AUTOMATION APPARATUS
for OCTANE and CETANE CRFR TEST ENGINES

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- FULLY Conform to Methods:
  ASTM D2699, ASTM D2700 , ASTM D2885, ASTM D613
- NO Modification to the Engines
- Easily Switchable Between Automated and Manual Operation
- Products from Data Capture Only to Hands Off Automation
- Reduced Operator Training Time
- Significant Operator Time Saving
- One Operator Can Run 4 CFR Engines
- Investment Payback in One Year
- Improved Data Precision
- Full Documentation for ISO Traceability
- Windows XP Based Operating Software

LAWLER
MANUFACTURING CORPORATION

PRODUCT OVERVIEW

Upgrading of Waukesha CFR laboratory and on-line octane test engines is now available that fully and in all details conform to ASTM D2699 and D2700 octane number test methods. The same system is able to perform Bracketing, Falling Level, and Compression Ratio procedures (Procedures A, B, & C) on MON and RON engines. Also available is a system for in-line octane engine automation as per ASTM D2885 method.

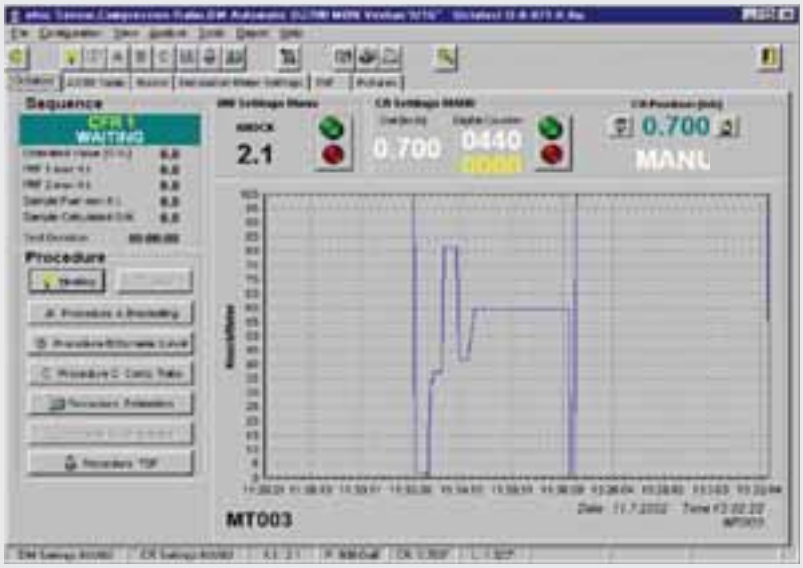
Unlike other systems, there is NO modification to the CFR engine, and on-the-fly switching from automated to manual operation is done by a simple turn of the fuel selector valve and an electrical switch.

Total automation is now also available for cetane CFR engines, for laboratory engines as well as in-line engines. The automation system is fully in accordance with ASTM D613 procedure.

Available are products ranging from economical data capture only, to full hands off automation. Each product is simply upgradable at a later date to the product with a higher degree of automation.

Key benefits of the OCTATEST and CETATEST product lines are:

Depending on the degree of automation selected, data is trapped from the knock meter, cylinder height position, and detonation meter. Detailed reports are printed out at end of each test or on command. Historic data is easily retrievable. This data is available for transfer to a LIMMS for storage or to a spread sheet for further analysis.



Software's Main Operating Screen

A PC with radio controlled mouse and keyboard (i.e. cable free) is included and supplied with Windows XP based proprietary software. Data capture and data management including all calculations and data storage are done by the software. This data capture offers full, simplified ISO traceability with full documentation.

Specifications subject to change without notice.
Bulletin OT0403

The operating parameters are automatically corrected by the software for barometric pressure and air moisture with internal sensor as per ASTM tables.

The software provides step by step check list and instructions that aid an even low skill operator to follow the correct procedure. Operator errors are reduced and data precision is improved.

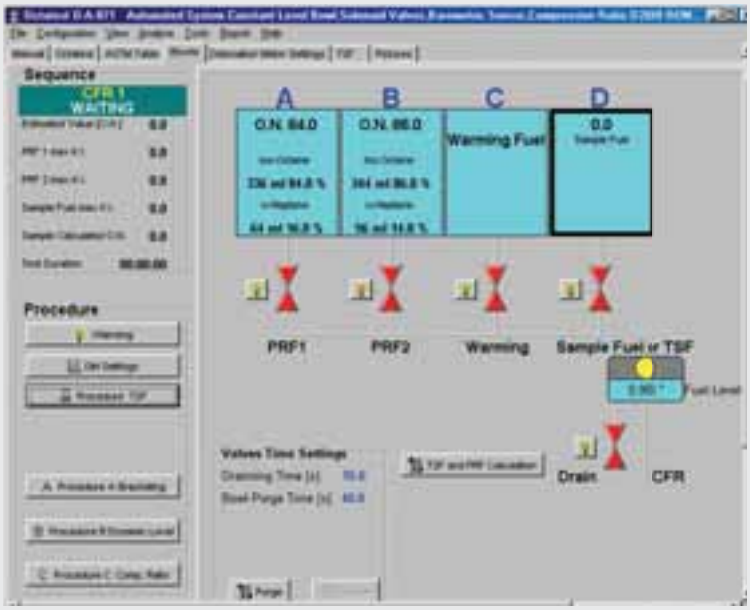
The system (depending on the degree of automation chosen) provides significant savings of operator's time. In fact, one operator can run 4 CFR engines when each is equipped with the full automation Octatest system. Operator reduction alone can payback the cost of automation in about one year.

Maximum fuel level is automatically determined as per ASTM procedure. This automation improves repeatability and precision of "maximum fuel level" determination.

The software facilitates PRF and TSF blending by doing all the needed calculations. Octane Number is rapidly estimated for bracketing. Integral data base is available for detonation meter calibration for all TSF temperatures. Installation is simple and a minimum of maintenance is required once installed.

Engine standardization routine (fit for use) is also part of the package. Automated procedure determines detonation meter settings.

Unlike as in the standard CFR engine, the PRF's, TSF, and test fuels flow through the same venturi. This removes one additional variable that improves precision.



The automation reduces operator errors in calculations and data recording. Precision of the octane number is improved compared to the published ASTM method precision (0.3 ON). Users report a precision of 0.1 ON.

The improved precision increases the refinery confidence, allowing it to blend closer to specifications. The improved precision potentially reduces the give-away by as much as 70%. A typical refinery can thus see an annual potential saving of $200,000.00. Pay back on the full Octatest automation is, therefore, less than 1 year.

AVAILABLE PRODUCTS

OCTATEST Model OD-201

- **Conforms to ASTM D2699 and D2700**
- **Knock Meter Output Data Capture**
- **Automated Calculation and Correction to ASTM Tables**
- **ISO Traceable Print Out Report**
- **Step by Step Guide to the Operator**

Model OD-201 is the lowest level product capturing data from the knock meter. It comes in a cabinet containing a Windows XP based PC, proprietary software and additional electronics for data capture. It is simply electrically connected to the knock meter output.

The PC comes with a radio connected keyboard and mouse thus avoiding cable entanglements.
Model OD-201 may be upgraded at a later date to any of the other octane products described below. Model OD-201 can also be used for older engines with the hand crank cylinder adjustment.

Octatest Control Unit

OCTATEST Model OD-412

Model OD-412 comes with the same features as Model OD-201 described above, but in addition comes with a device that automatically measures cylinder height. The software captures the knock meter data as well as the cylinder height data. The knock meter reading and cylinder height dial (or digital readout) may also be read as is with manual operation.

Model OD-412 also functions for older engines with the hand crank cylinder adjustment.

Model OD-412 may be upgraded after the original installation to Model OA-871 or Model OA-871X or Model OA-516 for full automation.

Cylinder Height
Data Acquisition System

OCTATEST Model OA-871

- Conforms to ASTM D2699 & D2700
  - Procedures A - Bracketing
  - Procedure B - Falling Level (Dynamic)
  - Procedure C - Compression Ratio
- Full, Hands Off Automation
- Automated Calculation and Correction to ASTM Tables
- Data Capture of Knock Meter & Cylinder Height
- Automated Cylinder Height Control
- Four Fuel Dispenser Bowls
- Automatic Fuel Level Adjustment
- On the Fly Switchable Between Automated and Manual Operation

4 Bowl Fuel Dispenser

Model OA-871 comes with the same features as Model OD-412 described on page 4, but in addition it automatically controls the cylinder height. Safety limit switches also are provided to protect the engine from damage.

Model OA-871 also comes with 4 covered bowls of the same volume as the original CFR engine plus an integral glass tube (protected from breakage) showing fuel level. The sample bowl has provision to be cooled by water. The bowls are connected via solenoid valves to a common fuel collector. The system has been designed to avoid fuel cross contamination and to minimize the entrapment of air bubbles. Also included is a precision fuel level float that is automatically driven up or down by a high precision stepper motor.

A simple turn of the fuel selector valve and an electrical switch returns the control from automated Model OA-871 to the operator and back again if so desired.

Model OA-871 has an additional safety feature that in the event of electrical power failure the solenoids on the fuel bowls automatically close. This prevents “run-away” of the engine.

OCATEST Model OA-871X

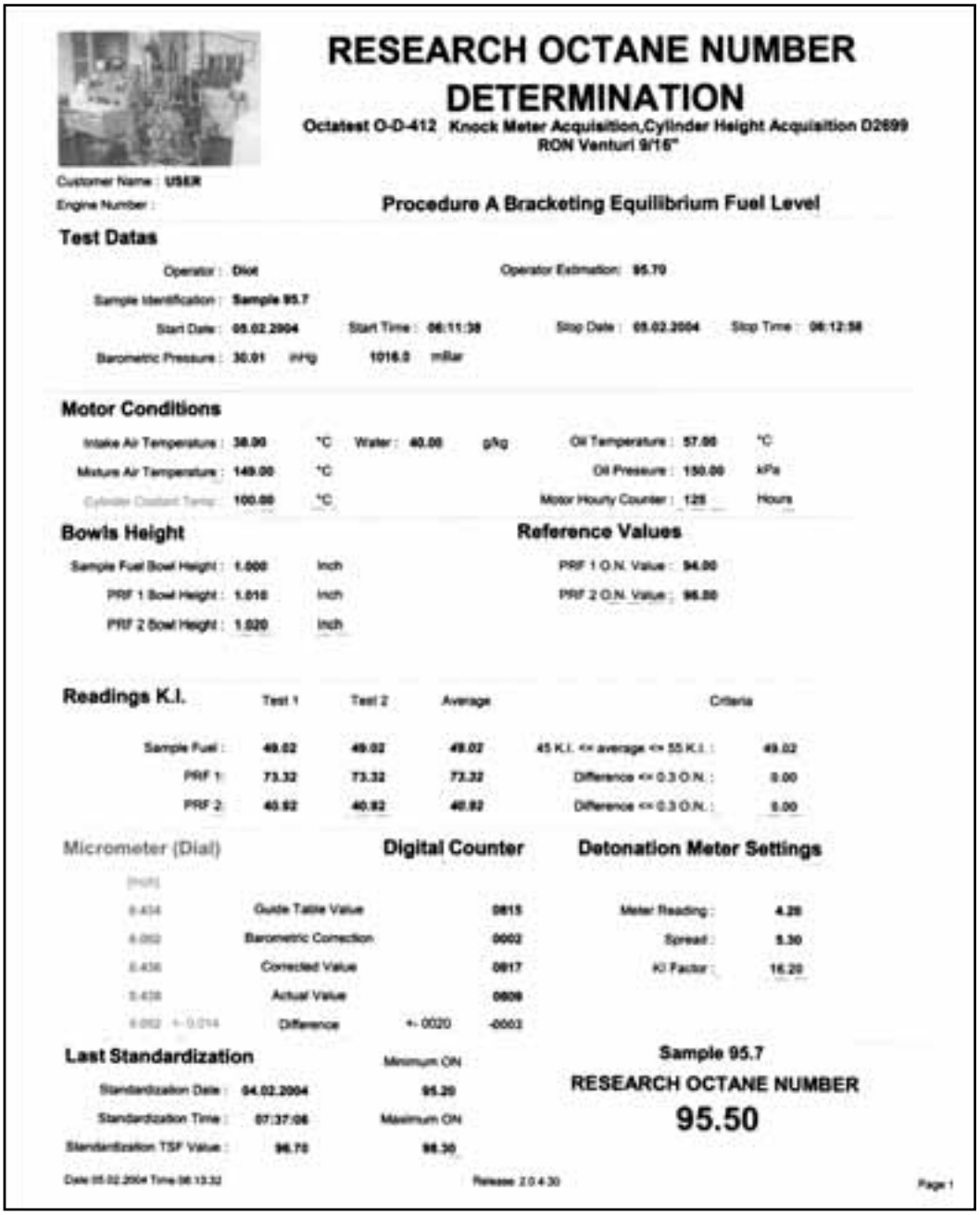
- Same as Model CD-555 plus
- Data Capture of Hand Wheel Position

Model CD-555X is the same as Model CD-555, above, but in addition has the ability to capture the hand wheel position using a laser measuring device.

Automated Fuel Level Controller

- **Similar to Model OA-871**
- **For Older Engines with Handcrank**

Model OA-516 is intended for the older Waukesha CFR engines originally equipped with hand crank for cylinder height adjustment. It functions the same as Model OA 871. The engines require to be retrofitted with an electric motor (not supplied) to drive the cylinder height adjustment.



RESEARCH OCTANE NUMBER DETERMINATION

Octatest O-D-412 Knock Meter Acquisition,Cylinder Height Acquisition D2699
RON Venturi 9/16"

Customer Name : USER
Engine Number :

Procedure A Bracketing Equilibrium Fuel Level

Test Datas

Operator : Diot — Operator Estimation : 95.70
Sample Identification : Sample 95.7
Start Date : 05.02.2004 — Start Time : 06:11:38 — Stop Date : 05.02.2004 — Stop Time : 06:12:58
Barometric Pressure : 30.01 inHg — 1016.0 mBar

Motor Conditions

Intake Air Temperature : 38.00 °C — Water : 40.00 g/kg — Oil Temperature : 57.00 °C
Mixture Air Temperature : 149.00 °C — Oil Pressure : 150.00 kPa
Cylinder Coolant Temp : 100.00 °C — Motor Hourly Counter : 125 Hours

Bowls Height

Sample Fuel Bowl Height : 1.000 Inch
PRF 1 Bowl Height : 1.010 Inch
PRF 2 Bowl Height : 1.020 Inch

Reference Values

PRF 1 O.N. Value : 94.00
PRF 2 O.N. Value : 96.00

Readings K.I.	Test 1	Test 2	Average	Criteria	
Sample Fuel :	49.02	49.02	49.02	45 K.I. <= average <= 55 K.I. :	49.02
PRF 1 :	73.32	73.32	73.32	Difference <= 0.3 O.N. :	0.00
PRF 2 :	40.92	40.92	40.92	Difference <= 0.3 O.N. :	0.00

Micrometer (Dial) — Digital Counter — Detonation Meter Settings

[PRF]			
0.434	Guide Table Value	0815	Meter Reading : 4.28
0.002	Barometric Correction	0002	Spread : 5.30
0.436	Corrected Value	0817	KI Factor : 16.20
0.438	Actual Value	0808	
0.002 +- 0.014	Difference	+- 0020 -0003	

Last Standardization

Standardization Date : 04.02.2004 — Minimum ON : 95.20
Standardization Time : 07:37:06 — Maximum ON : 96.30
Standardization TSF Value : 96.70

Sample 95.7
RESEARCH OCTANE NUMBER
95.50

Date 05.02.2004 Time 06:13:32 — Release 2.0.4.30 — Page 1

Sample Results Printout Report

IN-LINE OCTANE CFR ENGINE AUTOMATION

- **FULLY Conform to ASTM D2885 Test Method**
- **No Modification to the Engine**
- **Easily Switchable Between Automated and Manual Operation**
- **Improved Data Precision**
- **Give Away Reduced by 70%**
- **Pay Back in a Few Months**
- **ISO Traceability is Simplified With Full Documentation**
- **Automated Knock Meter Drift Compensation**
- **Automated Cylinder Height Adjustment**
- **Automated Adjustment of the Detonation Parameters**

Upgrading of Waukesha CFR octane test engines for fully automated on-line operation is now available that fully and in all details conform to ASTM D2885 test method. Unlike other systems, there is NO modification to the CFR engine, and on-the-fly switching from automated to manual operation is done by a simple turn of the fuel selector valve and a single electrical switch.

Depending on degree of automation selected, data is captured from the knock meter, cylinder height position, and detonation meter. The cylinder height position, and detonation meter parameters are automatically adjusted. The software does all data management, calculations, and data storage. This data capture offers full, simplified ISO traceability with full documentation. Detailed reports are printed out at end of each test or on command.

Historic data is easily retrievable from the hard drive. This data is available for transfer to a LIMMS for storage or to a spread sheet for further analysis.

The operating parameters are automatically corrected by the software for barometric pressure and air moisture with internal sensor as per ASTM tables.

OCTATEST Model OA-516

Model 2885-S consists of a cabinet with a PC, and assorted electronics. Windows based proprietary software manages the engine operation and the capture and management of knock meter data. The knock meter drift is automatically compensated.

Model 2885-SC is the same as Model 2885-S above but with the additional capability of automated adjustment of cylinder height and the capture of the cylinder height position.

Model 2885-SCD is the same as Model 2885-SC above but with the additional capability of automated parameter control of the detonation meter and the capture of the detonation meter data. The improved precision allows the refinery to operate with a significantly lower give away, up to 70%.

CETANE CFR ENGINE AUTOMATION

Upgrading of Waukesha CFR laboratory and on-line cetane test engines is now available that fully and in all details conform to ASTM D613 test method. Available are three products for laboratory engines and one for In-line engines. Products range from economical data capture only to full hands off automation. Each product is simply upgradable at a later date to the product with higher degree of automation.

Main Software Operating Screen

The software automatically records all data (depending on degree of automation) from dual cetane meter, hand wheel position, injection timing, and ignition delay. Data management and data treatment including all calculations and data storage are done by the software in strict accordance with ASTM D613 method.

This data capture offers full, simplified ISO traceability with full documentation. Test results precision is improved. Detailed reports are printed out at end of each test or on command. Historic data is easily retrievable. The data is available for transfer to a LIMMS for storage or to a spread sheet for further analysis. All calculations for U & T blends are done by the software.

CETATEST Model CD-555

- **Conforms to ASTM D613**
- **Data Capture from Dual Cetane Meter**
- **Automated Calculation and Correction to ASTM Tables**
- **ISO Traceable Print Out Report**
- **Step by Step Guide to the Operator**

Model CD-555 Data Acquisition System can now upgrade Waukesha cetane laboratory test engines to capture data from the dual cetane meter. It consists of a PC with additional electronics and supplied with Windows XP based proprietary software. The software guides the operator step by step as per ASTM D613 method. These instructions allow even a lesser skilled operator to perform the cetane test as specified by the method.

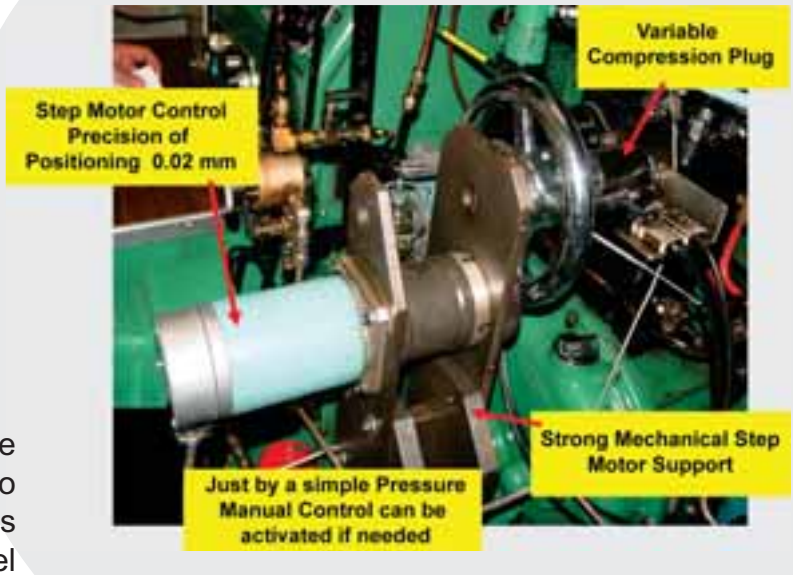
CETATEST Model CD-555x

- **Same as Model CD-555 plus**
- **Data Capture of Hand Wheel Position**

Model CD-555X is the same as Model CD-555, above, but in addition has the ability to capture the hand wheel position using a laser measuring device.

OCTATEST Model OD-201

- **Conforms to ASTM D613**
- **Same as Model CD-555X plus**
- **Full Hands-Off Automation**
- **Automated Hand Wheel Position Control**
- **Automated Injection Timing**
- **Automated Fuel Flow Control**



Model CA-745 is the full hands off cetane engine automation system with all the features of the above two models, plus automated hand wheel position control, plus injection timing, plus fuel flow control. The hand wheel control is accomplished with a high precision stepper motor mounted to the hand wheel. The positioning precision is 0.02 mm. The hand wheel can be still be manually overridden by only a slight finger pressure allowing test continuation in the manual mode.

OCTATEST Model OD-412

- **Conforms to ASTM D613**
- **In-Line Cetane Engine Operation**
- **Automated Certification Before Blending**

In-Line Fuel Sample Conditioning System

Model CA-970 has all the same features of Model CA-745, above, but is specifically adapted for on-line cetane engine operation. Model CA-970 is controlled from the control room, can be started and stopped remotely, and offers automated certification before blending.

AUTOMATED BLENDERS
for OCTANE and CETANE REFERENCE FUELS

- **FULLY Conform to Methods:**
  ASTM D2699, ASTM D2700, ASTM D2885, ASTM D613
- **Rapid Volumetric or Gravimetric Blending**
- **Precision of 0.02 mL or 0.02 gm**
- **Reduced Operator Errors**
- **Simple Operation**
- **Improved Precision of Octane/Cetane Results**
- **Fully Automated Preparation of:**
  PRF1, PRF2, TFS, U Blends, T Blends
- **Motor Driven Laser Detector of Burette Meniscus Volume**
- **Precision Balance for Gravimetric Measurement**
- **Space Saving, Small Foot Print Cabinet**

Four models of blenders are available for the automated preparation of reference fuels for CFR octane and cetane engines.

One set of blenders is based on the original ASTM methods specified procedure using volume (burettes) as the basis for the blend. Recently, ASTM approved the use of weight (precision balance) as the basis of preparing the blend. Both types of blenders are offered, one of each type for octane number and one of each type for cetane number reference fuels.

The volumetric blenders use a laser meniscus detector driven along the burette length measuring the volume with a precision of 0.02 mL. Three burettes, one each for iso-octane, heptane and toluene. The burettes are automatically filled, either via pressure or gravity feed of the fuel components.

The operator keys in the desired octane or cetane number on the key pad, presses Enter and 400 mL of blended reference fuels is delivered.

The gravimetric units operate in a similar fashion, but use a precision electronic balance to weight in the blend components.

Available Products:

Model OC-23-V
octane reference fuel blender has 3 ASTM burettes, each burette with a motor driven laser meniscus detector. The burettes may also be used in the traditional manual method. Burettes are available with 3 or 10 point volume certification. Model OC-23-V is housed in a space saving cabinet measuring 28 X 20 X 39 inches high (700 X 500 X 1000 mm high).

Model OC-35-W
is similar to Model OC-23-V above, but uses a precision balance to measure the weight of the individual reference fuel components for PFR1, PRF2, TSF for the desired octane number.

Model CE-28-V
is similar to OC-23-V but with only 2 burettes, and is used for the automated volumetric blending of the desired cetane number of U and T blends.

Model CE-39-W
is similar to Model OC-35-W but uses a precision electronic balance to automatically measure the weight of the individual components for U and T blends to the desired cetane number.

Model OC-23-V
Automated Octane PRF and TSF Blender

SELECT PETROLEUM TESTING INSTRUMENTS

Low Temperature Programmable Liquid Baths
for Brookfield Viscosity by ASTM D2983

Air and Liquid Baths
for Foam Testing Baths by ASTM D892 and D6082

Automated Cloud, Pour, and Cold Filter Plugging Points (CFPP)
as per ASTM D97, D2500, D6371 and IP-309

Low and High Temp. Kinematic Viscosity Baths
as per ASTM D445

High Temperature Bath for Distillate Fuels Stability
as per ASTM D6468

High Temperature Heated Tube Bath for API Gravity
as per ASTM D287, D1298

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MANUFACTURING CORPORATION

7 Kilmer Ct • Edison, NJ 08817
(732) 777-2040 • Fax (732) 777-4828
E-Mail: lawler@att.net
www.lawlercorp.com