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Overview

CANNON’s Thermoelectric Sample Conditioner (TESC) System provides controlled sample heating and cooling for ASTM D2983 and D8210. The low cost and a small footprint, compared to other sample conditioning options, allow several complete TESC Systems to be conveniently operated in the same bench-top area as a single competitor unit. This ensures labs have optimal test versatility and redundancy to maximize productivity and reduce downtime.

Theory of Operation

The TESC System uses a method equivalent to Procedure B of ASTM D2983 and ASTM D8210. To reduce test variability, the TESC System automates or removes many of the steps required to transfer the sample between conditioning and testing processes. Automation occurs through use of a thermoelectrically controlled sample chamber that manages the sample, without operator intervention, throughout the conditioning and testing processes.

Using a calibrated TESC System, an operator runs a D2983/D8210 test as follows:

1. Auto-zero the Brookfield DV2T viscometer.
2. Measure 20 mL of sample into a 25 mm × 150 mm, rimless test tube.
3. Carefully place the test tube with the sample into the TESC sample chamber.
4. Attach a #4B2 spindle to the DV2T and lower the viscometer into the run position.
5. Start both the temperature control program and the viscometer program.

Once the temperature control program starts, the TESC System heats the sample to the preheat temperature and maintains the sample at that temperature for the required time. The TESC System then cools the sample to room temperature at the same rate used to raise it to the preheat temperature, and then further cools the sample to the desired test temperature according to the equation in D2983 Annex A1. This controlled heating and cooling is critical to reducing variability.

Throughout the thermal conditioning process, the DV2T program records the temperature of the sample chamber while waiting to measure the viscosity. When thermal conditioning of the sample completes, the DV2T automatically measures the sample viscosity by stepping through the typical range of spindle speeds for the sample type or expected viscosity. This eliminates the need to run multiple tubes of a sample. Once the viscosity measurements finish, the TESC System returns the
sample to room temperature, nominally 25 °C. Afterwards, the operator can review the data and enhance the digital record with notes and additional information. The TESC System comes with a set of thermal conditioning programs for all of the common specification test temperatures as well as certain OEM measurement and report requirements.

### Table 1: TESC Thermal Conditioning Programs

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Preheat Temperature</th>
<th>Test Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low viscosity (ATF, hydraulic fluid)</td>
<td>50 °C</td>
<td>−10 °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>−20 °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>−30 °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>−40 °C</td>
</tr>
<tr>
<td>High viscosity (gear oil)</td>
<td>90 °C</td>
<td>−12 °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>−26 °C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>−40 °C</td>
</tr>
</tbody>
</table>

### Related Documents

### Table 2: Related Documents

<table>
<thead>
<tr>
<th>Title</th>
<th>Reference Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Test Method for Low-Temperature Viscosity of Lubricants Measured by Brookfield® Viscometer</td>
<td>ASTM D2983</td>
</tr>
<tr>
<td>Automotive Gear Lubricant Viscosity Classification</td>
<td>SAE J306</td>
</tr>
</tbody>
</table>
## Specifications / Compliances

### Table 3: Specifications and Compliances

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model</strong></td>
<td>Thermoelectric Sample Conditioner</td>
</tr>
<tr>
<td><strong>Methodology</strong></td>
<td>ASTM D2983-equivalent, ASTM D8210</td>
</tr>
<tr>
<td><strong>Applications</strong></td>
<td>Gear oils, automatic transmission fluids, industrial and automotive hydraulic oils, tractor fluids, lubricating oils</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td>(TESC only)</td>
</tr>
<tr>
<td><strong>(w × d × h)</strong></td>
<td>(with DV2T)</td>
</tr>
<tr>
<td></td>
<td>16.5 cm × 50.8 cm × 63.5 cm (6.5 in × 20 in × 25 in)</td>
</tr>
<tr>
<td></td>
<td>16.5 cm × 50.8 cm × 76.2 cm (6.5 in × 20 in × 30 in)</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>(TESC only)</td>
</tr>
<tr>
<td><strong>(with DV2T)</strong></td>
<td>16.8 kg (37 lb)</td>
</tr>
<tr>
<td></td>
<td>19.5 kg (43 lb)</td>
</tr>
<tr>
<td><strong>Operational temperature range</strong></td>
<td>–40 °C to +90 °C (± 0.1 °C)</td>
</tr>
<tr>
<td><strong>Sample capacity</strong></td>
<td>1 sample, 20 mL sample required</td>
</tr>
<tr>
<td><strong>Power requirements (max)</strong></td>
<td>100 – 240 VAC, 50/60 Hz, 300 watts</td>
</tr>
<tr>
<td><strong>Operating conditions</strong></td>
<td>15 °C to 30 °C, 10% to 75% relative humidity (non-condensing), Installation Category II, Pollution Degree 2</td>
</tr>
<tr>
<td><strong>Compliance</strong></td>
<td>CE Mark: EMC Directive (2004/108/EC); Low Voltage Directive (2006/95/EC); ROHS</td>
</tr>
</tbody>
</table>
Notes / Cautions / Warnings

Notes, caution, and warnings are used in the manual to call an operator’s attention to important details prior to performing a procedure or step. Read and follow these important instructions. Failure to observe these instructions may void warranties, compromise operator safety, and/or result in damage to the TESC System.

Notes provide more information about the content that follows.

Cautions alert the operator to conditions that may damage equipment.

Warnings alert the operator to conditions that may cause injury.

Safety Precautions

Please observe the following general safety precautions for proper and safe operation of the Thermoelectric Sample Conditioner.

- Only qualified personnel should operate the TESC System.
- Make sure that you read and understand all operating instructions and safety precautions listed in this manual before installing or operating your unit. If you have questions regarding instrument operation or documentation, contact Cannon Instrument Company.
- Do not deviate from the installation, operation, or maintenance procedures described in this manual. Improper use of the TESC System may result in a hazardous situation and may void the manufacturer’s warranty.
- Handle and transport the unit with care. Sudden jolts or impacts may cause damage to components.
- Observe all warning labels. Never remove warning labels.
- Never operate damaged or leaking equipment.
• Unless procedures specify otherwise, always turn off the unit and disconnect the MAINS AC power cable from the power source before performing service or maintenance procedures, or before moving the unit.

• Refer all service and repairs to qualified personnel.

The ~MAINS symbol indicates the connections for the AC power supply. The AC power input must match the electrical specifications of the instrument.

~MAINS
Never operate the equipment with a damaged MAINS AC power cable.

Use only the manufacturer-supplied MAINS AC power cable. This cable must be inserted into a receptacle with a protective earth ground.

(O)
The (O) symbol indicates the OFF position for the electrical switches for your unit.
Getting Started

Unpack and Inspect

Unpack and inspect the complete CANNON Thermoelectric Sample Conditioner System and all accessories as soon as they are received.

**Caution:** Many components are fragile. Use caution when moving and handling the TESC System and accessories.

1. Carefully unpack the entire contents of the shipment.
2. Referring to the packaging list, verify that all materials were received.
3. Inspect materials for defects and shipping damage. Contact your CANNON representative to resolve any issues.

**Table 4: Packing List (TESC System)**

<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>TESC base unit</td>
<td>17.5075</td>
</tr>
<tr>
<td>Mounting collar</td>
<td>17.5113</td>
</tr>
<tr>
<td>Retaining ring</td>
<td>17.5114</td>
</tr>
<tr>
<td>Retaining screws (4)</td>
<td>01.4022</td>
</tr>
<tr>
<td>MAINS AC power cable</td>
<td>74.2110 (US standard)</td>
</tr>
<tr>
<td>MAINS AC pass-through power cable</td>
<td>17.5135</td>
</tr>
<tr>
<td>RS-485 to USB cable</td>
<td>17.5122</td>
</tr>
<tr>
<td>Brookfield® DV2T viscometer</td>
<td>17.5126</td>
</tr>
<tr>
<td>Brookfield® #4B2 insulated spindle</td>
<td>17.5128</td>
</tr>
<tr>
<td>Brookfield® EZ-Lock spindle coupling</td>
<td>17.5129</td>
</tr>
</tbody>
</table>
Setup the TESC System

The TESC 2983 ships partially disassembled. Basic assembly is simple, quick, and requires only a few common tools as outlined in Table 6.

### Table 6: Tools and Materials Required

<table>
<thead>
<tr>
<th>Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TESC base unit</td>
<td>3/32&quot; Allen wrench</td>
</tr>
<tr>
<td>Brookfield DV2T viscometer Head Unit</td>
<td>Mounting collar</td>
</tr>
<tr>
<td>Retaining ring</td>
<td>Retaining screws (4)</td>
</tr>
<tr>
<td>MAINS AC power cable</td>
<td>MAINS AC pass-through power cable</td>
</tr>
<tr>
<td>USB A-to-B Cable</td>
<td></td>
</tr>
</tbody>
</table>

Attach the Brookfield Head Unit

Assemble the TESC System on a secure, level surface. The Brookfield Head Unit sits on top of the TESC Base Unit and is braced on a bracket frame. Simple installation consists of installing the Head Unit onto the bracket frame and then inserting the cables. Upon receipt, the Brookfield Head Unit appears as shown below in Figure 1.

![Four Retaining Screws](image)

**Figure 1: Brookfield Head Unit (on its side)**
Note: If the TESC System is moved after assembly, you must level the unit again.

1. Remove all four screws holding the retaining ring to the mounting collar using a $\frac{3}{32}$" Allen wrench. Refer to Figure 2.

2. Remove the retaining ring, keeping the mounting collar on the Head Unit as shown in Figure 2.

3. Place Head Unit and mounting collar on the bracket frame in the installation hole. Refer to Figure 3.

4. Attach the retaining ring to the mounting collar with the previously removed screws, with the bevel of the retaining ring facing outwards as shown in Figure 4.
5. Attach MAINS power cable and the USB A-to-B cable to the Head Unit as shown in Figure 5.

![Figure 5: Attach MAINS Power and USB Cable](image)

6. Attach the white Temperature Probe cable from the Base Unit to Head Unit. Refer to Figure 6.

![Figure 6: Temperature Probe Cable](image)
Figure 7: Assembled TESC System

- Brookfield DV2T viscometer
- Mounting Collar
- Viscometer tray
- Retaining ring
- Retaining screws (4)
- Test chamber
- TESC base unit
- Leveling screws
**Connect Cables**

All primary cables are shipped with the TESC System. Refer to Figures 8, 9 and 10 as necessary.

**Caution:** The MAINS AC pass-through connector on the TESC base is not controlled by the TESC System ON/OFF switch. Whenever the TESC base is plugged in, power will be passed to the Brookfield viscometer.

1. Verify that the DV2T power switch is off.
2. Verify that the TESC power switch is off.
3. Connect the MAINS AC pass-through power cable from the TESC base to the DV2T.
4. Connect the RTD probe from the TESC base to the socket on the back of the DV2T.
5. Connect the MAINS AC power cable to the TESC and a MAINS AC outlet.

![Figure 8: TESC with Watlow Controller](image-url)
Figure 9: Brookfield DV2T Connections

- RTD probe socket
- MAINS AC power input
- USB B
- USB A
- On/off switch

Figure 10: TESC Connections

- Serial number label
- MAINS AC pass-through (unswitched)
- MAINS AC power input (base)
Run Quick Verification Test
This test verifies system calibration and provides a technician with basic training in operating the CANNON Thermoelectric Sample Conditioner System.

Table 7: Tools and Materials Required

<table>
<thead>
<tr>
<th>Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembled TESC System with mounted Brookfield viscometer</td>
<td>20 mL of an appropriate reference sample</td>
</tr>
<tr>
<td>25 mm × 150 mm rimless, disposable test tube</td>
<td>Brookfield #4B2 insulated spindle</td>
</tr>
<tr>
<td>Sample preparation materials</td>
<td>USB flash drive with program files</td>
</tr>
</tbody>
</table>

1. Turn on DV2T and TESC. If the Watlow controller starts to run a program, press the red EZ button to halt the test. (Steps symbol ![steps](image) indicates a running program.)

2. Autozero DV2T:
   a. Remove spindle if present.
   b. Lower viscometer to measurement position.
   c. Level TESC System if necessary.
   d. Select Next on the DV2T AutoZero screen.
   e. When the DV2T indicates that the AutoZero is complete, raise viscometer.

3. Prepare a 20 mL sample according to your laboratory practices:
   a. Insert a 25 mm × 150 mm test tube containing 20 mL (± 0.2 mL) of the reference sample into the test chamber and gently hand-tighten the cone ring.
   b. Attach a clean #4B2 spindle to the viscometer.
   c. Carefully lower viscometer into measurement position.

4. Set the TESC System temperature:
   a. Using the control buttons on the Watlow controller, set the target temperature, which depends on the characteristics of the reference sample you are testing. The TESC System immediately begins cooling or heating to achieve the target temperature.
Note: The 2 hour DV2T calibration program waits 2 hours for the temperature of the sample to stabilize, and then it runs a viscometry test.

All TESC programs are preloaded by CANNON onto the DV2T. Backup copies are available on the USB flash drive.

5. Load and run the 2 hour DV2T temperature calibration program:
   a. From the DV2T Main Menu, select Load Test > Viscosity Tests > Internal Memory > Temp Cal 2 Hour DV2T.dvt.
   b. Click Run.

6. When the DV2T test completes, review the results by scrolling through the step results. Compare the measured viscosity at the highest torque reading to the certified viscosity of the sample. If the measured viscosity is outside of the tolerable range of the sample, the TESC System will need to be calibrated prior to running an ASTM D2983 test. Refer to section Calibrating the TESC System, for calibration instructions.

7. To save the test data from the DV2T:
   a. Click Save.
   b. If necessary, click Path and adjust the location to which the data saves.
   c. If necessary, click File Type and change the file type.
   d. Click Save.

Testing using the DV2T is complete. Click the Main Menu icon in the upper-left corner of the screen and click No when a dialog box prompts you to save the data.

Warning: Do not attempt to remove a sample from the test chamber until it has reached a safe handling temperature. Refer to your lab safety standards for more information.

Sample temperature will lag behind the temperature displayed by the Watlow controller (TE cooler block temperature). Wait until approximately 30 minutes after the controller reaches the target temperature before handling the sample.

8. Set the Watlow controller target temperature to +25.0 °C. When the sample reaches +25.0 °C, raise the viscometer; remove and clean spindle and test tube.
Running an ASTM D2983/D8210 Test

This procedure runs sample conditioning programs and viscosity tests designed to meet ASTM methods D2983 and D8210.

Table 8: Tools and Materials Required

<table>
<thead>
<tr>
<th>Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembled TESC System with mounted Brookfield DV2T viscometer</td>
<td>20 mL sample to be tested</td>
</tr>
<tr>
<td>25 mm × 150 mm rimless, disposable test tube</td>
<td>Brookfield #4B2 insulated spindle</td>
</tr>
<tr>
<td>Sample preparation materials</td>
<td>RS-485 to USB cable</td>
</tr>
<tr>
<td>USB flash drive with program files</td>
<td></td>
</tr>
</tbody>
</table>

1. Turn on DV2T and TESC. If the Watlow controller starts to run a program, press the red EZ button to halt the test. (Steps symbol indicates a running program.)

   **Note:** For instructions on installing the Watlow EZ-Zone Configurator program, refer to page 21.

2. If necessary, load the appropriate thermal conditioning program into Watlow controller:
   a. Connect PC to Watlow controller using RS-485 to USB cable.
   b. Launch Watlow configurator program: **Start Menu > EZ-ZONE Configurator > EZ-ZONE Configurator.**
   c. Select **Download a configuration file to a device.** Click **Next.**
   d. Select the COM port to which the Watlow controller is connected. Click **Next.**
   e. Select **Load Program from File.**
   f. Select program according to Table 9 or Table 11.
Table 9: ASTM D2983 Thermal Conditioning Programs

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Test Temperature</th>
<th>Test Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2983-Plus5-17hr.wcf</td>
<td>+5 °C</td>
<td>17.2 hours</td>
<td></td>
</tr>
<tr>
<td>D2983-Zero-17hr.wcf</td>
<td>0 °C</td>
<td>17.2 hours</td>
<td></td>
</tr>
<tr>
<td>D2983-Minus05-17hr.wcf</td>
<td>–5 °C</td>
<td>17.2 hours</td>
<td></td>
</tr>
<tr>
<td>D2983-Minus10-17hr.wcf</td>
<td>–10 °C</td>
<td>17.2 hours</td>
<td>ATF, hydraulic, etc.</td>
</tr>
<tr>
<td>D2983-Minus12-17hr.wcf</td>
<td>–12 °C</td>
<td>17.2 hours</td>
<td>Gear oils</td>
</tr>
<tr>
<td>D2983-Minus15-17hr.wcf</td>
<td>–15 °C</td>
<td>17.2 hours</td>
<td></td>
</tr>
<tr>
<td>D2983-Minus17pt8-17hr.wcf</td>
<td>–17.8 °C</td>
<td>17.2 hours</td>
<td></td>
</tr>
<tr>
<td>D2983-Minus18-17hr.wcf</td>
<td>–18 °C</td>
<td>17.2 hours</td>
<td></td>
</tr>
<tr>
<td>D2983-Minus20-17hr.wcf</td>
<td>–20 °C</td>
<td>17.2 hours</td>
<td>ATF, hydraulic, etc.</td>
</tr>
<tr>
<td>D2983-Minus23pt3-17hr.wcf</td>
<td>–23.3 °C</td>
<td>17.2 hours</td>
<td></td>
</tr>
<tr>
<td>D2983-Minus25-17hr.wcf</td>
<td>–25 °C</td>
<td>17.2 hours</td>
<td></td>
</tr>
<tr>
<td>D2983-Minus26-17hr.wcf</td>
<td>–26 °C</td>
<td>17.2 hours</td>
<td>Gear oils</td>
</tr>
<tr>
<td>D2983-Minus30-17hr.wcf</td>
<td>–30 °C</td>
<td>17.2 hours</td>
<td>ATF, hydraulic, etc.</td>
</tr>
<tr>
<td>D2983-Minus35-17hr.wcf</td>
<td>–35 °C</td>
<td>17.2 hours</td>
<td></td>
</tr>
<tr>
<td>D2983-Minus40-17hr.wcf</td>
<td>–40 °C</td>
<td>17.2 hours</td>
<td>Gear oil, ATF, hydraulic, etc.</td>
</tr>
</tbody>
</table>

Note: The Watlow calibration offset is unique at each test temperature; the offset for –40 °C may not be the same offset for –26 °C.

3. Using the Watlow configurator program, verify that the proper calibration offset has been entered into the program.
4. **Autozero DV2T:**
   a. Remove spindle if present.
   b. Lower viscometer to measurement position.
   c. Level TESC System if necessary.
   d. Press **Next** on the DV2T **AutoZero** screen.
   e. When the DV2T indicates AutoZero complete, raise viscometer.

5. **Prepare a 20 mL sample according to your laboratory practices:**
   a. Insert a 25 mm × 150 mm test tube containing 20 mL ± 0.2 mL of the reference sample into the test chamber and gently hand-tighten the cone ring.
   b. Attach a clean #4B2 spindle to the viscometer.
   c. Carefully lower viscometer into measurement position.

6. **Load and run the appropriate DV2T viscosity measurement program:**
   a. From the DV2T Main Menu, select **Load Test > Viscosity Tests > Internal Memory** > see Table 10 and Table 12. Refer to Figure 11.
   b. Click **Run**.
### Table 10: ASTM D2983 DV2T Viscometer Programs

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Test Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2983-Visc-17hr.dvt</td>
<td>17.2 hours</td>
<td>For any viscosity</td>
</tr>
</tbody>
</table>

**Warning:** The thermal conditioning program will return the TESC to 25 °C after test measurements are complete. Do not attempt to remove a sample from the test chamber until it has reached a safe handling temperature. Refer to your lab safety standards for more information.

7. Press red EZ button on the Watlow controller. Refer to Figure 12.

8. When the DV2T test completes, review the results by scrolling through the step results.

9. To save the test data from the DV2T:
   a. Click **Save**.
   b. If necessary, click **Path** and adjust the path to which the data saves.
   c. If necessary, click **File Type** and change the file type.
   d. Click **Save**.

**Note:** Full sample conditioning and viscosity test for ASTM method D2983 requires approximately 19.5 hours to complete.
Testing using the DV2T is complete. Click the Main Menu icon in the upper-left corner of the screen and click No when a dialog box prompts you to save the data.

**Warning:** Do not attempt to remove a sample from the test chamber until it has reached a safe handling temperature. Refer to your lab safety standards for more information.

Sample temperature will lag behind the temperature displayed by the Watlow controller (TE cooler block temperature). Wait until approximately 30 minutes after the controller reaches the target temperature before handling the sample.

10. If necessary, set the Watlow controller target temperature to +25.0 °C. When the sample reaches +25.0 °C, raise the viscometer; remove and clean spindle and test tube.

### Table 11: ASTM D8210 Thermal Conditioning Programs

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Test Temperature</th>
<th>Test Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D8210-Minus10-6hr.wcf</td>
<td>−10 °C</td>
<td>6 hours</td>
<td>ATF, hydraulic, etc.</td>
</tr>
<tr>
<td>D8210-Minus12-6hr.wcf</td>
<td>−12 °C</td>
<td>6 hours</td>
<td>Gear oils</td>
</tr>
<tr>
<td>D8210-Minus18-6hr.wcf</td>
<td>−18 °C</td>
<td>6 hours</td>
<td></td>
</tr>
<tr>
<td>D8210-Minus20-6hr.wcf</td>
<td>−20 °C</td>
<td>6 hours</td>
<td>ATF, hydraulic, etc.</td>
</tr>
<tr>
<td>D8210-Minus23pt3-6hr.wcf</td>
<td>−23.3 °C</td>
<td>6 hours</td>
<td></td>
</tr>
<tr>
<td>D8210-Minus26-6hr.wcf</td>
<td>−26 °C</td>
<td>6 hours</td>
<td>Gear oils</td>
</tr>
<tr>
<td>D8210-Minus30-6hr.wcf</td>
<td>−30 °C</td>
<td>6 hours</td>
<td>ATF, hydraulic, etc.</td>
</tr>
<tr>
<td>D8210-Minus35-6hr.wcf</td>
<td>−35 °C</td>
<td>6 hours</td>
<td></td>
</tr>
<tr>
<td>D8210-Minus40-6hr.wcf</td>
<td>−40 °C</td>
<td>6 hours</td>
<td>Gear oil, ATF, hydraulic, etc.</td>
</tr>
</tbody>
</table>

### Table 12: ASTM D8210 DV2T Viscometer Programs

<table>
<thead>
<tr>
<th>Program Name</th>
<th>Test Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D8210-Visc-6hr.dvt</td>
<td>6 hours</td>
<td>For any viscosity</td>
</tr>
</tbody>
</table>
Calibrating the TESC System

Cannon Instrument Company calibrates all TESC Systems as part of the manufacturing process. However, differing ambient conditions during usage may necessitate adjusting the offset values applied to the Watlow controller and Brookfield viscometer to ensure accurate results.

Two resistance thermometers installed in the thermal core monitor the temperature of the unit. The temperatures measured by these thermometers must be adjusted with an offset value to match the actual temperature of the sample being tested. For example, a temperature at the thermal core of –40 °C may result in the sample being at –39 °C due to the ambient air temperature of the lab warming the sample.

The Watlow controller manages the temperature of the TESC base unit via an RTD probe located in the thermal core in front of the test chamber. The Watlow controller displays the adjusted temperature. For example, the Watlow controller displays a temperature of –40.0 °C, but it is known that the sample is actually at –39.0 °C (see Table 13, row 1). To correct for this deviation, slightly more than +1 °C is added to the Calibration Offset value of the Watlow controller, such as +1.1 °C (see Table 13, row 2). Because the Watlow controls the temperature of the TESC core, this adjustment results in the sample gradually cooling to –40.0 °C when the Watlow controller is programmed to –40.0 °C (see Table 13, row 3).

| Table 13: Watlow Offset Example |
|-----------------------------|----------------|----------------|----------------|
| Watlow Display | Calibration Offset | Thermal Core | Sample Temperature |
| –40.0 °C | 0 | –40.0 °C | –39.0 °C |
| –38.9 °C | +1.1 °C | –40.0 °C | –39.0 °C |
| –40.0 °C | +1.1 °C | –41.1 °C | –40.0 °C |
During testing, the Brookfield viscometer measures and records the temperature of the TESC base unit via an RTD probe located in the thermal core behind the test chamber. Adjusting the offset of the Brookfield viscometer only enables the recording of an accurate sample temperature, it does not affect the operation of the TESC System.

### Table 14: Brookfield Offset Example

<table>
<thead>
<tr>
<th>Brookfield Display</th>
<th>Offset</th>
<th>Watlow Display</th>
<th>Sample Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>–41 °C</td>
<td>0</td>
<td>–40 °C</td>
<td>–40 °C</td>
</tr>
<tr>
<td>–40 °C</td>
<td>+1 °C</td>
<td>–40 °C</td>
<td>–40 °C</td>
</tr>
</tbody>
</table>

**Watlow Controller Calibration**

The Watlow controller must be calibrated before adjusting the temperature probe offset of the Brookfield viscometer.

### Table 15: Tools and Materials Required

<table>
<thead>
<tr>
<th>Description</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assembled TESC System with mounted Brookfield DV2T viscometer</td>
<td>20 mL of an appropriate reference sample</td>
</tr>
<tr>
<td>25 mm × 150 mm rimless, disposable test tube</td>
<td>Brookfield #4B2 insulated spindle</td>
</tr>
<tr>
<td>Sample preparation materials</td>
<td>RS-485 to USB cable</td>
</tr>
<tr>
<td>USB flash drive with program files</td>
<td></td>
</tr>
</tbody>
</table>

**Install Watlow Configurator Program**

A copy of the Watlow EZ-ZONE Configurator 6.0 program is provided with the TESC software package. Load this program onto a computer with a Windows® operating system prior to calibrating or operating the TESC System.

1. To load the Watlow EZ-ZONE Configurator 6.0 program, install and run USB flash drive > Watlow Configurator Installer > EZCv6.exe.

2. Follow the instructions provided by the installation wizard. For support and additional information, visit www.watlow.com.
Install RS-485 to USB Cable Drivers
The first time that the RS-485 to USB cable is connected to a computer, the Windows OS automatically attempts to install the proper device drivers. If it does not connect properly, drivers may be installed manually.

1. To manually load the drivers, run USB flash drive > Watlow Configurator Installer > CDM v2.12.10 WHQL Certified.exe.

2. Follow the instruction prompts by the installation wizard.

Calibration Procedure
Use the following procedure to calibrate the Watlow controller.

1. Turn on DV2T and TESC. If the Watlow controller starts to run a program, press the red EZ button to halt the test. (Steps symbol on Watlow controller indicate a running program.)

2. Autozero DV2T:
   a. Remove spindle if present.
   b. Lower viscometer to measurement position.
   c. Level entire unit if necessary.
   d. Select Next on the DV2T AutoZero screen.
   e. When the DV2T indicates AutoZero complete, raise viscometer.

3. Prepare a 20 mL sample according to your laboratory practices:
   a. Insert a 25 mm × 150 mm test tube containing 20 mL (± 0.2 mL) of the reference sample into the test chamber and gently hand-tighten the cone ring/collar. Refer to Figure 13.

Figure 13: Test Chamber with Cone Ring/Collar
b. Attach a clean #4B2 spindle to the viscometer.

c. Carefully lower viscometer into measurement position, ensuring spindle is centered in sample vial.

4. Using the control buttons on the Watlow controller, set the target temperature, such as –40 °C.

   **Note:** The 2 hour DV2T calibration program waits 2 hours for the temperature of the sample to stabilize, and then it runs a viscometry test. After the 2 hour soak and initial test, only 1 hour is required between tests for small temperature adjustments to stabilize.

   Ignore the temperature recorded by the DV2T. It may not be accurate, but this will not affect the calibration of the Watlow controller.

5. Load and run the 2 hour DV2T temperature calibration program:

   a. From the DV2T Main Menu, select **Load Test > Viscosity Tests > Internal Memory > Temp Cal 2 Hour DV2T.dvt**.

   b. Click **Run**.

6. Wait for the DV2T test to complete.

   **Note:** The computer needs to be connected to the TESC System and the Watlow configuration program needs to be running only when actively changing the Watlow controller. During test runs, the computer may be disconnected from the TESC System.

7. If it is not already running, start Watlow Configurator program:

   a. Connect PC to Watlow controller using RS-485 to USB cable.

   b. Launch Watlow Configurator program: **Start Menu > EZ-ZONE Configurator > EZ-ZONE Configurator**.

   c. Select **Configure a device while communicating with it**. Click **Next**.

   d. Select the COM port to which the Watlow controller is connected. Click **Next**.

   e. Select the TESC System from the list of available EZ-ZONE Devices. Click **Next**.

   f. In the **Parameter Menus**, open **EZ-ZONE PM > Setup > Analog Input**. The **Calibration Offset** appears in the display window.

8. When the DV2T test completes, review the results by scrolling through the step results.
Note: Because the TESC System is calibrated during manufacturing, only small adjustments of ±0.1 °C are necessary to fine tune the temperature setting. If desired, the actual temperature of the sample may be determined using a viscosity calculation tool, such as VISDISK (supplied by CANNON).

\[
\text{new offset} = \text{current offset} + \left( \frac{\text{actual viscosity} - \text{tested viscosity}}{\text{Rate} \times 10} \right)
\]

Where:

Rate of viscosity response to temperature change:
- 125 mPa(s) per 0.1 °C for CL160 at –40 °C
- 120 mPa(s) per 0.1 °C for CL280 at –26 °C

9. Compare the measured viscosity at the highest torque reading to the calibrated viscosity of the sample.

- If the measured viscosity is higher than the calibrated viscosity, then the temperature of the sample is lower than the target temperature. Subtract 0.1 °C from the value shown for the Calibration Offset and enter this new value into the Watlow configurator program. Continue to step 10.

- If the measured viscosity is lower than the calibrated viscosity, then the temperature of the sample is higher than the target temperature. Add 0.1 °C to the value shown for the Calibration Offset and enter this new value into the Calibration configurator program. Continue to step 10.

- If the measured viscosity is within the tolerance range of the calibrated viscosity of the sample, the temperature of the sample is correct. Calibration is complete, go to step 13.

10. Load and run the 1 hour DV2T temperature calibration program:

   a. From the DV2T Main Menu, select Load Test > Viscosity Tests > Internal Memory > Temp Cal 1 Hour DV2T.dvt.

   b. Click Run.

11. Wait for the DV2T test to complete.

12. Repeat steps 8 through 11 as needed. Step 10.a only needs to be performed one time.

13. Record the offset value. Enter this value into each TESC temperature control program prior to running a sample.
**Warning:** Do not attempt to remove a sample from the test chamber until it has reached a safe handling temperature. Refer to your lab safety standards for more information.

Sample temperature lags behind the temperature displayed by the Watlow controller (TE cooler block temperature). Wait approximately 30 minutes after the controller reaches the target temperature before handling the sample.

14. Press the red EZ button on the Watlow controller to halt the test. Set the Watlow controller target temperature to +25.0 °C. When the sample reaches +25.0 °C, raise the viscometer and remove and clean the spindle and test tube.

**Temperature Verification Procedure (or Alternate Temperature Calibration Procedure)**

1. Turn on the TESC. If the Watlow controller starts to run a program, press the red EZ button to halt the test. (Steps symbol on Watlow controller indicate a running program.)

2. Remove spindle if present.

3. Prepare a 20 mL sample according to your laboratory practices:
   a. Insert a 25 mm × 150 mm test tube containing 20 mL (± 0.2 mL) of the reference sample into the test chamber and gently hand-tighten the cone ring.
   b. Insert the temperature probe holder into the test tube. Refer to Figure 14.
   c. Insert the temperature probe into the probe holder. Refer to Figure 15.

---

**Figure 14: Inserting Temperature Probe Holder into Collar**
d. Connect the temperature probe to the handheld meter. Refer to Figure 16.

4. Using the control buttons on the Watlow controller, set the target temperature, such as –40 °C.

5. Wait 3 hours for the sample to reach -40 °C and equilibrate.

6. Turn on the thermometer and read the displayed temperature.

7. Enter the temperature offset:
   a. If the thermometer temperature shows the sample is too cold, calculate the difference from the Watlow temperature and the thermometer, and subtract that value from the offset.
   b. If the thermometer temperature shows the sample is too warm, calculate the difference from the Watlow temperature and the thermometer and add that value to the offset.
Brookfield DV2T Temperature Probe Offset Adjustment

Use the following procedure to adjust the probe offset. The temperature probe offset is the difference between the temperature displayed by the DV2T and the temperature displayed by the Watlow controller.

**Note:** Generated reports saved or printed from the DV2T do not indicate the offset.

1. Calibrate the Watlow controller.
2. Enter the offset value in the appropriate screen on DV2T and assign an appropriate label, such as –40 C.
3. Record Instrument ID, DV2T Serial Number, Probe Offset Label, and Offset Value.
## Specifications

### Table 16: Specifications

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Thermoelectric Sample Conditioner System</td>
</tr>
<tr>
<td>Methodology</td>
<td>ASTM D2983-equivalent, ASTM D8210</td>
</tr>
<tr>
<td>Applications</td>
<td>Gear oils, automatic transmission fluids, industrial and automotive hydraulic oils, tractor fluids, lubricating oils</td>
</tr>
<tr>
<td>Dimensions (w × d × h)</td>
<td>(TESC only) 16.5 cm × 50.8 cm × 63.5 cm (6.5 in × 20 in × 25 in)</td>
</tr>
<tr>
<td></td>
<td>(with DV2T) 16.5 cm × 50.8 cm × 76.2 cm (6.5 in × 20 in × 30 in)</td>
</tr>
<tr>
<td>Weight (TESC only)</td>
<td>16.8 kg (37 lb)</td>
</tr>
<tr>
<td></td>
<td>(with DV2T) 19.5 kg (43 lb)</td>
</tr>
<tr>
<td>Operational temperature range</td>
<td>–40 °C to +90 °C (± 0.1 °C)</td>
</tr>
<tr>
<td>Sample capacity</td>
<td>1 sample, 20 mL sample required</td>
</tr>
<tr>
<td>Power requirements (max)</td>
<td>100 – 240 VAC, 50/60 Hz, 300W</td>
</tr>
<tr>
<td>Operating conditions</td>
<td>15 °C to 30 °C, 10% to 75% relative humidity (non-condensing), Installation Category II, Pollution Degree 2</td>
</tr>
</tbody>
</table>
Warranty

Products Limited Warranty
In addition to other manufacturers’ warranties, Cannon Instrument Company (“the Company”) warrants all products (other than reagents and chemicals) delivered to and retained by their original purchasers to be free from defect in material and workmanship for one year from the date of the Company’s invoice to the purchaser. For a period of one year from the date of such invoice, the Company will correct, either by repair or replacement at the Company’s sole discretion, any defect in material or workmanship (not including defects due to misuse, abuse, abnormal conditions or operation, accident or acts of God, or to service or modification of the product without prior authorization of the Company) without charge for parts and labor. The determination of whether any product has been subject to misuse or abuse will be made solely by the Company. For repairs and service of the Brookfield DV2T and associated accessories, contact Brookfield Engineering.

The Company shall not be liable for any special, incidental, or consequential damages, or any damage to plant, personnel, equipment or products, directly or indirectly resulting from the use or misuse of any product. Representations and warranties made by any person, including dealers and representatives of the Company, which are inconsistent, in conflict with, or in excess of the terms of this warranty shall not be binding upon the Company unless placed in writing and approved by an officer of the Company.

Reagent and Chemical Warranty
Cannon Instrument Company (“the Company”) warrants all reagents and chemicals sold by the Company and delivered to and retained by their original purchasers to conform to the weight, specifications and standards stated on the package. The Company will, at its sole discretion, either replace or refund the price (net of freight, handling charges and taxes), of any reagent or chemical sold by the Company which does not conform to such weight, specifications and standards upon the prompt return of the unused portion. Except for replacement or refund of the net price, the Company shall not be liable for any damages occurring as a consequence of the failure of any reagent or chemical sold by the Company to conform to the weight, specifications and standards stated on the package.


Returning a Product to CANNON

Before returning a CANNON product for repair or service, make every attempt to identify the problem. If, after careful checking, the problem remains unidentified or unsolved, telephone Cannon Instrument Company (or the local service agent) to consult with a product specialist. If the specialist cannot recommend a simple solution or repair, CANNON will authorize the return of the product through the issuance of a Return Authorization number (RA).

CANNON Telephone Number: 814-353-8000

CANNON Fax Number: 814-353-8007

Products returned to CANNON must be carefully packed. Ship prepaid to the following address:

CANNON Instrument Company
ATTN: Return Authorization # __________
2139 High Tech Road
State College, PA 16803 USA

Please include the following:

Required Information

• The Return Authorization number (RA).

• The name and telephone number of the person at your company to contact regarding the product.

• Shipping and billing instructions for the return of the product to your location.

• A detailed explanation of the reason for the return. If the product is not covered by warranty, the customer will be provided with an estimate of the repair costs and asked for approval before any repairs are made. The customer will be required to issue a purchase order for the cost of the repairs.

Hazardous Materials

Please contact CANNON before returning a product that could possibly contain hazardous material.

Shipping Notification

Products returned without CANNON’s prior authorization, will not be accepted. The customer may be billed a testing fee if a product is returned to CANNON and found to be working properly.
## Replacement Parts List

### Table 17: TESC System Replacement Parts

<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>TESC base unit</td>
<td>17.5075</td>
</tr>
<tr>
<td>Mounting collar</td>
<td>17.5113</td>
</tr>
<tr>
<td>Retaining ring</td>
<td>17.5114</td>
</tr>
<tr>
<td>Retaining screws (4)</td>
<td>01. 4022</td>
</tr>
<tr>
<td>MAINS AC power cable</td>
<td>74.2110 (US standard)</td>
</tr>
<tr>
<td>MAINS AC pass-through power cable</td>
<td>17.5135</td>
</tr>
<tr>
<td>RS-485 to USB cable</td>
<td>17.5122</td>
</tr>
<tr>
<td>Brookfield® DV2T</td>
<td>17.5126</td>
</tr>
<tr>
<td>Brookfield® #4B2 insulated spindle</td>
<td>17.5128</td>
</tr>
<tr>
<td>Brookfield® EZ-Lock spindle coupling</td>
<td>17.5129</td>
</tr>
<tr>
<td>Test cells (pkg of 12); 25 mm OD × 150 mm, rimless</td>
<td>9725-F84</td>
</tr>
<tr>
<td>TESC Operator’s Manual</td>
<td>17.5125</td>
</tr>
<tr>
<td>USB flash drive with program files</td>
<td>17.5121</td>
</tr>
</tbody>
</table>

### Table 18: Standards

<table>
<thead>
<tr>
<th>Description</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity reference standard CL160, 500 mL</td>
<td>9727-N12.016</td>
</tr>
<tr>
<td>Viscosity reference standard CL280, 500 mL</td>
<td>9727-N26.016</td>
</tr>
</tbody>
</table>