 4 days. Examine at least once in the first 3 days and again after 4 days. Try not to disturb the gel during examination.



7. To examine the test, hold bottle against a light background and count all of the red / purple colonies, marking them off on the bottle with a felt tip pen.
Re-incubate and examine as necessary for up to 4 days. If there are too many colonies to count an estimate of their number can be made by comparison to the chart provided.



Notes
Alternative incubation temperatures may be appropriate. If the temperature falls below the required range during incubation, colonies will take longer to develop; extend incubation by a time equivalent to the time the temperature was below the required range. If it is difficult to distinguish colonies (e.g. streaky patches or unusual colour) see Instruction Leaflet and Technical Guidance document EP157 for further details.

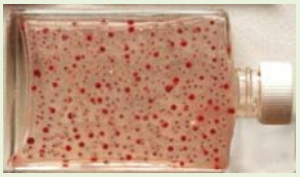
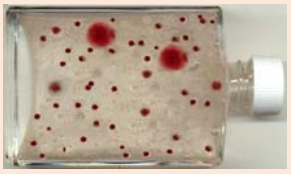
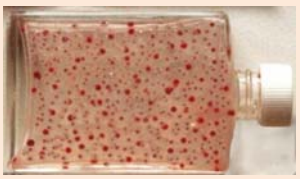
SUPPLY & DISTRIBUTION FACILITIES

Item	Sampling location	Sampling Frequency			Sample Category / Comment
		High risk facilities	Moderate risk facilities	Low risk facilities	
Import filtration	Filter Water Separator vessel drain line sample	Monthly	3 - 6 monthly	If other indicators of microbial contamination.	Category B.
	Line sample before filter	If heavy contamination is detected or suspected in filter drain, in storage tanks or in facilities upstream			Category A.
	Line sample out of filter				
Terminal Storage Tanks	Storage Tank drain line or dead bottom sample	Monthly	3 - 6 monthly	Annual monitoring after initial (at least) quarterly screening for 1 year to determine background contamination levels	Category B. In low risk tanks, annual monitoring of drain line samples may be advisable.
	Bulk fuel (e.g. suction level or upper / middle / lower samples	If heavy contamination is detected or suspected in tank drain / dead bottom sample		If other indicators of microbial contamination.	Category A.
Export filtration	Filter Water Separator vessel drain line sample	Monthly	3 - 6 monthly	If other indicators of microbial contamination.	Category B.
	Line sample before filter	If heavy contamination is detected or suspected in filter drain, in storage tanks or in facilities downstream			Category A.
	Line sample out of filter				
Pipelines	Low point samples	If heavy contamination is detected or suspected in facilities upstream or downstream of pipeline			Category B.

AIRPORT DEPOTS AND INTO-PLANE OPERATIONS

Item	Sampling location	Sampling Frequency			Sample Category / Comment
		High risk facilities	Moderate risk facilities	Low risk facilities	
Import filtration	Filter Water Separator vessel drain line sample	Monthly	3 - 6 monthly	If other indicators of microbial contamination.	Category B.
	Line sample before filter	If heavy contamination is detected or suspected in filter drain, in airport storage tanks or in facilities upstream			Category A.
	Line sample out of filter				
Airport Depot Storage Tanks	Storage Tank drain line sample	Monthly	3 - 6 monthly	Annual monitoring after initial (at least) quarterly screening for 1 year to determine background contamination levels	Category B. In low risk tanks, annual monitoring of drain line samples may be advisable.
	Bulk fuel (e.g. Suction level or Upper / Middle / Lower samples	If heavy contamination is detected or suspected in tank drain / dead bottom sample			Category A.
Into-hydrant and refueller loading filtration	Filter Water Separator vessel drain line sample	Monthly	3 - 6 monthly	If other indicators of microbial contamination.	Category B. All FWS vessels should be sampled and tested.
	Line sample before filter	If heavy contamination is detected or suspected in filter drain, in airport storage tanks or samples from the into-plane operation			Category A.
	Line sample out of filter				
Hydrant	Low point samples taken during routine flushing	Monthly sampling of at least one low point (rotate selection so different low points are sampled on each occasion)	3 monthly of at least one low point (rotate selection so different low points are sampled on each occasion)	If other indicators of microbial contamination.	Category A.
Refuellers / hydrant dispensers	Low point samples of refueller tanks and, if fitted with Filter Water Separators, filter vessel drains	Monthly sampling of at least one refueller (rotate selection so different refuellers are sampled on each occasion)	3 monthly sampling of at least one refueller (rotate selection so different refuellers are sampled on each occasion)	If other indicators of microbial contamination.	Category A. Increase sampling frequency of all refuellers / dispensers if contamination is detected in the hydrant, into-hydrant filtration or in the airport storage tanks. Also consider testing hose end samples at point of uplift to aircraft.
Defueling Vehicle	Vehicle Tank Sump drain line	Monthly	Quarterly and on return of product to main storage	Biannual for vehicles used for defueling	Category B.
Product recovery tanks	Drain line sample	Monthly and/or prior to return of product to main storage	Quarterly and/or prior to return of product to main storage	Quarterly where visual inspection is not possible.	Category B. JIG Guidelines allow quarterly **Microb**Monitor2 testing as an alternative to quarterly visual inspection of product recovery tanks; visual inspection interval can then be extended to one year.

How to Interpret MICROBMONITOR®2 Test Results For **Aviation** Fuel; Supply & Distribution, Airport Depots and Into-plane Operations

Interpretation	SAMPLE TYPE		
	Category A. Bulk fuel sample from supply & distribution / airport fuel depot or ANY sample from into-plane operation (1) (0.5 ml tested)	**Category B.** Drain, bottom or low point sample from storage tank, filter or pipeline in supply & distribution or airport fuel depot	
		Fuel phase (0.5 ml tested)	**Water phase** (0.01 ml tested)
Acceptable	**<4,000 cfu/litre** *(<2 colonies counted)*  **to** 	**<10,000 cfu/litre** *(<5 colonies counted)*  **to** 	**<100,000 cfu/ml** *(<1000 colonies estimated)*  **to** 
Moderate (Warning)	**4,000 – 20,000 cfu/litre** *(2 - 10 colonies counted)*  **to** 	**10,000 – 100,000 cfu/litre** ***(5 - 50 colonies counted)***  **to** 	**100,000 - 1,000,000 cfu/ml** *(1000 – 10,000 colonies estimated)*  **to** 
Heavy (Action)	**>20,000 cfu/litre** *(>10 colonies counted or estimated)*  **to** 	**>100,000 cfu/litre** *(>50 colonies counted or estimated)*  **to** 	**>1,000,000 cfu/ml** *(>10,000 colonies estimated)* 

The pictures shown are typical results for MicrobMonitor2. The size and shape of the colonies may vary but it is the number which is important. See notes opposite for further info on reading tests. For interpreting tests where colonies show unusual appearance or are not distinct see our leaflet Technical Assistance for Reading Results of MicrobMonitor2 (EP157).

If there is perceived to be a risk of Microbially Influenced Corrosion in the facility, then an occasional test for Sulphate Reducing Bacteria (SRB) in water in tanks is advised. Use the **Microb**Monitor Sig Sulphide Test (contact ECHA Microbiology for details).

INTERPRETATION OF TEST RESULTS

A general interpretation chart is provided in **Microb**Monitor2 test kit instructions but the chart on the page 8 can be used to specifically interpret test results of samples of aviation fuel from Storage, Supply & Distribution Facilities, Airport Depots and Into-plane Operations. According to test results, this chart defines contamination as Acceptable, Moderate or Heavy for each of two categories of sample;

Category A. Bulk fuel samples from supply & distribution facilities and airport fuel depots or ANY sample from the into-plane operation (i.e. hydrant low points, hydrant dispensers and refuellers). This category is also appropriate for samples taken from aircraft to check microbiological status prior to defuelling.

Category B. Drain, bottom or low point samples from storage tanks, filters or pipelines in supply & distribution and parts of the airport fuel depot before the hydrant or refueller loading. This category applies to samples taken for routine monitoring of facilities upstream of the into-plane operation.

The appropriate category for specific samples is shown in the tables on page 6 & 7.

Levels of microbial contamination in water phase will usually be much higher than in fuel phase which is why separate guidance is given for water phase and fuel phase in samples from drain lines or tank bottoms (Category B). In accordance with industry convention, water phase results are expressed per millilitre whilst fuel phase results are expressed per litre.

Levels of contamination in drain or bottom samples from storage tanks or filters before the into-plane operation (Category B) will generally be higher than in bulk fuel samples and samples from the into-plane operation (Category A). The limit values stated for Category A samples are the same as those given in the IATA *Guidance Material on Microbiological Contamination in Aircraft Fuel Tanks* referenced in the JIG Guidelines. The limit values given for Category B samples are the recommendations of ECHA Microbiology and are consistent with other industry guidance specific to fuel storage and supply; these limit values are less stringent than the IATA limit values for aircraft drain samples because in normal circumstances fuel will be filtered prior to into-plane delivery and fuel in aircraft tanks is generally expected to be cleaner. Water in aircraft tanks should be clean condensate water but water in storage tanks in the supply chain may originate from environmental contamination (e.g. sea water, tank wash water etc.) and have a higher "background" microbial count. All values are for guidance only and variation to these limits may be appropriate in consideration of sampling location, operating practice and experience and the perceived risk; in some cases more stringent standards may be appropriate for fuel in long term storage.

Low point samples will indicate worst case and will not necessarily reflect the status of bulk fuel delivered from the tank. Heavy contamination in the tank bottom indicates a potential for contaminating bulk fuel, particularly if product settling after fuel receipts is inadequate or if there are failures in filtration. Increasing trends of contamination may be as important as absolute limit values. It is recommended to retest a fresh sample if moderate or heavy contamination is detected, to confirm the result before taking corrective action. In some cases, contamination can be transient and corrective action is not necessary but persistent indications of moderate or heavy contamination should instigate remedial measures.

If heavy contamination is confirmed on retest of the bottom or drain samples it is recommended that representative bulk fuel layer samples are tested. Depending on the size of the tank this could be upper, middle and lower layer samples or, for smaller tanks a single representative sample, such as suction level. The diagram on page 8 provides a summary of a typical microbiological monitoring programme and recommended actions in response to various levels of contamination detected.

Testing bulk fuel layer samples, tank suction level samples and into-plane samples can provide indication of status of fuel uplifted to aircraft and provide assurances about fuel quality. However, it should be appreciated that results of tests of samples of bulk fuel and fuel at point of delivery will be applicable only to the time of sampling; microbial contamination in bulk fuel may be unevenly distributed and levels of contamination detected will vary with time. Contamination levels in bulk fuel in storage tanks will generally decrease with product settling and increase if tank bottoms are disturbed. Numbers of cfu/litre cannot be used alone to indicate whether fuel is fit for purpose and consideration of other test data and operating circumstances will be appropriate.

It is recommended that expert advice is sought where heavy contamination is indicated in bulk fuel.

Routine Monitoring of Aviation Fuel with MICROBMONITOR®2; Supply & Distribution, Airport Depots and Into-plane Operations

Take Bottom or Drain Sample every 1 – 6 Months (See Tables on pages 6-7)

Test 0.5 ml of fuel with **Microb**Monitor2

- If water is present in the sample, fuel should be taken from just above the interface (do NOT include water, emulsion or particulate from the interface)
- 0.01 ml water phase can be tested separately if required.

Fuel contamination level:

ACCEPTABLE*

- Continue routine monitoring
- Reduce test frequency if three successive results are Acceptable
- Drain off any water found in tanks.
- If water was present and was tested but was NOT acceptable, increase monitoring frequency of fuel to ensure fuel remains unaffected.

Fuel contamination level:

MODERATE (Warning)*

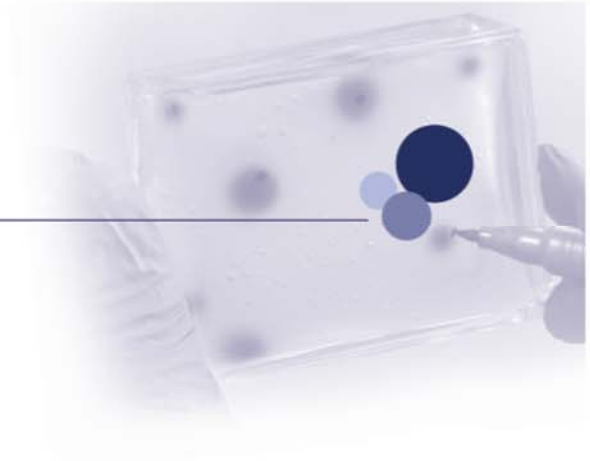
- Confirm that draining regimes are adequate and review records for all designated low points and sumps for warning indicators (increased water, poor appearance etc.)
- Check filter differential pressure (DP) and Millipore records for anomalies.
- Repeat testing as soon as practical and in any event within 1 week to confirm and, if still present, seek further technical advice.
- Increase frequency and volume of flushing of tank/vessel sump drain.
- As a minimum, weekly re-testing should be completed until microbe levels return to normal background levels.

Fuel contamination level:

HEAVY (Action)*

- Take all actions as for MODERATE contamination except retesting should be conducted IMMEDIATELY and the following action taken if confirmed.
- For Tanks; test representative fuel samples (either composite tank samples from the same locations and or other locations downstream including finally delivered fuel).
- For defuelling vehicles; test running sample from filter sumps.
- If contamination in any bulk/outlet fuel sample is MODERATE (as per Category A):
  - Plan and schedule remedial measures according to company procedures.
  - If possible inspect tanks internally (e.g. via tank top) and if sludge is present, consider tank cleaning.
  - Inspect relevant filter water separator vessels and change filters if there is visual evidence of microbial growth.
- If contamination in any bulk/outlet fuel sample is HEAVY (as per Category A):
  - Action as above PLUS;
  - Check all filters downstream for cleanliness and integrity
  - Quarantine fuel from effected tanks / vehicle (s) and seek urgent advice from Operations Management and subject matter experts for remedial actions.
  - Apply a settling time of a minimum 3 hours per metre depth of fuel then test fresh bottom / drain and bulk fuel samples.
  - Tank should not be returned to service until all bulk fuel samples show absence of heavy contamination.
  - If moderate or heavy contamination persists in bulk/outlet fuel, tank cleaning and remedial measures should be scheduled at the earliest opportunity.
  - If contamination in bulk/outlet fuel samples is >100,000 cfu/litre the fuel may be unfit for use unless it can be cleaned up (e.g. by filtration or settling); seek advice.

* See interpretation chart on page 8 for definition of acceptable, moderate and heavy contamination levels for various samples.



This leaflet is appropriate for samples of aviation fuel from storage, supply & distribution facilities, airport depots and into-plane operations. Other technical leaflets are available at www.echamicrobiology.com

- For interpretation of results of tests of **aviation fuel samples from aircraft** please see our leaflet EP096 *How to Routine Monitoring of Aircraft Fuel Tanks with* ***Microb****Monitor2 in Accordance with IATA Guidance.*

- For interpretation of results of tests of samples from **diesel fuel storage tanks** please see our leaflet and EP132 *Routine Monitoring of Diesel Fuel Tanks and Distribution Systems with* ***Microb****Monitor2.*

- For interpretation of results of tests of samples from **marine diesel end user tanks** please see our leaflet and EP166 *Routine Monitoring of Marine Diesel on Ships and Offshore Installations with* ***Microb****Monitor2.*

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