
# K16500, K16591, K16502, K16592
# Rapid Flash Tester, Closed Cup

## *Operation and Instruction Manual*

REV B

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*Petroleum Testing & Analysis Instrumentation • Custom Design & Manufacturing*

# CERTIFICATE OF CONFORMANCE

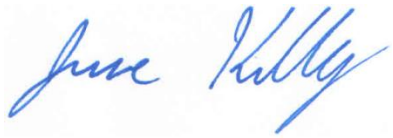
## Rapid Flash Point Tester
## K165XX

**This certificate verifies that part number K165XX, Rapid Flash Point Tester, was manufactured in conformance with the applicable standards set forth in this certification.**

**Specifications:**

**ASTM D3278**
**ASTM D3828**
**ASTM D4206**
**DOT CFR 49-173.115**
**IATA**
**ISO 9038**

**This unit is tested before it leaves the factory, to ensure total functionality and compliance to the above specifications and ASTM standards. Test and inspection records are on file for verification.**



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**Application Engineer**
**Koehler Instrument Company**

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# 1 Introduction

The Rapid Tester is specifically designed for ascertaining the flash point of a volatile material or whether the flash point temperature of a material is within established limits (Flash / No Flash Procedure). Instruments utilize equilibrium, closed cup technology.

This manual provides important information regarding safety, technical reference, installation requirements, operating condition specifications, user facility resource requirements, and operating instructions for the Rapid Flash Tester, Closed Cup. This manual should also be used in conjunction with applicable published laboratory procedures. Information on these procedures is given in section 1.2.

## *1.1 Koehler's Commitment to Our Customers*

Providing quality testing instrumentation and technical support services for research and testing laboratories has been our specialty for more than 50 years. At Koehler, the primary focus of our business is providing you with the full support of your laboratory testing needs. Our products are backed by our staff of technically knowledgeable, trained specialists who are experienced in both petroleum products testing and instrument service to better understand your requirements and provide you with the best solutions. You can depend on Koehler for a full range of accurate and reliable instrumentation as well as support for your laboratory testing programs. Please do not hesitate to contact us at any time with your inquiries about equipment, tests, or technical support.

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## *1.2 Recommended Resources and Publications*

Test cup and lid and shutter are dimensionally in accord with ASTM, IP, ISO and BSI requirements as delineated in their standards:

1. American Society for Testing and Materials (ASTM)
   100 Barr Harbor Drive
   West Conshohocken, Pennsylvania 19428-2959, USA
   Tel: +1 610 832 9500
   Fax: +1 610 832 9555
   http://www.astm.org
   email: service@astm.org

   **ASTM Publication:**
   - ASTM D3278: Flash Point of Liquids by Small Scale Closed Cup Apparatus
   - ASTM D3828: Flash Point by Small Scale Closed Tester

2. International Organization for Standardization (ISO)
   1, rue de Varembé
   Case postale 56
   CH-1211 Geneva 20, Switzerland
   Tel: 41 22 749 01 11
   Fax: 41 22 733 34 30
   http://www.iso.org

   **ISO Publication:**
   - ISO 3679: Determination of Flash Point – Rapid Equilibrium Closed Cup Method
   - ISO 3680: Determination of Flash / No Flash – Rapid Equilibrium Closed Cup Method
   - ISO 9038: Test for Sustained Combustibility of Liquids

3. Energy Institute (IP)
   61 New Cavendish Street
   London, WIM 8AR, United Kingdom
   Tel: 44 (0)20 7467 7100
   Fax: 44 (0)20 7255 1472
   http://www.energyinstpubs.org.uk/

   **IP Publication:**
   - IP 303: Determination of Closed Flash Point – Mini Equilibrium Method

4. British Standards Institute
   389 Chiswick High Road
   London
   W4 4AL
   United Kingdom
   Tel: 44(0)20 8996 9001
   Fax: 44(0)20 8996 7001
   http://www.bsigroup.com

   **BSI Publication:**
   - BS 3900 Part A11:
   - BS 3900 Part A13
   - BS 3900 Part A14:

Accepted by:
- CPSC: United States Consumer Products Safety Commission
- DOT: United States Department of Transportation
- EPA: United States Environmental Protection Agency
- NFPA: National Fire Protection Association
- OSHA: United States Occupational Safety and Health Administration

### *1.3 Instrument Specifications*

| | |
|---|---|
| ***Models:*** | K16500, K16502<br>K16591, K16592 |
| ***Electrical Requirements:*** | 98-132V, 50/60Hz<br>196-264V 50/60Hz |
| ***Flash Point Temperature Range:*** | -36° to 572°F<br>-30° to 300°C |
| ***Temperature Display:*** | Digital °F/°C LCD display and mercury-in-glass thermometer dual scale 30 to 600°F and 0 to 316°C |
| ***Cup Type:*** | Closed, equilibrium test |
| ***Operational Sample Size:*** | 2ml to 212°F (100°C)<br>4 ml above 212 to 527°F (100 to 300°C) |
| ***Repeatability:*** | In accordance with Industry Test Method |
| ***Reproducibility:*** | In accordance with Industry Test Method |
| ***Dimensions:*** | 15.0x3.4x5.3 in.<br>(38.1x8.64x16.25 cm) |
| ***Net Weight:*** | 6lbs (2.7kg) |

## 2 Safety Information and Warnings

**Safety Considerations.** The use of this equipment may involve *hazardous* materials and operations. This manual does not purport to address all of the safety problems associated with the use of this equipment. It is the responsibility of any user of this equipment to investigate, research, and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

**Equipment Modifications and Replacement Parts.** Any modification or alteration of this equipment from that of factory specifications is not recommended voids the manufacturer warranty, product safety, performance specifications, and/or certifications whether specified or implied, and may result in personal injury and/or property loss. Replacement parts must be O.E.M. exact replacement equipment.

**Unit Design.** This equipment is specifically designed for use in accordance with the applicable standard test methods listed in section 1.2 of this manual. The use of this equipment in accordance with any other test procedures, or for any other purpose, is not recommended and may be extremely hazardous.

**Chemical Reagents Information.** Chemicals and reagents used in performing the test may exhibit potential hazards. Any user must be familiarized with the possible dangers before use. We also recommend consulting the Material Data and Safety Sheet (MSDS) on each chemical reagent for additional information. MSDS information can be easily located on the internet at http://siri.uvm.edu or http://www.sigma-aldrich.com.

**WARNING:** Flash point testers aid in determining the temperature at which application of a test flame causes the vapors of a sample to ignite under specified conditions of test. Flammable and potentially explosive materials are involved in the presence of a source of ignition. It is the direct responsibility of the user to establish appropriate safety and health practices for all personnel. The test procedures contained in this manual are for reference purposes only. The user of the Rapid

Tester® is to follow the instructions, warnings, and the cautions contained in the industry test methods.

Under no circumstances should this product be used except by qualified, trained personnel and not until the instructions, labels or other literature accompanying it have been carefully read and understood and all precautions followed as set forth herein.

# 3 Getting Started

## 3.1 Unpacking

Carefully unpack, account for and inspect the Rapid Tester, thermometer, fuel supply, syringe, cord and plug and optional accessories if ordered. Inspect each item for possible shipping damage. Be careful not to discard any components that may be enclosed in packing material.

## 3.2 Assembly

1. Place instrument on a level bench top in a draft free area.

2. Remove the two screws from the thermometer hold down bracket. Remove the wood dowel thermometer substitute if provided.

3. Remove the thermometer from its shipping tube and inspect. If the mercury column is separated, the thermometer must be cooled and the mercury shaken down into the bulb.

4. Each instrument is supplied with a small package of Heat Transfer Compound. Apply the compound to the bulb of the thermometer so that full contact will be made with the walls of its well when inserted into the cup.

5. Insert the thermometer carefully into the test cup. Rotate the thermometer to position the scale for convenient reading of degrees Fahrenheit or Celsius. Position the thermometer so that its end which is the high temperature reading will be fully under the clip. Replace the screws. To avoid breaking the thermometer, do not tighten the screws to cause more than a soft contact of the clip on the glass.

6. The primary power cord has an internationally uniform plug for connection to the instrument. The plug which mates with the U.S. standard, 115v grounded receptacle is standard. For 230V service or export, the cord does not contain a plug. Its three conductors are stripped of insulation and ready for termination in user supplied plug. The record contains three No. 18 AWG conductors. When attaching the plug, be sure to connect the green, ground conductor. The instrument circuitry is internally grounded to its enclosure and integral power cord receptacle.

7. Check that the instrument primary power switch is in the OFF (switch depressed to "O") position. Verify that the voltage stated on the label below the primary power receptacle is the same as your primary power source. Connect the power cord to the instrument and then to your power supply receptacle.

8. If testing is at temperatures above 400°F (204°C), remove the silicone test cup o-ring seal. Be sure that the groove is clean. Then place gasket partially into groove. Lower lid of lid and shutter to slowly press gasket into groove. Fasten lid with locking handle. The gasket will withstand the higher temperature but is not as resilient and therefore the silicone 0-ring is recommended for testing below 400°F (204°C).

9. Engage the threads of the fuel supply valve assembly to the fuel tank. Be sure that threads are fully engaged to prevent leakage of butane. Place fuel tank in its instrument well. Press the clear tubing onto the fuel supply valve and onto the fuel inlet of the lid and shutter assembly. Turn the red knob of the fuel tank clockwise until the container valve is closed. The shaft actuated by turning the red knob, first opens the container valve and then closes it. Then turn the red knob counterclockwise one (1) full turn. This will open the container valve. Light the pilot on the lid and shutter assembly. Turning the red knob of the fuel tank clockwise will cause reduction in flame extension. Adjustment of the pinch valve over the clear plastic tubing will cause the test flame to become the same size as the 0.157 inch (4mm) diameter gauge circle on the lid of the lid and shutter assembly. Turn off fuel supply by turning the red knob of the fuel tank clockwise.

**WARNING:** Fuel tank includes butane, use with care to avoid accidental fires. Do not puncture or incinerate. Exposure to temperatures above 120°F (49°C) may cause bursting. Be sure Rapid Tester

is fully assembled when in use. Internal barrier insulation reduces ambient temperature for fuel tank.

10. Press primary power switch to "I" (ON). Adjust temperature control knob while depressing Preset and turn temperature control knob to cause digital readout to be at approximately 149°F (65°C). Release the Preset switch. The digital readout and the mercury-in-glass thermometer will indicate rising cup temperature. Turn the temperature control knob counterclockwise and switch instrument primary power switch to "O" OFF.

### *3.3 Preparation of Dry Ice/Acetone Slurry (Optional)*

Solid carbon dioxide in equilibrium with carbon dioxide vapor at one atmosphere will provide cooling to a temperature as low as -78°C / 109.3°F. The liquid acetone provides good thermal contact throughout the bath. It also prevents air from diluting the carbon dioxide gas at the surface of the dry ice. The test cup must not be cooled to a temperature below -38.4°C, the freezing point of mercury.

1. Extinguish the pilot and test flames.

2. Remove the top cover of the refrigerant charged cooling block and fill the cylinder one-quarter to one-half full with acetone. DO NOT FILL TO HIGHER LEVEL.

3. Pulverize some dry ice with a grinder or by wrapping chunks of dry ice in a tower and crushing them with a mallet.

**WARNING:** Use tongs or insulated gloves when handling dry ice.

4. Add small quantities of pulverized dry ice to the cylinder with a spatula. This dry ice will evaporate almost immediately and cause considerable foaming at the surface.

5. Add additional, small amounts of pulverized dry ice, waiting after each addition until the foaming subsides.

6. Eventually, some dry ice will begin to accumulate at the bottom of the cylinder. At this point, small chunks of dry ice can be added without causing serious foaming.

7. Stir the mixture to ensure temperature uniformity. There should be a slow but steady stream of carbon dioxide bubbles rising from the bottom of the refrigerant charged cooling block.

8. Replace the top cap to prevent excess venting of acetone vapor.

9. Remove the bottom cap just before inserting the cooling block into the test cup.

## 4 Descriptions

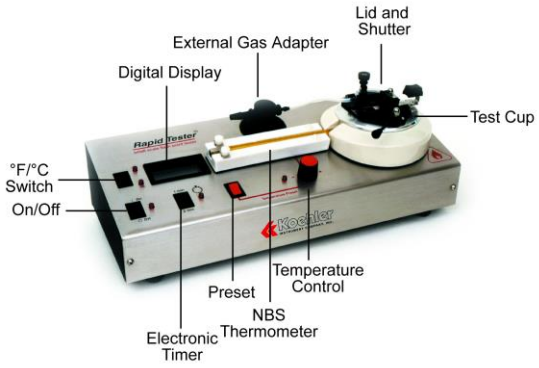



**Figure 1. Instrument Descriptions**

**Electrical Circuitry**

The primary voltage of 115/230V, 50/60 Hz is regulated to provide instrument control which is virtually constant. Each instrument is internally connected for user's nominal voltage of 115 or 230v prior to shipment. Its voltage connection is stated below the primary power inlet.

**Sample Size**

The sample size for testing at 212°F (100°C) and lower is 2 ml. Above 212°F (100°C), the sample size is 4 ml.

**Syringe**

An adjustable syringe is standard. It includes a holder with adhesive backing to allow mounting on, for example, a laboratory bench or onto the Rapid Tester enclosure above the digital display. Spacers are provided to simplify 2 ml or 4 ml sampling. Materials of higher viscosity such as adhesives, a 2 or 4 ml by volume sample is placed directly into the cup by use of a spatula (user supplied).

**O-ring/Gasket**

The seal between the cup and lid & shutter as shipped is silicone for testing to 400°F (204°C). A separate gasket is also supplied for testing from 400 to 572°F (204 to 300°C).

**Temperature Displays**

The Closed Cup Model covers the temperature range of -36 to 572°F (-38 to 300°C). The refrigerant charged cooling block, is required for below ambient testing. The standard dual scale thermometer, reads to low temperatures of 32°F and 0°C. For lower temperatures, the (-36 to 105°F) or (-38 to 40°C) thermometers will be needed. The thermometers are traceable for accuracy to the U.S. National Institute of Standards and Technology.

The digital temperature indicator compliments the thermometers and a simple switch action changes the reading to either °C or °F. Its range is ambient to 572°F (300°C). The digital temperature indicator provides instantaneous readings as compared to a mercury-in-glass thermometer which gives an average indication at the instance of reading. Therefore the slight fluctuation is a reminder of instant and actual temperature portrayal and the need to record the average or the digit between the high and low. If the average digital temperature display differs by more than 2°F or 1°C from the thermometer reading, it may be desirable to cause the Rapid Tester to heat within the range of your normal temperature usage, from low to high temperature. Record the thermometer readings and simultaneously the digital display every 20°F or 10°C to provide data points for a graph depicting any variation. This graph can then be referred to when recording the digital display and correcting to the thermometer.

Set-a-temp control permits simple adjustment and automatic regulation of test temperatures higher than ambient. Press the Preset switch while turning the temperature control knob until the target temperature is displayed. Release the switch and set-a-temp takes over. The test cup is automatically heated until the target temperature is attained. The instrument automatically maintains the target temperature. Slight movement of the temperature control knob may be necessary to obtain a specific target temperature.

**Test Cup**

Instrument utilizes closed cup type equilibrium test technology. Dimensions of test cup and lid and shutter assembly meet the exact dimensional requirements of applicable domestic and international standards which are:

ASTM D 3243, D 3278 and D 3828
IP 303
ISO 3679 and 3680
BS 3900 Parts A11, A14

The standard cup is aluminum. An optional cup with its companion lid and shutter of 316 stainless steel material is available for higher corrosion resistance.
The test cup is insulated with 1 inch (2.54 cm) surrounding sides and 1.5 inch (3.81 cm) at its bottom of low thermal conductivity ceramic fiber. When the test cup is at 300°F (148°C), the cold face temperature of the ceramic is 100°F (38°C). This attention to restricting heat flow achieves a higher degree of repeatable flash points than feasible in prior designs. Heating rates for the aluminum cup and/or 316 stainless steel cup are on the order of 7 minutes from ambient, 68°F/20°C to 212°F/100°C.

**Timer**

An electronic timer includes switching for either 1 or 2 minutes and an associated red LED. The light glows red when the timer is actuated and is switched off when the period elapses and a signal is emitted.

**Cooling Block**

The Metal Cooling Block, is primarily used to help lower the cup temperature quickly to prepare for the next test. One or more may be stored in a refrigerator for this purpose.

For some testing at elevated temperatures, it may require one or more applications to cause required cooling.

**Refrigerant Charged Cooling Block (Optional)**

This accessory is a thermally insulated cylinder with an aluminum alloy base (for thermal transfer) which fits the test cup recess. It includes a top and bottom cover.

For test temperature above 40°F/5°C, the cylinder may be charged with a mixture of crushed ice and distilled water.

For test temperature below 40°F/5°C, the cylinder may be charged with dry ice/acetone slurry. Refer to Section 3.3 for directions to prepare dry ice/acetone slurry.

**WARNING:** Safety glasses and gloves should be used when preparing acetone/dry ice slurry.

**Repeatability and Reproducibility**

As the test cup with its lid and shutter assembly is in accord with dimensions required by applicable standards, the repeatability and reproducibility are also in accord with the respective standards.

# 5 Operation

## *5.1 Flash Point Determination*

### *5.1.1 Ambient to 572°F (300°C) Testing*

1. Inspect sample well and lid/shutter for cleanliness and freedom from contamination.

2. Switch instrument to “I” (ON).

3. Adjust temperature control knob while depressing Preset switch until digital meter reads a temperature that is at least 9°F (5°C) below expected flash point temperature.

4. When the digital display reaches the Preset temperature, the red light will extinguish. It may be necessary to make a slight adjustment using the temperature control knob. The red light will glow whenever the instrument is heating the cup to maintain the specified temperature.

5. Be sure that the syringe is clean and dry. Draw 2 ml of sample [test temperatures of 212°F (100°C) or less] or 4 ml [test temperatures of 212°F (100°C) or higher] after target temperature is reached and discharge into the sample well.

6. Open the gas control valve and light pilot/test flame. Turn the gas control valve clockwise to reduce the pilot flame. The pilot flame is to be a minimum size to automatically relight test flame. Adjust test flame size with the pinch valve to match the 0.157 inch (4mm) diameter gauge ring on the lid and shutter.

7. Set timer by pressing its switch to "1 min" [test temperatures of 212°F (100°C) or less] and "2 min" [test temperatures of 212°F (100°C) or higher].

8. When the time has elapsed, slowly and uniformly open and close the slide completely over a period of 2fi seconds while watching for a flash. The material has flashed if a comparatively large flame appears and propagates over the surface of the liquid. Sporadically, when near the actual flash point temperature, application of the test flame may give rise to a blue halo (circular band); this should be ignored.

9. Close gas control valve after each test. Record barometric pressure. Report FLASH or NO FLASH. *Once the test flame has been applied to the sample, the test is terminated and a fresh sample must be used for each successive test.*

10. To prepare for the next test, unlock the lid and shutter. Soak up the sample using paper tissues and thoroughly clean the lid and shutter assembly. The filling orifice should be cleaned with a pipe cleaner or similar device. Do not lubricate the shutter slide. Clean the syringe.

11. If No Flash has been observed, at the initial estimated flash point temperature, repeat the test at a 9°F (5°C) higher temperature. Again, if No Flash is observed, repeat the test at additional 9°F (5°C) higher intervals until a Flash is observed.

12. If a Flash was observed during the initial test, use a test temperature 9°F (5°C) lower and repeat the procedure. If a Flash is again observed, repeat at 9°F (5°C) lower intervals until No Flash is observed.

13. Having established a Flash within two temperatures 9°F (5°C) apart, repeat either procedure at 2°F (1°C) intervals from the lower of the two temperatures until a Flash is observed. Record the temperature of the test when the Flash occurs as the Actual Flash Point.

14. Close gas control valve after each test.

15. Record the barometric pressure.

16. This Flash Point will be to the nearest 2°F. If closer accuracy is needed, further testing at a 1°F (0.5°C) lower temperature is required.

### *5.1.2 Sub-Ambient Testing*

1. When the tests are to be made at temperatures lower than ambient, it is necessary to use the sub-ambient

thermometer. This substitution should be carried out in accordance with Section 3.2, Assembly. When the sub-ambient thermometer is installed, care must be taken not to exceed +105°F (+40°C).

2. Lower test cup temperature by use of the Refrigerant Charged Cooling Block. For flash point temperatures above 40°F (5°C), the cylinder may be charged with a dry ice/acetone slurry. Refer to Section 3.3 for directions to prepare dry ice/acetone slurry.

3. Cool the sample and syringe in a cooling medium to a temperature approximately 10 to 20°F (5 to 10°C) below the estimated flash point temperature.

4. Remove the cooling source and dry the test cup. Close the lid and shutter assembly.

5. Ensure that the syringe is clean and dry. Charge with 2 ml of sample. Introduce the sample using the syringe, both of which have been pre-cooled to a temperature of 10 to 20°F (5 to 10°C) below the target temperature. Do not switch on the timer!

6. Open the gas control valve and light pilot/test flame. Turn the gas control valve clockwise to reduce the pilot flame. The pilot flame is to be at a minimum size to automatically relight the test flame. Adjust test flame size with the pinch valve to match the 0.157 inch (4mm) diameter gauge ring.

7. Allow the cup temperature to rise under ambient conditions. When the specified temperature is reached, slowly and uniformly open and close the slide completely over a period of 2fi seconds while watching for a flash. The material has flashed if a comparatively large blue flame appears and propagates over the surface of the liquid. Sporadically, when near the actual flash point temperature, application of the test flame may give rise to a blue halo (circular band); this should be ignored.

8. Close gas control valve after each test. Record barometric pressure. Report FLASH or NO FLASH. *Once a test flame has been applied to the sample, the test is terminated and a fresh sample must be used for each successive test.*

9. To prepare for the next test, unlock the lid and shutter. Soak up the sample using paper tissues and clean the lid and shutter assembly. The filling orifice should be cleaned with a pipe cleaner or similar device. Do not lubricate the shutter slide. Clean the syringe.

10. If No Flash has been observed at the initial estimated flash point temperature, repeat the test at a 9°F (5°C) higher temperature. Again if No Flash is observed, repeat the test at additional 9°F (5°C) higher intervals until a Flash is observed.

11. If a Flash was observed at the initial estimated flash point temperature, use a test temperature 9°F (5°C) lower and repeat the procedure. If a Flash is again observed, repeat at additional 9°F (5°C) lower intervals until No Flash is observed.

12. Having established a Flash within two temperatures 9°F (5°C) apart, repeat either procedure at 2°F (1°C) intervals from the lower of the two temperatures until a Flash is observed. Record the temperature of the test when the Flash occurs as the Actual Flash Point.

13. Close gas control valve after each test.

14. Record the barometric pressure.

15. This Flash Point will be to the nearest 2°F. If closer accuracy is needed, further testing at a 1°F (0.5°C) lower temperature is required.

## *5.2 Flash/No Flash Test*

### *5.2.1. Ambient to 572°F (300°C) Testing*

1. Inspect sample well and lid/shutter for cleanliness and freedom from contamination.

2. Switch instrument to "I" (ON).

3. Adjust temperature control knob while depressing Preset switch until digital meter reads required temperature. Release Preset switch.

4. When the digital display reaches the Preset temperature, the red light will extinguish. It may be necessary to make a slight adjustment using the temperature control knob. The red light will glow whenever the instrument is

heating the cup to maintain the specified temperature.

5. Be sure that the syringe is clean and dry. Draw 2 ml of sample [test temperatures of 212°F (100°C) or less] or 4 ml [test temperatures of higher than 212°F (100°C)], transfer to the filling orifice after target temperature is reached and discharge into the sample well.

6. Set timer by pressing its switch to "1 min" [test temperatures of 212°F (100°C) or less] and "2 min" [test temperatures of 212°F (100°C) or higher].

7. Open gas control valve and light pilot/test flame. Turn the gas control valve clockwise to reduce the pilot flame. The pilot flame is to be at minimum size to automatically relight test flame. Adjust the test flame size with the pinch valve to match the 0.157 inch (4mm) diameter gauge ring on the lid of the lid and shutter.

8. When the time has elapsed, slowly and uniformly open and close the slide completely over a period of 2fi seconds while watching for a flash. The material has flashed if a comparatively large flame appears and propagates over the surface of the liquid. Sporadically, when near the actual flash point temperature, application of the test flame may give rise to a blue halo (circular band); this should be ignored.

9. Close gas control valve after each test. Record barometric pressure. Report FLASH or NO FLASH. *Once a test flame has been applied to the sample, the test is terminated and a fresh sample must be used for each successive test.*

10. To prepare for the next test, unlock the lid and shutter. Soak up the sample using paper tissues and clean the lid and shutter assembly. The filling orifice should be cleaned with a pipe cleaner or similar device. Do not lubricate the shutter slide. Clean the syringe.

### *5.2.2. Sub-Ambient Testing*

1. When tests are to be made at temperatures lower than ambient, it is necessary to use the sub-ambient thermometer. This substitution should be carried out in accordance with Section 2 -Assembly. When the sub-ambient thermometer is installed, care must be taken not to exceed +105°F (+40°C).

2. Lower test cup temperature by use of the Refrigerant Charged Cooling Block. For flash point temperatures above 40°F (5°C), a mixture of water and crushed ice placed in the cylinder may be suitable. For temperatures below 40°F (5°C), the cylinder may be charged with a dry ice/acetone slurry. Refer to Section 3.3 for directions to prepare dry ice/acetone slurry.

3. Cool the sample and syringe in a cooling medium to a temperature approximately 10 to 20°F (5 to 10°C) below the specified temperature.

4. Cool the test cup until the temperature declines to approximately 10 to 20°F (5 to 10°C) below the specified temperature.

5. Remove the cooling source and dry the test cup. Close the lid and shutter assembly.

6. Ensure that the syringe is clean and dry. Charge with 2ml of sample. Introduce the sample using the syringe, both of which have been pre-cooled to a temperature 10 to 20°F (5 to 10°C) below the target temperature. Do not switch on the timer!

7. Open the gas control valve and light pilot/test flame. Turn the gas control valve to reduce the pilot flame. The pilot flame is to be at minimum size to automatically relight test flame. Adjust test flame size with the pinch valve to match the 0.157 inch (4mm) diameter gauge ring.

8. Allow the cup temperature to rise under ambient conditions. When the specified temperature is reached, slowly and uniformly open and close the slide completely over a period of 2fi seconds while watching for a flash. The material has flashed if a comparatively large flame appears and propagates over the surface of the liquid. Sporadically, when near the actual flash point temperature, application of the test flame may give rise to a blue halo (circular band); this should be ignored.

9. Close gas control valve after each test. Record barometric pressure. Report FLASH or NO FLASH. *Once a test flame has been applied to the sample, the test is terminated*

*and a fresh sample must be used for each successive test.*

10. To prepare for the next test, unlock the lid and shutter assembly. The filling orifice should be cleaned with a pipe cleaner or similar device. Do not lubricate the shutter slide. Clean the syringe.

## 5.3 Method for Determining Dilution of a Flammable Liquid by another Flammable Liquid

**NOTE:** This procedure utilizes an example of engine lubricant dilution by fuel to portray method.

This is a suggested procedure for determination of volatile, flammable liquid dilution or contamination of turbine or reciprocating engine lubricants.

Slight dilution of lubricants with fuel can reduce the lubricity of the lubricant and dangerously lower its flash point. This may result in a fire and/or loss of an engine.

Dilution/Time characteristics may identify degree of engine component wear.

Materials Required:

- Rapid Tester, Closed Cup Model
- Refrigerant charged cooling block
- Barometer
- Burette Type II Style I, Class B- Fed. Spec. NNN-B 789-50 ml
- Pipet Type I, Class B- Fed. Spec. NNN-P-350-10 ml.
- Bottles, 2 oz., glass, wide mouth
- Fuels, standard, as required
- Lubricants, standard, as required
- n-Decane, n-Undecane, n-Tetradecane and n-Hexadecane or other verification standards, as required, for checking the Rapid Tester
- Cooling Mixture of ice water or dry ice (solid $CO_2$) and acetone
- Heat transfer paste

### 5.3.1. Sampling

Obtain at least 100ml samples from the bulk source and store in nearly full, tightly closed clean glass containers or in other containers suitable for the types of liquid being sampled.

Erroneously high flash points may be obtained if precautions are not taken to avoid loss of volatile material. Do not open sample containers unnecessarily and do not transfer the sample to the cup unless its temperature is at least 20°F (10°C) below the expected flash point. Samples from leaky containers should not be used.

### 5.3.2. Procedure

Using a fresh sample of the lubricant being tested, measure into 2 oz. bottles, 49.7 ml, 49.5 ml, 47.5 ml and 45.0 ml of the standard lubricant respectively. Then pipet into each bottle sufficient amount of the standard fuel under test to equal 50 ml, resulting in lubricants with volume concentration of 0.6%, 1.0%, 2.0%, 5.0% and 10.0% contaminants.

**NOTE:** When residual fuel such as residual JP-4 is to be determined in lubricants, the fuel should be distilled off below 275°F and discarded (about 55%). Use the remainder (about 45%) in preparation of the calibration samples. Other temperatures may be selected as agreed upon.

Determine the flash point of each mixture according to the procedure (Section 3). Shake each test sample bottle for thorough mixing before extracting a test specimen. When barometric pressure differs from 760 mm (101.2 kPa), calculate the flash point temperature by means of the equation in Section 6.2.

Construct a graph plotting the percent contaminant as the abscissa and the flash point temperature as the ordinate.

### 5.3.3. Application

After determining the flash point temperature of a lubricant sample which may be diluted with a volatile, flammable liquid such as a fuel, refer to the graph. At the point where the temperature intersects the curve, the percent dilution if any, can be determined by locating the corresponding number of abscissa. This information will assist an investigation as to the source of the contamination.

If there is a percent of dilution that is acceptable, use the graph to determine the correlating temperature. Then use the Flash / No Flash procedures in Section 5.2 to rapidly determine acceptable lubricant.

By knowing the minimum flash point temperature of acceptable lubricant, using the Flash / No Flash procedure in Section 5.2, acceptable quality can

be determined for lubricants that may be diluted by other volatile, flammable material.

#### *5.3.4. Conclusion*

This procedure is provided as a guide for initiating a method whereby flash point testing can be a useful tool in determining dilution of a flammable liquid by another flammable liquid.

# 6 Calibration

## *6.1 Instrument Calibration*

- Determine the flash point of the check or reference standard that has a flash point temperature that is near your target temperature by following the direction in Section 4. When the instrument is operating properly, the flash point temperature for that check fluid will be obtained within the tolerances stated. If the flash point is not within the tolerance stated, refer to Section 7.

- Typical specifications for flashpoint check or reference standards. Refer to the reference standard supplier certification for the batch you are using.

  - n-Decane
    - Specific Gravity: 60/60°F (15.5/15/6°C), 0.73 nominal
    - Boiling Point: 345.38°F (174.1°C)
    - Melting Point: 21.46°F (-29.7°C) minimum
    - Flash Point: 115 ± 1°F (46.1 ± 0.5°C) acceptable range
  - n-Undecane
    - Specific Gravity: 60/60°F (15.5/15/6°C), 0.74 nominal
    - Boiling Point: 386.15°F (196.75°C)
    - Melting Point: -14.8°F (-25.6°C)
    - Flash Point: 140 ± 2°F (60 ± 1.0°C)
  - n-Tetradecane
    - Specific Gravity: 60/60°F (15.5/15/6°C), 0.7628 nominal
    - Boiling Point: 488.6°F (253.7°C)
    - Melting Point: 42.6°F (5.9°C)
    - Flash Point: 211 ± 2°F (99 ± 1.0°C)
  - n-Hexadecane
    - Specific Gravity: 60/60°F (15.5/15/6°C), 0.77 nominal
    - Boiling Point: 548.6°F (287°C)
    - Melting Point: 64.4°F (18°C)
    - Flash Point: 275 ± 2°F (135 ± 1.0°C)

## *6.2 Barometric Pressure Correction*

When the barometric pressure differs from 760 mm Hg (101.2 kPa), calculate the flash point temperature by means of the following equations:

Calculated flash point = F + 0.06 (760 -P)
= C + 0.03 (760 -P)

Where: F,C = observed flash point, °F (or °C) and
P = barometric pressure, mm Hg.

Determine the corrected specification flash point by the following equation:

F = S -0.06 (760 -P)
C = S -0.03 (760 -P)

# 7 Maintenance

## *7.1 Test Cup Fails to Heat*

- Check electrical supply and power cord. Be sure power switch is “O” (OFF). Disconnect power cord. Use ⁄ inch (0.64cm) wide screw driver blade and turn fuse holder cover counterclockwise. Test fuse. Replace if necessary, install and replace fuse cover. Reconnect power cord.

- Check temperature control potentiometer. Disconnect primary power cord. Remove thermometer by disengaging the two screws on the thermometer hold down bracket. Remove and place thermometer where it will not be damaged. Remove four screws, two front and two at back which hold top cover to base of instrument. Remove top cover carefully and invert onto soft material to cushion switches, etc. Remove the three conductors from the electronic circuit board terminal strip. Test potentiometer. It is rated 2K ohms, 10 turns. Replace as necessary.

- Check condition of the following by sequentially removing their conductors from the electronic circuit board terminal strip and replacing the conductors after test component is found to be operational:

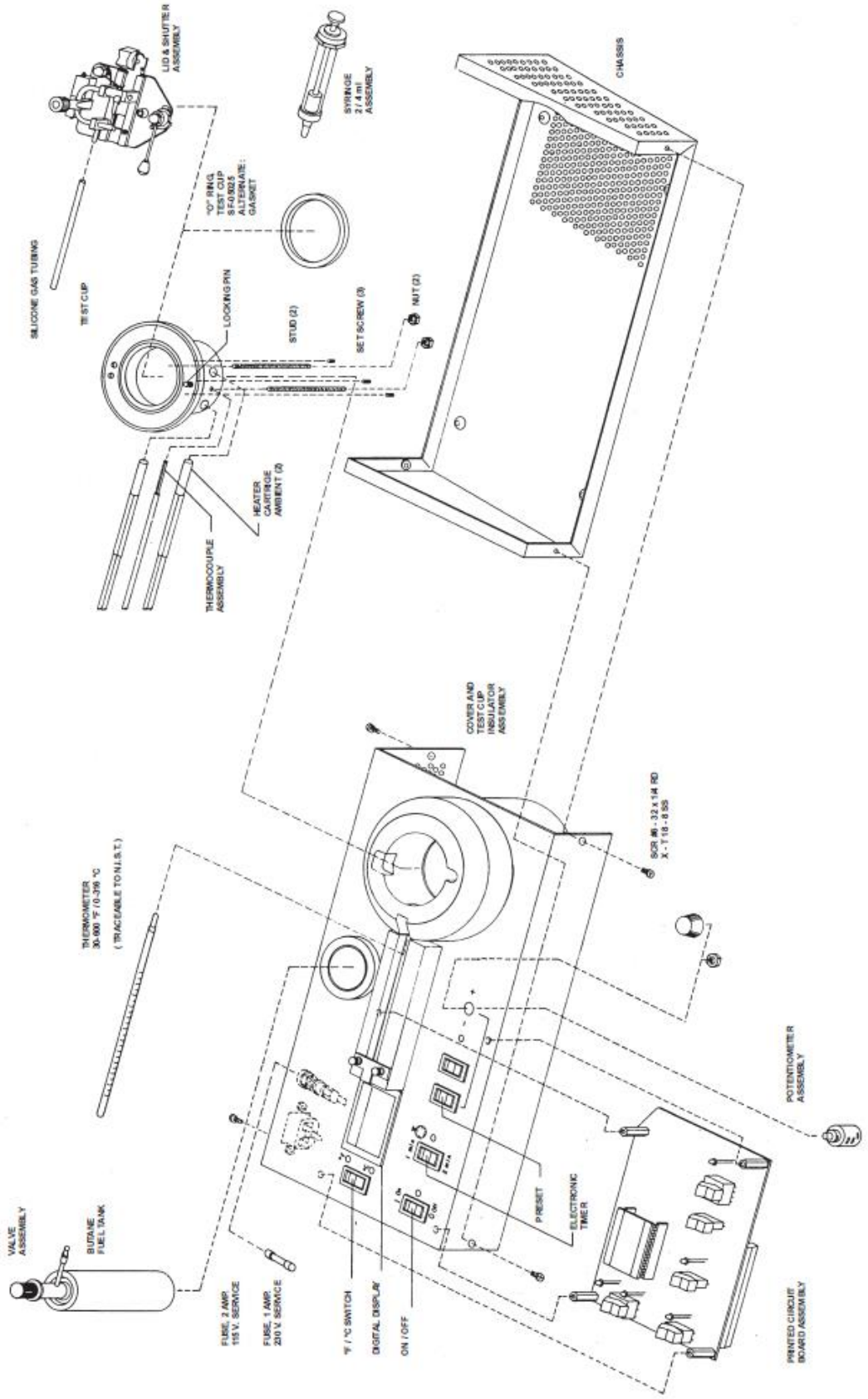
  - Separately, check that the two cartridge heaters are each rated 115V, 50W.
  - Primary conductors from transformer.

- Conductors from primary power receptacle. Check for continuity between conductors and blades in receptacle.

## 7.2 Temperature Control Does Not Regulate

- If electronic circuit board is potential cause, replace it. Identify and remove all conductors not from circuit board. Remove the four hold down screws. Pry board gently to cause switch retainers to release. When installing a circuit board be sure that the four switches and five LEDs are oriented to be inserted into the switch bezels and LED cups. Replace screws and conductors.
- If the thermocouple is suspect, replace by:
  - Disconnecting the thermocouple leads and cartridge heater leads from the circuit board terminals. Release the conductors from retaining devices. Remove the nuts from the two studs at the bottom of the white ceramic thermal insulator. Remove the ceramic insulator and protect the conductors as they slip through their outlet.
  - Disengage the set screw in the base of the test cup. The thermocouple can be drawn from the test cup. Reverse when installing a replacement.
- If either cartridge heater requires replacement, a similar procedure is required. The two set screws in the bottom of the test cup each retain a cartridge heater. Disengage the threads of a set screw releases the inoperative heater. Draw out and replace the heater. Engage the threads of the set screw until it holds the cartridge heater in place. Do not over tighten as the heater jacket could be pierced. Re-assemble.

## 7.3 Assembly Diagram



## 8 Service

Under normal operating conditions and with routine maintenance, the Rapid Closed Cup Flash Tester should not require service. Any service problem can be quickly resolved by contacting Koehler's technical service department either by letter, phone, fax, or email. In order to assure the fastest possible service, please provide us with the following information.

Model Number: _____

Serial Number: _____

Date of Shipment: _____

## 9 Storage

This laboratory test instrument is equipped with electrical components. Storage facilities should be consistent with an indoor laboratory environment. This testing equipment should not be subjected to extremes of temperature and/or moisture.

This equipment was shipped from the factory in a corrugated cardboard container. If long term storage is anticipated, re-packing the instrument in a water-resistant container is recommended to ensure equipment safety and longevity.

## 10 Warranty

We, at Koehler, would like to thank you for your equipment purchase, which is protected by the following warranty. If within one (1) year from the date of receipt, but no longer than fifteen (15) months from the date of shipment, Koehler equipment fails to perform properly because of defects in materials or workmanship, Koehler Instrument Company, Inc. will repair or, at its sole discretion, replace the equipment without charge F.O.B. its plant, provided the equipment has been properly installed, operated, and maintained. Koehler Instrument Company must be advised in writing of the malfunction and authorize the return of the product to the factory. The sole responsibility of Koehler Instrument Company and the purchaser's exclusive remedy for any claim arising out of the purchase of any product is the repair or replacement of the product. In no event shall the cost of the purchaser's remedy exceed the purchase price, nor shall Koehler Instrument Company be liable for any special, indirect, incidental, consequential, or exemplary damages. KOEHLER INSTRUMENT COMPANY, INC. DISCLAIMS ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE. Please save the shipping carton in the event the equipment needs to be returned to the factory for warranty repair. If the carton is discarded, it will be the purchaser's responsibility to provide an appropriate shipping carton.

## 11 Returned Goods Policy

To return products for credit or replacement, please contact Koehler Customer Service with your purchase order number, our packing list/invoice number, the item(s) to be returned and the reason for the return. You will be issued a Returned Authorization (RA) number, which must be prominently displayed on the shipping container when you return the material to our plant. Shipping containers without an RA number prominently displayed with will be returned to the sender. Goods must be returned freight prepaid. Returns will be subject to a restocking charge, the application of which will depend upon the circumstances necessitating the return. Some returns cannot be authorized, including certain products purchased from outside vendors for the convenience of the customer, products manufactured on special order, products shipped from the factory past ninety (90) days, and products which have been used or modified in such a way that they cannot be returned to stock for future sale.

## Notes

## Notes