

FAME in Avtur – ‘FIJI’

IP 583

Rapid Screening Method for Aviation fuels

FAME – limits for JET Fuel

DEF STAN 91-91 and ASTM D1655

5ppm

5 ppm in context

5ppm = 0.0005 %

50ppm = 0.005%

50,000ppm = 5%

- Incident 2008
- JET A1 parcel 6000m³ contaminated by 1.7m³ of DIESEL
- Diesel contained FAME at 4.8% (B5)
- Result JET contaminated at 14ppm



*source JIG / BP

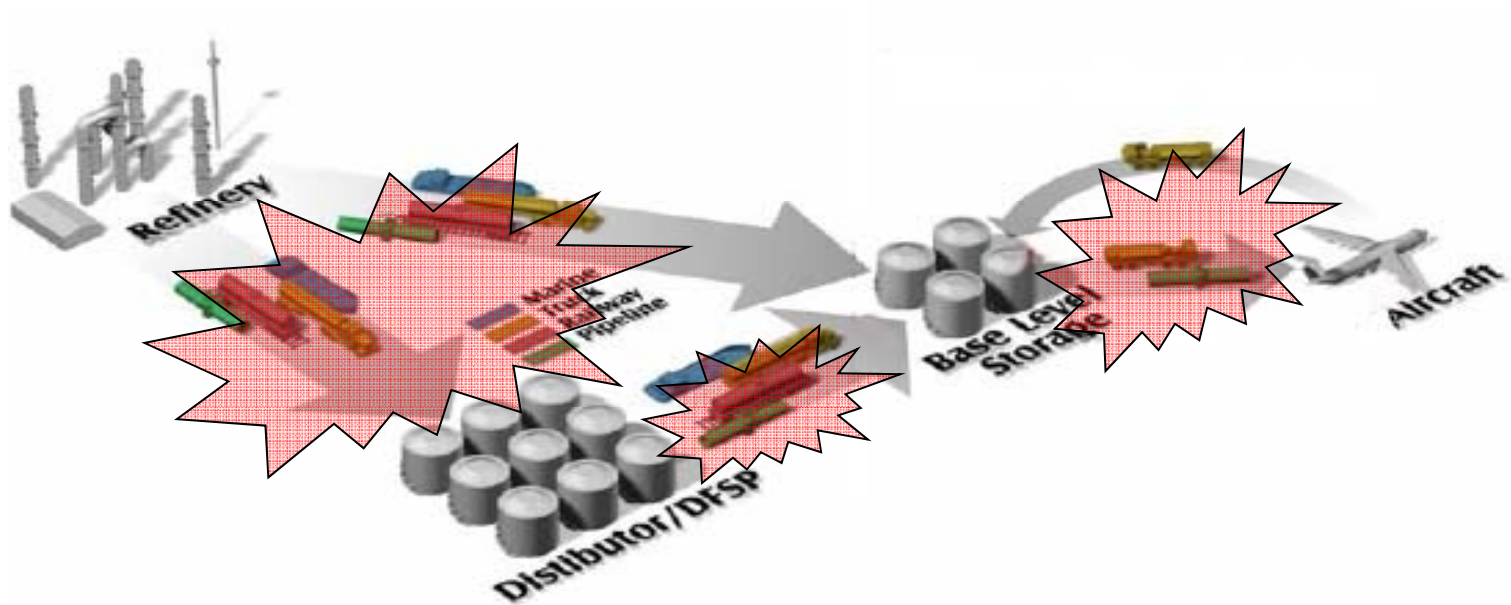
- 6,000,000 litres
- 1,700 litres B5 diesel
- = 14ppm & off spec fuel

FAME – Issues and Status

- FAME – Fatty Acid Methyl Ester included in Diesel.
 - EN590 – up to 5%
 - D975 – up to 7%
- In many cases Diesel and JET used shared multiproduct pipelines.
- FAME – Surface active, sticks to the pipelines
- JET can release FAME from tankers and pipelines – potential for cross contamination

Fuel contamination

Whenever fuel is moved or stored there is the potential for contamination



Fuel specifications and limits

- DEF STAN 91-91 limits FAME to 5mg/kg (PPM)
- ASTM D1655 balloting to limit FAME to 5mg/kg
- JIG guidelines issued
www.jointinspectiongroup.org
- FAA Document issued

FAME Level	Limitations ¹				Comments
	Aircraft En-route	Engines Operated on the Ground	Aircraft on ground (engines not yet operated)	Aircraft waiting to be fuelled	
Less than 5 ppm	None	None	None	None	Level within specification criteria
5 ppm to 30 ppm	Two uplifts ² of fuel containing FAME	Two uplifts of fuel containing FAME	Allow dispatch. Two uplifts of fuel containing FAME	Fuel aircraft and allow dispatch. Two uplifts of fuel containing FAME	Contact aircraft and engine manufacturer to determine subsequent maintenance actions or develop a return to service maintenance program and submit for FAA approval
Greater than 30 ppm	Divert immediately to suitable airport	Do not allow dispatch	Do not start aircraft or allow dispatch. Take action to ensure fuel in aircraft tanks is below 30 ppm FAME then apply requirements as defined for 5 ppm to 30 ppm.	Do not fuel aircraft. Take action to ensure fuel supply to aircraft is below 30 ppm FAME then apply requirements as defined for 5 ppm to 30 ppm.	Contact aircraft and engine manufacturer to determine subsequent maintenance actions or develop a return to service maintenance program and submit for FAA approval

Fuel specifications and limits

- 5 PPM difficult in the real world
- Dispensation to authorise 30 ppm under consideration
- JIP group formed to
 - Develop test methods
 - Assess 100ppm for approval

Standardisation

IP 583 “Determination of the fatty acid methyl esters content of aviation turbine fuel using flow analysis by Fourier transform infrared spectroscopy — Rapid screening method”

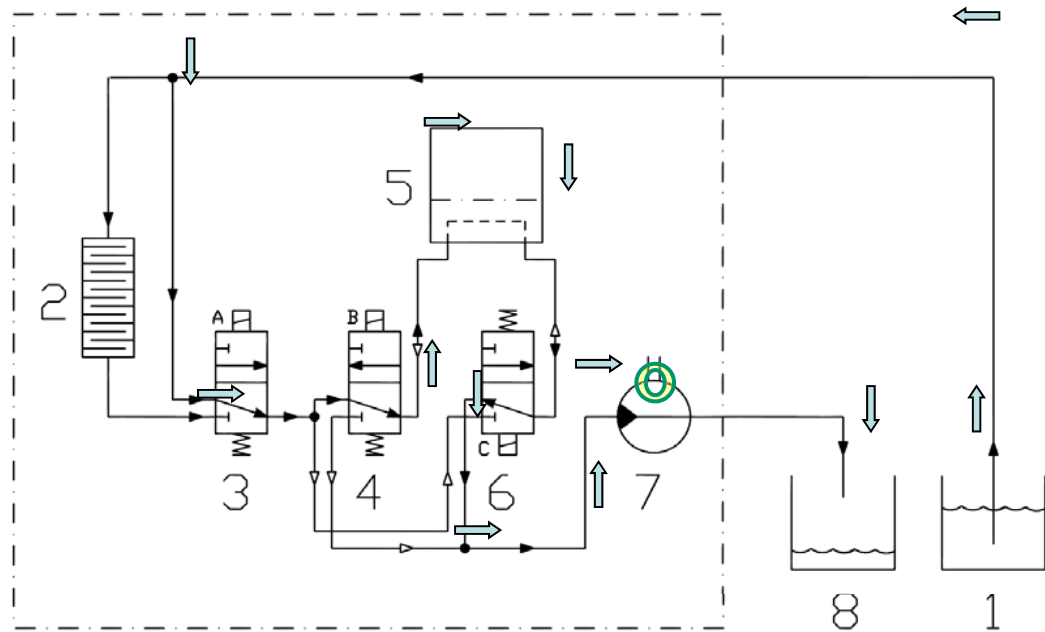
Rapid screen test – background

- 2007 Initial research
- 2008 collaborative effort with Shell Global Solutions
 - 5 mg/kg analytical extraction test FTIR / SPE technology.
 - Stanhope-Seta creates unique rapid screening technique based on FA-FTIR (Flow Analysis) for 30 to 100 mg/kg levels
- 2008 Successful robustness trials FTIR/SPE and FA-FTIR
- 2009 Improved method with new Chemometrics model.

Rapid screen test – Design Requirements

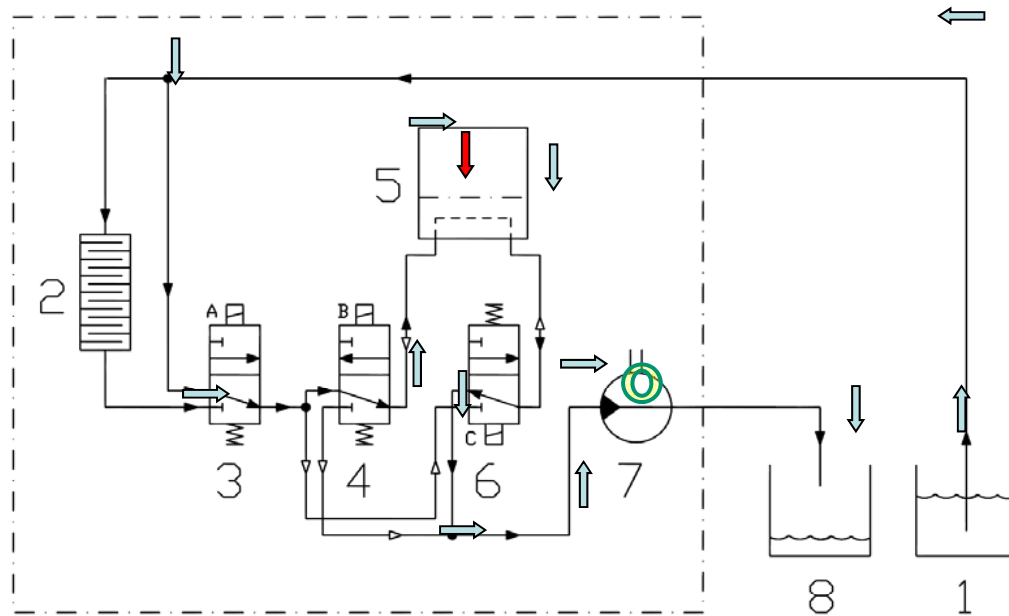
- Ability to screen for 100 mg/kg of FAME
- Measure between 30 and 400 mg/kg if possible
- Minimal training
- No solvents
- The sample volume less than 100 ml
- Less than 30 minutes to complete a test
- Reproducibility less than 15 mg/kg at the 30 mg/kg level and less than 50 mg/kg at the 100 mg/kg levels (2R rule)

- FIJI Developed comprising
 - FTIR as the measurement technology
 - Sample prep system
 - Automated software
 - Calibration and verification system
- Why not use ‘vanilla’ FTIR instruments
 - FTIR limit of detection 5% = 50,000PPM
 - Reminder We need 30ppm = 0.0030%
- FIJI is therefore not just FTIR!



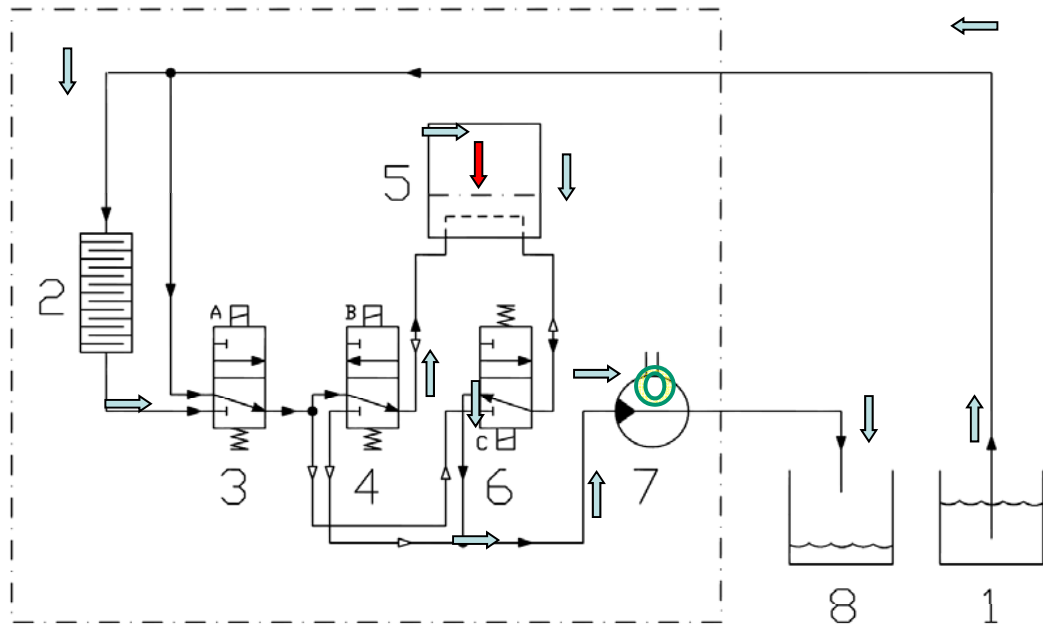
- 1 Test portion container
- 2 Sorbent cartridge and filter
- 3,4, and 6 Solenoid valves
- 5 FTIR through flow cell
- 7 Pump
- 8 Waste container

Prime and flush					
Measure spectrum of test portion					
Measure spectra from the SC					
Calculate and display result					
Flush out test portion					
Purge with air					



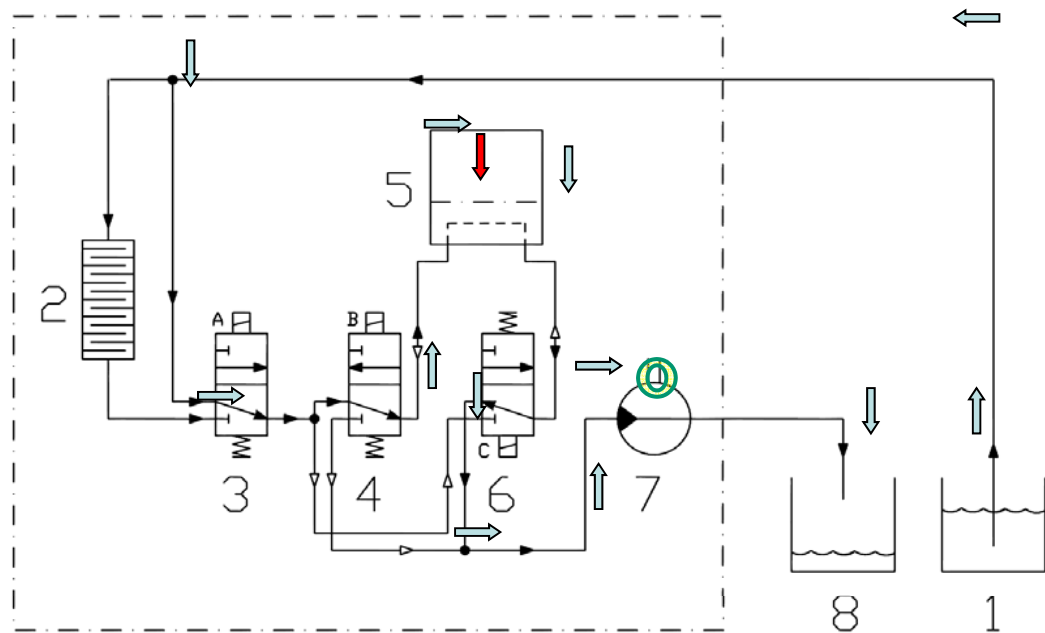
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The FIJI Instrument



PC Software



Seta Analytics FIJI

Manual Purge

GO!

Abort Test

Sample ID:

Operator:

Fuel Density:

Test Date:

FAME:

Graph

Print Report Save Report Load Report Calibration Exit

3.1.2. [6.3]

Running a test

1. Empty/replace waste



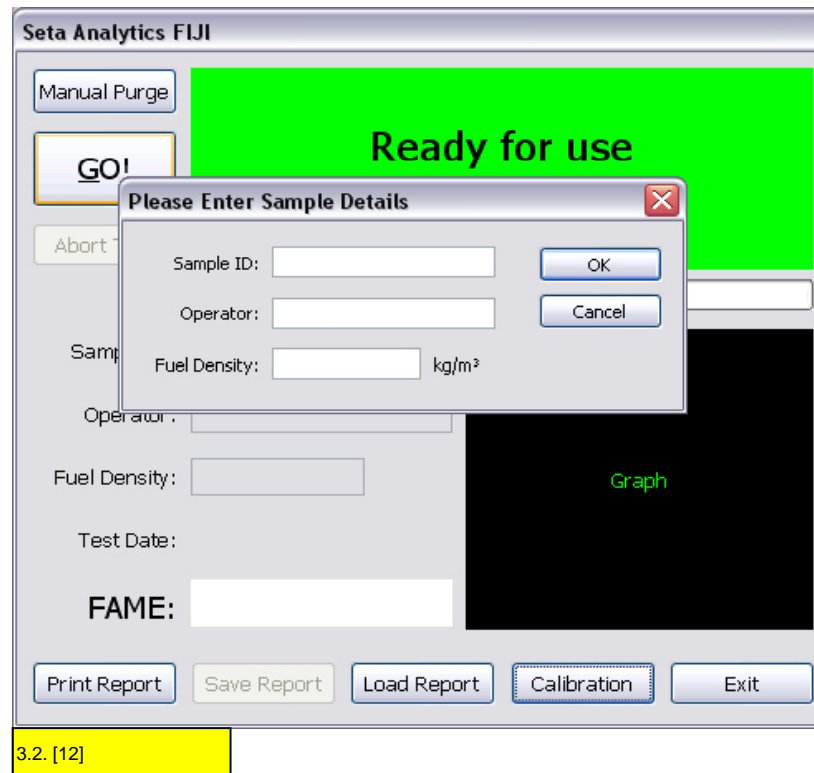
2. Replace cartridge



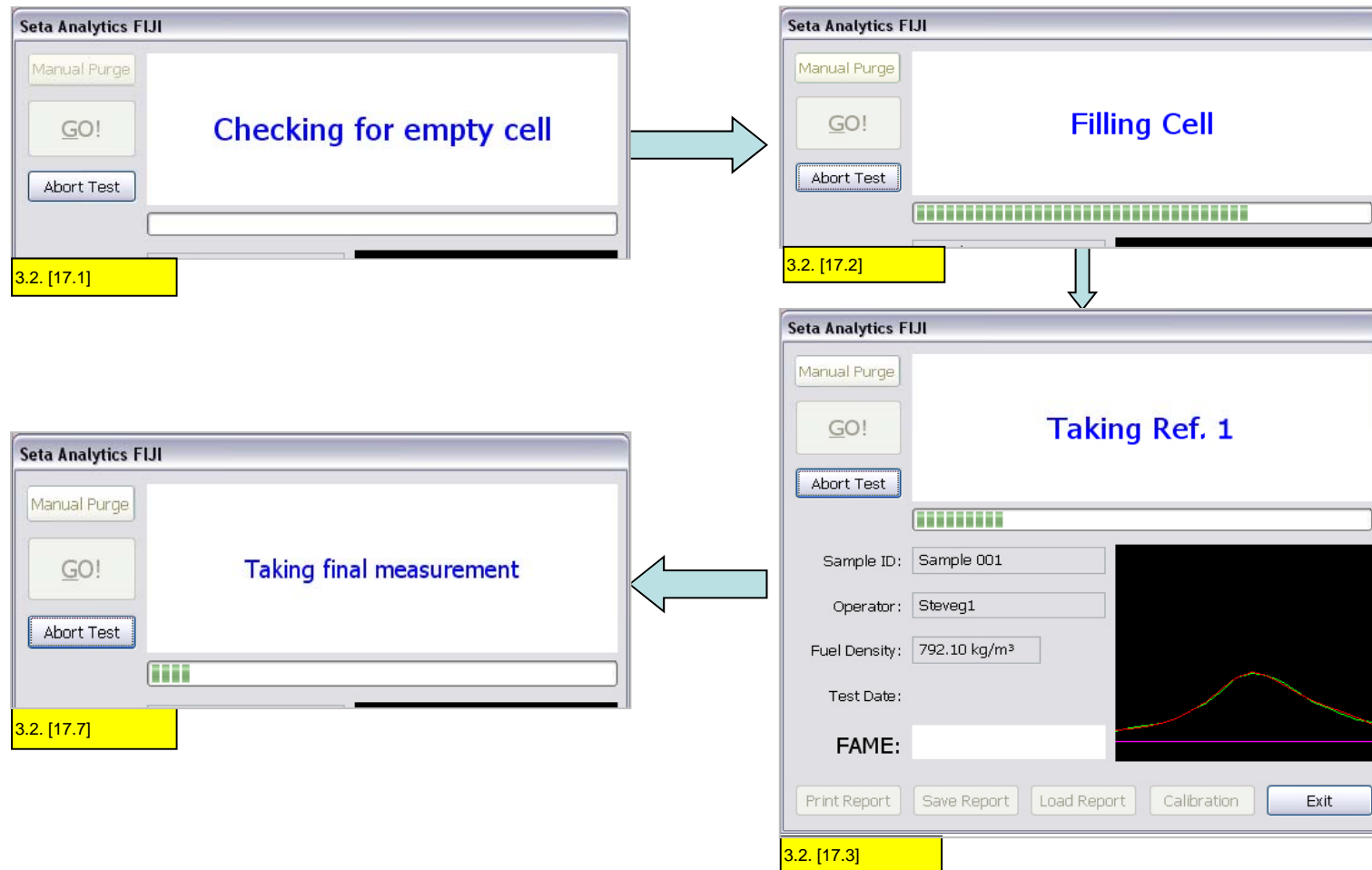
3. Add sample (50ml)



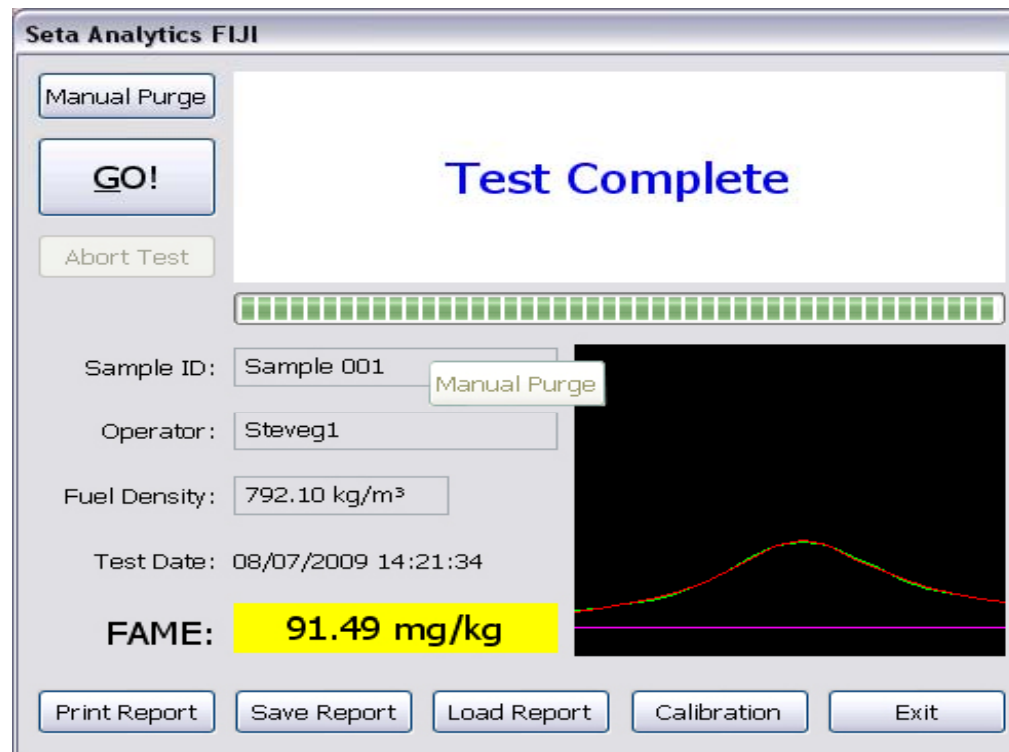
Running a test



Running a test



Running a test



Seta Analytics FIJI

Manual Purge

GO!

Abort Test

Test Complete

Sample ID: Sample 001

Operator: Steveg1

Fuel Density: 792.10 kg/m³

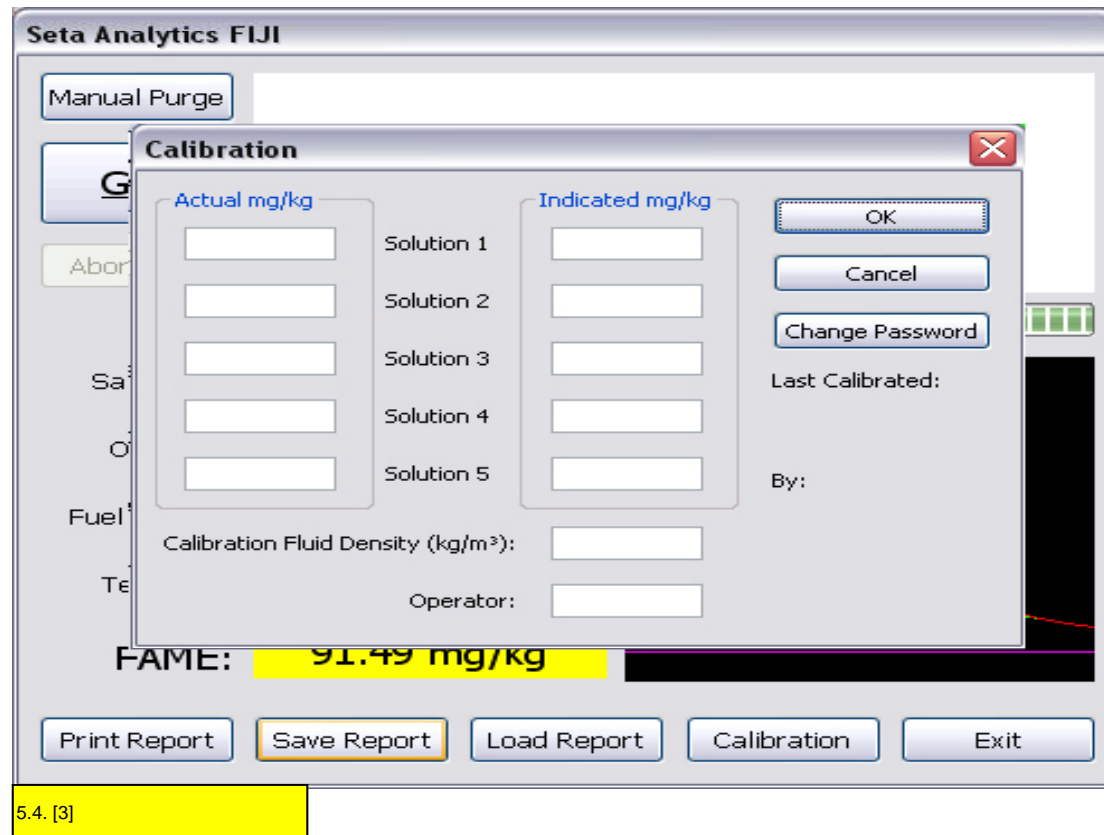
Test Date: 08/07/2009 14:21:34

FAME: 91.49 mg/kg

Print Report Save Report Load Report Calibration Exit

3.2. [21]

Calibration



The screenshot shows the 'Calibration' dialog box within the 'Seta Analytics FIJI' software. The dialog box is titled 'Calibration' and has a close button (X) in the top right corner. It contains the following fields and controls:

- Actual mg/kg:** A column of five input fields for Solutions 1 through 5.
- Indicated mg/kg:** A column of five input fields for Solutions 1 through 5.
- Calibration Fluid Density (kg/m³):** An input field.
- Operator:** An input field.
- Buttons:** 'OK', 'Cancel', and 'Change Password' are located on the right side.
- Labels:** 'Last Calibrated:' and 'By:' are located on the right side.
- Background:** The background shows a 'Manual Purge' button and a 'FAME: 91.49 mg/kg' display.

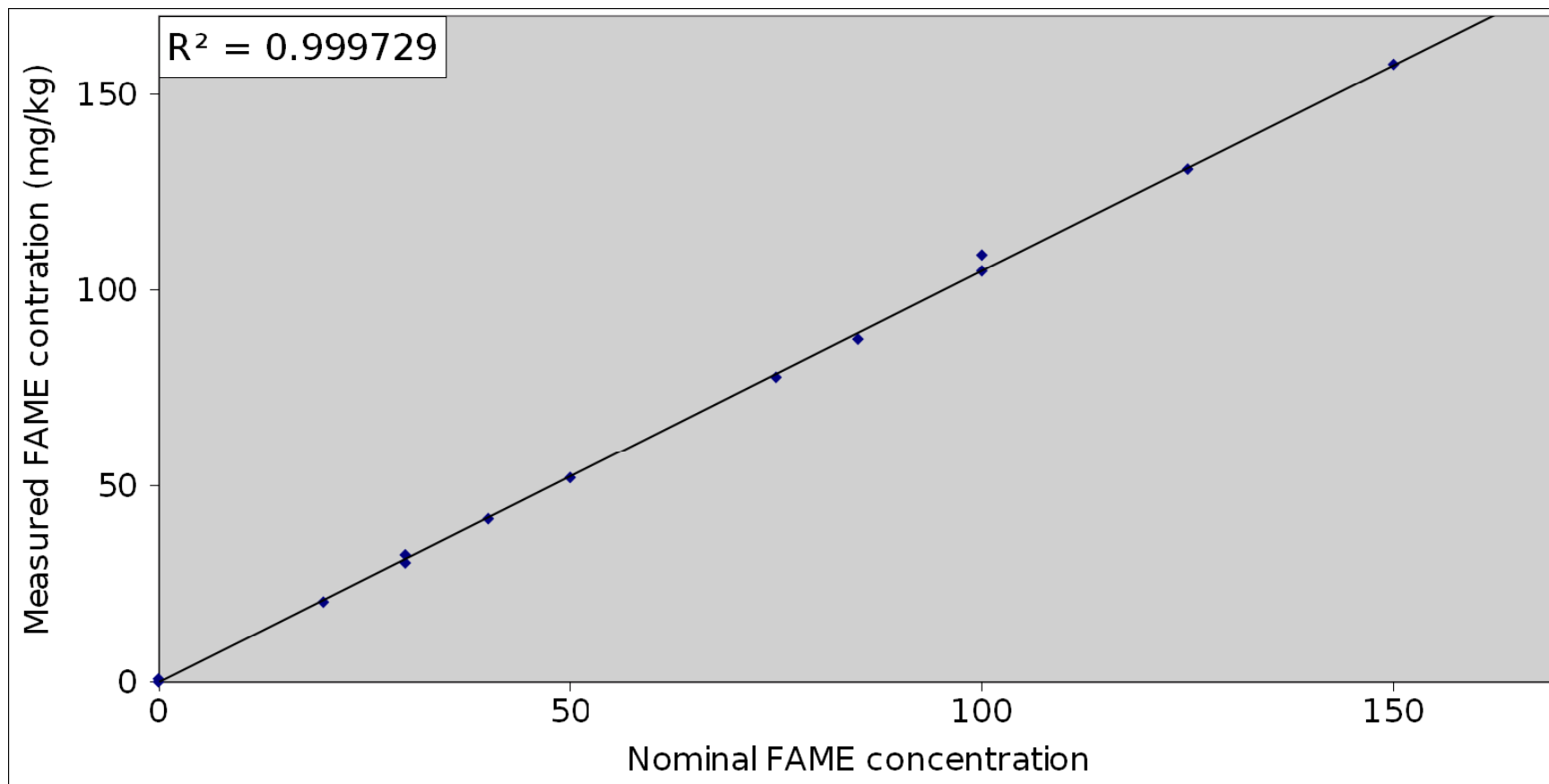
5.4. [3]

Precision & Round Robin

Participants

- BP UK
- Chevron Belgium and USA
- CLH Spain
- Cranfield University – Military Academy UK,
- Exxon (ITS) UK
- Shell UK
- Stanhope-Seta UK
- Total France
- DESC (USA) in Germany

Round Robin Data



IP 583 Precision

Repeatability [r] and Reproducibility [R] mg/kg

Level of Result	Samples 1 - 13	
	r	R
20.00	3.3	3.7
30.00	3.5	3.9
50.00	3.8	4.4
100.00	4.8	5.5
150.00	5.8	6.6

Round robin (ILS) conducted according to IP 367 (ISO 4259)/ D6300 using D2PP 15 Samples and duplicates fully random and blind coded