

WINdose for Excel **2002**

Installation & Operations Manual

Software Install Version 2.0.0

Calibration Specific Workbook Version 2.7.0

REQUIREMENTS

WINdose for Excel 2002 was designed in a Microsoft Excel™ platform. *WINdose for Excel 2002* was developed and intended for use as a component of the GEX *WINdose Dosimetry System*. It was designed to provide communication between the Thermo Spectronic *Genesys 20* spectrophotometer and an IBM compatible PC with a Microsoft *Windows™ 2000* or higher operating system and *Microsoft Excel 2000* or higher spreadsheet application program. The program contains communication files that are not compatible with older versions of these Microsoft Products.

DISCLAIMER and GENERAL PRECAUTIONS

The *WINdose for Excel* software program is intended for use in the preparation of standardized Dosimetry Report forms that are printed, reviewed and authorized as documents by the end user. The software was not designed to provide database or information storage in any manner. The user is responsible for verification of the accuracy of the data contained in the reports generated using the *WINdose for Excel* software. Users are also responsible for determining the suitability and performance of the software for their specific applications.

GEX Corporation does not warrant the data input or output associated with this software. All dose results and any subsequent usage of the data derived from usage of this software are the sole responsibility of the user. Further, by acceptance, implementation and use, the user assumes any and all risks associated with usage of this user manual and the associated software product.

WINdose for Excel workbooks communicate only with Genesys 20 spectrophotometers. The use of any other spectrophotometer requires that the software be used in the manual mode (see Appendix A – Manual Mode Operation). Custom communication interfaces may be developed and validated separately based on a customer specific set of requirements.

The *WINdose for Excel* worksheets contain both locked and unlocked cells. Users should have a working knowledge of basic Microsoft *Windows™* and Microsoft *Excel™* functions in order to use the worksheets effectively.

WINdose for Excel users assume complete responsibility for the application of the software product and agree to use the software program in accordance with the information and instructions contained in this user manual. The examples given in this manual are based on GEX recommended program uses; other uses of the program are possible. Contact GEX to discuss your specific application needs.

CALIBRATION SPECIFIC WORKBOOKS

The *WINdose for Excel 2002* installation CD installs a demonstration file on your computer in the *WINdose for Excel 2002* folder inside the Program Files folder on the Hard Drive of the computer. This file is for demonstration and training purposes only. A Calibration Specific Workbook with calibration coefficients specific to your facility and your dosimeter batch and thickness must be developed and installed separately. The dose calculation coefficients from your specific GEX dosimeter batch calibration are embedded into each Calibration Specific Workbook. Users must execute a calibration and develop a response function in the form $\text{Response} = f(\text{dose})$, either using GEX services or independently, and GEX Customer Service will prepare the Calibration Specific Workbook. Contact GEX Customer Service for more information.

WINdose for Excel 2002 Software Validation Certificate

The *WINdose for Excel 2002* software program was developed using generally accepted industrial practices for software development design control that included use of a formal Design Requirements document to guide the design and validation of the product. The completed software was placed under version and change control and underwent formal verification and validation testing to confirm that the product fulfilled its Design Requirements when used in accordance with this Installation and Operations Manual.

The verification and validation testing demonstrated that the *WINdose for Excel 2002* product meets its full design specifications and operational performance requirements when the software is used with the GEX *WINdose* Dosimetry System components in accordance with the instructions provided in the Installation and Operations Manual and related procedures contained in the S6100 Procedure Template Notebook. The verification and validation testing also determined that the use of constants in the software such as calibration curve coefficients were appropriate for the requirements and intended functionality of the software product and provided verifiable results that were repeatable and reproducible.

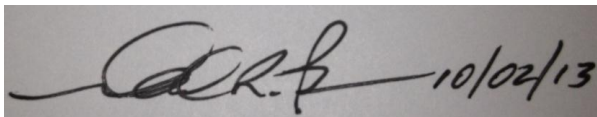
Security is applied to preformatted sections of each spreadsheet and to constants and macros used in the workbook through GEX managed password control. The calibration identification and curve coefficients are contained in a hidden, password protected worksheet. This password is maintained by GEX Corporation and available for use only by trained GEX personnel unless specifically requested by the user, in which case the validation of security is the responsibility of the user.

Hazards analysis testing resulted in the implementation of standard MS Excel™ protective functions to eliminate potential damage to the *WINdose for Excel* workbooks including the prevention of worksheet formatting or deleting cells, rows, or columns.

Since different calibration coefficients and dosimeter thickness and initial absorbance values (constants) may be used for each individual Calibration Specific Workbook, users are instructed to perform a verification test of the dose output upon receipt of each Calibration Specific Workbook against the "Dose Estimate Table" in the associated Calibration Report (see GEX procedure template #100-255 for a recommended procedure for verifying the validity of the dose calculations in *WINdose for Excel*).

The full *WINdose for Excel* software verification and validation testing and software development history package is available for customer review and audit at our facility during normal business hours. These records will be maintained by GEX for an indefinite period.

Unauthorized modification of *WINdose for excel* worksheets voids the validation. For more information see page 7 regarding customization of worksheets.



Michael R. Pageau
President
GEX Corporation

WINdose for Excel - Theory of Operation

The *WINdose for Excel* program was designed and developed as a major component of the WINdose Dosimetry System. The function of the *WINdose for Excel* software is to provide the means of recording dosimeter absorbance measurements and preparing standardized dosimetry reports related to the dose measurements made for facility dose mapping, product dose mapping, and routine process dose monitoring applications.

WINdose for Excel utilizes specialized coding with embedded calibration coefficients derived from user specific dosimeter batch calibrations to estimate doses from user entered dosimeter absorbance values in what are referred to as Calibration Specific Workbooks. The software program requires a computer with a Microsoft Windows™ operating platform, MS Excel™ with MS Visual Basic™ tools and a USB or Serial port to operate.

Dosimetry worksheets in Calibration Specific Workbooks provide a means for user data entry for specific GEX products or dosimetry tests. Users complete the preformatted worksheets, filling in colored space holders with appropriate data specific to the dosimetry process run or test begin performed. Information such as the technician name, date, the product information and run identification number, and process date(s) are entered into the header section. Dosimeter specific information including batch ID and calibration ID, calibration coefficients, etc. are stored as constants in the specific WINdose for Excel workbook itself. After the header information is entered, the measurement process can begin.

The software uses MS Visual Basic™ code and custom macros embedded in an MS Excel™ workbook to transfer absorbance values directly from an integrated spectrophotometer (hand entry of the absorbance is also available). This software was designed to work only with the Thermo Fisher Scientific Genesys 20 spectrophotometer using a bi-directional communication link via RS232 or USB connection. The Genesys 20 display shows the current dosimeter absorbance value that allows the operator visual verification of the data values as they are transferred into the computer software. The Genesys 20 is preset at the factory to default to the 552 nm wavelength of the B3 dosimeters at the conclusion of the automated instrument startup process.

Dosimeter ID #'s are recorded by the operator along with their specific measurement locations. The software program accepts this data via direct input through the computer keyboard or through a keyboard wedge barcode reader. The B3 dosimeter packages are then opened, the dosimeters removed and transferred into a dosimeter holder, and placed into the sample compartment of the spectrophotometer.

A digital value of absorbance is displayed on the spectrophotometer. Once the readout value is stable and observed as reasonable, a computer keyboard command is used to instruct the software program to transfer the spectrophotometer value into the worksheet. As each absorbance value is entered, an embedded formula automatically calculates the response value (net change in absorbance per dosimeter thickness) and the dose from your batch calibration curve coefficients.

The completed *WINdose for Excel* worksheets may then be printed, reviewed, authorized, and archived. The software can be used without connection to the spectrophotometer using manual data entry from the spectrophotometer display, if needed.

WINdose for Excel 2002 Installation

The enclosed CD contains the installation program for *WINdose for Excel 2002*. Turn off virus protection software before installing *WINdose for Excel* as some files required to establish communication with the spectrophotometer must be written directly into the MS Windows™ System folder. Virus protection software can be turned on again after the installation is complete.

WINdose for Excel 2002 must be installed on your computer's Hard Drive. Do not install the program over a network as it will not function.

Installation Procedure:

- 1) Close all programs and insert the WINdose for Excel CD.
- 2) Open the CD and view contents.
- 3) Read and follow any README files that contain version specific information and additional instruction.
- 4) Double-click "setup.exe". Setup will load the installation program and check your system setup.
- 5) Follow the installation instructions on-screen.
- 6) Depending on the existing software components in the computer system, setup may require that the computer be restarted.
- 7) Open the computer's Programs and Features and check that WINdose for Excel 2002 is present in the program list to verify that the program installed correctly.
- 8) An Adobe Acrobat .PDF copy of this manual is also found on the CD.

CAUTION: Setup installs a demonstration file during the initial *WINdose for Excel* installation. This file is not appropriate for use at your process facility and is for training and installation verification purposes only. Contact GEX to obtain current industry recommendations related to performing a traceable calibration of specific dosimeter batch. After you have performed a traceable calibration, you will receive your Calibration Specific Workbook. The Calibration Specific Workbook file will need to be installed onto the computer and is the executable file. Users may have more than one Calibration Specific Workbook but only one file should be opened and operated at a time. You can remove the demonstration file at a later time.

Hardware Installation

Attach the RS-232 cable to the Genesys 20 spectrophotometer and to the COM1 port on the computer. The *WINdose for Excel* software is set to only recognize the COM1 port. Set the utilized port to COM1 if it isn't already. Also, check to make sure that the COM1 settings on the computer match the settings on the spectrophotometer. Be sure this is set appropriately or the data input function will not work. Use a USB adapter (provided with GEX supplied cables) and again ensure the port is identified as COM1.

If used, attach a barcode reader (GEX Part# P4201) to the computer. The GEX Part # P4201 barcode reader does not require any additional software installation.

Installing your Calibration Specific Workbook

When you have a Calibration Specific Workbook from GEX you only need to load the file onto any location on any computer that you have installed *WINDose for Excel 2002*. Use standard MS Windows methods such as “copy and paste” or “drag and drop”.

Please maintain a master copy of the Calibration Specific Workbook in a secure location. GEX maintains copies of all Calibration Specific Workbooks supplied to customers.

INSTALLATION:

Copy your **Calibration Specific Workbook** file to the chosen directory location on the computer. It is recommended that the demonstration file (Excel file named “WINDose for Excel 2002”) be removed at this time and remove any link to the file that may have been created in the “Start” menu (see below for more details).

As a preferred method, choose an installation location other than the desktop and then create a shortcut to the specific *WINDose for Excel* file. Use standard MS Windows™ methods to create the shortcut.

Instructions for Removing WINDose for Excel 2002 Demo file

Browse to the directory C:\Program Files\WINDose for Excel 2002. Highlight the “WINDose for Excel 2002” file as shown in the picture. Press the Delete key or drag it to the Recycle Bin.



Then click the Windows™ Start button and navigate to the WINDose for Excel 2002 shortcut. Right click the shortcut and select Delete from the menu or change the path to a WINDose for Excel **Calibration Specific Workbook** file.

Customizing Facility Information

Contact GEX Customer Service for information and requirements related to modification of any of the preformatted worksheets. GEX maintains formal change control over the *WINdose for Excel* software and will provide users with a controlled means of customizing the software to specific user needs in a controlled manner. All header information can be changed and forms can be customized to meet functional or interface/layout requirements. Some charges may apply for time consuming modifications and this is consulted with the customer on an as-needed basis.

GEX CUSTOMER SERVICE

Phone: 303-400-9640

Fax: 303-400-9831

Email: sales@gexcorp.com

Basic Operation

STARTING THE EQUIPMENT:

Start your computer before turning the Genesys 20 instrument on. The instrument may be turned off and on without rebooting your computer. Turn the instrument off and on once per day, to allow it to run through its self-testing (immediate off and then on requires no additional warm up). Perform the following:

- Remove the cuvette cup, turn on the instrument.
 - Allow the instrument to warm up for at least thirty minutes
 - Ensure that the instrument is set to 552 nm
 - Ensure that the instrument is in the Absorbance mode
 - Insert the cuvette cup and close the sample compartment lid
 - Zero the instrument (DoseStix ready for measurement)
- Continue for WINdose dosimeters only
- Insert the sample holder (Part# P4502) and close the sample compartment lid
 - Zero the instrument (WINdose ready for measurement)

NOTE - The worksheet screens shown in this manual are samples only. Your screens may have a slightly different appearance depending on your computer setup and any customization.

STARTING THE PROGRAM:

First, verify that the executable file is marked “read-only”. Right click on the file and select “properties” and check that the “read-only” box is checked. This should prevent the user from saving dosimetry data into the executable file.

Next, open the demonstration file or your Calibration Specific Workbook by double clicking on the MS Excel file or shortcut link.

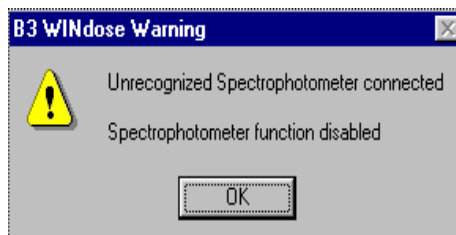
When opening, you may get messages regarding macros. Macros must be enabled in Excel for the program to operate, either temporarily or permanently. You will also need to allow access to the VBA project object model in Excel for the program to communicate with the spectrophotometer. Consult with your IT specialist to setup your security settings (you may need to close and reopen all Excel files for any security changes to take effect). Steps will vary depending on the version of MS Windows and MS Excel you are using.

The program will search for the spectrophotometer for up to 10 seconds. During this time, a message will appear on screen as shown below.



During this period, the standard Excel™ edit menus at the top of the screen will turn gray and not be functional. Do not make any keyboard entries or mouse clicks during this period. If the program cannot communicate with the spectrophotometer within 30 seconds, the warning message will appear. As with the demonstration workbooks, you can still run the dose calculation macro but all absorbance reading information will have to be entered manually.

If the program cannot communicate with the spectrophotometer, the following warning message will appear. Close the program and check the RS232 cable connections and COM1 setup as described earlier in this manual.



This warning will appear every time the program cannot communicate with a Genesys 20 spectrophotometer. You may use the program without the computer being connected to the Genesys 20 spectrophotometer. See Appendix A "Manual Mode Operation" for more information.

SELECT THE WORKSHEET TO USE:

The batch **Calibration Specific Workbook** contains worksheets for the products that a customer uses. This setup is determined at the time of the dosimeter batch calibration. Custom worksheet modifications are available at any time by contacting GEX.

To begin using the software, simply open the **Calibration Specific Workbook** and select the appropriate dosimetry worksheet. There are several basic worksheets and, for electron beam users, several specialty worksheets. Worksheets that you do not use that were not removed by GEX from your **Calibration Specific Workbook** may also be deleted at any time using standard MS Excel conventions.

STANDARD WORKSHEETS:

| Name: | Use: |
|---------------------|---------------------------------------|
| B3000 - Dose Report | 1 dosimeter replicate per dose point |
| B3002 - Dose Report | 2 dosimeter replicates per dose point |
| B3004 - Dose Report | 4 dosimeter replicates per dose point |

Other variations of these worksheets may be developed.

APPLICATION SPECIALTY WORKSHEETS:

| Name: | Use: |
|------------------------------|---------------------------------------------------------|
| B3106 - X and Y Uniformity | Process uniformity measurement strips |
| B3110 – Energy Wedge Card | 10MeV extrapolated range energy using RISØ wedge |
| B3112 – Energy Wedge Card | 5MeV extrapolated range energy using RISØ wedge |
| B3200 – B3 Film Energy Stack | Extrapolated range energy measurement 100-300 keV range |
| B3202 – B3 Film Energy Stack | Extrapolated range energy measurement 50-120 keV range |

Other worksheets such as custom worksheets may be developed.

Using Standard WINdose for Excel Worksheets

INFORMATION ENTRY:

The top fourteen rows of all worksheets provide fillable cells that are used to document product and process information. Make entries in the colored cells, all other cells are locked. As information is entered or values change, the cell turns white. The 'tab' key will move the cursor to all unlocked cells in the worksheets, the arrow keys can be used to move to any cell in the worksheets. The routine dosimetry screens appear like this:

| | | | | | | | | | |
|----|-----------------|--|--|-------------------------|--|----------------------|--|--|--|
| 5 | | | | DOSIMETRY REPORT | | | | | |
| 6 | | | | | | | | | |
| 7 | Customer: | | | Process Number: | | | | | |
| 8 | Product: | | | Process Specification: | | | | | |
| 9 | Lot(s): | | | Dmin/Ref Ratio: | | Dmax/Ref Ratio: | | | |
| 10 | Quantity: | | | Min Dose Spec: | | Max Dose Spec: | | | |
| 11 | Process Date: | | | | | | | | |
| 12 | Technician: | | | | | | | | |
| 13 | Dosimetry Date: | | | Min Dose in Process: | | Max Dose in Process: | | | |
| 14 | Instrument: | | | | | | | | |

Rows 15-17 are dedicated to displaying the stored information about the dosimeter batch and calibration and appear like this:

| | | | | | | |
|----|--------------------|-----------------|-------------------|------------------|----------------------------------|--------|
| 15 | Correction Factor: | 1.00 | Wavelength (nm): | 552 | Average Thickness (t): | 0.0187 |
| 16 | Dosimeter Batch: | GEX B3 batch BE | Calibration Date: | 19-Jul-11 | Initial Average Absorbance (Ao): | 0.000 |
| 17 | Calibration ID: | 3083-M-BE-GEX | Dose Range: | 1.61 to 79.4 kGy | Software Version: | 2.7.0 |

See **Appendix B** of this manual for a detailed description of each field in the Dosimetry Report.

MEASURING DOSIMETERS: (Example shown is a B3000 Worksheet):

Enter a dosimeter identification number in the first shaded cell in row 20, column B. This may be done manually or through a bar code reader.

| 18 | | Dosimeter | Irradiated | Response | | Adjusted |
|----|--------------|-----------|-----------------|---------------|------------|------------|
| 19 | Dosimeter ID | Position | Absorbance (Ai) | {Ai - Ao} / t | Dose (kGy) | Dose (kGy) |
| 20 | 12345467 | | 0.000 | 0.000 | na | |
| 21 | | | | | | |

Using the tab or arrow keys, move to the next cell to the right (column C) and type a position identifier for the dosimeter, this may be a number or a word, and use the tab or arrow keys to move one cell to the right (column D).

| 18 | | Dosimeter | Irradiated | Response | | Adjusted |
|----|--------------|-----------|-----------------|---------------|------------|------------|
| 19 | Dosimeter ID | Position | Absorbance (Ai) | {Ai - Ao} / t | Dose (kGy) | Dose (kGy) |
| 20 | 12345467 | Reference | 0.000 | 0.000 | na | |
| 21 | | | | | | |

Place a dosimeter in the spectrophotometer. When the value is stable, hold down the 'Control' (Ctrl) and 'Shift' keys and then press the letter 'a': **Ctrl+Shift+a**. The absorbance value measured by the spectrophotometer will be transferred into the cell, the response value and doses are calculated, and a new row inserted with the cursor placed in the Dosimeter ID column.

| 18 | | Dosimeter | Irradiated | Response | | Adjusted |
|----|--------------|-----------|------------------------------|----------------------------------------|------------|------------|
| 19 | Dosimeter ID | Position | Absorbance (A _i) | (A _i - A _o) / t | Dose (kGy) | Dose (kGy) |
| 20 | 12345467 | Reference | 0.250 | 13.369 | 13.6 | 13.6 |
| 21 | | | 0.000 | 0.000 | na | |
| 22 | | | | | | |

The standard worksheets vary by the number of replicate absorbance values the worksheet uses. Above you saw how to fill in the B3000 worksheet.

In a B3002 worksheet (two dosimeter replicates per package) use the **Ctrl+Shift+a** command to transfer the replicate A absorbance value (column D), and the cursor moves to the next column (E). Repeat the **Ctrl+Shift+a** command to transfer the replicate B value.

So with each worksheet, the software requires you to transfer the correct number of values per row before it will calculate and allow another measurement.

In each of the different standard worksheets, the dosimeter response is calculated automatically from the formula: Irradiated Absorbance (A_i) minus Original Absorbance (A_o) divided by Thickness (t).

$$\text{Response} = (A_i - A_o) / t$$

The **A_o** and **t** values are stored constants listed in the “Calibration Information” (rows 15-17) on the worksheets.

The “Dose (kGy)” is computed from the embedded curve coefficients. “Adjusted Dose”, “Min Dose in Process” and “Max Dose in Process” are calculated as follows:

- Adjusted Dose – Is the calculated Dose (kGy) multiplied by the Correction Factor.
- Max Dose in Process – Calculates the maximum Adjusted Dose value for the process run multiplied by the Dmax/Ref Ratio.
- Min Dose in Process – Calculates the minimum Adjusted Dose value for the process run multiplied by the Dmin/Ref Ratio.

You must enter values into the **Dmin/Ref Ratio** and **Dmax/Ref Ratio** in order for maximum and minimum doses in process to calculate.

| DOSIMETRY REPORT | | | | | | |
|------------------|----------------------------------|------------|------------------------------|----------------------------------------|------------|-----------------------------------------------------|
| 5 | | | | | | |
| 6 | | | | | | |
| 7 | Customer: | | | Process Number: | | |
| 8 | Product: | | | Process Specification: | | |
| 9 | Lot(s): | | | Dmin/Ref Ratio: 1.5 | | Dmax/Ref Ratio: 2 |
| 10 | Quantity: | | | Min Dose Spec: | | Max Dose Spec: |
| 11 | Process Date: | | | | | |
| 12 | Technician: | | | | | |
| 13 | Dosimetry Date: | | | Min Dose in Process: 20.4 | | Max Dose in Process: 27.2 |
| 14 | Instrument: | | | | | |
| 15 | Correction Factor: 1.00 | | Wavelength (nm): 552 | | | Average Thickness (t): 0.0187 |
| 16 | Dosimeter Batch: GEX B3 batch BE | | Calibration Date: 19-Jul-11 | | | Initial Average Absorbance (A _o): 0.000 |
| 17 | Calibration ID: 3083-M-BE-GEX | | Dose Range: 1.61 to 79.4 kGy | | | Software Version: 2.7.0 |
| 18 | Dosimeter | Irradiated | Response | | Adjusted | |
| 19 | Dosimeter ID | Position | Absorbance (A _i) | (A _i - A _o) / t | Dose (kGy) | Dose (kGy) |
| 20 | 12345467 | Reference | 0.250 | 13.369 | 13.6 | 13.6 |
| 21 | | | 0.000 | 0.000 | na | |
| 22 | | | | | | |

WARNINGS:

- 1) Do not use the Enter key after making a measurement. Doing so may put you into the wrong cell for the next measurement.
- 2) Do not try to use "Caps Lock" instead of "Shift + a." It doesn't work.

Print the worksheet to create the final report. Signature spaces for the technician and a reviewer are provided at the bottom of the page. To start a new worksheet, simply close and re-open the program.

RE-MEASURING A DOSIMETER:

If it becomes necessary to re-measure a dosimeter there are two options. Highlight the appropriate absorbance cell in the worksheet and manually enter an absorbance of 0.000. Move the cursor into the "Response" column and press **Ctrl+Shift+a**. This clears the original dose calculation. Then move the cursor back into the cell to be re-measured. Insert the dosimeter back into the spectrophotometer. Use the **Ctrl+Shift+a** command as normal. The absorbance value will transfer and operate normally. The program will not insert a new row unless you are on the last row that you had used.

Alternatively, create a new report for any re-measurement activities.

MISSING OR DAMAGED DOSIMETERS:

WARNING: Should one dosimeter be damaged out of a group (i.e. – 1 replicate out of 2 for the B3002) the following steps MUST be followed to record an accurate measurement:

- 1) The software requires that a value be entered in the first absorbance column if there is more than one on a particular worksheet. Therefore, in the example of the B3002, even if Replicate A is damaged you must enter Replicate B in the first absorbance column in order for the program to calculate doses.
- 2) In the example above, you must delete the 0.000 from the Replicate B absorbance column so that the column is blank (null). The response calculates an average of the two absorbance columns in this case and it will count the 0.000 as a value and divide the sum of the two absorbances by 2 to get the average if you do not make the unused column null. See the examples below.

INCORRECT METHOD

| 18 | | Dosimeter | Irradiated Absorb. | | Response | | Adjusted |
|----|--------------|-----------|--------------------|-------|-------------------|------------|------------|
| 19 | Dosimeter ID | Position | A | B | $(A_i - A_o) / t$ | Dose (kGy) | Dose (kGy) |
| 20 | 1234567 | Reference | 0.250 | 0.000 | 6.684 | 5.4 | 5.4 |
| 21 | | | 0.000 | 0.000 | 0.000 | na | |

CORRECT METHOD

| 18 | | Dosimeter | Irradiated Absorb. | | Response | | Adjusted |
|----|--------------|-----------|--------------------|-------|-------------------|------------|------------|
| 19 | Dosimeter ID | Position | A | B | $(A_i - A_o) / t$ | Dose (kGy) | Dose (kGy) |
| 20 | 1234567 | Reference | 0.250 | | 13.369 | 13.6 | 13.6 |
| 21 | | | 0.000 | 0.000 | 0.000 | na | |

OUT OF RANGE MESSAGES:

Occasionally doses will not compute and the “Dose (kGy)” column will look like this:

| 18 | | Dosimeter | Irradiated | Response | | Adjusted |
|----|--------------|-----------|-----------------|---------------|-------------|------------|
| 19 | Dosimeter ID | Position | Absorbance (Ai) | (Ai - Ao) / t | Dose (kGy) | Dose (kGy) |
| 20 | 12345467 | Reference | 0.040 | 2.139 | Under Range | |
| 21 | 1234568 | Reference | 1.050 | 56.150 | Over Range | |

These messages signify that the dosimeter response does not lie within the calibrated range of the dose response curve. In the example above, row 20 is below the calibrated range, and the row 21 is above the calibrated range.

DELETING UNUSED ROWS IN A STANDARD WORKSHEET:

If using worksheet that creates new rows for each measurement, such as worksheet B3000, there will be one empty row of data at the end of each report. This row can be removed to make the report nice, neat, and clean. Place the cursor in any cell on the empty row and use the key command **Ctrl+Shift+k** to remove an empty row.

This command will only function on rows with no dose value and 0.000 values for absorbance.

TRAINING AND SUPPORT:

To arrange installation support and/or schedule an interactive training support session, contact GEX Customer Service at 303-400-9640 or e-mail us at: sales@gexcorp.com

Appendix A - Manual Mode Operation

WINdose for Excel was designed for measuring *B3WINdose* dosimeters while connected to a Genesys 20 spectrophotometer. However, it is possible to operate it in manual mode only, with certain precautions. The worksheets do not contain detailed error-trapping and are intended to be used by qualified personnel under controlled conditions.

All worksheets in the workbook were designed to obtain values from the spectrophotometer when you press the three keys **Ctrl+Shift+a**, and to insert rows when appropriate. If you use the software for manual data entry, the only difference is how the **Ctrl+Shift+a** command must be used.

When there is no spectrophotometer or communications have been lost, using **Ctrl+Shift+a** with the cursor in an absorbance cell will result in error messages. In such cases, the absorbance value must be manually entered using a keyboard, the **Ctrl+Shift+a** command is still used to calculate doses and create new rows, but it will only function when executed with the cursor placed manually in the 'Response' column. You must use the arrow keys or the mouse to position the cursor in the 'Response' column. All other operations of the Calibration Specific Workbook already described remain the same with the exception that all absorbance values are manually entered.

Appendix B – Dosimetry Report Fields

| DOSIMETRY REPORT | | | | | | | | | |
|------------------|--------------------|-----------|-----------------|---------------|------------------------|-----|---------|----------------------------------|------------|
| 5 | | | | | | | | | |
| 6 | | | | | | | | | |
| 7 | Customer: | 1 | | | Process Number: | 9 | | | |
| 8 | Product: | 2 | | | Process Specification: | 10 | | | |
| 9 | Lot(s): | 3 | | | Dmin/Ref Ratio: | 11 | | Dmax/Ref Ratio: | 12 |
| 10 | Quantity: | 4 | | | Min Dose Spec: | 13 | | Max Dose Spec: | 14 |
| 11 | Process Date: | 5 | | | | | | | |
| 12 | Technician: | 6 | | | | | | | |
| 13 | Dosimetry Date: | 7 | | | Min Dose in Process: | 15 | | Max Dose in Process: | 16 |
| 14 | Instrument: | 8 | | | | | | | |
| 15 | Correction Factor: | 1.00 | 17 | | Wavelength (nm): | 552 | 20 | Average Thickness (t): | 0.1 |
| 16 | Dosimeter Batch: | GEX B3 t | 18 | | Calibration Date: | 19: | 21 | Initial Average Absorbance (Ao): | 0.0 |
| 17 | Calibration ID: | 3083-M-BE | 19 | | Dose Range: | 22 | 9.4 kGy | Software Version: | 2.7.0 |
| 18 | | Dosimeter | | Irradiated | Response | | | Adjusted | |
| 19 | Dosimeter ID | Position | Absorbance (Ai) | (Ai - Ao) / t | Dose (kGy) | | | Adjusted | Dose (kGy) |
| 20 | 26 | 27 | 28 | 29 | 30 | | | 31 | |
| 21 | | | | | | | | | |

- 1) **Customer** – Name of the customer whose product was processed.
- 2) **Product** – Identification of the product processed.
- 3) **Lot(s)** – Lot or lot numbers that were processed.
- 4) **Quantity** – Quantity of the product processed.
- 5) **Process Date** – Date the product was processed.
- 6) **Technician** – Name of the technician performing the dosimetry and filling out the report.
- 7) **Dosimetry Date** – Date the dosimetry for the process run was performed.
- 8) **Instrument** – The name and/or serial number of the spectrophotometer used in the dosimetry measurement.
- 9) **Process Number** – Identification number assigned to the specific process run.
- 10) **Process Specification** – Identifier of the **Process Specification** that defines the master processing specifications.
- 11) **Dmin/Ref Ratio** – The ratio of the reference monitoring position to the minimum dose position on the product (E-Beam) or carrier (Gamma) established during dose mapping.
- 12) **Dmax/Ref Ratio** – The ratio of the reference monitoring position to the maximum dose position on the product (E-Beam) or carrier (Gamma) established during dose mapping.
- 13) **Min Dose Spec** – The determined minimum dose the product must receive as specified in the Product Specification.
- 14) **Max Dose Spec** – The determined maximum dose the product can receive as specified in the Product Specification.
- 15) **Min Dose in Process** – The estimated minimum dose in process determined by taking the lowest **Adjusted Dose** in the process multiplied by the **Dmin/Ref Ratio** (from process specification).
- 16) **Max Dose in Process** – The estimated maximum dose in process determined by taking the highest **Adjusted Dose** in the process multiplied by the **Dmax/Ref Ratio** (from process

- specification).
- 17) **Correction Factor** – A linear correction used to adjust dose calculations based on calibration specific data (e.g. a correction of 0.10 can be used to convert from kGy to Mrad).
 - 18) **Dosimeter Batch** – The dosimeter batch that was calibrated and that is valid for use with the **Calibration Specific Workbook** ID being displayed.
 - 19) **Calibration ID** – The GEX assigned calibration ID for the specific “best fit” curve that the software is using to calculate doses.
 - 20) **Wavelength** – The wavelength at which the spectrophotometer must be set to read dosimeters from the **Dosimeter Batch**.
 - 21) **Calibration Date** – The date the dosimeter batch calibration was performed.
 - 22) **Dose Range** – The range of doses that the calibration is certified for and thus the range within which the software can estimate doses.
 - 23) **Average Thickness** – The average thickness of the dosimeter batch used for the calibration.
 - 24) **Initial Average Absorbance** – The initial average background absorbance of the dosimeter batch used for the calibration.
 - 25) **Software Version** – The version of the *WINdose for Excel* **Calibration Specific Workbook** being used.
 - 26) **Dosimeter ID** – The individual identification number of the dosimeter.
 - 27) **Dosimeter Position** – The position of the dosimeter during the process run (i.e. Reference Position, etc.).
 - 28) **Irradiated Absorbance** – The absorbance value of the dosimeter as determined with the spectrophotometer
 - 29) **Response $(A_i - A_o) / t$** – The calculated response of the dosimeter per the listed formula.
 - 30) **Dose (kGy)** – The dose calculated by the software from a dosimeter **Response** value.
 - 31) **Adjusted Dose** – The Dose (kGy) multiplied by the correction factor if one is used. Default setting is 1.00.

B3106 Appendix

DESCRIPTION

The B3106 worksheet is used to read the optical absorbances of the sequentially numbered dosimeters. The results also update and display a uniformity graph of the dose results. These may be used for electron beam applications involving evaluation measurements of horizontal and perpendicular scan uniformity or any testing using the product. The B3106 strip cards may be joined to form strips of continuous lengths or staggered/overlapped to increase the measurement interval resolution.

GENERAL INFORMATION

Users should have a working knowledge of basic Microsoft Excel™ functions and charts in order to use the worksheets and manipulate the charts effectively.

Some cells are unlocked to allow users to adjust them for their specific systems.

For detailed instructions on performing measurements using the B3106 Uniformity Strips, see GEX Procedure Template #100-261 or your company specific procedure, if applicable.

Measuring the B3106 Uniformity Measurement Strip

Open *WINdose for Excel* and select the B3106 worksheet from the tabs at the bottom of the screen. Enter the processing information in the top section of the worksheet.

The dosimeters in each strip are provided in sequential order for user convenience. Enter the first dosimeter number into cell B20 and the worksheet will automatically fill in the next nine numbers.

If you are using more than one B3106 strip for one direction's length, simply enter the first dosimeter of the next strip after the last dosimeter of the previous strip. The worksheet comes preformatted for a total of 30 dosimeters but can be customized by GEX to span any length using any spacing interval the user requires.

Measuring the Strips of Dosimeters

Measure the irradiated absorbances of each dosimeter on the strip from end to end using the instructions earlier in this manual. For this type of worksheet, new rows are not added but are instead preformatted for a specific distance.

Calculating the Uniformity

The worksheet automatically calculates the dose relative to the entrance dose in column J. The relative dose is calculated by dividing the measured dose by the average of the measured doses. The worksheet also automatically calculates the average dose, the standard deviation of the doses, and the coefficient of variance (CV) of this average. The CV is then expressed as a percent.

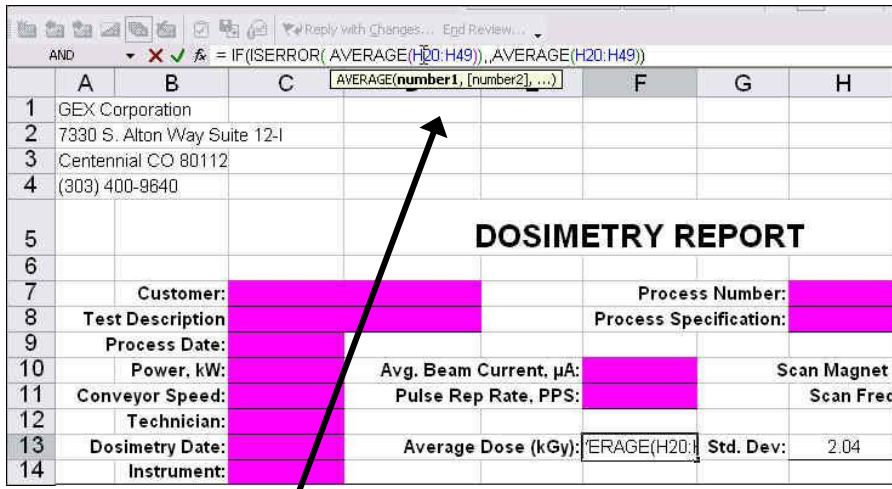
For some types of uniformity measurements, such as scan width/height, users may wish to select the flat portion of the curve and eliminate the overscan tails for the uniformity measurement. The example below shows how this may be performed.

EXAMPLE:

The following is an example of a scan width/height test showing how the electron beam drops off at the end of the scan. Uniformity is tested over the area of greatest interest, in this situation the width of a product tote 20 inches wide. Dosimeters #1-#2 and #22 - # 30 were extended beyond the product in order to demonstrate that the electron beam overscanned the width of the product. The area of greatest interest therefore involves only dosimeters #3 through #21.

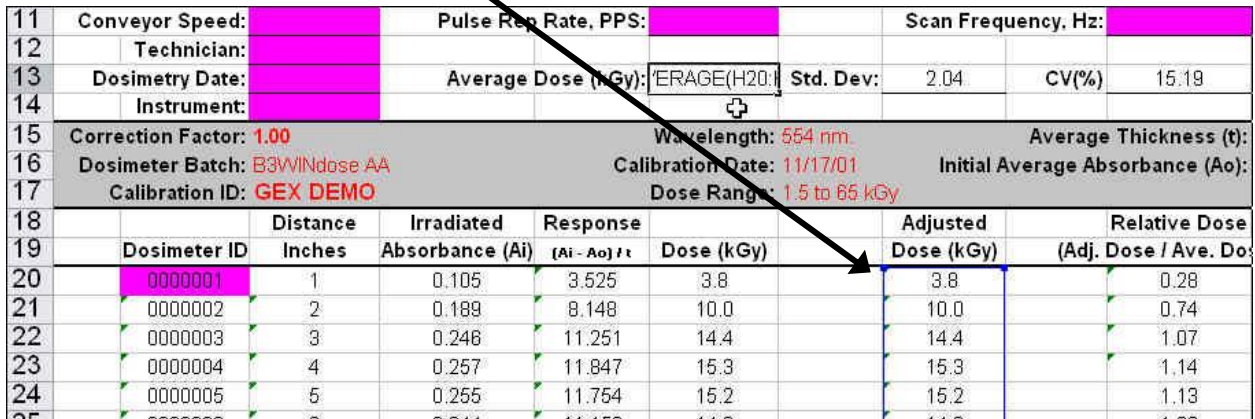
Average Dose formula cell (Cell F15):

This formula is preset to incorporate all 30 preformatted rows (H20 to H49). To modify, select cell F15 and click the mouse in the range (H20:H49) that is displayed in the Excel Formula Bar near the top of the screen. This highlights both ranges in the formula (**NOTE:** both ranges are the same). This also highlights the actual column of data with a colored border box. Resize the box to incorporate only those points which are of interest for the test. You will have to do this twice as there is one box for each range in the formula even though they are the same range. Hit the RETURN key when you have the proper range selected. For our example, we will select (H22 to H40).



| | A | B | C | D | E | F | G | H |
|----|------------------------------|---|------------------------|---|------------------------|---|------|---|
| 1 | GEX Corporation | | | | | | | |
| 2 | 7330 S. Alton Way Suite 12-I | | | | | | | |
| 3 | Centennial CO 80112 | | | | | | | |
| 4 | (303) 400-9640 | | | | | | | |
| 5 | DOSIMETRY REPORT | | | | | | | |
| 7 | Customer: | | | | Process Number: | | | |
| 8 | Test Description | | | | Process Specification: | | | |
| 9 | Process Date: | | | | | | | |
| 10 | Power, kW: | | Avg. Beam Current, µA: | | Scan Magnet | | | |
| 11 | Conveyor Speed: | | Pulse Rep Rate, PPS: | | Scan Freq | | | |
| 12 | Technician: | | | | | | | |
| 13 | Dosimetry Date: | | Average Dose (kGy): | | Std. Dev: | | 2.04 | |
| 14 | Instrument: | | | | | | | |

Note that the cell F13 is highlighted and its formula appears in the Formula Bar. Then click on the range and it turns color, noting that it is selected. Then if you scroll down, you will see the range highlighted with a border box like the example below.



| | | | | | | | | |
|----|-------------------------------|----------|----------------------------|---------------|----------------------------------|------------|----------------------|--|
| 11 | Conveyor Speed: | | Pulse Rep Rate, PPS: | | Scan Frequency, Hz: | | | |
| 12 | Technician: | | | | | | | |
| 13 | Dosimetry Date: | | Average Dose (kGy): | | Std. Dev: | | 2.04 | |
| 14 | Instrument: | | | | | | | |
| 15 | Correction Factor: 1.00 | | Wavelength: 554 nm. | | Average Thickness (t): | | | |
| 16 | Dosimeter Batch: B3WINd0se AA | | Calibration Date: 11/17/01 | | Initial Average Absorbance (Ao): | | | |
| 17 | Calibration ID: GEX DEMO | | Dose Range: 1.5 to 65 kGy | | | | | |
| 18 | | Distance | Irradiated | Response | | Adjusted | Relative Dose | |
| 19 | Dosimeter ID | Inches | Absorbance (Ai) | (Ai - Ao) / t | Dose (kGy) | Dose (kGy) | (Adj. Dose / Ave. Do | |
| 20 | 0000001 | 1 | 0.105 | 3.525 | 3.8 | 3.8 | 0.28 | |
| 21 | 0000002 | 2 | 0.189 | 8.148 | 10.0 | 10.0 | 0.74 | |
| 22 | 0000003 | 3 | 0.248 | 11.251 | 14.4 | 14.4 | 1.07 | |
| 23 | 0000004 | 4 | 0.257 | 11.847 | 15.3 | 15.3 | 1.14 | |
| 24 | 0000005 | 5 | 0.255 | 11.754 | 15.2 | 15.2 | 1.13 | |
| 25 | 0000006 | 6 | 0.244 | 11.152 | 14.5 | 14.5 | 1.08 | |

Note in the example below, there are two boxes that you must resize for the desired range. In this case, one is blue and one is green. Extend or shorten the boxes depending on the modification required to achieve the desired range.

| | | | | | | | |
|----|--------------------|--------------|----------------------|-----------------------|----------------------------------|------------|-----------------------|
| 11 | Conveyor Speed: | | Pulse Rep Rate, PPS: | | Scan Frequency, Hz: | | |
| 12 | Technician: | | | | | | |
| 13 | Dosimetry Date: | | Average Dose (kGy): | $\text{RAGE}(H22:H4)$ | Std. Dev: | 2.04 | |
| 14 | Instrument: | | | | CV(%) | 15.19 | |
| 15 | Correction Factor: | 1.00 | Wavelength: | 554 nm. | Average Thickness (t): | | |
| 16 | Dosimeter Batch: | B3WINdose AA | Calibration Date: | 11/17/01 | Initial Average Absorbance (Ao): | | |
| 17 | Calibration ID: | GEX DEMO | Dose Range: | 1.5 to 65 kGy | | | |
| 18 | | Distance | Irradiated | Response | | Adjusted | Relative Dose |
| 19 | Dosimeter ID | Inches | Absorbance (Ai) | $(A_i - A_o) / t$ | Dose (kGy) | Dose (kGy) | (Adj. Dose / Ave. Do) |
| 20 | 0000001 | 1 | 0.105 | 3.525 | 3.8 | 3.8 | 0.28 |
| 21 | 0000002 | 2 | 0.189 | 8.148 | 10.0 | 10.0 | 0.74 |
| 22 | 0000003 | 3 | 0.246 | 11.251 | 14.4 | 14.4 | 1.07 |
| 23 | 0000004 | 4 | 0.257 | 11.847 | 15.3 | 15.3 | 1.14 |
| 24 | 0000005 | 5 | 0.255 | 11.754 | 15.2 | 15.2 | 1.13 |
| 25 | 0000006 | 6 | 0.244 | 11.153 | 14.3 | 14.3 | 1.06 |

| | | | | | | | |
|----|--------------------|--------------|----------------------|---------------------|----------------------------------|------------|-----------------------|
| 11 | Conveyor Speed: | | Pulse Rep Rate, PPS: | | Scan Frequency, Hz: | | |
| 12 | Technician: | | | | | | |
| 13 | Dosimetry Date: | | Average Dose (kGy): | $\text{E}(H22:H49)$ | Std. Dev: | 2.04 | |
| 14 | Instrument: | | | | CV(%) | 15.19 | |
| 15 | Correction Factor: | 1.00 | Wavelength: | 554 nm. | Average Thickness (t): | | |
| 16 | Dosimeter Batch: | B3WINdose AA | Calibration Date: | 11/17/01 | Initial Average Absorbance (Ao): | | |
| 17 | Calibration ID: | GEX DEMO | Dose Range: | 1.5 to 65 kGy | | | |
| 18 | | Distance | Irradiated | Response | | Adjusted | Relative Dose |
| 19 | Dosimeter ID | Inches | Absorbance (Ai) | $(A_i - A_o) / t$ | Dose (kGy) | Dose (kGy) | (Adj. Dose / Ave. Do) |
| 20 | 0000001 | 1 | 0.105 | 3.525 | 3.8 | 3.8 | 0.28 |
| 21 | 0000002 | 2 | 0.189 | 8.148 | 10.0 | 10.0 | 0.74 |
| 22 | 0000003 | 3 | 0.246 | 11.251 | 14.4 | 14.4 | 1.07 |
| 23 | 0000004 | 4 | 0.257 | 11.847 | 15.3 | 15.3 | 1.14 |
| 24 | 0000005 | 5 | 0.255 | 11.754 | 15.2 | 15.2 | 1.13 |
| 25 | 0000006 | 6 | 0.244 | 11.153 | 14.3 | 14.3 | 1.06 |

The range now begins at H22. Resize the bottom portion of the box in the same manner until you have the desired range.

Std. Dev formula cell H13

Perform the same actions as for the Average Dose formula. They should utilize the same range of dosimeters.

CV cell J13

The coefficient of variance is calculated by dividing the Standard Deviation (Std. Dev) by the Average Dose. It is then multiplied by 100 so it can be expressed as a percent. This formula needs no change as you have already modified the range for the two components that are used to calculate CV.

B3110/B3112 Appendix

DESCRIPTION

The B3110 product and its associated *WINdose for Excel* worksheet were specifically designed for use with the Risø aluminum wedge to estimate energies based on an extrapolated range technique for electron beam accelerator systems with approximate energies of 2 – 20 MeV. The product uses an array of *B3WINdose* dosimeters spaced at specific depth intervals on a die-cut card with two alignment holes that fit snugly over the posts on the Risø wedge.

When the dosimeter optical absorbances are read into the worksheet and the corresponding doses calculated, an energy can be estimated using certain equations given in ISO/ASTM 51649. The worksheet also contains a chart that updates automatically and plots the dose values against the depth in aluminum.

GENERAL INFORMATION

Users should have a working knowledge of basic Microsoft Excel™ functions and charts in order to use the worksheets and manipulate the charts effectively.

The template is not completely protected to allow user flexibility. Some cells are unlocked to allow a user to adjust the range of data used in the calculation for use with various energy systems.

The range of data used for the energy calculations and graphical plotting are preset at GEX. These ranges may need to be modified by the user for their specific beam energy.

For information regarding using the Risø Wedge, refer to GEX procedure template #100-260.

Measuring the B3110/B3112 Wedge Card Array

Open the workbook and select the appropriate worksheet from the tabs at the bottom of the screen. Enter the processing information in the top section of the worksheet. This information should be entered so that beam parameters can be documented. For guidance, see ISO/ASTM 51649.

The dosimeters are provided in sequential order for user convenience. Enter the first dosimeter number into cell B20 and the worksheet will automatically fill in the remaining numbers.

Measure the irradiated absorbances of each dosimeter on the wedge card from top to bottom in sequential order, filling in the worksheet as described earlier in this manual. For this type of worksheet, new rows are not added as in the standard dosimetry worksheets.

It may not be necessary to measure all dosimeters on the card: the lower the energy, the less penetration and therefore fewer dosimeters receive a dose. Discontinue making measurements after obtaining two or three absorbance measurements that are “under range”.

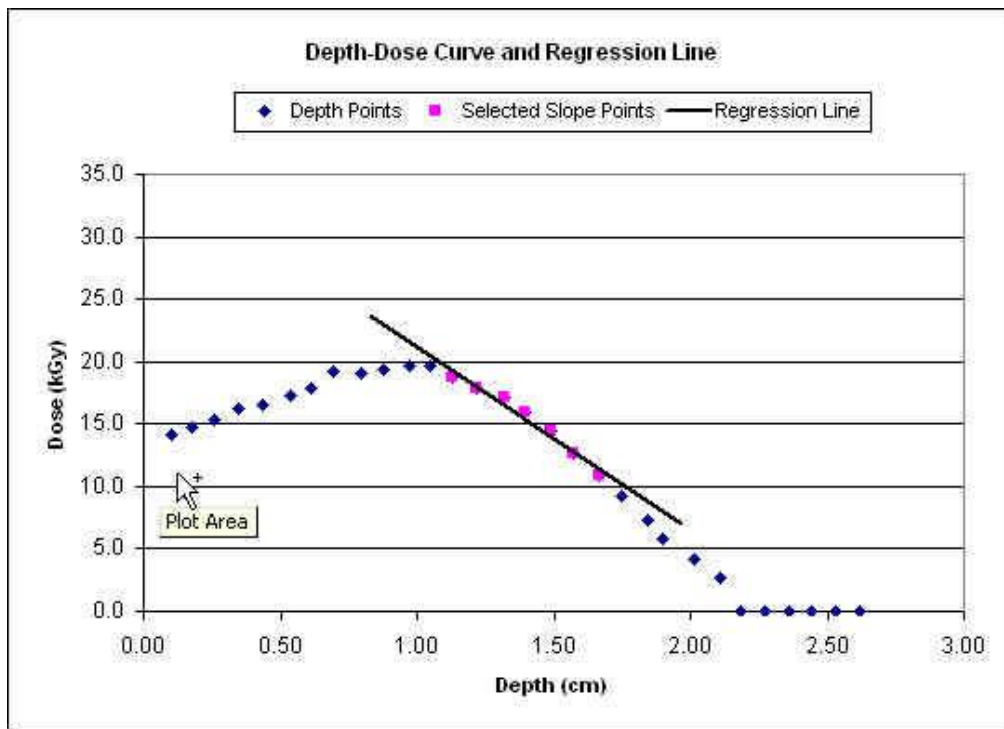
Estimating the Energy

The worksheet automatically calculates and plots the dose values against the thickness of the aluminum.

| | | | | | | | | | |
|----|--|-------------------------|--------|-------------|-------|--|--|--|--------------------------------------------------------------|
| 63 | | | | | | | | | |
| 64 | | Extrapolated Range (cm) | | | | | | | NOTE: The fitted series (Slope & Y intercept, and the |
| 65 | | Slope | -18.82 | Y-Intercept | 42.22 | | | | Trend line on the chart) defaults to the 15th through |
| 66 | | | | | | | | | 21st dosimeters only. The data ranges should be |
| 67 | | R50 | 1.72 | Rex | 2.24 | | | | adjusted by the user to incorporate more or fewer |
| 68 | | | | | | | | | data points appropriate to the energy being tested. |
| 69 | | | | | | | | | See the <i>WINdose for Excel 2002</i> Installation and |
| 70 | | Ea | | Ep | | | | | Operations manual for detailed instructions. |
| 71 | | 10.56 | | 11.506 | | | | | |
| 72 | | | | | | | | | <i>Ea and Ep calculated using ISO/ASTM formulae</i> |
| 73 | | | | | | | | | <i>A3.19 and A3.18 respectively per ICRU Report 35</i> |
| 74 | | | | | | | | | |

Adjusting the Energy Calculation and Graphical Representation:

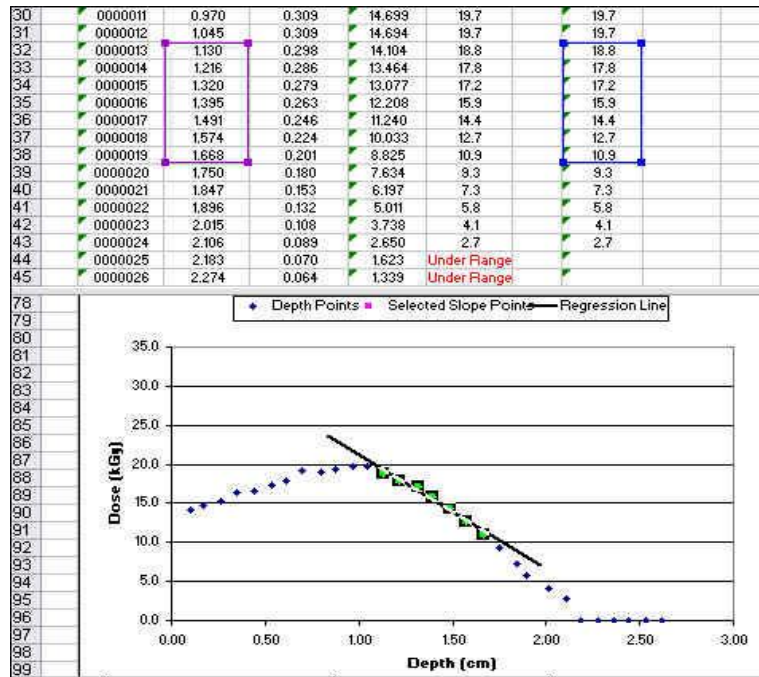
The Extrapolated Range formulas, the Estimated Energy formula, and the Trendline on the chart are preset to ranges typical for 5 or 10 MeV. If needed, the user may define the quantity and location of points that are used to estimate the energy. Some experimentation may be necessary to determine the "ideal" range to be used.



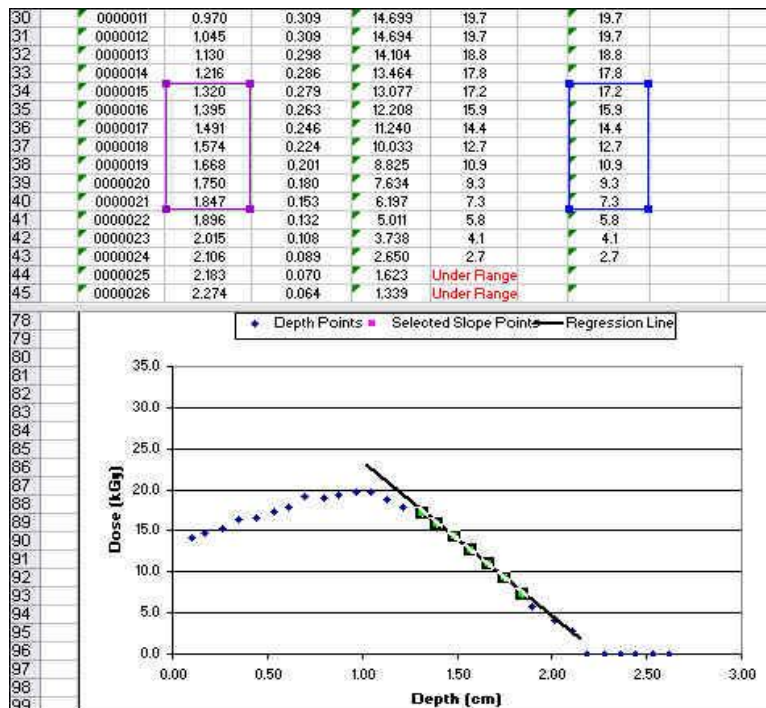
Sample of a curve fit before selecting appropriate data range

In the example above, the points preformatted for the energy calculation are not the most preferred for the test. The points used will need to be modified along with the calculations of **slope** and **y-intercept**. It is usually easiest to begin with adjusting the trendline on the chart. The trendline on the chart is not linked to the other formulas. Adjusting this fit first guides the user in adjusting the calculations.

The steepest slope for the fitted portion of the depth-dose curve should be used for energy analysis. The blue spots represent all of the relative doses in the stacks. The magenta spots represent only the relative doses selected for the trendline curve fit. Click onto one of the magenta spots. The active data ranges for the trendline fit are highlighted. Select, drag or resize the range boxes to ranges that result in a slope that incorporates at least 5 depth and dose measurements.



Sample Trendline Editing



Select cell C65 (Slope formula). Click into the formula bar and edit the data range either manually or by

dragging all the boxes to the same cells that were selected for the trendline.

Select cell E65 (Y-intercept formula). Click into the formula bar and edit the data range either manually or by dragging the boxes to the same cells that were selected for the trendline and slope in the graph.

| CELL | | X | ✓ | = | =INTERCEPT(H31:H39,C31:C39) | | | | |
|------|-------------------------|---------|--------|-----------------------------------------------------|-----------------------------------------------------|------|------|------|---|
| A | B | C | D | E | F | G | H | I | J |
| 26 | AA- | 0000007 | 0.713 | 0.490 | 24.378 | 31.1 | 0.00 | 31.1 | |
| 27 | AA- | 0000008 | 0.799 | 0.495 | 24.649 | 31.5 | 0.00 | 31.5 | |
| 28 | AA- | 0000009 | 0.891 | 0.493 | 24.541 | 31.3 | 0.00 | 31.3 | |
| 29 | AA- | 0000010 | 0.979 | 0.495 | 24.649 | 31.5 | 0.00 | 31.5 | |
| 30 | AA- | 0000011 | 1.070 | 0.484 | 24.054 | 30.6 | 0.00 | 30.6 | |
| 31 | AA- | 0000012 | 1.151 | 0.454 | 22.432 | 28.2 | 0.00 | 28.2 | |
| 32 | AA- | 0000013 | 1.238 | 0.430 | 21.135 | 26.3 | 0.00 | 26.3 | |
| 33 | AA- | 0000014 | 1.327 | 0.396 | 19.297 | 23.7 | 0.00 | 23.7 | |
| 34 | AA- | 0000015 | 1.415 | 0.340 | 16.270 | 19.6 | 0.00 | 19.6 | |
| 35 | AA- | 0000016 | 1.499 | 0.290 | 13.568 | 16.0 | 0.00 | 16.0 | |
| 36 | AA- | 0000017 | 1.586 | 0.229 | 10.270 | 11.9 | 0.00 | 11.9 | |
| 37 | AA- | 0000018 | 1.677 | 0.181 | 7.676 | 8.8 | 0.00 | 8.8 | |
| 38 | AA- | 0000019 | 1.757 | 0.141 | 5.514 | 6.3 | 0.00 | 6.3 | |
| 39 | AA- | 0000020 | 1.858 | 0.105 | 3.568 | 4.0 | 0.00 | 4.0 | |
| 40 | AA- | 0000021 | 1.942 | 0.077 | 2.054 | 2.3 | 0.00 | 2.3 | |
| 41 | AA- | 0000022 | 2.023 | 0.060 | 1.135 | 1.3 | 0.00 | 1.3 | |
| 42 | AA- | 0000023 | 2.116 | 0.049 | 0.541 | 0.7 | 0.00 | 0.7 | |
| 43 | AA- | 0000024 | 2.205 | 0.046 | 0.378 | 0.5 | 0.00 | 0.5 | |
| 65 | Extrapolated Range (cm) | | | | The fitted series (Slope & Y intercept, and the | | | | |
| 67 | Slope | | -36.88 | Y-Intercept | Trendline on the chart) default to the 15th through | | | | |
| 68 | | | | | 23rd dosimeters only. The data ranges should be | | | | |
| 69 | R50 | Rex | Rp | adjusted by the user to incorporate more or fewer | | | | | |
| 70 | 1.09 | 1.52 | 1.50 | data points appropriate to the energy being tested. | | | | | |

Example: Selecting Y-intercept data range

The extrapolated range parameters and estimated energy automatically re-calculate when the **slope** and **y-intercept** are modified.

Double check that the range used for the trendline on the graph match the ranges used in the **slope** and **y-intercept** calculations.

DISCUSSION:

The aluminum depth values used in the energy calculations were validated using a reference point for measurement based on the method described in ISO/ASTM 51649:2005 Appendix A3. The use of other reference points may result in different energy estimations. Refer to ISO/ASTM Note A3.10 for additional information. See GEX Tech Memo 100-204 for detailed information about GEX's development of this technique and contact GEX Customer Support with any questions at 303-400-9640 or sales@gexcorp.com