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DynaLog File Viewer Reference Guide

MARK-Series MLC
Millennium MLC
HD120 MLC

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Abstract

The DynaLog File Viewer Reference Guide (P/N 100013698-05) provides reference information and procedures for using the DynaLog File Viewer, version 7.0.

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Chapter 1 Introduction

This reference guide describes *DynaLog files* and how to use DynaLog File Viewer, version 7.0 (DFV), a program that analyzes data in DynaLog files and displays the data in graphical formats.

DynaLog File Viewer Reference Guide is written for physicists who want to statistically evaluate leaf positions and the beam state of the Clinac during a dynamic treatment using a MARK-Series MLC or a Millennium MLC (this includes the HD120 MLC). This guide uses the term MARK-Series to indicate all pre-Millennium MLCs including MLC, Standard MLC, CR-MLC, and MARK-Series MLC.

Before You Begin

Before you begin using DFV, you should be familiar with the Microsoft Windows operating environment and have basic knowledge of the MLC software.

Visual Cues

This reference guide uses the following visual cues for locating and identifying information:

Bold—Identifies menu commands, items you can click or select on the screen, and keyboard keys.

Italics—Used for new terms, emphasis, and book titles.

`Monotype`–Identifies file names, folder names, and text that either appears on the screen or that you are required to type in.

Note: *Describes actions or conditions that can help the user obtain optimum performance from the equipment or software.*

Related Publications

The following Varian publications provide additional information for using DFV:

- *Millennium MLC Instructions for Use* (P/N 100023304)
- *Millennium System and Maintenance Guide* (P/N 100012956)
- *MLC File Format Description* (P/N 1106064)
- *HD120 MLC Instructions for Use* (P/N 100029584)
- *HD120 MLC Systems and Maintenance Guide* (P/N 100029585)
- *MLC User Guide* (P/N 1101351)
- *MLC System and Maintenance Guide* (P/N 1101018)
- *Argus Linac IMRT User Guide* (P/N 100014669)
- *DMLC Implementation Guide* (P/N 1105417)
- *DMLC Test Patterns and Procedures* (P/N 100012878)

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3. Click **Contact U**s at the top of the window.

4. From the Contact Us page:
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2. In the Services & Support menu, choose **Oncology Support**.

3. Click **Contact Varian Oncology** on the right side of the screen.

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DynaLog File

A DynaLog file is a record of the actual dose fraction (dose dynamic) or gantry angle (arc dynamic) versus actual MLC leaf positions from either a *dynamic treatment* or a segmental treatment, generated in ASCII format. A dynamic treatment is a treatment during which the MLC leaves, collimator, or gantry moves while the beam is on and both the dose rate and the speed of the leaves are continually adjusted by the control system. The DynaLog data are taken every 50 ms by the MLC controller. The recording continues until the dynamic treatment is completed or terminated or until the DynaLog file recording time limit is reached. That time limit depends on the MLC memory resources and the MLC software version. After the time limit is reached, the dynamic treatment continues to completion, but no further DynaLog information is collected for that treatment. However, MLC software version 7.X has unlimited size (time). Auto save is only accomplished if automatic DynaLog logging was started prior to treatment.

The MLC controller stores the DynaLog data in a temporary memory buffer. Each time you load a new dynamic treatment, the MLC controller overwrites the DynaLog data from the previous treatment. As a result, the DynaLog data for the finished treatment is no longer retrievable. To prevent losing data from your dynamic treatment, save the DynaLog files after each field or turn on the auto-save of DynaLog files.

DynaLog File Size

The DynaLog file size is dependent upon the elapsed treatment time. The longer the dynamic treatment lasts, the larger the DynaLog file size becomes.

File size might become a consideration on the MARK-Series MLC, where the file needs to be transferred from the controller using floppy disks.

If the file becomes too large, you can use a file-compression utility to reduce its size so that it fits on the floppy disk. One popular compression tool is PKZIP, available from the PKWARE web site at **`http://www.pkware.com`**. Another alternative is the public domain compression tool Zip from the Info-ZIP Group, which you can find in the **`ZipTool`** directory on the DFV installation CD-ROM. For more information about using this utility, see Appendix B "Compressing DynaLog Files."

DynaLog File Viewer Description

DFV is a utility program that allows you to view data from DynaLog files in graphical formats, whereas a standard text editor such as WordPad or Notepad does not allow you to do so. DFV takes the data from the DynaLog files and converts the data into tables and plots. DynaLog files are viewed by using one of the following formats:

- Error Histogram shows information for all leaf position deviations. DFV creates a histogram with a tally of the number of leaf position deviations within each bin. This plot is broken into 0.05 cm bins spanning a total range from 0–1.00 cm. The plot has a zero deviation bin for deviations less than 0.005 cm and an *above maximum* bin for deviations greater than 1.00 cm. The error histogram bin boundaries represent position deviations at the isocenter plane.

- Error RMS shows the calculated root mean square (RMS) value for leaf deviations. DFV calculates RMS values for leaf position deviations of individual leaves using the following formula:

$$LeafErrorRMS = \sqrt{\frac{\sum_{t=1}^{n} (LeafPlanPos_t - LeafActualPos_t)^2}{n}}$$

where:

t = data sample index

n = total number of samples

Note: *DynaLog files contain all leaf positions, but a leaf is included in the RMS calculations only if it or the opposing leaf moves during the treatment.*

- Beam Hold Off plot shows when and how often the beam hold-off is asserted during the dynamic treatment. This plot can be used as a tool to ensure that the system is operating correctly.
- Beam On plot shows when and how often the beam is on during the dynamic treatment.

For examples of each of the data tables and plots, as well as instructions on how to use DFV, see Chapter 3, “Using DynaLog File Viewer.”

Chapter 2 Generating DynaLog Files

The MARK-Series MLC and Millennium MLC controllers operate in different software environments; therefore, the procedure for generating DynaLog files for each type of controller is different. This chapter provides step-by-step instructions for generating DynaLog files for the MARK-Series MLC and the Millennium MLC.

Generating DynaLog Files for a MARK-Series MLC

To generate DynaLog files for a MARK-Series MLC, perform the following steps:

1. Close the patient file on the workstation.
2. Type **F** on the MLC controller keyboard.

   The MLC controller prompts you to type a letter that represents the disk drive where you want to save the DynaLog files for both carriages.
3. To save the DynaLog files, perform one of the following:

   Type **A** to save the DynaLog files onto a floppy disk.

   or

   Type **C** to save the DynaLog files to the hard disk drive.

Note: *DynaLog files saved to the hard disk drive are stored in the MLC controller directory and are not accessible while the MLC controller is in use. To access the files, exit the MLC controller.*

Once the disk drive has been specified where to save the DynaLog files, the MLC controller writes **`dynaloga.001`** for carriage A and **`dynalogb.001`** for carriage B to the designated drive. The MLC controller automatically increases the file extension number (for example, **`.002`**, **`.003`**, **`.004`** and so forth), each time new DynaLog files are generated.

If the DynaLog files are saved to a hard disk drive, to copy them onto a floppy disk, type one of the following commands at the MS-DOS prompt:

```
copy dynaloga.xxx a:dynaloga.xxx
copy dynalogb.xxx a:dynalogb.xxx
```

where **xxx** is the appropriate three-digit extension.

Generating DynaLog Files for a Millennium MLC

The Millennium MLC controller operates in a VxWorks® environment. Serial communications using HyperTerminal needs to be set up to communicate with the MLC controller, and an Ethernet connection is required to transfer DynaLog files to the workstation.

Use one of the following methods to generate DynaLog files for the Millennium MLC:

- Enter a command to save the DynaLog files for only the dynamic treatment just completed.
- Enter a command to make the MLC controller automatically save the DynaLog files after the completion of each dynamic treatment. There are two possible way to automatically save DynaLog files:
  - Enter a command at HyperTerminal that turns on the auto-save only for the current session.
  - Modify the appropriate **startup.*** file to turn auto-save on permanently.

Note: *The Millennium MLC controller automatically names the file when generating new DynaLog files. The name is based on the patient's information and time of treatment.*

To enable the system to generate and save dynaLogs automatically, in the HyperTerminal at the VxWorks prompt, type the following command:

`diagAutoDynalogs 2, 1` (for 6.X)

or

`diagAutoDynalogs 1` (for 7.X)

To turn off this feature, type the command:

`diagAutoDynalogs 2, 0` (for 6.X)

or

`diagAutoDynalogs 0` (for 7.X)

When this feature is enabled, as soon as a dynamic MLC treatment finishes, the controller writes those treatment DynaLog files to the DynaLogs folder subdirectory within the default **`FTP`** root directory on the MLC workstation. For example:

`...\Oncology\MLC\Controller\exec\DynaLogs\...`

Unlike manually generated DynaLog files, the controller assigns unique filenames to the automatically generated DynaLog files. The Revision A filenames are in the following form:

`CYYYYMMDDHHNN[ID].dlg` (ID :up to 25 characters in length)

where the values are as follows:

`C`	A or B for the MLC carriage (leaf bank)
`YYYY`	4-digit year
`MM`	2-digit month
`DD`	2-digit day of the month
`HH`	24-hour clock time stamp
`NN`	minutes time stamp
`ID`	VARiS Vision or ARIA field serial number, if VARiS Vision or ARIA is present, or the filename of the MLC plan file, if VARiS Vision or ARIA is not present.

The Revision B MLC controller names the files using the following convention:

CYYYYMMDDHHNNSS_<Patient ID>.dlg

where the values are as follows:

C	A or B for the MLC carriage (leaf bank)
YYYY	4-digit year
MM	2-digit month
DD	2-digit day of the month
HH	24-hour clock time stamp
NN	minutes time stamp
SS	seconds time stamp
<Patient ID>	The Patient ID, up to 25 characters

Chapter 3 Using DynaLog File Viewer

This chapter provides step-by-step instructions for using DynaLog File Viewer.

Starting DFV

DFV opens, saves, and displays the DynaLog files in data tables and plots.

To start DFV, double-click the **DynaLog File Viewer** icon on the desktop. (Alternatively, from the Windows **Start** menu, select **Programs** | **MLC Utilities** | **DynaLog File Viewer**)

When the program opens for the first time, the Configuration dialog box is displayed, allowing you to choose which MLC calculations are to be used, and what file formats are available (see "Setting the DynaLog File Interpretation" on page 13).

After the first time, when the program opens, the Open dialog box for the current configuration opens (see "Opening DynaLog Files" on page 15 and "Opening Classic DynaLog Files" on page 18).

Setting the DynaLog File Interpretation

What types of files you can open and how the data is interpreted is determined by which MLC type you specify. As noted in "Starting DFV" on page 13, you are prompted to select an MLC type when you start DFV for the first time. You can also change the MLC type at any time by selecting **MLC Type** from the **Config** menu (see Figure 1).

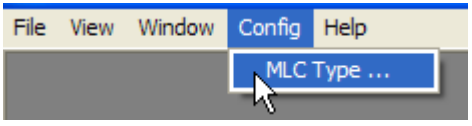


Figure 1 Config Menu

The dialog box in Figure 2 is opened so that you can select the MLC type.

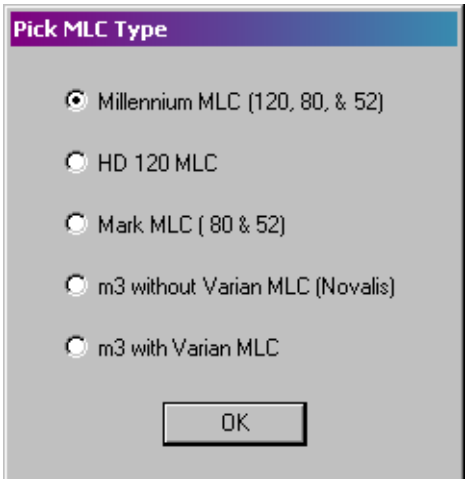


Figure 2 Pick MLC Type Dialog Box

The five choices represent the five MLC configurations. Each configuration uses different correction factors and calculation sets.

Note: *The same data yields different results using different configuration settings. Therefore, you should ensure that you select the configuration that was used to collect your data.*

If you select Millennium MLC or HD 120 MLC in the Pick MLC Type dialog box, you can open either Millennium DynaLog files or Classic files. If you select any of the other three configuration types, you can only open Classic files. For more information, see "Opening Millennium DynaLog Files" on page 15 and "Opening Classic DynaLog Files" on page 18.

Opening DynaLog Files

From the File menu, DFV can open either Millennium DynaLog files or Classic files.

Note: *You can only open Millennium DynaLog files if you have the MLC type set to Millennium MLC (see "Setting the DynaLog File Interpretation" on page 13).*

Opening Millennium DynaLog Files

If your version of DFV is configured for Millennium DynaLog files, the Open Dynalog File for Carriage A window (Figure 3) opens when you start the program.

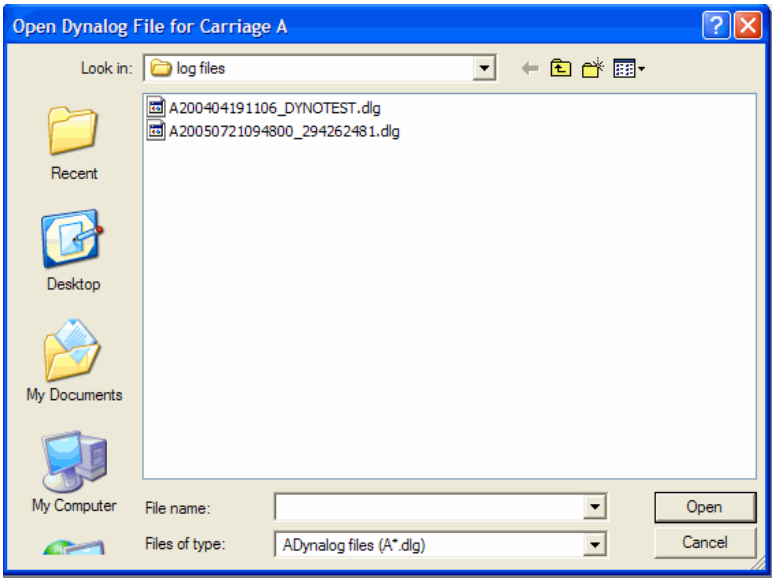


Figure 3 Open Dynalog File for Carriage A Window

At other times, you can display this window from the File menu (Figure 4).

To open a Millennium DynaLog file, perform the following steps:

1. From the **File** menu, select **Open Dynalog Files** (Figure 4).

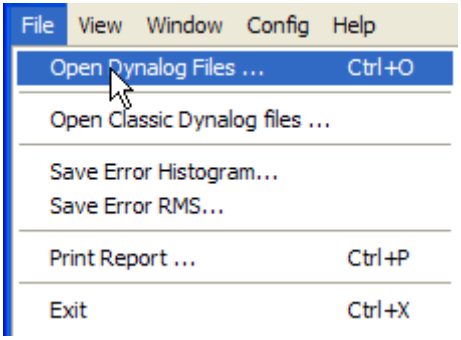


Figure 4 Open DynaLog Files from the File Menu

   The Open Dynalog File for Carriage A window (Figure 3) appears. If the desired file is not available, use the folder navigation buttons in the window to navigate to the directory containing the desired file to open.

2. Select the file for carriage A (for example, **`A20050721094800_294262481.dlg`**).

3. Click **Open**.

   The program opens the files for Carriage A and Carriage B. The filename for Carriage B is automatically assumed to be the same as that for Carriage A with a B prefix instead of an A.

The program automatically generates the data tables and plots for both the error RMS and the error histogram data and displays them in the main window (Figure 5).

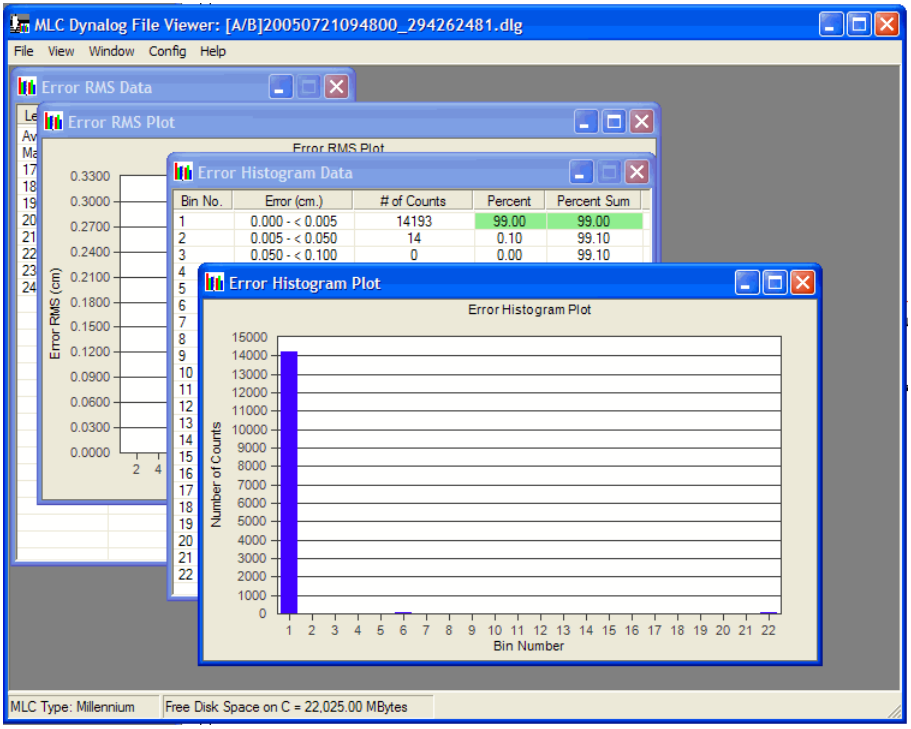


Figure 5 Example of DynaLog Files in Main Window

Opening Classic DynaLog Files

To open a Classic DynaLog file, perform the following steps:

1. From the **File** menu, select **Open Classic Dynalog Files** (Figure 6).

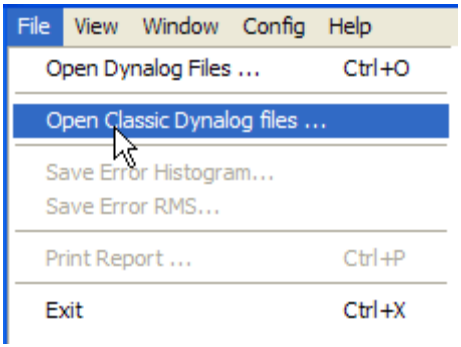


Figure 6 Open Classic DynaLog File from the File Menu

The Open Classic Dynalog File for Carriage A window (Figure 7) appears.

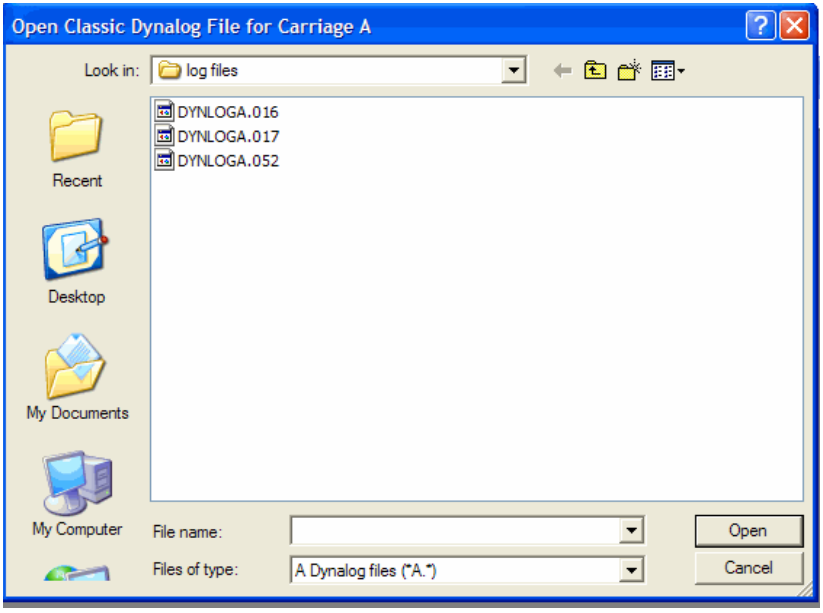


Figure 7 Open Dynalog File for Carriage A Window

2. If the desired file is not available, use the folder navigation buttons in the window to navigate to the directory containing the desired file to open.
3. Select the file for carriage A (for example, **`DYNALOGA.015`**).
4. Click **Open**.

   The program opens the files for Carriage A and Carriage B. The file for Carriage B is automatically assumed to be the same as that for Carriage A with the last letter of the filename being B instead of A.

   The program automatically generates the data tables and plots for both the error RMS and the error histogram data and displays them in the main window (Figure 8).

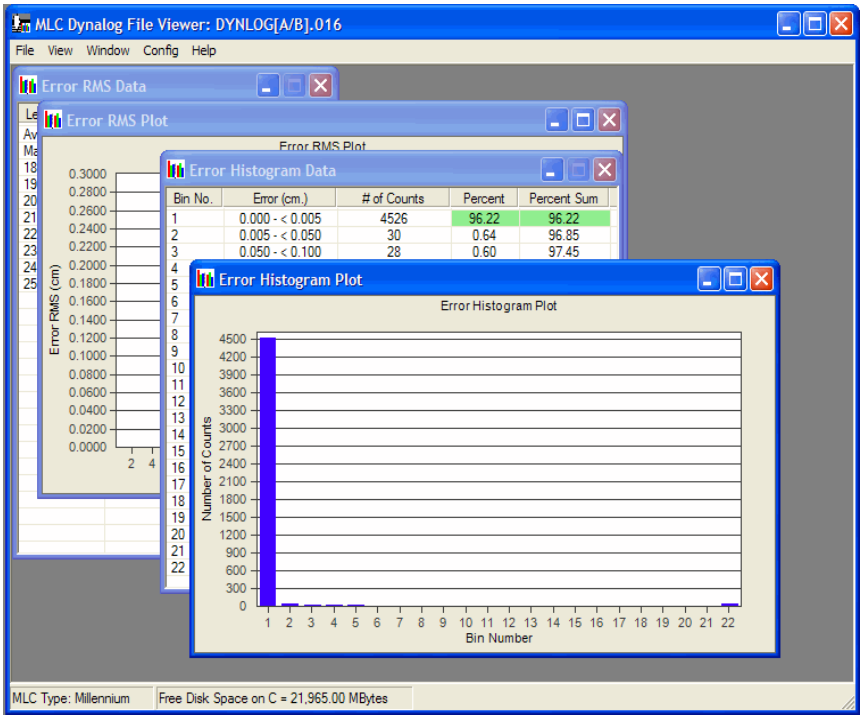


Figure 8 Example of Classic DynaLog Files in Main Window

Saving DynaLog Analysis Results

To save the error histogram data table, perform the following steps:

1. From the **File** menu, select **Save Error Histogram** (Figure 9).

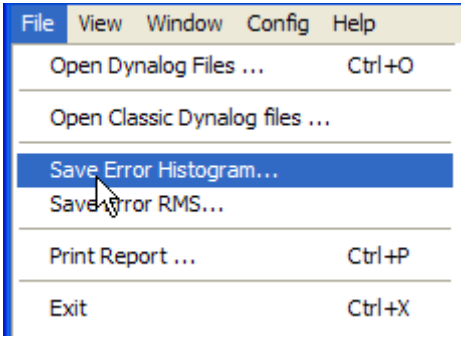


Figure 9 File Menu: Save Error Histogram Command

The Save Histogram Data window (Figure 10) appears.

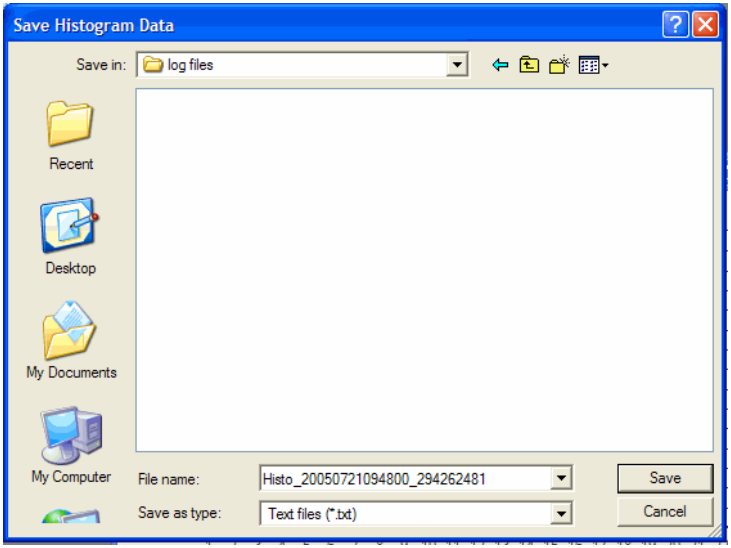


Figure 10 Save Histogram Data Window

2. Accept the default file name or type a new file name for the error histogram data table in the **File name** text box.

3. Click **Save**.

   DFV saves the file for the error histogram data table and closes the window.

The error histogram data file is an ASCII text file that contains the same data as the Error Histogram Data window, described in "Error Histogram" on page 23.

To save the error RMS data, perform the following steps:

1. From the **File** menu, select **Save Error RMS (**Figure 11**)**.

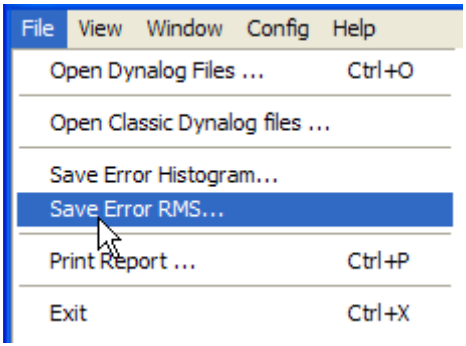


Figure 11 File Menu: Save Error RMS Command

The Save RMS Data window (Figure 12) appears.

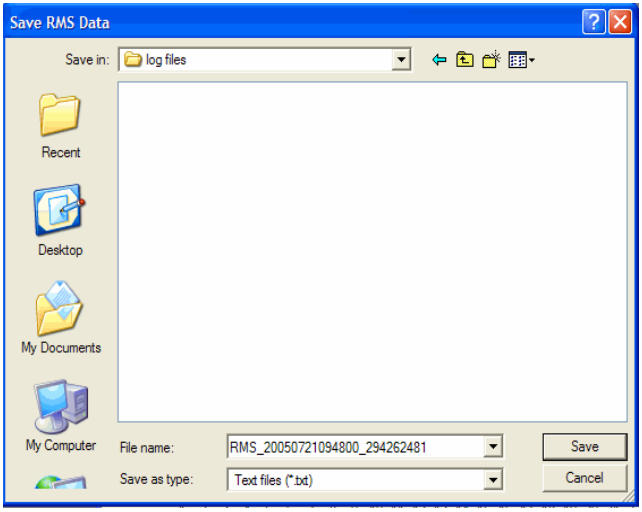


Figure 12 Save RMS Data Window

2. Accept the default file name or type a new file name for the error RMS data table in the **File name** text box.
3. Click **Save**.

   The program saves the error RMS file and closes the window.

The error RMS data file is an ASCII text file that contains the same data as the Error RMS Data window, described in "Error RMS" on page 25.

Viewing DynaLog Data in Graphical Formats

If the tables and plots for the DynaLog data are not visible, reopen them from the View menu and select the desired data tables and plots to view (Figure 13).

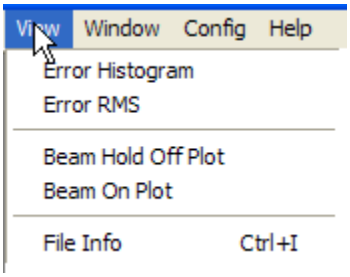


Figure 13 View Menu

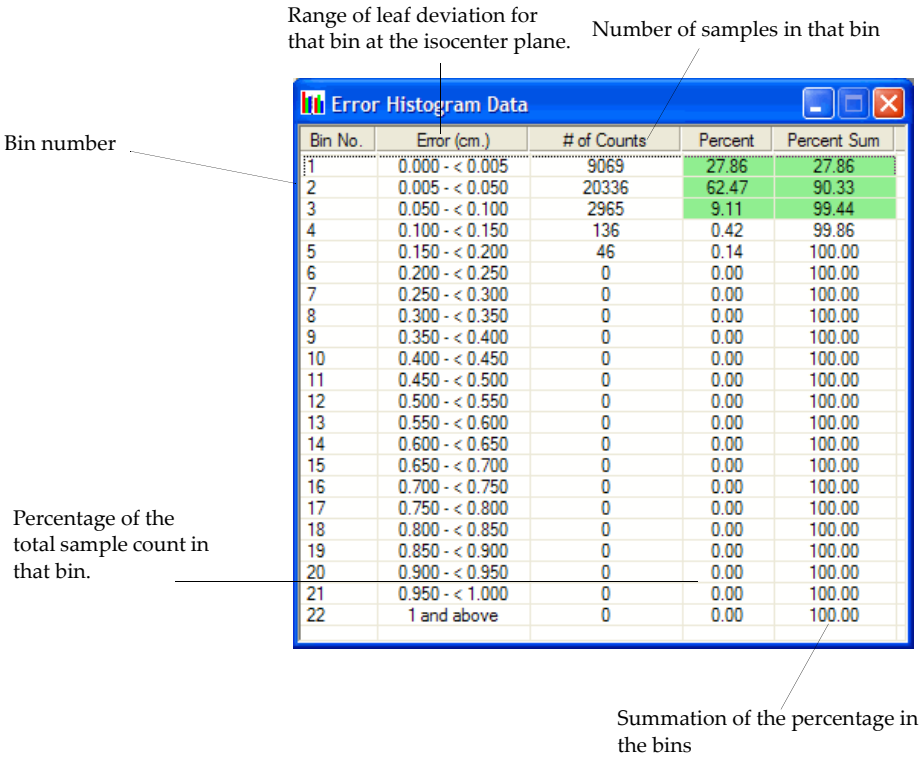
When selecting either Error Histogram or Error RMS from the View menu, DFV displays both the data table and the plot in the main window. For clarity, this reference guide shows the data tables and plots in individual figures.

Error Histogram

To view the error histogram data, select **Error Histogram** from the **View** menu. You can also select either **Error Histogram Data** or **Error Histogram Plot** from the **Window** menu.

DFV opens both the Error Histogram Data (Figure 14) and the Error Histogram Plot windows (Figure 16).

The Error Histogram Data table has five columns.



Error Histogram Data

Bin No.	Error (cm.)	# of Counts	Percent	Percent Sum
1	0.000 - < 0.005	9069	27.86	27.86
2	0.005 - < 0.050	20336	62.47	90.33
3	0.050 - < 0.100	2965	9.11	99.44
4	0.100 - < 0.150	136	0.42	99.86
5	0.150 - < 0.200	46	0.14	100.00
6	0.200 - < 0.250	0	0.00	100.00
7	0.250 - < 0.300	0	0.00	100.00
8	0.300 - < 0.350	0	0.00	100.00
9	0.350 - < 0.400	0	0.00	100.00
10	0.400 - < 0.450	0	0.00	100.00
11	0.450 - < 0.500	0	0.00	100.00
12	0.500 - < 0.550	0	0.00	100.00
13	0.550 - < 0.600	0	0.00	100.00
14	0.600 - < 0.650	0	0.00	100.00
15	0.650 - < 0.700	0	0.00	100.00
16	0.700 - < 0.750	0	0.00	100.00
17	0.750 - < 0.800	0	0.00	100.00
18	0.800 - < 0.850	0	0.00	100.00
19	0.850 - < 0.900	0	0.00	100.00
20	0.900 - < 0.950	0	0.00	100.00
21	0.950 - < 1.000	0	0.00	100.00
22	1 and above	0	0.00	100.00

Figure 14 Error Histogram Data Window

The last column contains the summation of the percentages in the fourth column. If the sum of the percentages reaches 95% within the first 8 rows, then the Percent and Percent Sum columns of the row that crosses the 95% threshold, as well as the previous rows, are shaded green.

If the sum of the percentages does not reach 95% in the first 8 rows, then the first 8 rows are shaded green, and the subsequent rows are shaded red up to the row that reaches the 95% mark.

If there is a non-zero # **of Counts** value for bin 22, then that value is shaded yellow (see Figure 15).

Error Histogram Data

Bin No.	Error (cm.)	# of Counts	Percent	Percent Sum
1	0.000 - < 0.005	14193	99.00	99.00
2	0.005 - < 0.050	14	0.10	99.10
3	0.050 - < 0.100	0	0.00	99.10
4	0.100 - < 0.150	0	0.00	99.10
5	0.150 - < 0.200	0	0.00	99.10
6	0.200 - < 0.250	34	0.24	99.34
7	0.250 - < 0.300	15	0.10	99.44
8	0.300 - < 0.350	0	0.00	99.44
9	0.350 - < 0.400	0	0.00	99.44
10	0.400 - < 0.450	0	0.00	99.44
11	0.450 - < 0.500	13	0.09	99.53
12	0.500 - < 0.550	9	0.06	99.60
13	0.550 - < 0.600	0	0.00	99.60
14	0.600 - < 0.650	0	0.00	99.60
15	0.650 - < 0.700	0	0.00	99.60
16	0.700 - < 0.750	11	0.08	99.67
17	0.750 - < 0.800	9	0.06	99.73
18	0.800 - < 0.850	0	0.00	99.73
19	0.850 - < 0.900	0	0.00	99.73
20	0.900 - < 0.950	0	0.00	99.73
21	0.950 - < 1.000	5	0.03	99.77
22	1 and above	33	0.23	100.00

Figure 15 Error Histogram Data with Shading for Bin 22

The specifications that determine pass or fail (red or green) are set to match the current Varian specification, and cannot be altered by the user.

The Error Histogram Plot provides a graphical representation of the Error Histogram Data values.

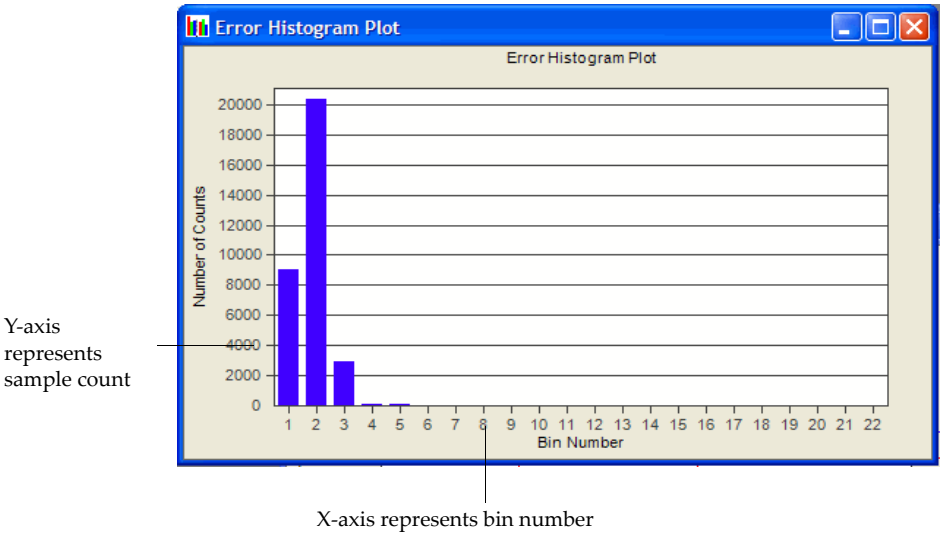


Figure 16 Error Histogram Plot Window

Error RMS

To view the error RMS data, select **Error RMS** from the **View** menu.

DFV displays both the Error RMS Data (Figure 17) and the Error RMS Plot (Figure 18) windows.

The first row of the Error RMS Data table shows the average RMS error for the moving leaves on carriage A and carriage B. The second row shows the maximum of the RMS error for the leaves on carriage A and carriage B. The green shading indicates the maximum of the two. If the maximum value is greater than the acceptance specification, then the value is shaded red instead of green.

The remaining rows represent the RMS error for each individual leaf. All error values are in units of centimeters at the treatment plane. Leaf pairs that do not move during the course of the treatment are not included in the RMS calculations.

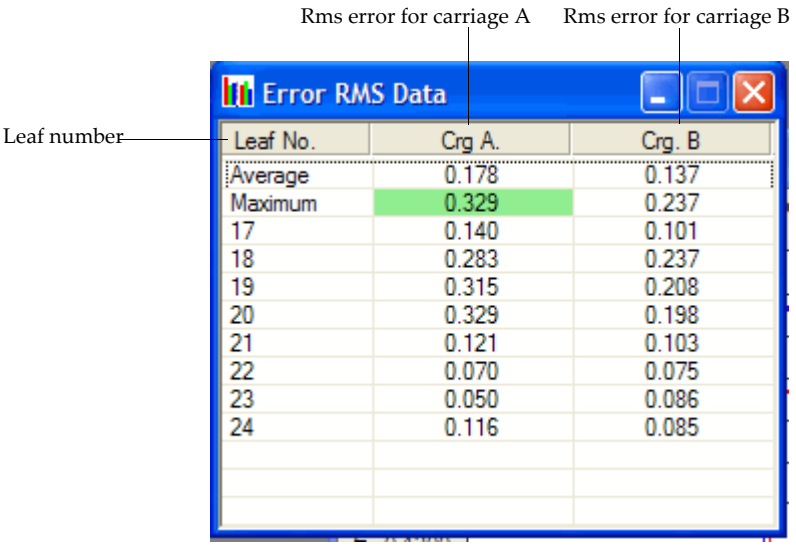


Figure 17 Error RMS Data Window

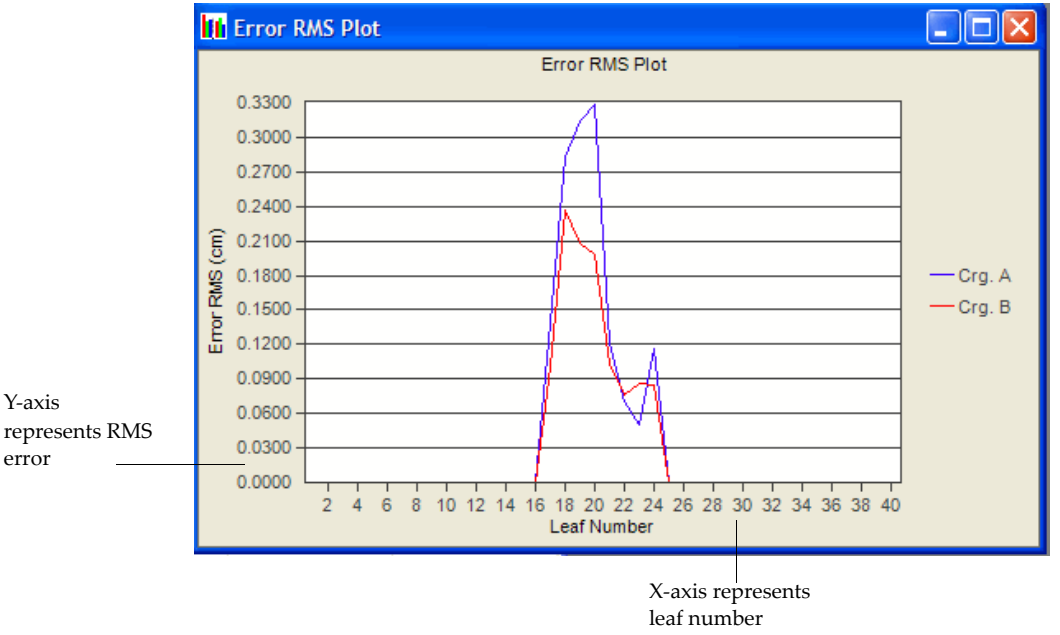


Figure 18 Error RMS Plot Window

Beam On Plot

To view the Beam On Plot, select **Beam On Plot** from the **View** menu.

The Beam On Plot window (Figure 19) appears.

This plot shows the state of the beam during the dynamic treatment as a function of time. The X-axis represents time; the Y-axis has a 0 or 1 value. A 1 represents the state in which the beam is on, and 0 represents the state in which the beam is off.

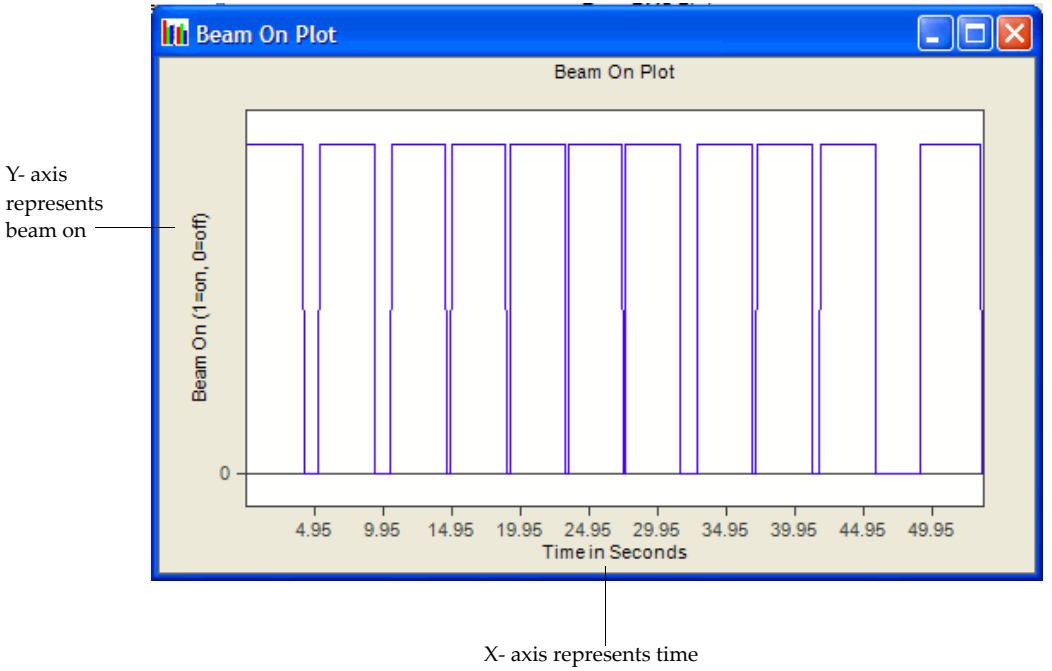


Figure 19 Beam On Plot Window

Beam Hold Off Plot

To view the Beam Hold Off Plot, select **Beam Hold Off Plot** from the **View** menu.

The Beam Hold Off Plot window (Figure 20) appears.

This plot shows the state of the beam hold-off during the dynamic treatment as a function of time. The Y-axis can have a value of 0 or 1. A 1 represents the state in which the beam hold-off is on (X-ray off), and 0 represents the state in which the beam hold-off is off (X-ray on). The X-axis represents time.

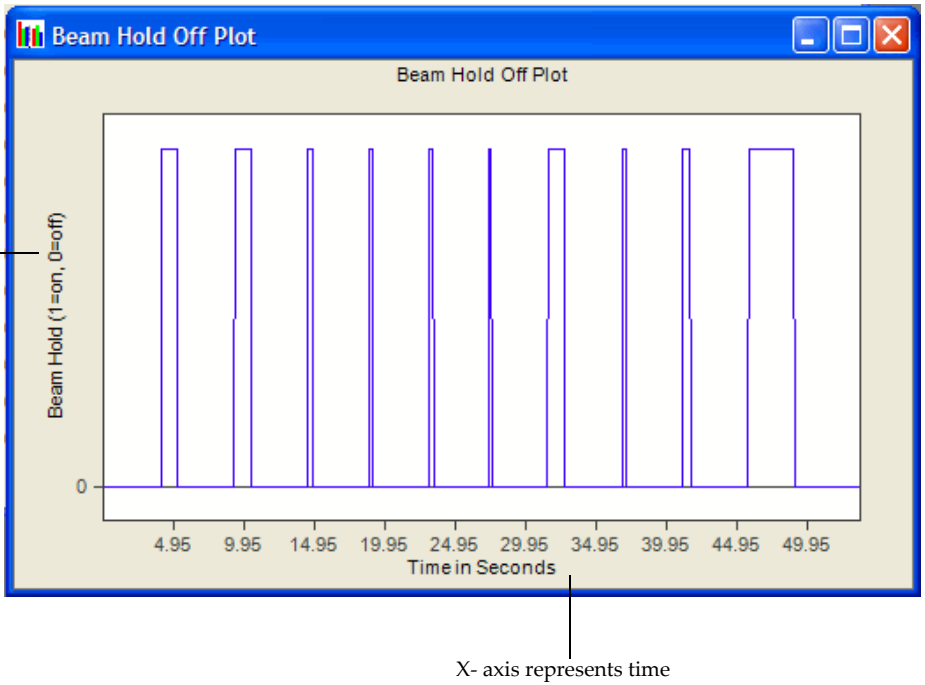


Figure 20 Beam Hold Off Plot Window

Arranging DynaLog File Graphical Formats

When several data tables and plots are open, specify which data table or plot appears in the front by clicking on the window or by using the Window menu.

From the **Window** menu, select the desired DynaLog file information to bring to the front (Figure 21) or click on the window.

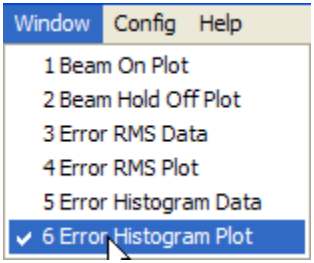


Figure 21 Window Menu

The Window menu displays only the open data tables and plots. Data tables and plots are numbered in the order in which they were opened.

Note: *In order to bring a specific data table or plot to the front, that data table or plot must be active and appear in the main DFV window.*

Displaying File Information

Display information about the current data files by selecting the **File Info** option from the **View** menu.

Figure 22 shows an example of the information displayed about the current data files.

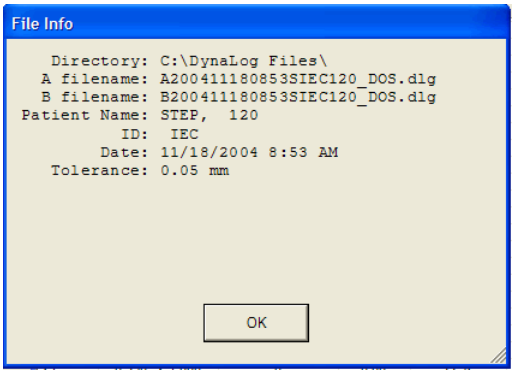


Figure 22 File Info Data Box

Printing DynaLog File Reports

To print DynaLog file reports, select **Print Reports** from the **File** menu. In the standard Windows print dialog box, select the desired printer and click **OK**.

The **Print Reports** option prints a single report with file information, plus the data tables and charts from the windows that are open. This can include:

- Error Histogram Plot
- Error Histogram Data
- Error RMS Plot
- Error RMS Data
- Beam On Plot
- Beam Hold Off Plot

Closing DynaLog Files

Close the DynaLog file tables and plots by clicking the close button (X) in the upper right corner of the respective windows.

Obtaining the DFV Version Number

You can display the DFV version number by selecting **About** (Figure 23) from the **Help** menu.

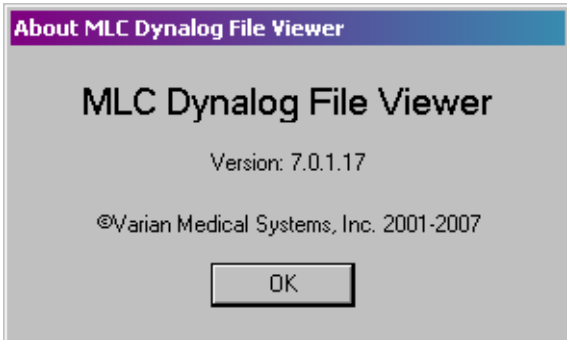


Figure 23 About MLC Dynalog File Viewer Data Box

Exiting DFV

To exit DFV, select **Exit** from the **File** menu.

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Chapter 4 Interpreting DynaLog Analysis Results

This chapter describes how to interpret the statistical analysis of DynaLog data results.

DFV Analysis of Step-and-Shoot Treatments

In order to understand the statistical analyses performed by DFV for step-and-shoot treatments, it is important to understand some details on how the leaves are instructed to move throughout the treatment, and how this information is recorded in the DynaLog files.

Varian dynamic MLC treatments are driven by MLC plan files, also known as *dva* files. MLC plan files are the instructions for the positioning of all MLC leaves throughout the treatment, and consist of a progressive sequence of dose fractions; associated with each dose fraction is an intended position for each leaf. Step-and-shoot treatments contain alternating *step* and *shoot* segments: the step segment instructs the leaves to move with no dose increase; the shoot segment instructs the dose fraction to increase with no leaf movement.

In each 50-ms control cycle, the Clinac reports the current dose fraction along with the actual position of each leaf. The MLC controller determines if the actual dose fraction has reached the next dose fraction listed in the MLC plan file. If so, the next dose fraction, along with a new set of leaf positions, is read from the MLC plan file; these positions then become the *new* expected leaf positions. At this *transition* point, the leaves are in the leaf positions associated with the former dose fraction—the *old* positions—but the MLC controller now expects them to be at the *new* positions. Often for the step-and-shoot technique, these position changes are large—on the order of millimeters or even centimeters—and they exceed the dynamic leaf tolerance. In this case, a beam hold-off is asserted.

At this instant in time, the following occurs:

- Leaf position deviations are equal to the distance between the current actual leaf positions (which were the *old* expected positions) and the newly calculated expected leaf positions.
- Beam hold-off has been asserted.
- Beam hold-off instruction has not yet been delivered to the Clinac, and so the beam is still on.

The DynaLog file record for this instant records the following:

- Beam hold-off = 1 (Yes) or = 2 (during LFIMRT carriage group transitions)
- Beam on = 1 (Yes)
- Actual leaf positions equal to the *old* positions
- Expected leaf positions equal to the *new* positions

Note: Even if the dynamic leaf tolerance is not exceeded, these *transition values* are still relatively large.

The DFV includes all DynaLog file data points with beam on = 1 in its calculations, and so these transition points are always included. The result is that, at each transition point, leaf deviation values equal to the intended incremental movement of the leaf—relatively large values—are included in the statistical calculations.

It is important to understand that under this normal operation of the MLC, these transition-point deviations are always included in the statistical results calculated by DFV.

Relation Between Dynamic Tolerance and RMS Error

DynaLog data depend on the dynamic plan and the treatment setup.

Typically, DynaLog data include the following characteristics:

- Distinguishable correlation exists between the histogram distribution and the RMS error values for leaf position deviations. When the RMS error values are large, the histogram bin counts reflect this fact. For example, more tallies may be in bin ranges trending toward 1.0 cm. On the other hand, when the RMS error values are smaller, more tallies may be in bin ranges trending toward 0.0 cm.

Note: *The number of RMS samples is derived from the summation of bin tallies and the number of active leaves, according to the following equation:*

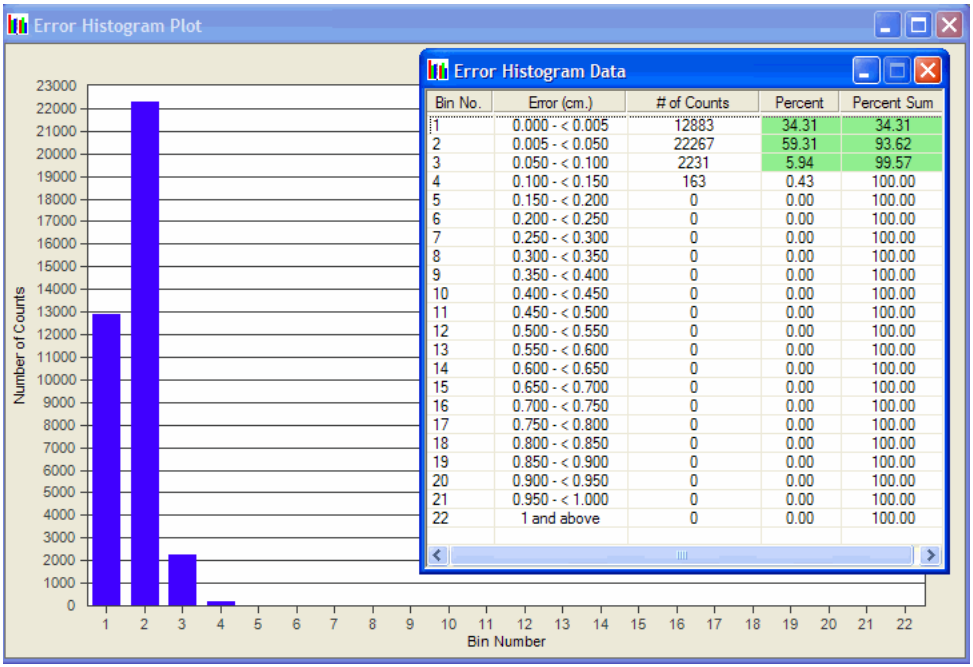
$$\text{Number of RMS Samples} = \frac{\text{Summation of Bin Samples}}{\text{Number of Active Leaves}}$$

Active leaves are those leaves that move during the delivery of the dynamic field.

- Smaller dynamic tolerance values result in lower RMS error values, whereas larger dynamic tolerance values result in higher RMS error values.
- Smaller dynamic tolerance values result in a larger occurrence of beam hold-offs.

Figure 24 through Figure 32 show results of the Error Histogram Values, Error RMS Values, and Beam Hold Off Plot windows of DynaLog files from treatments delivered using various total doses and dose rates

Figure 24 shows the Error Histogram Data window. The inset window shows quantitative leaf histogram data values split into bins, the number of tallies per bin, and the percentage of occurrences in each bin. The large window displays a graphical representation of the same data. This IMRT plan was delivered using 180 MU at a dose rate of 300 MU/min.



Bin No.	Error (cm.)	# of Counts	Percent	Percent Sum
1	0.000 - < 0.005	12883	34.31	34.31
2	0.005 - < 0.050	22267	59.31	93.62
3	0.050 - < 0.100	2231	5.94	99.57
4	0.100 - < 0.150	163	0.43	100.00
5	0.150 - < 0.200	0	0.00	100.00
6	0.200 - < 0.250	0	0.00	100.00
7	0.250 - < 0.300	0	0.00	100.00
8	0.300 - < 0.350	0	0.00	100.00
9	0.350 - < 0.400	0	0.00	100.00
10	0.400 - < 0.450	0	0.00	100.00
11	0.450 - < 0.500	0	0.00	100.00
12	0.500 - < 0.550	0	0.00	100.00
13	0.550 - < 0.600	0	0.00	100.00
14	0.600 - < 0.650	0	0.00	100.00
15	0.650 - < 0.700	0	0.00	100.00
16	0.700 - < 0.750	0	0.00	100.00
17	0.750 - < 0.800	0	0.00	100.00
18	0.800 - < 0.850	0	0.00	100.00
19	0.850 - < 0.900	0	0.00	100.00
20	0.900 - < 0.950	0	0.00	100.00
21	0.950 - < 1.000	0	0.00	100.00
22	1 and above	0	0.00	100.00

Figure 24 Error Histogram Data and Plot at 180 MU and 300 MU/Min

Figure 25 shows a plot of leaf RMS error values for the same treatment as used for Figure 24.

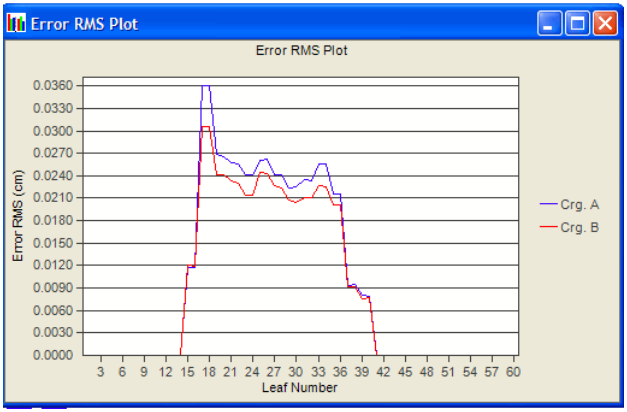


Figure 25 Error RMS Values Plot at 180 MU and 300 MU/Min

Figure 26 shows the Beam Hold Off plot for the same treatment. In this case, there were no beam hold-offs.

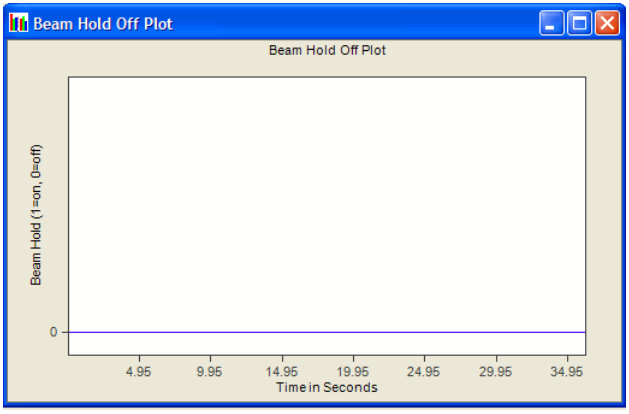
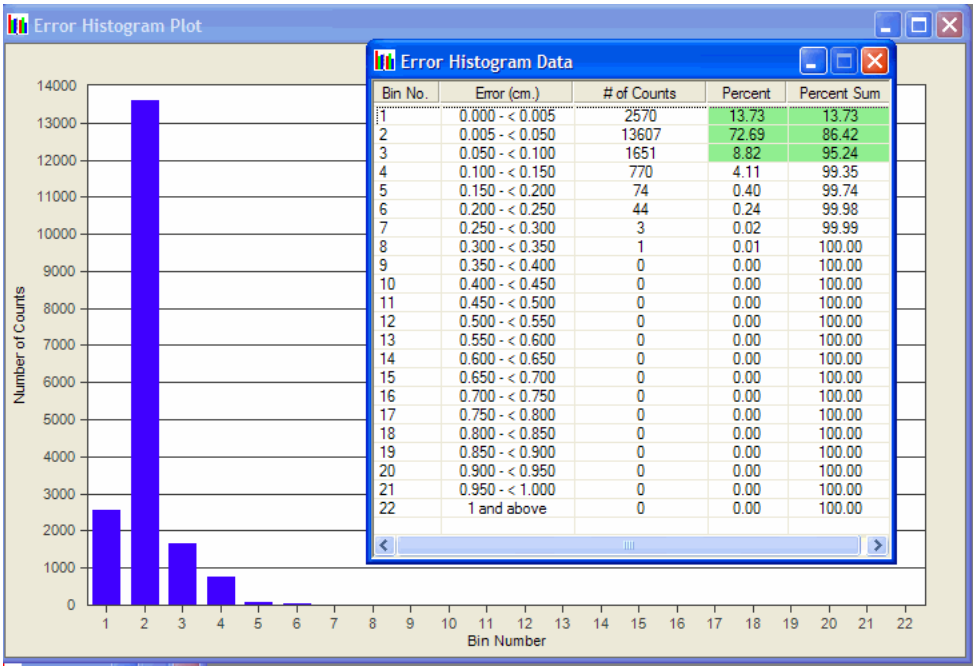


Figure 26 Beam Hold Off Plot at 180 MU and 300 MU/Min

Figure 27 shows the same display as shown in Figure 24, except that the treatment represented in Figure 27 was delivered using a dose rate of 600 MU/min rather than 300 MU/min. The higher dose rate requires the leaves to move faster to maintain the desired dose versus position prescribed in the MLC plan file. Note the higher percentage of counts in the 0.005 cm–0.05 cm bin (72.69%) compared to the same bin shown in Figure 24 (59.31%).



Bin No.	Error (cm.)	# of Counts	Percent	Percent Sum
1	0.000 - < 0.005	2570	13.73	13.73
2	0.005 - < 0.050	13607	72.69	86.42
3	0.050 - < 0.100	1651	8.82	95.24
4	0.100 - < 0.150	770	4.11	99.35
5	0.150 - < 0.200	74	0.40	99.74
6	0.200 - < 0.250	44	0.24	99.98
7	0.250 - < 0.300	3	0.02	99.99
8	0.300 - < 0.350	1	0.01	100.00
9	0.350 - < 0.400	0	0.00	100.00
10	0.400 - < 0.450	0	0.00	100.00
11	0.450 - < 0.500	0	0.00	100.00
12	0.500 - < 0.550	0	0.00	100.00
13	0.550 - < 0.600	0	0.00	100.00
14	0.600 - < 0.650	0	0.00	100.00
15	0.650 - < 0.700	0	0.00	100.00
16	0.700 - < 0.750	0	0.00	100.00
17	0.750 - < 0.800	0	0.00	100.00
18	0.800 - < 0.850	0	0.00	100.00
19	0.850 - < 0.900	0	0.00	100.00
20	0.900 - < 0.950	0	0.00	100.00
21	0.950 - < 1.000	0	0.00	100.00
22	1 and above	0	0.00	100.00

Figure 27 Error Histogram Data and Plot at 180 MU and 600 MU/Min

Figure 28 shows the plot of leaf RMS error values for this treatment. Notice that the general shape of the curve is similar to Figure 25, but the individual peak values have increased compared to the individual peak values in Figure 25.

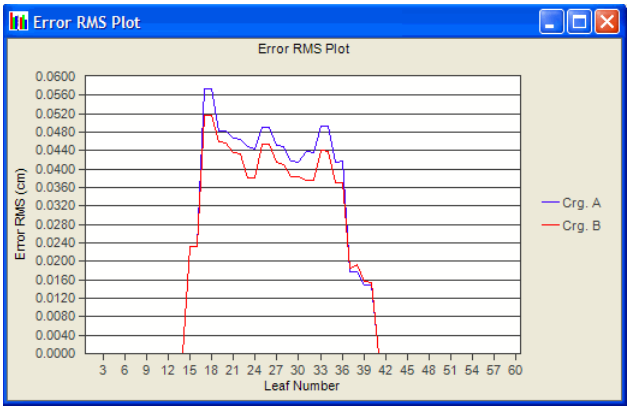


Figure 28 Error RMS Values Plot at 180 MU and 600 MU/Min

Figure 29 shows the Beam Hold Off plot for the treatment delivered at 600 MU/min. This plan results in more beam hold-offs compared to Figure 26, because the beam needed to be paused while the leaves moved into the positions as prescribed in the MLC plan file.

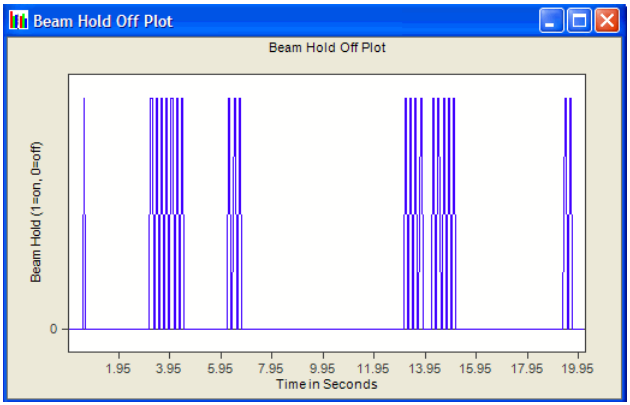
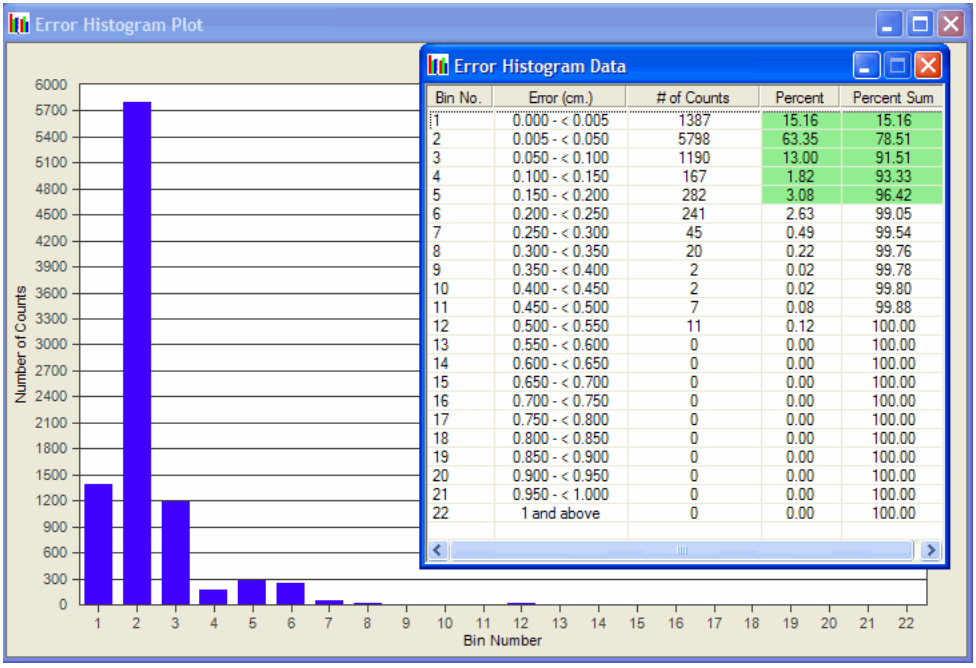


Figure 29 Beam Hold Off Plot at 180 MU and 600 MU/Min

Figure 30 corresponds to Figure 24 except that Figure 30 was generated with a total dose of 45 MU rather than 180 MU. The lower total dose requires the leaves to move at a faster speed to maintain the desired dose versus position prescribed in the MLC plan file. Note the slightly higher percentage of counts in the 0.005 cm–0.05 cm bin (63.35%) compared with the same bin shown in Figure 24 (59.31%).



Bin No.	Error (cm.)	# of Counts	Percent	Percent Sum
1	0.000 - < 0.005	1387	15.16	15.16
2	0.005 - < 0.050	5798	63.35	78.51
3	0.050 - < 0.100	1190	13.00	91.51
4	0.100 - < 0.150	167	1.82	93.33
5	0.150 - < 0.200	282	3.08	96.42
6	0.200 - < 0.250	241	2.63	99.05
7	0.250 - < 0.300	45	0.49	99.54
8	0.300 - < 0.350	20	0.22	99.76
9	0.350 - < 0.400	2	0.02	99.78
10	0.400 - < 0.450	2	0.02	99.80
11	0.450 - < 0.500	7	0.08	99.88
12	0.500 - < 0.550	11	0.12	100.00
13	0.550 - < 0.600	0	0.00	100.00
14	0.600 - < 0.650	0	0.00	100.00
15	0.650 - < 0.700	0	0.00	100.00
16	0.700 - < 0.750	0	0.00	100.00
17	0.750 - < 0.800	0	0.00	100.00
18	0.800 - < 0.850	0	0.00	100.00
19	0.850 - < 0.900	0	0.00	100.00
20	0.900 - < 0.950	0	0.00	100.00
21	0.950 - < 1.000	0	0.00	100.00
22	1 and above	0	0.00	100.00

Figure 30 Error Histogram Data and Plot at 45 MU and 300 MU/Min

Figure 31 corresponds to Figure 25 except that, while the general shape of the curve remains quite similar to the curve in Figure 25, the individual peak values have increased from over 0.036 cm in Figure 25 to a little over 0.11 cm in Figure 31.

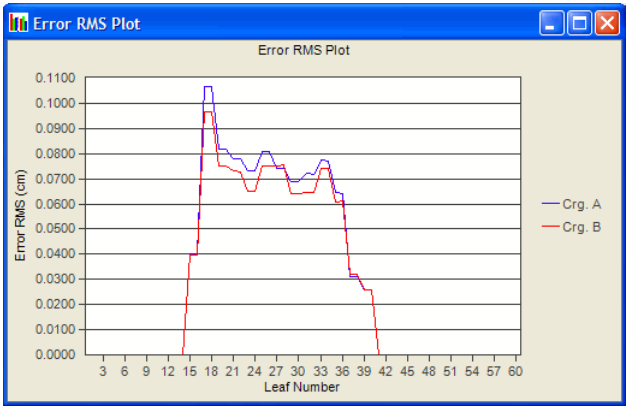


Figure 31 Error RMS Values Plot at 45 MU and 300 MU/Min

Figure 32 corresponds to Figure 26 and Figure 29 except that the total dose and/or dose rate was reduced. Notice the larger number of beam hold-offs in this plot compared to the beam hold-offs in Figure 29. This is what is expected when the treatment conditions are changed so that the time allowed for the leaf movements is reduced from 0.30 minutes at 600 MU/min and 180 MU total dose to 0.15 minutes at 300 MU/min and 45 MU total dose.

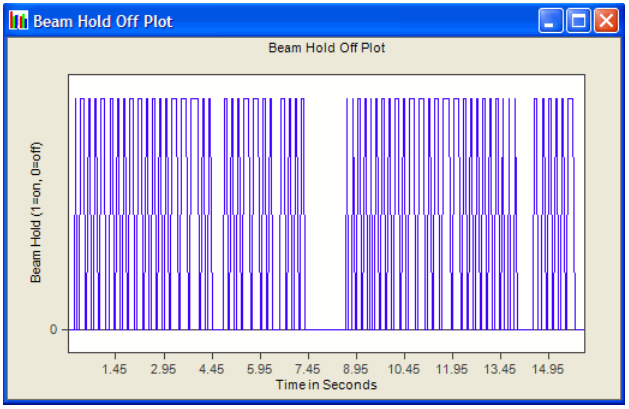


Figure 32 Beam Hold Off Plot at 45 MU and 300 MU/Min

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Appendix A DynaLog File Contents

This appendix describes the DynaLog file naming convention, file header, and file contents for the Millennium Revision B file type, which is the only file type generated by the current version of the MLC software.

File Naming Convention

The MLC controller names the files using the following convention:

```
[A or B]YYYYMMDDHHNNSS_<Patient ID>.dlg
```

where:

C	A or B for the MLC carriage (leaf bank)
YYYY	4-digit year
MM	2-digit month
DD	2-digit day of the month
HH	24-hour clock time stamp
NN	minutes time stamp
SS	seconds time stamp
<Patient ID>	The Patient ID, up to 25 characters

File Header

The file header consist of 4 lines with the following meanings:

Line	Format	Description
1	B	Letter indicating version
2	<Lastname>,<Firstname>,<ID>	Patient information, up to 25 characters
3	<Field Serial Number> or <PlanUID>,<Beam Number> or <Plan filename>	If VARiS 6.2 or Treat 6.5 or greater or Standalone[a]
4	<long>	Tolerance
5	<long>	Number of leaves in MLC
6	<long>	Clinac Scale 0 = Varian scale 1 = IEC scale

a. The logic for determining the third line is as follows: If the Field Serial number is non-zero, it is assumed to be VARiS 6.2. If the Field Serial number is zero and the PlanUID is non-zero, it is assumed to be Treat 6.5 or greater. If both the Field Serial number and the PlanUID are zero, the filename is used. If the filename is an empty string, a blank line is written.

File Content

Each line of the DynaLog file contains the following:

Column	Format	Description
1	<long>	Current dose fraction or current gantry rotation[a]
2	<long>	Previous segment number (starting with zero)
3	<long>	Beam hold-off state 2 = LFIMRT carriage group transitions 1 = MLC beam hold-off signal asserted 0 = MLC beam hold-off signal not asserted
4	<long>	Beam on state 1 = Clinac beam is on 0 = beam is off
5	<long>	Previous segment dose index or previous segment gantry angle
6	<long>	Next segment dose index or next segment gantry angle
7	<long>	Gantry rotation in 10th of a degree
8	<long>	Collimator rotation in 10th of a degree
9	<long>	Upper Y1 jaw position in mm in the isoplane
10	<long>	Upper Y2 jaw position in mm in the isoplane
11	<long>	Lower X1 jaw position in mm in the isoplane
12	<long>	Lower X2 jaw position in mm in the isoplane

Column	Format	Description
13	<long>	Carriage expected position in 100th of a mm
14	<long>	Carriage actual position in 100th of a mm
The remaining columns contain the following values for each leaf in the carriage. (nLeaf = 0, 1, 2, and so on)		
4*nLeaf + 15	<long>	Expected position
4*nLeaf + 16	<long>	Actual position
4*nLeaf + 17	<long>	Previous field position
4*nLeaf + 18	<long>	Next field position

a. For RapidArc and conformal arc plans, dose fraction information is displayed only if you remove the # character preceding the diagUseRapidArcDynalogFormat command in the MLC controller startup script. In all other cases, gantry rotation in tenths of a degree is displayed if you retain the # character preceding the diagUseRapidArcDynalogFormat command.

Note:

- *All dose fractions range from 0 to 25000.*
- *All gantry and collimator angles are recorded in tenths of degrees, Varian scale.*
- *All jaws are recorded in millimeters in the isoplane.*
- *All carriage and leaf positions are recorded in hundredths of millimeters, in the leaf (physical) plane. Zero is at the centerline. Positive means retracted. Negative means extended across the centerline.*

Appendix B Compressing DynaLog Files

Zip is a file compression utility that reduces a file size. Zip typically compresses DynaLog files to approximately 10% of their original size. UnZip is the counterpart to Zip—it decompresses zipped files. Zip and UnZip are public domain programs from the Info-ZIP Group. Info-ZIP software (Zip, UnZip and related utilities) is freeware and can be obtained as either source code or executables from the Internet.

This appendix provides instructions on how to use the Zip and UnZip utilities to compress and restore DynaLog files. For more detailed instructions on the use of these programs, including descriptions of features that are not described here, refer to the complete program documentation, included in zip files in the **`ZipTool\Distrib`** directory of the DFV installation CD-ROM.

Note: *These procedures apply only for a MARK-Series MLC controller. Because Millennium MLC DynaLog files do not need to be transferred to floppy disks, this process does not apply to Millennium MLC controllers.*

Installing Zip and Unzip

The files **`Zip.exe`** and **`UnZip.exe`** are located in the **`ZipTool`** directory on the DFV installation CD-ROM.

To install the Zip and Unzip files, perform the following steps:

1. Copy **`UnZip.exe`** to **`C:\`** on the computer on which the DynaLog files are to be analyzed.
2. Copy **`Zip.exe`** to **`C:\`** on the MLC controller computer. (If the controller does not have a CD-ROM drive, transfer this file using a floppy disk.)

Zipping DynaLog Files

To zip DynaLog files directly to a floppy disk on a MARK-Series MLC controller computer, perform the following steps:

Note: *Zipping DynaLog files can only be done when the computer is not running MLCX.*

1. If MLCX is running, exit that program by typing **E**.
2. Insert the floppy disk into the appropriate drive.
3. Change the current directory to the directory containing the desired DynaLog files to compress.
4. At the DOS prompt, type the zip command using the following syntax:

   C:\zip <zipfilename> <file list>

   For example:

   ```
   C:\zip a:dlogs dynloga.001
   ```

   compresses **dynloga.001** to a file named **dlogs.zip** on the **A:** drive.

   ```
   C:\zip a:dlog1 dynloga.001 dynlogb.001
   ```

   compresses **dynloga.001** and **dynlogb.001** to a file named **dlog1.zip** on the **A:** drive.

   The normal DOS wildcard characters apply.

   ```
   C:\zip dlogall dynlog?.*
   ```

   compresses all files matching this wildcard template to a file named **dlogall.zip** in the current directory. Depending on the number and size of the original DynaLog files in this example, if **dlogall.zip** fits onto a floppy disk, it can be copied to the floppy disk using one of the normal DOS commands.

Unzipping DynaLog Files

Once the zip files are copied to the destination computer containing **`UnZip.exe`**, the DynaLog files from the zip files can be retrieved. UnZip is a DOS program, so these steps must be executed in a command prompt window.

To retrieve the DynaLog files from the zip files, perform the following steps:

1. Change the current directory to the directory containing the desired zip files to decompress.
2. At the DOS prompt, type the unzip command using the following syntax:

   C:\unzip <zipfilename>

   The **`.zip`** extension to the zip filename is optional. UnZip extracts all the files that had been compressed into the specified zip file, restoring each to the current directory with its original filename.

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