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1.0 PURPOSE

This procedure describes a method for verifying the calibration of the Genesys 20 spectrophotometer against certified traceable standards, describes other instrument performance test methods for the Genesys 20, describes the calibration frequency and method for the Spectronic Standards, and recommends maintenance activities.

2.0 FREQUENCY

- 2.1. The Genesys 20 instrument can only be internally serviced and calibrated by the manufacturer (Thermo Fisher Scientific). GEX recommends that the calibration performed by the manufacturer of the Genesys 20 be verification tested periodically to ensure that the instrument is operating within specified limits.

NOTE: GEX performs calibration verification testing every 30 days ± 15 days. The frequency may be decreased if a daily performance verification test program is used at the facility. See *GEX Doc #100-210, Genesys 20 General Practices and Information* for details.

NOTE: The test method for calibration verification is a combination of prescribed tests from the Spectronic Standards Operator's Manual and GEX experience with the instrument for its intended use.

- 2.2. The Genesys 20 spectrophotometer is calibration certified by the manufacturer. The calibration should be verified by the user before being placed in use. Do not attempt to repair or otherwise service the Genesys 20, as only the manufacturer can perform service.
- External cleaning, replacing the power cable, changing the sample holder (refer to the Genesys 20 Operator's Manual) or replacing the RS232 cable are not conditions that require calibration verification testing.
- 2.3. The Genesys 20 spectrophotometer calibration verification should be performed in the following events:
- Location change
 - After a return shipment following cleaning and/or re-certification
 - Instrument is jarred or dropped
 - Lamp replacement
- 2.4. The calibration of the Genesys 20 spectrophotometer should be verified immediately after a lamp replacement or following a lamp alignment adjustment. The manufacturer's stated lifetime for a lamp is near 1000 hours. However, replacement at approximately 800 hours is recommended to reduce the potential for lamp failure during a measurement session. Refer to the Genesys 20 Operator's Manual for the method to check the lamp usage hours and instructions for lamp replacement.

CAUTION: Use only the manufacturer's certified replacement lamps supplied by GEX or the manufacturer. Other replacement lamps are not to be used even though they may have similar technical specifications. Users have reported problems when trying to use lamps from other manufacturers.

- 2.5. A formal daily checks program to assess the performance of the Genesys 20 spectrophotometer should be established and used for each Genesys 20 (see the Note below).
- 2.6. Maintain the instrument in an area that minimizes personnel traffic with minimal particulate potential and meeting the temperature and RH conditions specified in the Genesys 20 Operator's Manual.

NOTE: GEX recommends verification of the Genesys 20's photometric accuracy before the first measurement session of each day using B3 dosimeters that have been established as "references". See GEX Doc #100-210 for detailed information.

3.0 MATERIALS

- 3.1. Genesys 20 Spectrophotometer and Operator's Manual.
- 3.2. Spectronic Standards and Calibration Certificate.
- 3.3. Genesys 20 Calibration Form [Doc#100-262] revision B or higher.
- 3.4. Irradiated B3 dosimeter (see Section 7.0 for requirements)
- 3.5. B3 dosimeter holder P4502 (WINdose) or P4506 (DoseStix)
- 3.6. Dosimeter handling tools

4.0 GENESYS 20 CALIBRATION VERIFICATION TESTING PROCEDURE

- 4.1. Open *GEX Doc# 100-262, Genesys 20 Calibration Verification Form*. Complete all of the header information. Remove the cuvette cup, close the sample compartment lid, and turn on the spectrophotometer. Allow the instrument to proceed through its internal performance checks (approximately 3 minutes). Allow the instrument the full 30 minute manufacturer's suggested warm-up period before use.

NOTE: GEX Doc# 100-262 has two tabs to perform calibration verification using either Spectronic Standards Set 1 or Spectronic Standards Set 2. Standards Set 1 has 10 standards included in the set and will follow steps 4.2.1 – 4.2.4. Standards Set 2 has 7 standards included in the set, and will follow steps 4.2.5 – 4.2.8.

- 4.2. Perform the verification testing as described below. Record the values on GEX Doc# 100-262.

4.2.1 0% Transmittance and Stray Radiant Energy Test

- 4.2.1.1 Press the 'A T C' button to change the instrument mode to Transmittance.
- 4.2.1.2 Set the wavelength to 400nm. Press the '0 Abs 100% T' button to zero the instrument.
- 4.2.1.3 Insert the 0%T standard. Close the sample compartment lid and record the value in the '%T Result' column. Remove the 0%T standard. A value of 0.0 is the acceptable result. Record 'Pass' or 'Fail' in the appropriate cell to the right.
- 4.2.1.4 Insert the 400nm SRE filter. Close the sample compartment lid and record the value in the '%T Result' column. A value of 0.45 or lower is the acceptable result. Record 'Pass' or 'Fail' in the appropriate cell to the right.
- 4.2.1.5 Change the wavelength to 340nm. Press the '0 Abs 100% T' button to zero the instrument.

- 4.2.1.6 Insert the 340nm SRE filter. Close the sample compartment lid and record the value in the '%T Result' column. A value of 0.45 or lower is the acceptable result. Record 'Pass' or 'Fail' in the appropriate cell to the right.

4.2.2 Photometric Performance and Accuracy/Linearity Test

- 4.2.2.1 There are nominal 10%T and 50%T Standards for this test.
- 4.2.2.2 From the standard's calibration certificate, enter the certified value of each standard into the cells in column B on the form.
- 4.2.2.3 Set the wavelength to 590nm. Press the '0 Abs 100% T' button to zero the instrument.
- 4.2.2.4 Insert each standard and record the value in the '%T Result' column.
- 4.2.2.5 The value should be $\pm 1.2\%T$ from the certified Standard Value in order to pass. Enter 'Pass' or 'Fail' into the appropriate cells.

4.2.3 1ST WAVELENGTH ACCURACY TEST

- 4.2.3.1 Select the Wavelength Standard (λ). From the Spectronic Standards Calibration Certificate, enter the standard's peak absorbance into the cell in column B.

NOTE: Use the Wavelength Standard that has a spectral bandwidth (SBW) that is closest to your instrument's SBW if your exact SBW is not listed (Genesys 20 has an 8nm spectral bandwidth).

- 4.2.3.2 The form will calculate $\pm 7\text{nm}$ from the standard's peak value.
- 4.2.3.3 Set the spectrophotometer to the first wavelength that the form determines. Press the '0 Abs 100% T' button to zero the instrument.
- 4.2.3.4 Insert the Wavelength Standard and close the sample compartment lid. Record the value in the '%T Result' column.
- 4.2.3.5 Set the spectrophotometer to each of the remaining wavelengths, making sure to zero the instrument before inserting the standard each time.
- 4.2.3.6 Once all wavelengths have been tested and the results recorded, enter the wavelength at which the peak %T value was found over the range into the cell in column E.
- 4.2.3.7 The value should be $\pm 3\text{nm}$ from the Standard Peak Value in order to pass. Record 'Pass' or 'Fail' into the appropriate cell on the form.

4.2.4 2ND WAVELENGTH ACCURACY TEST

- 4.2.4.1 Select the Wavelength Standard (λ). From the Spectronic Standards Calibration Certificate, enter the standard's peak absorbance into the cell in column G.

NOTE: Use the spectral bandwidth peak value that is closest to your instrument if your exact bandwidth is not listed (Genesys 20 has an 8nm spectral bandwidth). For the second test, use the next largest spectral bandwidth peak value that exceeds the Genesys 20's 552nm peak.

- 4.2.4.2 The form will calculate $\pm 7\text{nm}$ from the standard's peak value.
 - 4.2.4.3 Set the spectrophotometer to the first wavelength that the form determines. Press the '0 Abs 100% T' button to zero the instrument.
 - 4.2.4.4 Insert the Wavelength Standard and close the sample compartment lid. Record the value in the '%T Result' column.
 - 4.2.4.5 Set the spectrophotometer to each of the remaining wavelengths, making sure to zero the instrument before inserting the standard each time.
 - 4.2.4.6 Once all wavelengths have been tested and the results recorded, enter the wavelength at which the peak %T value was found over the range into the cell in column J.
 - 4.2.4.7 The value should be $\pm 3\text{nm}$ from the Standard Peak Value in order to pass. Record 'Pass' or 'Fail' into the appropriate cell on the form.
- 4.2.5 **0% Transmittance and Stray Radiant Energy Test**
- 4.2.5.1 Press the 'A T C' button to change the instrument mode to Transmittance.
 - 4.2.5.2 Set the wavelength to 400nm. Press the '0 Abs 100% T' button to zero the instrument.
 - 4.2.5.3 Turn and insert any of the filters in the set 90° so the metal side is in the beam to block it. Close the sample compartment lid and record the value in the '%T Result' column. Remove the 0%T standard. A value of 0.0 is the acceptable result. Record 'Pass' or 'Fail' in the appropriate cell to the right.
 - 4.2.5.4 Insert the 400nm SRE filter. Close the sample compartment lid and record the value in the '%T Result' column. A value of 0.45 or lower is the acceptable result. Record 'Pass' or 'Fail' in the appropriate cell to the right.
- 4.2.6 **Photometric Performance and Accuracy/Linearity Test**
- 4.2.6.1 There are nominal 3%T, 10%T, 30%T, and 50%T Standards for this test.
 - 4.2.6.2 Enter the certified value of each standard into the cells in column B of the form (from the Standards Calibration Certificate).
 - 4.2.6.3 Set the wavelength to 590nm. Press the '0 Abs 100% T' button to zero the instrument.
 - 4.2.6.4 Insert each standard and record the value in the '%T Result' column.
 - 4.2.6.5 The value should be $\pm 1.2\%T$ from the certified Standard Value in order to pass. Enter 'Pass' or 'Fail' into the appropriate cells.
- 4.2.7 **1st WAVELENGTH ACCURACY TEST**
- 4.2.7.1 Select the Wavelength Standard (λ). From the Spectronic Standards Calibration Certificate, enter the standard's peak absorbance into the cell in column B.

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- 4.2.7.2 The form will calculate $\pm 7\text{nm}$ from the standard's peak value.
 - 4.2.7.3 Set the spectrophotometer to the first wavelength that the form determines. Press the '0 Abs 100% T' button to zero the instrument.
 - 4.2.7.4 Insert the Wavelength Standard and close the sample compartment lid. Record the value in the '%T Result' column.
 - 4.2.7.5 Set the spectrophotometer to each of the remaining wavelengths, making sure to zero the instrument before inserting the standard each time.
 - 4.2.7.6 Once all wavelengths have been tested and the results recorded, enter the wavelength at which the peak %T value was found over the range into the cell in column E.
 - 4.2.7.7 The value should be $\pm 3\text{nm}$ from the Standard Peak Value in order to pass. Record 'Pass' or 'Fail' into the appropriate cell on the form.
- 4.2.8 **2ND WAVELENGTH ACCURACY TEST**
- 4.2.8.1 Select the Wavelength Standard. From the Spectronic Standards Calibration Certificate, enter the standard's peak absorbance into the cell in column G.
 - 4.2.8.2 The form will calculate $\pm 7\text{nm}$ from the standard's peak value.
 - 4.2.8.3 Set the spectrophotometer to the first wavelength that the form determines. Press the '0 Abs 100% T' button to zero the instrument.
 - 4.2.8.4 Insert the Wavelength Standard and close the sample compartment lid. Record the value in the '%T Result' column.
 - 4.2.8.5 Set the spectrophotometer to each of the remaining wavelengths, making sure to zero the instrument before inserting the standard each time.
 - 4.2.8.6 Once all wavelengths have been tested and the results recorded, enter the wavelength at which the peak %T value was found over the range into the cell in column J.
 - 4.2.8.7 The value should be $\pm 3\text{nm}$ from the Standard Peak Value in order to pass. Record 'Pass' or 'Fail' into the appropriate cell on the form.

5.0 B3 FILM ABSORBANCE PEAK VERIFICATION TEST PROCEDURE

The Genesys 20 instruments used to measure B3 film dosimeters are set at a fixed wavelength established for B3 film during the batch calibration, and it is essential that the instrument performance be routinely monitored and/or verified frequently. Therefore, GEX recommends performance of a B3 film peak absorbance test using a single B3 dosimeter covering a measurement range from 545nm through 559nm in 1nm increments to verify that the instrument is able to measure the peak value for B3 film at 552nm $\pm 2\text{nm}$. This wavelength verification test is in addition to the Thermo Spectronic manufacturer recommended wavelength accuracy test, and should be performed during the calibration verification of the instrument at the same test frequency.

- 5.1. Set the instrument to 545nm in the Absorbance mode.
- 5.2. Use a single dosimeter with an absorbance of .250A or greater. Record the dosimeter ID into the cell in column J.

- 5.3. Insert the dosimeter into the dosimeter holder and measure the dosimeter. Record the value on *GEX Doc# 100-262, Genesys 20 Calibration Verification Form*, in the 'Absorbance Result' column.
- 5.4. Repeat the test at each wavelength from 545nm to 559nm; removing the dosimeter and zeroing the instrument each time.
- 5.5. Review the results and enter the wavelength at which the maximum value was obtained into the appropriate cell. The wavelength at which the maximum value is found should be 552nm \pm 2nm. There should be a gradual rise and fall of the absorbance values on either side of the peak. If the test has strange results or generates questions, contact GEX Customer Service immediately.

6.0 SPECTRONIC STANDARDS CALIBRATION PROCEDURE

- 6.1. The Spectronic Standards should be returned to the manufacturer for calibration approximately every two years (\pm 30 days) to confirm that the standards have not changed.
 - 6.1.1 Contact GEX Customer Service by phone or email to order GEX Part# S4320 (re-calibration for Spectronic Standards, or contact the manufacturer directly.
- 6.2. The Spectronic Standards shall be returned to the manufacturer for recalibration immediately after damage or suspected damage. Repair may not be possible.
- 6.3. Schedule the calibration with the manufacturer approximately one month in advance to allow adequate turnaround time. A second set of standards may be useful.
- 6.4. Do not touch the surface of the glass in the standards. Fingerprints and scratches will affect the measured absorbance. If contamination or damage to the glass should occur, return the standards set for recalibration.
- 6.5. Always store the standards in their case when not in use. Always keep the cover closed and latched. Never expose the standards to airborne contaminants like smoke, dust, oil vapor, or chemical fumes.
- 6.6. Remove any dust or lint only as described in the Operator's Manual. When properly handled, the filters should not require cleaning until they are due for recalibration. The recalibration process includes cleaning of the individual pieces of glass as part of the service.
- 6.7. Keep the standards at a consistent temperature and relative humidity to ensure consistent measurements. Environmental fluctuations can affect results.

7.0 OPTICAL ALIGNMENT USING A P4502 HINGED DOSIMETER HOLDER

The alignment of the light beam through the sample chamber is important when using the Genesys 20 to measure B3 WINdose dosimeters. The optical alignment can be optimized by manipulating the light source.

- 7.1 Set the instrument to 552nm in the Absorbance mode. Press the '0 Abs 100% T' button to zero the instrument.
- 7.2 Insert the P4502 Hinged Dosimeter Holder and close the sample compartment lid. Observe the value on the instrument display. This value represents the amount of light which is being blocked by the dosimeter holder. The goal is to have the lowest possible value. A value of .300A or lower is acceptable; however, follow the steps below to optimize the optical alignment.
 - 7.2.1 Remove the door of the lamp compartment on the side of the instrument.

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- 7.2.2 Using a forceps or other tool, gently move the tip of the lamp in relation to the entrance slit. By monitoring the instrument display, move the tip of the lamp up or down or side to side (to and away from the entrance slit) until the minimum value obtainable is achieved on the instrument's display.

8.0 GENESYS 20 MAINTENANCE

- 8.1. The cuvette cup and dosimeter holders (P4502 & P4506) can accumulate particulate over time. The cuvette cup and P4502 holder should be 'air washed' with compressed air on a monthly basis. The P4506 holder can be removed from the cuvette cup assembly and opened using an appropriate Allen wrench (hex head wrench) and cleaned using isopropyl alcohol and/or compressed air.
- 8.2. Lamp replacement. See the Genesys 20 Spectrophotometer Operator's Manual for details on lamp replacement.

9.0 ASSOCIATED DOCUMENTS

- *Doc# 100-210, Genesys 20 General Practices and Information*
- *Genesys 20 Operator's Manual*
- *Spectronic Standards Operator's Manual*

10.0 ASSOCIATED RECORDS

- *Doc# 100-262, Genesys 20 Calibration Verification Form*

11.0 REVISION CONTROL HISTORY

DATE	CHANGE DESCRIPTION	REVISION
10/20/15	Revised to clarify spectral bandwidth selection per ECO #70207.	F

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