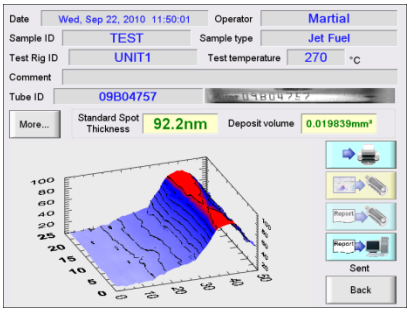
Deposit Rater – DR 10
Test methods: IP 597, ASTM D 3241, IP 323, ISO 6249
Aviation Turbine Fuel - Standard Specification ASTM D 1655 and Def Stan 91-91

AD systems has developed a new instrumental method for quantitative measurement of thermal oxidation deposit (also known as JFTOT®), in which the thickness of the deposit is accurately determined. This new approach removes all the test subjectivity from the test method.



Significance and Use

The Jet Fuel Thermal Oxidation Test ASTM D3241 is universally used by the industry to evaluate temperature stability of aviation turbine fuels and to assess the level of deposits that it can form when liquid fuel contacts heated surfaces during gas turbine operation. The ASTM D3241 is a standard test required to be run on every batch of jet fuel produced according to ASTM D1655 or DEF STAN 91-91 specifications.

In this test method, the fuel is circulated during a specified period of time at fixed flow rate over an aluminium tube heated at a specified temperature. At the end of the 2H30 thermal oxidation phase, the tube is extracted. The tube is then visually rated. The fuel is pass or fail rated according to the coloration of the tube due to oxidation deposit formed on its surface.

The tube is rated visually by the operator against reference color scale requiring significant experience and expertise. But operator capabilities vary, so evaluation of color can be quite subjective. In addition if tube coloration doesn't match one of standard color, the fuel is automatically rejected whatever is the real deposit thickness.

Many studies have been published on the fact that color does not provide real information on the thickness and volume of deposits, parameters which are far more meaningful for characterizing jet fuels for users and suppliers.

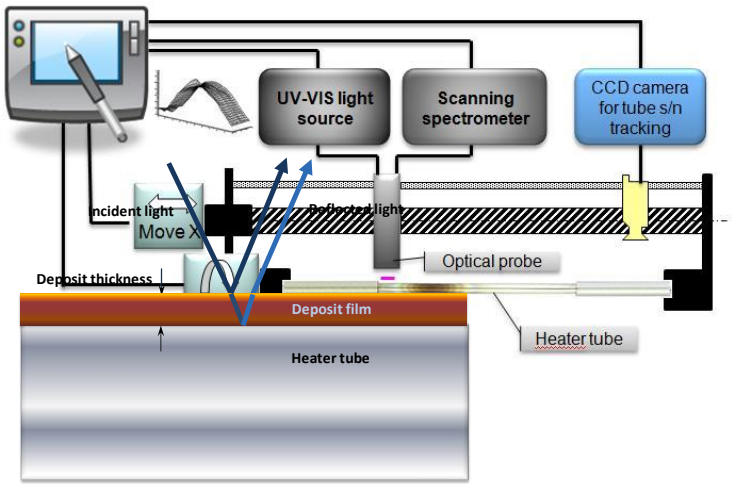
The aviation fuel industry found that one of the most crucial part of this test method is the tube rating. **The Deposit Rater - DR 10 is the method that the industry was looking for during these last 15 years. This objective analysis replaces the visual subjective rating and it significantly increases the safety that remains the main focus for the aviation industry.**

Applications

The DR10 is designed for all types of applications related to thermal oxidation testing of aviation turbine fuels including research, refining, pipeline, terminals, and mobile laboratory applications - every location where thermal oxidation of jet fuel is evaluated.

Principle

The DR 10 uses fiber optic interferometry technique. Specific light is emitted on the surface of the heater tube.

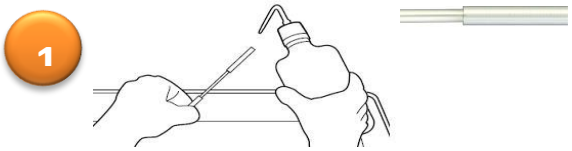


The reflected light is collected and interference created by the deposit is processed by the spectrometer. The software analyzes the interference fringes and calculates the deposit thickness. The

full scan of tube surface on 1,200 points is completed in less than 15 minutes.

Operation

❶ - The heater tube is prepared according to ASTM D3241 test procedure and is then placed in the test chamber of the DR 10 Deposit Rater.



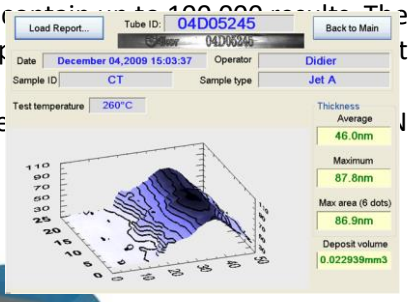
❷ - The tube is then plac
Test chamber of the DR 1

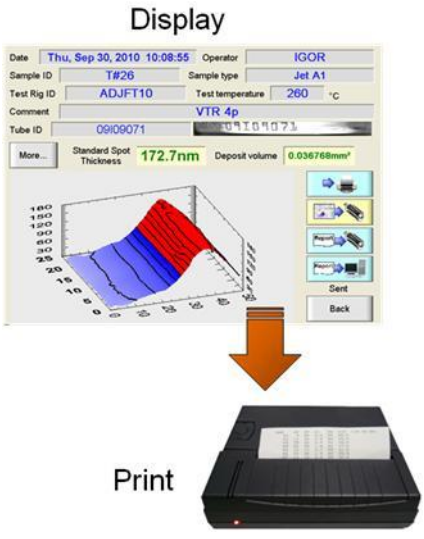
❸ - All samples details are entered and the operator presses the START button.

❹ - The result is reported after 15 minutes.

Reporting

At the end of the test, the result is saved in a built-in data base that can
thickness deposit is reported in nameters. The 3D deposit profile is disp
thickness area greater than 85 nm is displayed in red color.
The results can be displayed, printed, memorized on a USB disk on ke
connection.



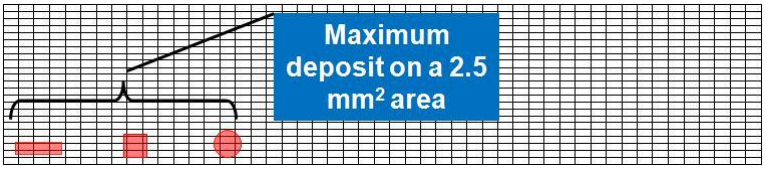


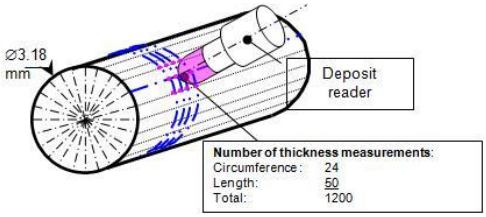
The DR 10 reports the following data:

- **The Standard Spot Thickness**

The DR 10 measures the deposit thickness at 1200 different points of the heater tube circumference. The standard spot thickness is the mean thickness deposit for the six thickest points in a 2.5 mm2 area (according to ASTM D3241 method definition).

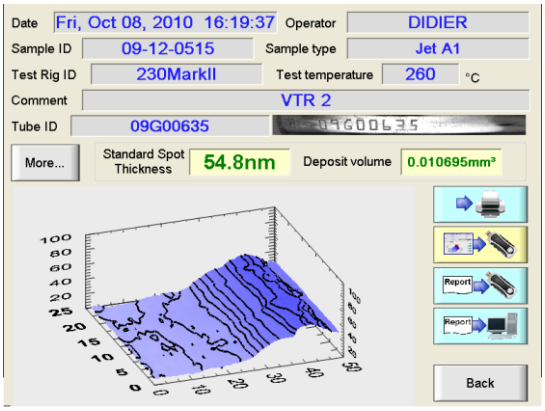
Grid of 50 x 24 Points :





- **The deposit volume**

The deposit volume is the total deposit volume measured on the circumference of the tube on a length of 50mm.



- **Maximum thickness**

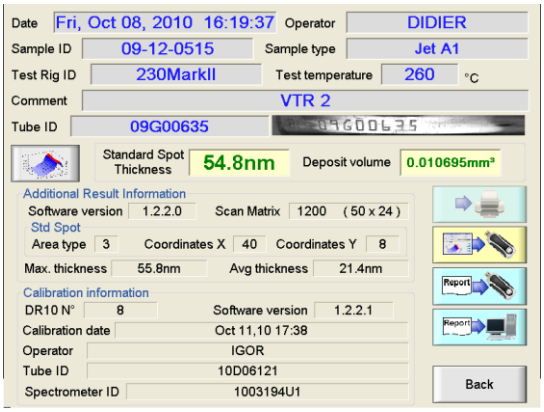
The maximum deposit thickness is the thickest point among the 1200 measured points

- **Average thickness**

The average deposit thickness is the mean value of the 1200 measured points.

List of parameters saved with a result:

- Sample type
- Sample ID
- Date & time
- Operator name
- Test Rig Identification used for the JFTOT® phase
- JFTOT® temperature
- Heater tube serial number
- Comments
- X and Y Coordinates for the standard spot localization
- Calibration information (tube serial number + date of calibration)
- Instrument serial number
- Software version



All the above results and parameters in addition with the 1200 thickness points can be saved on a USB disk on key or send to the local network if the DR 10 is connected to the network. The format of the file allows for Excel importion and future manipulation of the data.

Example of the printed test report:

ADsystems DR 10 DEPOSIT RATER

* Serial N° 1 * Software 1.2.2.0

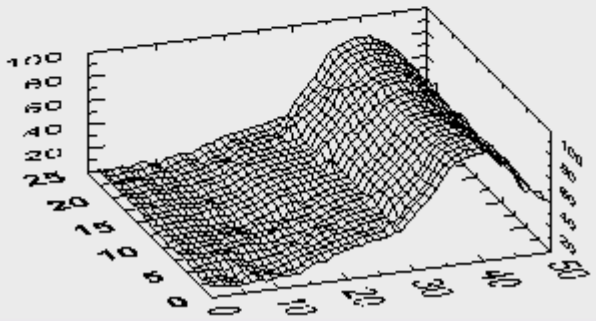
TEST REPORT

Test date : Wed, Sep 22, 2010 11:50:01
Sample ID : TEST
Fuel Type : Jet Fuel
Test temperature : 270°C
Test rig ID : UNIT1
Tube ID : 09B04757
Operator : Martial
Comment :

Standard Spot : 92.2nm

Deposit volume : 0.019839mm³

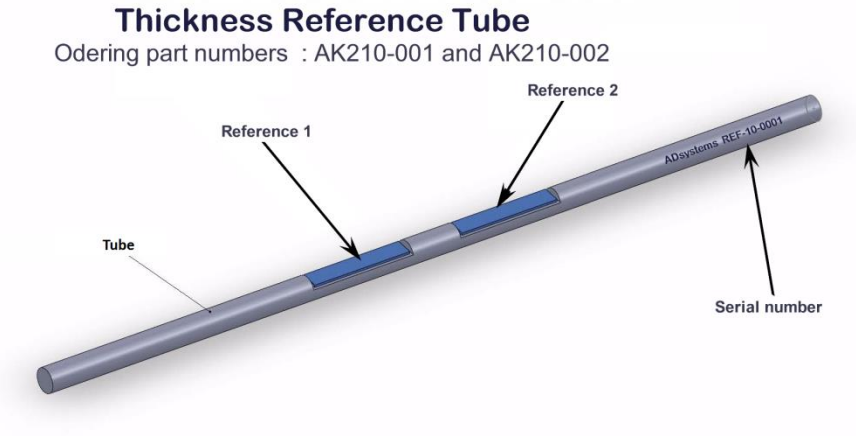
3D Deposit profile



Reference tube for the verification of the DR 10 accuracy

Use:

The AD systems thin film thickness reference tube is suitable for the verification of the accuracy of the thin film thickness measurement by the DR10 Deposit Rater instrument in nanometer range. **It is intended to verify that the deposit thickness measured by the DR 10 is a correct and consistent**.



Description:

The AD systems thin film thickness reference is made of silicon wafer that has a pattern of uniform, thermally grown silicon dioxide film on the polished surface. The standard set consists of two wafer plates with two different certified thickness values of silicon dioxide film (Reference 1 and Reference 2). Wafer plates are fixed on a stainless steel metal support that mimics the dimensions of the ASTM D3241 heater tube. Each set has an engraved identification serial number.

Example of certified values:

	Reference 1	Reference 2
Certified value :	**102.3 nm**	**157.7 nm**
Uncertainty* :	**± 0,8 nm**	**± 0.8 nm**
Acceptance limits :	**± 3,5 nm**	**± 3,8 nm**

* Expanded uncertainty at approximately 95% confidence level with the coverage factor k=2 as defined by the ISO Guide to the Expression of Uncertainty in Measurement, 1995

Traceability:

The thin film thickness reference tube (Reference 1 and Reference 2) are traceable to Spectroscopic Ellipsometer (SE) measurements performed by a National Laboratory for Metrology. It meets the requirements for calibration and testing laboratories as defined in the EN ISO/IEC 17025.

DR 10 Features and Benefits

- **Quick, easy, and objective rating**

The DR 10 provides an objective quantitative method for assessment of turbine fuel thermal stability. It eliminates the subjectivity inherent to the visual rating. It measures the thickness of deposit regardless of its color and resolves the issue of abnormal and borderline rating ambiguity

- **Increases safety**

The DR 10 totally eliminates all safety risks linked to the human factor, a fail fuel is always rated as a fail fuel.

- **Reduces labor**

The DR 10 is a "Set it and Forget it" instrument. Once the heater tube is positioned in the rating comparment, the operator keys in all test details and starts the test. Then all test phases are automatic. The operator time is reduced to its minimum. At the end of the test, the corrected result is displayed and automatically transferred if the DR 10 is connected to a LIMS system.

- **Multi-applications instrument**
  - Research
  - Field test (military mobile labs)
  - Refinery, pipeline and terminals for jet fuel certification. The DR 10 is not yet approved but it can be used to detect wrong visual ratings.

- **Very compact design, rigid construction**

The DR 10 instrument does not take more bench space than the VTR. Consequently it can be installed at the same place where the VTR instrument was used.

- **Quality Procedure features**

The DR 10 enhances a built-in result data base. All details related to each test result are memorized. In addition, all information related to the instrument calibration is memorized to ensure a perfect traceability.

Technical information

Reported results	Measurement range
Average thickness	10 to 1200 nm
Maximum thickness	10 to 1200 nm
Maximum thickness on 2,5mm^2 area	10 to 1200 nm
Deposit volume	0 to 0.5 mm^3

Technical specifications	Description
Test duration	Less than 15 minutes
Number of measurement points	1,200 points
Parameters saved with a test result	Sample type Sample ID Date & time Operator name Test Rig Identification used for the JFTOT® phase JFTOT® temperature Heater tube serial number Comments X and Y Coordinates for the standard spot localization Calibration information (tube serial number + date of calibration) Instrument serial number Software version
Results storage	Up to 100 000 results
LAN connectivity	Ethernet port RJ45
Printer output	Serial port (printer is optional)
Data output	USB (2), Ethernet
Dimensions	W x D x H (mm) W x D x H (inches) 250 x 160 x 290 (10”x 16”x 12”)
Weight	10 kg (22 lb)
Electrical	115 to 230V - 2 A - 50/60 Hz

DR 10 Packing list:

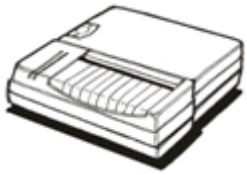
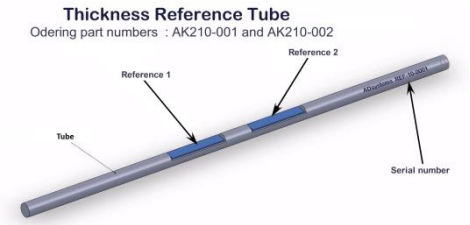
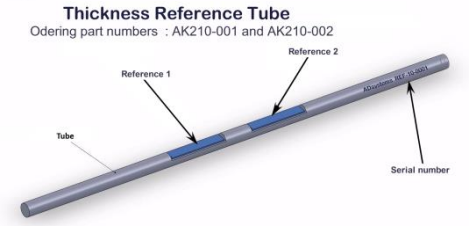
- 1 x DR 10 Apparatus
- 1 x Instruction / User manual

PARTS DESCRIPTION

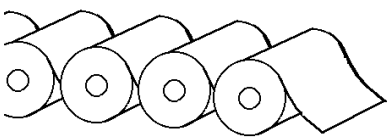
The INSTRUMENT

Part number	Description	Picture
AA210-001	**DEPOSIT RATER INSTRUMENT – DR 10** *Thermal Oxidation of Aviation Turbine Fuels* *Measurement of Deposit Thickness on Heater Tube* *in the range of 10 to 1200 nm* *Electrical: 110/240 VAC, 2A, 50/60 Hz,* *User manual in English*	

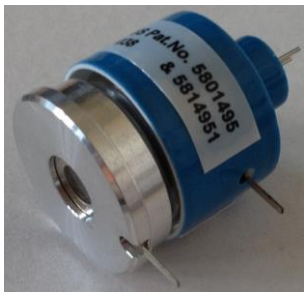
ACCESSORIES

AK000-005	Printer 112mm **230V** 50/60Hz *Industrial thermal printer. Delivered pre-configured, with cable, adapter and 1 paper roll*	
AK000-006	Printer 112mm **115V** 50/60Hz *Industrial thermal printer. Delivered pre-configured, with cable, adapter and 1 paper roll*	
AK210-001	LOW RANGE THICKNESS REFERENCE TUBE Special verification tube with two certified reference thicknesses of **102 nm** and **157 nm**	
AK210-002	HIGH RANGE THICKNESS REFERENCE TUBE Special verification tube with two certified reference thicknesses of **375 nm** and **1000 nm**	

CONSUMABLES

AC000-001	Set of 10 printer paper rolls 112mm	

AC210-001 DR10 LIGHT SOURCE REPLACEMENT KIT



ORDERING INFORMATION

(Standard Quote, refer to the price list for unit prices)

The instrument:

P/N	Qty	Designation	Unit Price
AA210-001	1	**DEPOSIT RATER INSTRUMENT – DR 10** 115 – 230V ; 50/60 Hz	

Accessories :

AK000-005	1	Printer 230V – 50/60Hz	
AK000-006	or 1	Printer 115V – 50/60Hz	
AK210-001	1	LOW RANGE THICKNESS REFERENCE TUBE	
AK210-002	1	HIGH RANGE THICKNESS REFERENCE TUBE	

Consumable parts :

AC000-001	3*	SET OF 10 PRINTER PAPER ROLLS 112 mm	
AC210-001	1*	DR10 LIGHT SOURCE REPLACEMENT KIT	

Note: The recommended consumable parts are for one year operation, please adjust the one year recommended quantities to your needs