

# Damage Boundary Software

## Operation Manual.

### **I. General**

The Damage Boundary Optional software program is intended to aid in the process of determining the fragility of a product using the ASTM D-3332 test method. Please refer to the Standard for details.

The Damage Boundary, (DB herein) process utilizes a programmable shock machine capable of sequentially shocking a product under test with half sine and trapezoidal shock acceleration waveforms. For operation of your shock machine, please refer to your operation manual.

This software runs only as a sub module of the GHI Systems, Inc., WinCAT and must be installed with WinCAT Software Version 2.7.5 dated 10-10-01. This manual describes the operation of the DB Software in conjunction with the WinCAT System.

The output of this program is a test report which includes the required DB Plot, a listing of the database file containing the shock test results, identification headings, and user entered comments. This report also lists the Critical Acceleration and Velocity Change values which are the objectives of the DB process.

The values of shock amplitude and duration are recorded by the WinCAT System which monitors an accelerometer mounted on the shock machine table. The resulting test values are passed to the DB Software after each shock. ASTM-D3332 is based on positive acceleration values. If your shock table accelerometer is mounted inverted, reinstall it in the correct orientation, or use the WinCAT "Invert" function to make the signal positive.

### **II. Theory of Operation**

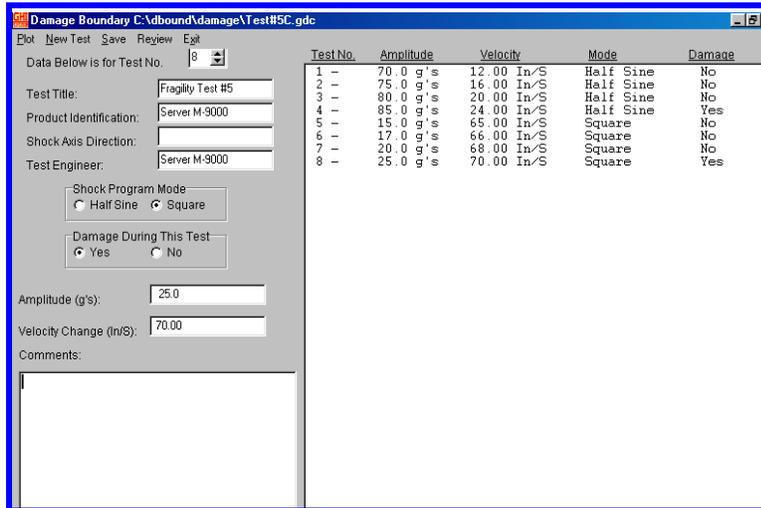
The DB process is based on inputting a series of shocks to a product until damage is detected.

The shocks conform to one of two profiles: half sine (actually haversine), or trapezoidal. Each shock is intended to stress the product in a defined way. The half sine shocks produce high accelerations at low velocity change while trapezoid shocks produce large velocity changes at low accelerations and long durations.

There is a relationship between shock acceleration and velocity change. This relationship is shown by the damage boundary curve which defines combinations of shock amplitude and velocity change that will cause damage. From this line, critical acceleration and velocity change that the product can survive are determined. These values are then used to set parameters for a cushion design and also for verification drop tests. During the DB process, shocks produced are monitored and analyzed by the WinCAT System. Resulting data are passed to the DB Software. Data passed is saved in a database file which is created by the DB software. As the test progresses, new data are added until it has been determined that damage has occurred for both the half sine and the trapezoidal shocks. The data base file is then verified to insure that the saved values are correct. If necessary, the DB Software provides editing and re-saving capability for the database file.

When the database file is complete then it is plotted in the standard DB Plot format. This on-screen plot provides a check for valid data. If not correct, DB provides a method of editing the data base file. The DB plot also includes the Critical Acceleration and Velocity Change values. The DB Plot can also be captured from the screen using the Windows "Print Screen" function. Refer to Windows documentation on how to use this function.

Figure 1 shows the main DB Screen with a typical Data Table. At the left are editing boxes for entry of test parameters, such as Test Title, Product Identification, and the name of the Test Engineer. At the center of the left panel are Windows style Radio Dials to set the programmer mode and damage condition of the current test number. Below this field is a comments entry box which is used to describe the test and its results completely. All of these items will appear on the printed test report. In the large window at the right, the test results contained in the database file are listed. This is the Data Table includes shock amplitude, velocity change, programmer mode and damage status.



**Figure 1** Main DB Screen is displayed when the 'DB' ICON on the WinCAT Menu Bar is clicked.

### **III. Functions of Menu Bar Items.**

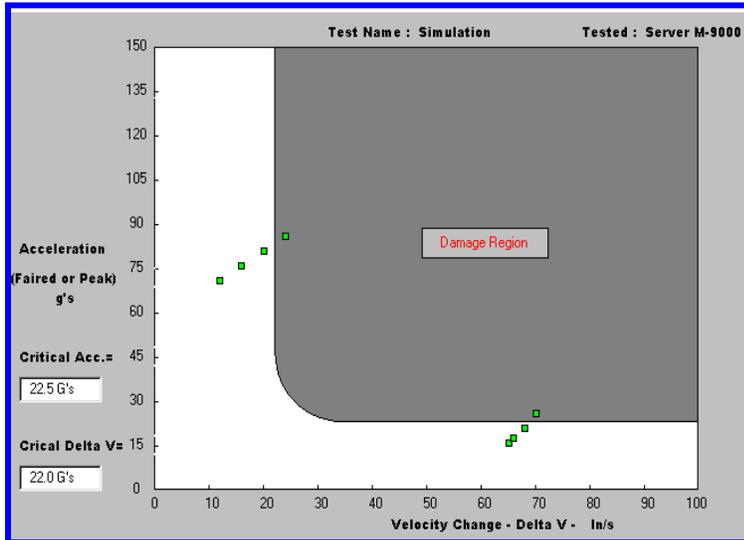
The following explains the use of items at the top menu bar position of the DB Screen.

1. Plot. Plots the Data Table values in the ASTM DB format. When clicked, the DB Plot screen is shown with the plot. The computed values of Critical Acceleration and Velocity Change are also shown. It should be noted that a correct plot can only be produced if the data are correct. Check the Data Table before attempting a DB plot. If necessary, the DB Software allows editing of all values of a partial or complete DB database file.

The DP Plot auto-scales the Acceleration and Velocity Change grids to accommodate the maxima on the Data Table. A typical DB Plot is seen in Figure 2.

2. New Test. Clears the current Data Table and resets the test counter to 1 for the first test of a new sequence. Fill in the test data items to be displayed on the Test Report.

When complete, Save the file using 'Save' and the 'First or Last File to Data Base' selection on the menu bar of the DB Screen. The normal



**Figure 2** Typical Damage Boundary Plot. Critical Acceleration and Velocity Change are shown in Data Windows at the left.

WinCAT file management functions are blocked for DB database files. This will create a new database file on your HD. All such files are saved in the default database file sub directory named 'Damage'.

Test data will be added to this file during the testing sequence.

3. Save This selection saves either a new empty database file or one partially completed to the hard disk. Two selections in this mode are possible.

A. *To Save New Data.* This selection increments the test counter and is used to save a file after data has been captured and measured by the WinCAT.

B. *First or Last File to Data Base.* This selection is used to create a new database file with new header data on the DB screen, or save the complete file after testing is completed.

4. Review This function allows recall of a saved data base file that has previously been saved to the Damage sub-directory on the hard disk. It is used to reopen a test sequence if it was terminated for any reason prior to completion, or to open a completed file to re-plot the DB Curve.

### Caution

Do not recall a database file when an incomplete file is still open on the system. To do so may contaminate your present file.

**Note:** In the event the test was terminated prior to completion, such as to enable inspection of the product, insure that the data base file has been saved using 'First or Last File to Data Base.' To restart with the next test click on Review, the default Damage sub directory will be displayed. Select the proper incomplete test file and open the file. Inspect the data to determine at what point the test was terminated. Re-save the file using 'Save' and 'To Save New Data.' This will increment the test counter. The next test can proceed by exiting to the WinCAT.

5. Exit This returns operation to the WinCAT System to acquire new test data, and sets the test counter to the next valid number. The DB screen must be exited after new data is saved . Do not use the Minimize function to recall the WinCAT program. Use the Exit function to return to the WinCAT. Before this is done, insure that the most recent data and mode identifiers have been saved to the database on the hard disk using 'Save' and the 'To Save New Data' function. This will increment the test counter.

If you click on the DB Icon before new data is captured, then the previous tests data will be loaded to the DB Data Table. If this occurs, simply return to the WinCAT, capture and measure the next test and then click on the DB Icon. The data on the DB Data Table will be overwritten with the new data. If not, the user may edit the values on the DB screen Data Table. However, do not save and update the database file from the DB screen until the data is correctly listed on the Data Table.

#### **IV. Features and Operation.**

1. *Step #1.* From the WinCAT waveform screen, click on the DB Icon.

Prior to starting a new test sequence, it is necessary to enter relevant test information using the entry and edit boxes on the Main DB Screen. When entering this information, limit your entries to 20 characters.

A. **Data Below is for Test No:** This “spinner” box defines the test line in the database from which data is being displayed in the editing boxes below. The user may edit the data in the database file by using the spinner to select which test data line is to be edited, and then typing over the data in the data boxes below. In addition, the damage condition or program mode may also be changed.

As changes are made, they may be seen in the Data Table.

B. **Test Title** Enter a name that identifies the test sequence. This name will also become the name of the database file.

C. **Product Identification.** Enter the description of the product, including part or serial number, as needed.

D. **Shock Axis.** Enter the primary direction of the shock being applied to the product under test. This is not required, but is saved in the database. It needs to be entered only for the first test as orientation will not change during the test series. The box is blanked for each succeeding test in the event that a change in orientation is made for any reason.

E. **Test Engineer.** Enter the name of the responsible person for this test.

F. **Shock Program Mode.** Click on the radio dial to select either Half Sine or Square (trapezoidal) shock pulse for next test.

G. **Damage During Last Test.** Click on the radio dial that indicates the damage condition of the product. Note: The test may be terminated to inspect the product, if necessary, after first saving the database file. The next test in the sequence may be restarted by using “Review” to upload the specific database file.

H. **Amplitude (g’s).** Readout from database of shock pulse amplitude, peak or faired/average, from the selected line of the Data Table.

I. **Velocity Change (In/ S).** Readout from database of shock

pulse velocity change from the shock on the selected line of the Data Table.

J. **Comments.** By placing the cursor in this box, comments may be added up to the capacity of the box. These comments will appear at the base of the DB Test Report.

K. **Data Table.** The Data Table displays the shock values in the database file with the name listed in Test Title. These data may be edited if not correct, even after the data base file is saved. A typical Data Table is shown in Figure 3 below.

2. **Step #2.** Proceed with the test sequence. After completion of the entries into the data base file, **save the file**. This is done by clicking on Save at the top of the screen and clicking on “First or last file for this test.” This will save the database to the hard disk.

3. **Step #3.** Click on Exit on the Menu Line of the main DB Screen. This will return control to the WinCAT System for capturing and analyzing the next shock test in the series. Proceed with the shock test.

If not using the Auto Mode, use the cursor to zero the time and integral

Test No.	Amplitude	Velocity	Mode	Damage
1 -	70.0 g's	12.00 In/S	Half Sine	No
2 -	75.0 g's	16.00 In/S	Half Sine	No
3 -	80.0 g's	20.00 In/S	Half Sine	No
4 -	85.0 g's	24.00 In/S	Half Sine	Yes
5 -	15.0 g's	65.00 In/S	Square	No
6 -	17.0 g's	66.00 In/S	Square	No
7 -	20.0 g's	68.00 In/S	Square	No
8 -	25.0 g's	70.00 In/S	Square	Yes

Figure 3 Typical Data Table display of date in Database file.

at the 10% amplitude point on the left side of the shock pulse. To read the data, place the cursor at the corresponding amplitude point on the right side of the pulse. Check the Peak, Velocity Change, and Duration readings in the WinCAT data box. If necessary, use the post recording low pass filter to remove any shock machine noise in order to read the true peak. For good half sine shocks, the proper frequency can be

determined by computing  $f=5/2t$  where  $t$  is the duration as measured above.

In the case of a trapezoidal shock pulse, measure the pulse duration prior to using the Fairing or Averaging Cursor. Move the time cursor to the start of the trapezoid shock pulse (left edge) and set the time and velocity change integral to zero by using the Zero Time and Zero Integral ICONs. Now move the cursor to the end of the trapezoid shock waveform and the duration and velocity change will be measured and entered into the data box at the bottom of the screen.

Compute the correct filter frequency with the relationship  $f=20/2t$  where  $t$  is the duration of the trapezoid pulse measured at the 5-10% amplitude points at start and end of the pulse.

Use the WinCAT Fairing Cursor function to determine the “faired” or “average” acceleration level. Refer to the WinCAT manual for information on this function.

When all shock data are shown correctly in the Data Box at the bottom of the screen, click on the ‘DB’ ICON to return to the DB Screen.

**4. Step #4.** Review the data that has been entered in the Data Table on the DB screen and make needed corrections, then proceed to ‘a’ below.

a. If damage has not been detected, Save the database file in the default ‘DAMAGE’ subdirectory using the ‘To Save New Data’ which increments the test counter. Prior to saving, make sure the Programmer Mode is correctly set. When saved, return to #3 and perform the next test. If damage has been detected, continue to ‘b’ below.

b. If damage is detected, change the Damage Indicator on the DB screen to “Damage” and the programmer mode to Square if the previous test used the Half Sine Program Mode. If this was the last test in the sequence, then ‘Save’ using ‘First or Last File to Data Base.’ If this is not the final test and another test is to be done, then ‘Save’ using ‘To Save New Data.’ The data base file should be saved in the ‘DAMAGE’ sub directory. When saved and if more tests are needed, return to #3. If the test is completed, proceed to #5.

**5. Step #5.** Plot the DB Curve. Check to see if the Data Table lists the correct data, program mode and damage status. Click on Plot on the

Menu Bar. When the plot appears, check for correct format. The damage boundary line should pass between the damage related data point and the immediately preceding point at the mean value.

**6. Step #6.** Print the Test Report. The DB software's test report is not linked to the test report of the host WinCAT software.

This report is formatted with information contained on the DB Main Screen including Date, Test Engineer, Test Name, Product Tested, the DB Plot, the Data Table, and Comments. All of these items are contained in the data base file that is saved to the PC HD. They may be recalled, edited, re-saved and plotted at any time following a test.

This completes a fragility assessment test. If other formats for the test reports are desired, refer to functions provided by Windows, including the Print Screen which can cut the DB Plot to the Clipboard to paste into a word processor generated test report.



# WinCAT

# Damage Boundary Software Operators Manual

**for WinCAT Version 2.7.5b-10-01-01**

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