GEX CORPORATION
THE DOSIMETRY COMPANY

TECHNICAL MEMORANDUM

NOTICE: This document is version controlled and was produced as a part of the GEX Information Program which requires that all Series 100 documents be reviewed periodically to maintain currency and continuity of information. Appropriate Technical Memorandum are used to provide detailed information in support of the Product Data Sheets as well as GEX Recommended Procedures and to provide technical information in support of GEX Marketing documents.

REVISION HISTORY: Feb. 3, 2015 *Included 3% and 30% neutral density filter references for Spectronic Standards 2. Updated references of 'Thermo Spectronic' to 'Thermo Fisher Scientific' and revised wavelength accuracy to ±3nm as the acceptance criteria per ECO# 70207. Reorganized document and removed redundant information.*

GENESYS 20 – GENERAL PRACTICES AND INFORMATION

Release Date: February 3, 2015

The spectrophotometer serves as the centerpiece of the B3 WINdose Dosimetry System and this document summarizes important recommendations for optimum performance of the Genesys 20 spectrophotometer with B3 film dosimeters. A Technical Appendix is included describing key functionality with recommended methods for evaluating and monitoring the performance stability of the Genesys 20 over time.

INSTALLATION OF THE GENESYS 20

Locate the Genesys 20 spectrophotometer(s) in an access controlled environment with stable temperatures maintained between 15-30°C. Use an Un-Interrupted Power Supply (UPS) with sufficient protection for line current protection to avoid current spikes and drop-outs.

GENESYS 20 CALIBRATION AND MAINTENANCE PROGRAM

See GEX Doc# 100-254, Genesys 20 Calibration and Maintenance, which provides proceduralized instructions on how to perform instrument calibration verification using the Spectronic Standards Set or equivalent. The verification should test at a minimum:

a. Test the photometric performance using neutral density filters.
b. Verify the wavelength accuracy
c. Test to ensure that stray light is not affecting the instrument.
d. Verify the peak absorbance of the B3 dosimeter

CAUTIONS

1) The Genesys 20 cannot be field calibrated. The Genesys 20 should be returned to Thermo Fisher Scientific for service and/or cleaning with calibration re-certification. The use of another vendor may void the warranty. Please check with GEX or Thermo Fisher Scientific before doing so.
2) Never attempt to open the Genesys 20 outer cover or attempt to perform any form of service of the instrument. Outside calibration service companies should not attempt to re-calibrate and certify the Genesys 20.
3) Never use the Genesys 20 above the 2.5 Absorbance Units maximum value. The display of the instrument will blink indicating an over range value.

GENESYS 20 ERRORS:

The Genesys 20 responds to internally detected malfunctions by audible and visual signal. The audio signal consists of single or multiple beeps and the visual signal consists of the Error Message displayed on the two line LCD display. Some error messages do not remain permanently on the screen. It is

important for an operator to properly interpret error codes per their definitions as listed in the instrument manual.

OTHER ATYPICAL MALFUNCTIONS

- WINdose holder not properly seated in the cuvette cup; absorbance value displayed will be unstable.
- Power supply electronics failing. Instrument shuts down unexpectedly. After restart, instrument should perform normally unless there is an actual internal failure condition.
- Instrument does not enter the sequence of initial tests upon powering up; the display reports software version on the display and audio alarm beeps persistently. This is the indication of major failure on the main circuit board.
- Light bulb filament not properly positioned in front of the entrance slit (optical alignment). See procedure 100-254 cited previously for detail.

If the instrument fails to perform within specification or displays a malfunction condition that cannot be cleared by a simple re-start process, contact GEX to discuss appropriate actions.

The most common failure reported for Genesys 20s is related to stray light alarms. This is often an indication that the instrument has accumulated particulate that is interfering with its operation and that the unit should be returned to the factory for cleaning and recertification by Thermo Fisher Scientific.

USING B3 DOSIMETERS AS REFERENCES FOR DAILY PERFORMANCE TESTING

It is important to have verification that the Genesys 20 spectrophotometers used to measure B3 dosimeters produce constant and accurate results over the life of a B3 batch calibration. A major advantage of using B3 radiochromic film is its post-irradiation stability after heat treatment.

GEX has demonstrated a simple means of monitoring the performance level of the Genesys 20 spectrophotometer on a daily basis using B3 dosimeters as references. This approach uses actual B3 dosimeter replicates to verify that the instrumentation is able to return the same B3 response values that it did at the time of the batch calibration. A baseline is established for each Genesys 20 instrument to establish the acceptance limits for the daily checks test of the spectrophotometers and allows the application of trend analysis to detect even a small change over time.

These same B3 dosimeter references can also be used to validate new replacement Genesys 20 instruments or to re-validate a returning Genesys 20 that has been sent to the manufacturer for cleaning and recertification.

IMPLENTING AND USING A DAILY CHECKS PROGRAM

1. On a daily basis, power down and then restart the Genesys 20 so the “self-test” functions embedded in the Genesys 20 can execute its internal instrument functionality testing routine.

   CAUTION: Failure to turn the Genesys 20 on and off daily creates a risk that a key function could fail and not be detected until the next instrument start-up cycle.

2. Remove the entire cuvette cup assembly and close the cover (lid) to the measurement compartment during the “re-start” or initial start-up and warm up period.

   CAUTION: Never leave the B3 WINdose dosimeter holder in the sample compartment during the start-up cycle. The WINdose holder will cut off a portion of the light beam from reaching the detector which may lead to significant instrument drift and the need to re-zero often until the Genesys 20 is re-started with the holder removed.

3. Once the Genesys 20 has completed all internal tests (takes approximately 3 minutes to complete) during its start-up cycle, verify that there were no error messages.

4. Allow the full 30 minutes (or more) of manufacturer recommended warm up time before use.

5. Use the Genesys 20 'Utilities' menu to check and record the number of hours on the Tungsten Halogen lamp since last replacement as a part of a daily, weekly or monthly preventative maintenance plan. Proactively replace the Tungsten Halogen lamp every 800 hours of total elapsed operating time. While the lamps are rated for 1000 hours, it is not recommended to wait for failure but rather to avoid lamp failure.

   CAUTION: Use powder-free gloves or lint-free tissue while handling the replacement lamps making sure to insert the lamp so the filament is positioned directly in front of the entrance slit. Use only Genesys 20 replacement lamps sourced by Thermo Fisher Scientific and supplied by GEX. Avoid lamp substitutes from any other source as the unit was designed specifically for this specific lamp and its exact specifications.

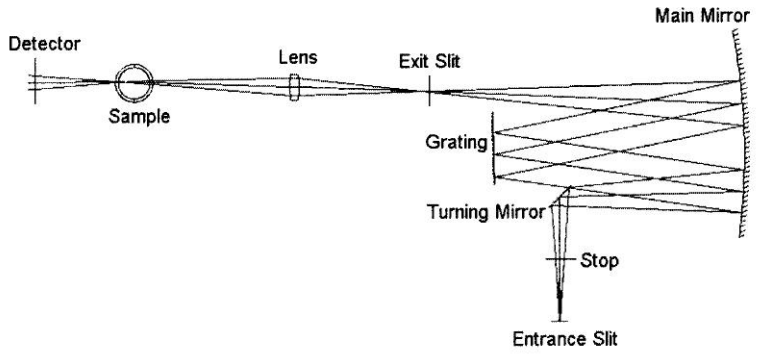
6. Establish and use a performance baseline test for each Genesys 20 being used. Predictable performance of a dosimetry system depends on assurance that the instruments used for the dose measurements are stable and perform within their specified limits.

   IMPORTANT: The user can perform daily performance verification of the photometric scale and wavelength accuracy by using B3 films that have been established as references. Refer to the section "Long term monitoring of the photometric scale using B3 film references and neutral density filters" in the Technical Information Appendix for detail.

TECHNICAL INFORMATION APPENDIX

1. General instrument design philosophy.

- Optical component design of Genesys 20
  The Genesys 20 spectrophotometer is classified in optical terms as a single beam and single mirror, Czerny-Turner type monochromator unit. The monochromator uses a 1200 line/mm reflective grating as a wavelength dispersing element.
  The monochromator has fixed slit width optics and a fixed value of Spectral Band Width specified as not greater then 8nm. The entire optical system excluding the light source and the detector is sealed in a single compartment. The optical system is not end user or field serviceable. The simplified schematic diagram of the system layout is shown in the figure below.



Lamp:	The Tungsten-Halogen lamp provides continuous energy output. There is no illumination optics between the lamp and the entrance slit. Instead, the lamp is mounted very close to the entrance slit.
Stop:	An optical stop reduces the amount of stray light in the instrument.
Turning Mirror:	The turning mirror directs the diverging beam to the main mirror.
Main Mirror:	The main mirror converts the diverging beam to parallel light and directs it to the grating.
Grating:	The planar grating, whose orientation is controlled by a micro-stepping motor, sends a horizontally dispersed spectrum of collimated light back to the main mirror.
Main Mirror:	The beam hits the main mirror a second time and is focused onto the exit slit.

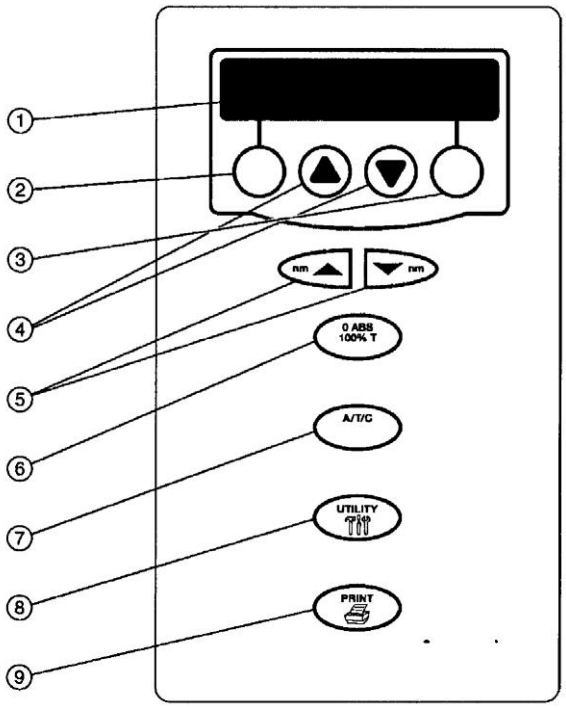
General instrument design philosophy (CONTINUED).

- **Detector component design of Genesys 20**
  The light detector of the Genesys 20 spectrophotometer is a solid state photodiode array located in the front section of the instrument immediately following the sample compartment. The mounting plane of the detector is angled with respect to the incoming light beam in order to minimize back reflections into the sample compartment.

- **VIS part of the spectrum as the wavelength operating range of Genesys 20.**
  The Genesys 20 spectrophotometer is designed to operate only in the visible (VIS) part of electromagnetic spectrum specified by the manufacturer in the range from 320nm to 1100nm. This instrument specification is wider then commonly used boundaries for the visible spectrum portion typically defined in the range from about 340 nm to 800 nm. The optical subcomponents of the instrument are not designed, nor are they specified to operate in the ultra violet (UV) or the infra red (IR) part of the spectrum. It appears that the wider than typical wavelength specification refers to the spectral output of the light source (tungsten – halogen type) and spectral sensitivity of the solid state detector employed in the design of Genesys 20.

- **Photometric scale of Genesys 20 appropriate for B3 dose range**
  The instrument specification for its photometric range is said to extend from 0% to 125% on the Transmittance scale or equivalently from -0.1 to 2.5 on the Absorbance scale. This range is very well matched with the dynamic range in which the B3 film dosimeter is designed to perform (i.e. < 1.0 kGy to >100 kGy). The absorbed dose levels at which the colored dye development in B3 dosimeters show slow but progressive saturation effects are well below the maximum measurable Absorbance and without effects of stray light interference on the measured value. The B3 saturation absorbance due to radiation exposure occurs at approximately 1.6 Absorbance Units. It is worth noting that at an absorbance value of 2.5 the initial light beam has been attenuated to about 0.3% of its initial intensity.

- **Embedded Genesys 20 programmed operating and performance verification functions**
  The Genesys 20 instrument uses embedded programming during start-up to provide instrument diagnostics, performance, and functionality verification. It takes approximately 3 minutes for the Genesys 20 to complete the self-diagnostics each time the unit is re-started. The results of these internal self-tests are reported to the operator on an LCD display. This display is limited to two lines. The operator can use several buttons on the control pad to execute all user accessible functions and options of the instrument (see figure on following page).



1. Display - 20-character, 2-line LCD
2. Soft key 1 - Function varies depending on screen; generally Escape, Back Up, or Clear
3. Soft key 2 - Function varies depending on screen; generally Enter, Accept, or Continue
4. Scroll keys - Used to scroll through menus and enter numeric values
5. Wavelength controls - Increase and decrease the wavelength settings
6. 0 Abs/100%T - Automatically sets the instrument to zero absorbance (100%T)
7. A/T/C - Switches between absorbance, %transmittance, and concentration modes
8. Utility - Accesses instrument set-up, diagnostics, and other functions
9. Print - Sends currently displayed data to selected printer

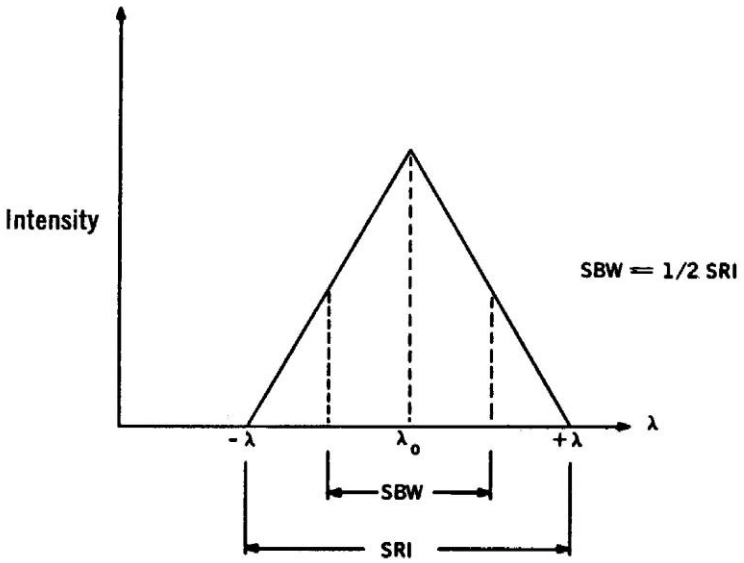
- **Wavelength calibrating and wavelength access look up tables (instrument specific).**
  The access to any desired wavelength on the Genesys 20 wavelength scale is accomplished by the micro stepper motor driving the angular orientation of the diffraction grating (wavelength dispersing element) by the number of steps called upon from the micro stepper look up table. The use of the stepper motor provides accurate and repetitive access to any wavelength on the wavelength scale. In addition to the instrument specific micro stepper motor look up table, the Genesys 20 is also pre-loaded with the instrument specific wavelength calibration look up table. Both tables reside in the EPROM (Erasable Programmable Read Only Memory) on the main controller board. In very seldom instances, numerical data in either table may get lost from EPROM chip. In such a situation, the Genesys 20 defaults to the embedded Default Wavelength Calibration Table. The default table is considered fairly accurate but it may not be accurate enough to comply with the wavelength accuracy specification for Genesys 20 stated at ±2nm over the entire range of wavelengths.

  In addition to the look up table, the other anchoring point of the wavelength scale is the null position of the diffraction grating. The null position defines the “zeroth order” intensity peak while the diffraction grating is positioned perpendicular to the light beam and optically acting as a mirror. The null position is verified every time during the Genesys 20 start up and is reported as “Monochromator Init” on the Genesys 20 LCD display.

2. Critical instrument specifications and their significance in thin film application.

- **Slit width**
  The slit width is the physical width of the monochromator exit slit opening in millimeters. It is the exit slit of the monochromator that defines the band of wavelengths directed at the sample. The Genesys 20 spectrophotometer uses an optical system having a fixed width of the exit slit. The exit slit width of the monochromator according to the manufacturer is fixed at 1.0mm.

- **Spectral Band Width (SBW) of the instrument (or spectral bandpass of the instrument)**
  The light directed at the sample is not strictly monochromatic. It contains added wavelengths (colors) present on both sides of the nominally selected wavelength and the band is defined by the slit width. This band is referred to as Spectral Region Isolated (SRI) and a fraction of its span is occupied by the Spectral Band Width (SBW). In an idealized description, the radiant intensities of side wavelengths would decrease linearly to an arbitrary level of 0.1% of the maximum intensity. The radiant intensity transfer function would then have the shape of an isosceles triangle.

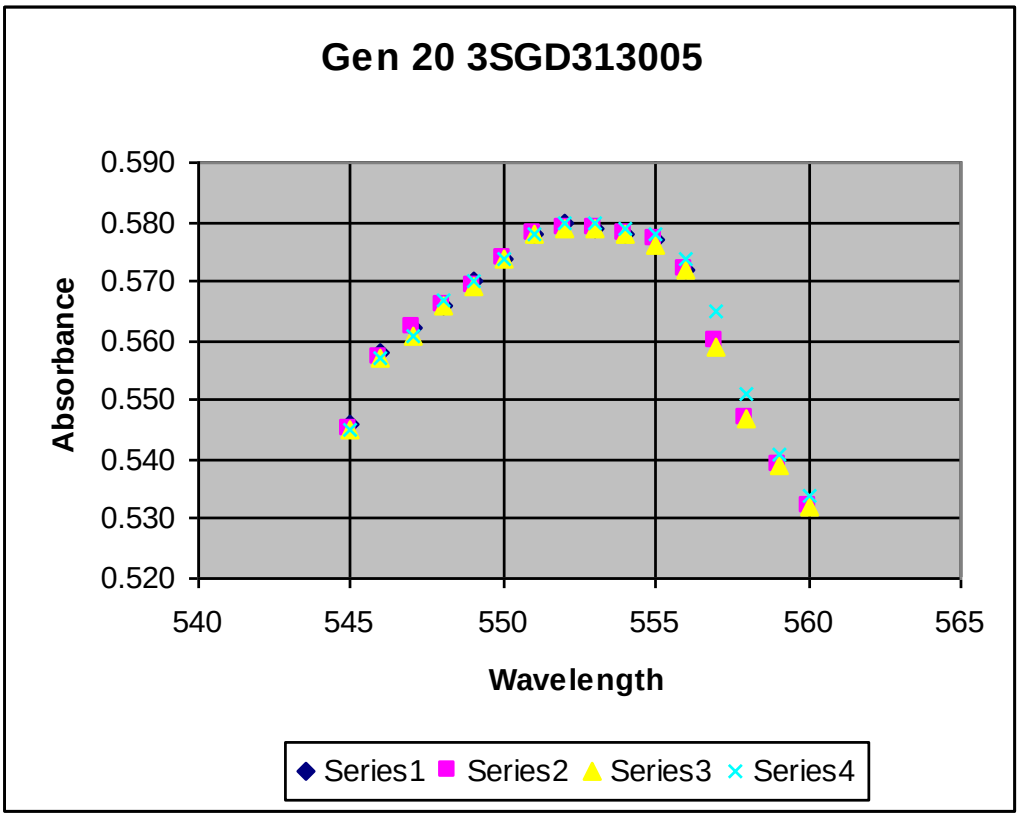


Intensity Distribution of Energy Emerging from Exit Slit as a Function of Wavelength

The Spectral Region Isolated (SRI) can be well approximated by an isosceles triangle with the Full Width at Half Maximum (FWHM) of its height defining the Spectral Band Width (SBW) and it is expressed in nanometers. In terms of radiant energy emerging from the slit, the portion occupied by the SBW contains ¾ or 75% of all the radiant energy and in terms of range of wavelengths it is ½ or 50% as wide as the Spectral Region Isolated. The parameter of high importance (without getting into precise definition of this quantity) in the description of the optical system discussed here is the dispersion function **D** and its reciprocal $\mathbf{D^{-1}}$. The product of slit width in millimeters by the reciprocal of dispersion $\mathbf{D^{-1}}$ gives the numerical value of Spectral Band Width (SBW).

- **Wavelength accuracy.**
  The Genesys 20 instrument can access a specifically selected wavelength between 320nm and 1100 nm with a manufacturer specified wavelength accuracy of ±2nm over the entire range.

- **Wavelength reproducibility specification**
  The wavelength reproducibility specification assures that the repetitive process of access to the same wavelength is always no worse than 0.5nm between repetitions.



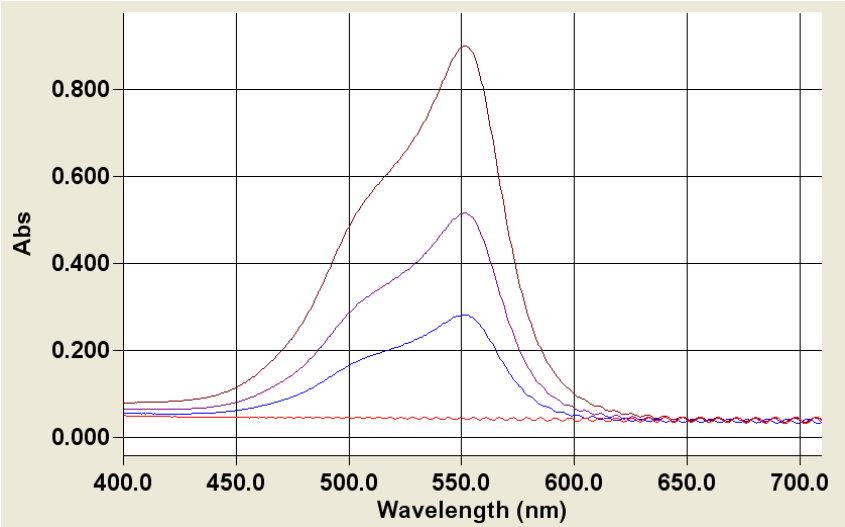
Reproducibility plot of 4 separate measurement sets of the same B3 dosimeter over 2 days.

- **Stray light influence**
  Any radiant energy reaching the detector that originates outside of the SBW of energies available from the slit of the monochromator is considered spurious and contaminating. The presence of stray radiant energy artificially creates a departure from linearity according to Beer-Lambert's law and depresses the high absorbance end (low transmittance end) of the photometric scale of the instrument. Stray light error messages reported by the Genesys 20 following its initial internal checks performed during start-up of the instrument may be an indication that the unit needs to be returned to the factory for cleaning and recertification.

3. Application specific performance aspects.

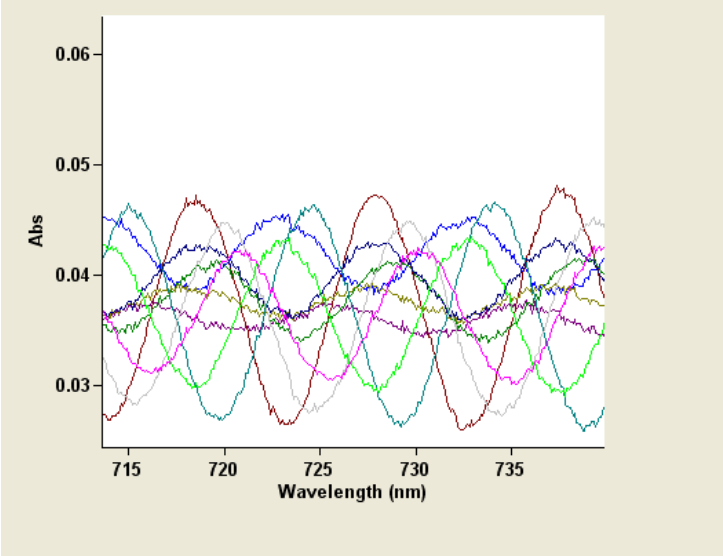
- **The wide 8nm bandpass of Genesys 20 is highly beneficial in the context of avoiding optical interference fringes.**
  In order for the instrument to properly resolve separate but closely adjacent absorbance peaks (or inversely, not to detect the presence of interference fringes), the SBW of a monochromator must be only a fraction of the natural spectral width of the peak (or inversely comparable to or greater then the FWHM of an interference fringe).

  Either of these conditions is met by the Genesys 20 with the SBW specified to be not greater then 8nm while the observed bandwidth of irradiated B3 absorbance peak is about 9nm. (The full spectrum in the illustration below has been acquired using the Cary 300 scanning spectrophotometer).



The chart above shows wavelength scans of low medium and high dose B3 DoseStix dosimeters performed using a Varian Cary 300 spectrophotometer to show the constancy of the central B3 peak found over the 550-555 nm range.

Interference fringes (oscillations) in the thin film are easily detectable by the Cary 300 spectrophotometer at the longer wavelengths to the right of the main absorbance peak. The Genesys 20 spectrophotometer is however totally immune to detection of the oscillations having the SBW comparable or greater then the FWHM of the oscillation.



The chart above shows multiple interference fringes in B3 films at a 3.0nm SBW setting used on the Cary 300. Each trace is a scan of a separate B3 film. The image captures the details of differences in amplitude and the out of phase condition between different B3 film samples. The Genesys 20 instrument on the other hand does not see these fringes because of its 8 nm SBW which is the

equivalent of averaging the Cary 300 absorbance data over an 8 nm range that eliminates optical fringe interference.

- **Selection of the wavelength of the measurement**.
  In typical dosimetric applications using thin radiochromic films, the Genesys 20 spectrophotometer is used most of the time at the "center" wavelength of absorbance peak. GEX has identified a broad stable peak that reproducibly occurs over full dose range of B3 in a region from 550nm to 554nm. Therefore, GEX Corporation continues to approve use of the historically accepted 554nm wavelength but recommends 552nm for absorbance measurement of B3 film. A user may determine the peak wavelength of B3 dosimeters using their Genesys 20 instruments by performing the single nm incremental scan over the range from 545nm-559nm.

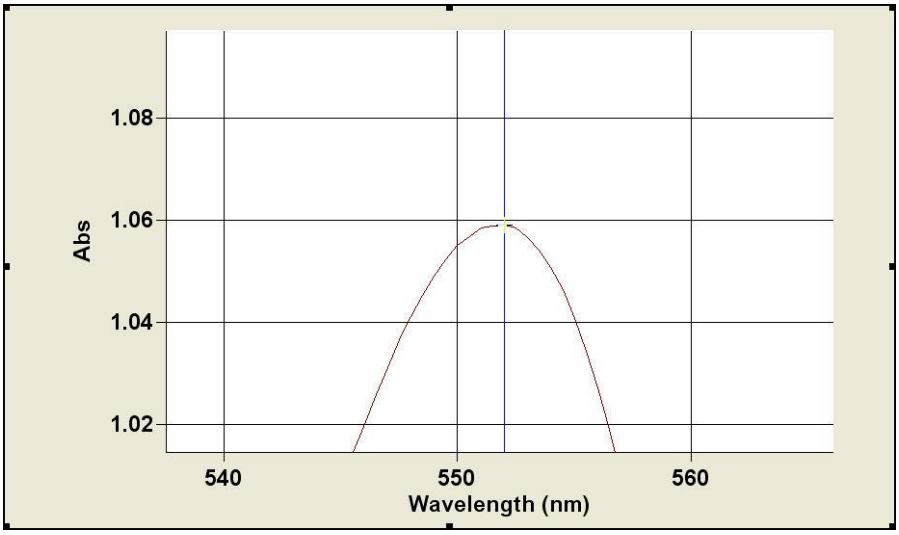


Image of the peak of a high dose (120 kGy) B3 film dosimeter. The vertical line intercepting the peak is positioned at 552.0nm. The scan was acquired using the Cary 300 spectrophotometer.

- **Small aperture B3 WINdose dosimeter holder**.
  In the WINdose dosimeter the B3 film occupies only the circular section of the paper overlay. The design of the B3 WINdose dosimeter holder (GEX part # P4502) employs both a conical shaped aperture and then the annular shaped aperture. The diameter of the annular section of the aperture reduces the dimensions of the beam spot as it proceeds through the holder. The resultant geometry is such that the size of the beam spot intercepted by the B3 film present in the holder is always smaller than the diameter of the film area. The probability of the light beam striking the paper overlay of a dosimeter is greatly reduced by this design. However, this geometry reduces the light energy flux reaching the detector and necessitates down-rating of the long term stability of the instrument from the value stated in the manufacturer's specifications. The manufacturer specification of drift being less than 0.003 Absorbance Units / hour is therefore down rated to instrument drift being less or equal than 0.001 Absorbance Units for at least half of one hour.

- **Drift in displayed absorbance caused by the start -up process with the restrictive aperture of the P4502 holder.**

  CAUTION: During instrument start up, always verify that the Genesys 20 sample compartment does not have a dosimeter holder or anything else than could interfere with the light beam path in any way. For example, leaving a P4502 WINdose dosimeter holder in the sample compartment cuvette holder of a Genesys 20 during instrument start-up will result in considerable and unwanted instrument drift during measurement use after warm-up. The dosimeter holder designed for the WINdose dosimeters has a restrictive aperture that reduces a portion light beam that would have reached the detector if the holder was not present. This loss of light striking the detector was not considered or expected during the design of the Genesys 20 and must be avoided to obtain optimum performance of the instrument.

- **Periodic instrument restarts for POST (Power-On Self Tests).**
  The control and supervision of the internal workings of the Genesys 20 is vested with embedded programmed sequences of the main controller. In order for these sequences to be executed, the controller must be initialized which occurs when the Genesys 20 is restarted or turned on initially. The consequence of this approach is the need for the user to initiate periodic restarts of the Genesys 20. A Genesys 20 re-start permits the instrument to undergo a full Power-On Self Test (POST) and execute all internally built-in microprocessor actions. The failure of a sub-component of the Genesys 20 is readily detected by simply restarting the Genesys 20 at a minimum of once over every 24 hour period of use.

- **Lamp replacement and alignment.**

  CAUTION: Always use Thermo or GEX supplied lamp replacements.

  The Tungsten – Halogen lamp used in the Genesys 20 spectrophotometer has manufacturer recommended replacement period of 1000 hours. It is our recommendation that the lamp is replaced at the period of not more than 800 hours. Proactive replacement of the lamp eliminates possible darkening of the glass envelope toward the end of the life time or having possible instability (flickering) in the filament and reduction in luminous energy output. We have no recorded observations pertinent to these events but is recommended as a potentially highly valuable preventative measure. The detailed lamp replacement procedure is included in the Genesys 20 manual.

  In addition to recommendations outlined in the procedure, there is an additional recommendation that can optimize positioning of replacement lamp:

  While inserting replacement tungsten-halogen lamp bulb, attention should be paid to position the lamp filament directly in front of the entrance slit. The pins on the light bulb are relatively long and permit insertion the bulb either not far enough into the bulb socket or just past the optimum location in front of the entrance slit. See GEX Doc# 100-254 for detail.

- **Long term monitoring of the photometric scale using B3 film references and neutral density filters.**

  As outlined in the main document section, GEX recommends use of a simple daily instrument check program to monitor and verify stability of the photometric scale of the Genesys 20 spectrophotometer. The following is a suggested method for implementing such a program.

Accumulated data regarding long term stability of post irradiation heat treated B3 dosimeters indicates that B3 dosimeters are completely stable over the period of many months with a measured change in absorbance being typically less than 1.0% in a year. This unique stability quality of post irradiation heat treated B3 dosimeters makes them ideal for use as reference controls.

While any post irradiation B3 dosimeter can be established and used as a reference, B3 replicates from dose sets used in a batch calibration provide a simple and direct means of traceability back to the calibration itself. Selected B3 dosimeters are established as references by simply measuring and recording their absorbances 32 consecutive times for each at the established B3 measurement wavelength on each instrument. The average of these 32 measurements serves as the baseline data for each B3 reference dosimeter for use as a daily check of the photometric response prior to performing dosimetry measurements.

The use of a simple daily check of the Genesys 20 instrument using established B3 dosimeter references provides verification the instrument is performing correctly. This simple test also provides ongoing data that can be recorded and used to identify a performance trend. Although GEX uses low medium and high dose B3 references, use of a single B3 reference at a middle dose range is considered sufficient following a daily instrument restart to verify the photometric scale performance of the Genesys 20.

Our experience at GEX in using these internal B3 dosimeters as references in daily monitoring instrument checks revealed a slight growth in the B3 references over time that is on the order of approximately one percent per year. This gradual signal growth is shown to be consistent for the low, medium and high dose references. We have also shown that a typical reference dosimeter sample can be expected to have a six month or more useful life when used on a daily basis if proper measurement handling and storage care is used. When handling and caring for these B3 dosimeter references, please keep in mind that these dosimeters are designed and manufactured as a single use item.

Dosimeter replicates retained from the initial B3 dosimeter batch calibration dose point sets provide an excellent source of dosimeter sets for use as internal instrument references.
In addition to the use of highly stable B3 dosimeters as references, GEX recommends including use of the 10% Transmittance and/or 50% Transmittance neutral density filters from the Spectronic Standard Set for monitoring the photometric scale stability of the Genesys 20 instruments during a batch calibration life cycle.

NOTE: For users of the Spectronic Standard Set 2, GEX recommends also including the use of the 3% Transmittance and/or 30% Transmittance neutral density filters for monitoring the photometric scale stability of the Genesys 20 instruments during a batch calibration life cycle. This approach provides two to four independent reference sources to help verify a change in the photometric scale performance reproducibility of the Genesys 20, with the B3 reference also confirming the wavelength accuracy reproducibility of the Genesys 20 on a daily basis.

NOTE: A number of users have reported that simply using the baseline of a single B3 dosimeter with acceptance at ±0.05% is sufficiently effective for daily checks testing.

An example of a daily checks worksheet is found on the following page which contains results for a single month. GEX experience with the use of B3 references indicates that one should expect to be able to maintain absorbance CVs at 0.4% for the low dose, 0.2% for the middle dose and 0.15% for the high dose B3 references (reduced instrument noise influence at higher dose). The example worksheet also shows the ability to maintain multiple Genesys 20

instrument within limits of 1.0% or better that provides verification of their interchangeability or the ability to combine calibration data sets for use in single combined B3 batch calibrations.

Daily Instrument Checks Example

Title:	Daily checks of spectrophotometer performance
Purpose:	Verify expected performance of spectrophotometer stability and reproducibility using Standard's Set photometric filters and DoseStix references at three dose levels
SOP in Use:	None
Instructions:	
1	Start all instruments subjected to test from "cold" start and at the same time
2	Allow for the warm-up period as specified by separate procedure
3	At 552nm record transmittance of 10% and 50% filters on Genesys 20
4	Enter into the data table
5	Repeat on any other Genesys 20 involved in test
6	Go to absorbance mode changing cup holder to accommodate DoseStix films
7	At 552nm record absorbance of LOW MID HI dosimeters on all Genesys 20s
8	Repeat #7 with Cary 300 at 552nm, 4nm SBW, 0.5 sec averaging time.
Conditions of the Test:	
Date	Daily
Operator	Marian Strzelczyk
Instrument	Two Genesys 20
Dosimeter Type	Single DoseStix at three dose levels
Wavelength	552 nm
SN	3SGD313005 and 3SG347012
Last calibration	7/31/2006
Calibration due date	8/30/2006

Mean	1.007	1.007	0.297	0.296	0.116	0.117	0.330	0.330	0.553	0.554
St Dev	0.0004	0.0004	0.0003	0.0005	0.0004	0.0004	0.0005	0.0006	0.0009	0.0008
CV	0.04%	0.04%	0.10%	0.17%	0.33%	0.31%	0.15%	0.18%	0.16%	0.14%
	10% standard	10% T standard	50% standard	50% T standard	Gen20 #1 low	Gen20 #2 low	Gen20 #1 mid	Gen20 #2 mid	Gen20 #1 high	Gen20 #2 high
Aug-06	3SGD313005	3SG347012	3SGD313005	3SG347012	8229122B	8229122B	8228929A	8228929A	8347153B	8347153B
1-Aug	1.006	1.006	0.297	0.297	0.116	0.116	0.330	0.331	0.553	0.554
2-Aug	1.007	1.007	0.297	0.297	0.116	0.117	0.331	0.331	0.553	0.554
3-Aug	1.007	1.007	0.297	0.297	0.116	0.117	0.331	0.331	0.554	0.555
4-Aug	1.006	1.007	0.297	0.297	0.116	0.117	0.330	0.331	0.554	0.555
7-Aug	1.007	1.006	0.297	0.297	0.116	0.118	0.330	0.329	0.555	0.552
8-Aug	1.007	1.007	0.297	0.297	0.117	0.118	0.330	0.330	0.553	0.554
9-Aug	1.007	1.007	0.297	0.297	0.116	0.117	0.330	0.331	0.553	0.553
10-Aug	1.007	1.006	0.297	0.296	0.116	0.117	0.331	0.331	0.553	0.554
11-Aug	1.007	1.007	0.297	0.297	0.116	0.117	0.330	0.330	0.552	0.554
14-Aug	1.007	1.007	0.297	0.297	0.117	0.117	0.330	0.331	0.554	0.554
15-Aug	1.006	1.007	0.297	0.296	0.116	0.117	0.330	0.331	0.554	0.554
16-Aug	1.007	1.006	0.297	0.296	0.116	0.117	0.330	0.330	0.553	0.553
17-Aug	1.007	1.007	0.297	0.297	0.116	0.117	0.331	0.330	0.554	0.554
18-Aug	1.007	1.007	0.297	0.296	0.116	0.117	0.330	0.330	0.553	0.553
21-Aug	1.007	1.007	0.297	0.296	0.117	0.117	0.331	0.331	0.554	0.555
22-Aug	1.007	1.007	0.297	0.297	0.116	0.117	0.331	0.330	0.554	0.554
23-Aug	1.006	1.007	0.297	0.296	0.117	0.117	0.331	0.331	0.554	0.554
24-Aug	1.006	1.006	0.296	0.296	0.116	0.117	0.330	0.330	0.552	0.553
25-Aug	1.006	1.007	0.296	0.296	0.116	0.117	0.330	0.330	0.551	0.553
28-Aug	1.007	1.006	0.297	0.296	0.116	0.117	0.331	0.330	0.552	0.554
29-Aug	1.007	1.007	0.297	0.296	0.116	0.117	0.331	0.331	0.553	0.553
30-Aug	1.007	1.007	0.297	0.296	0.116	0.117	0.331	0.330	0.553	0.553
31-Aug	1.007	1.007	0.297	0.296	0.116	0.117	0.331	0.330	0.553	0.553