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User's Guide to ReGS: A Realistic Grading System (Version 2.24)

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Abstract

The Realistic Grading System (ReGS) is an interactive, computer-based training tool designed to teach hardwood lumber grading in accordance with National Hardwood Lumber Association grading rules. The user is shown a pictorial representation of the board under consideration and answers questions until the board grade is estimated. Once a grade is selected, the user is informed whether the selected grade is correct and the reasons for the assigned grade. The user also can create files describing boards using the built-in ReGS editor. The program is supplied with over 1500 red oak boards.

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1. Getting Started

The Realistic Grading System (ReGS) version 2.24 is a computer-based training tool (Gatchell 1992a) designed to teach hardwood lumber graders in accordance with National Hardwood Lumber Association (NHLA) grading rules (NHLA 1990). It shares the same basic grading program on which the Hardwood Lumber Training Program (HaLT) is based (Klinkhachorn et al. 1992). ReGS also grades boards containing taper or small amounts (approximately one-quarter inch) of crook.

As an advanced tool in the training of hardwood lumber graders, ReGS provides many important features. It can consider 10 types of defects: stain, checks, sound knots, unsound knots, wane, pith, splits, holes, decay, and, to allow grading of tapered or crooked boards, marginal void. The user can control the display of either board face while grading to determine the better and worse faces. ReGS also includes:

- High resolution color graphics that allow color encoding of the 10 defects.
- The ability to zoom into 4-foot sections of the board for greater detail.
- On-screen rulers, in normal and expanded view, to measure the defect and board dimensions.
- Mouse support to simplify the user-interface.
- A board editor that allows a board to be created using keyboard or mouse.
- A timer that limits the amount of time ReGS uses when grading a board.

1.1 Hardware and Software Requirements

ReGS runs on the IBM PC family of computers, including the XT, AT, PS/2, and all true compatibles.[1] It requires an EGA or better graphics adapter and at least a floppy disk drive (a hard drive with at least 3.5 megabytes of free disk space is recommended). ReGS also includes mouse support to simplify user interaction, though a mouse is not required. ReGS requires MS-DOS version 3.3 or later and at least 640K of RAM. Although ReGS will successfully run on less powerful systems, it is recommended that a fast 80286-based system or better with at least one megabyte of hard drive space be used to provide prompt and reasonable grading times.

1.2 Installing ReGS

The distribution diskette contains an installation program for the ReGS program and data from the "1992 Data Bank for Red Oak Lumber" (Gatchell 1992b). This program copies the compressed files containing the program and data to the destination drive and directory. Next, these files are automatically decompressed and the original compressed files removed.

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[1] The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

The following steps cover the installation of ReGS onto the hard disk drive. After these steps are performed, ReGS can be run from the MS-DOS prompt.

1. Beginning Installation

To begin installation, place the distribution diskette in the floppy drive. Next, make the floppy drive containing the distribution diskette the working drive. At the DOS prompt, type the letter identifying the floppy drive and a colon. Then press Return. On most computers, the floppy drive is A: or B:. For this example use drive A:. At the DOS prompt, enter:

A:

Then, to run the install program, type:

REGSINST

at the DOS prompt and press Return. When the install program begins running, the initial screen shown in Figure 1.2-1 will appear. Press the "C" key to continue with the installation, or "A" to abort.

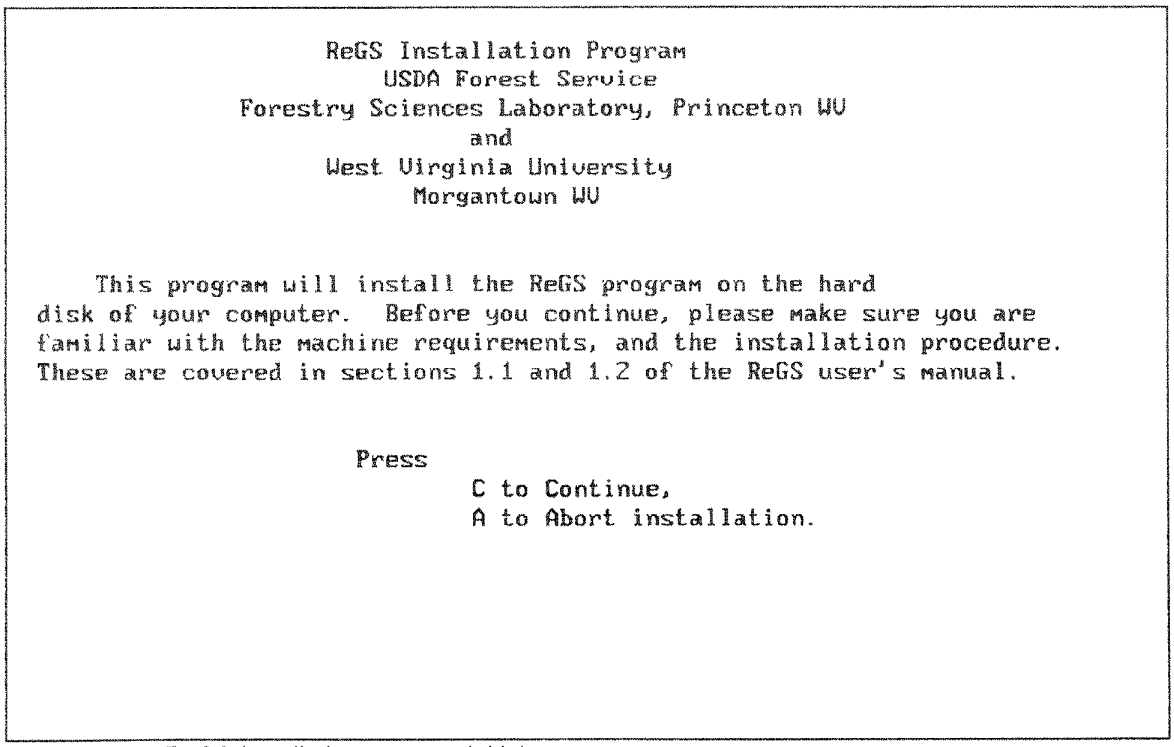

Figure 1.2-1. ReGS installation program initial screen.

2. Confirming the Install Destination

The next screen (Fig. 1.2-2) shows the drive and subdirectory on which the ReGS program and data will be installed. The default location is drive C:, in the subdirectory \REGS. If this location is

acceptable, press the "C" key to continue and proceed to step 4. If you do not want to continue with the installation, press the "A" key to abort. If you would like to install ReGS to another drive or subdirectory, press "M" to modify the destination and proceed to step 3.

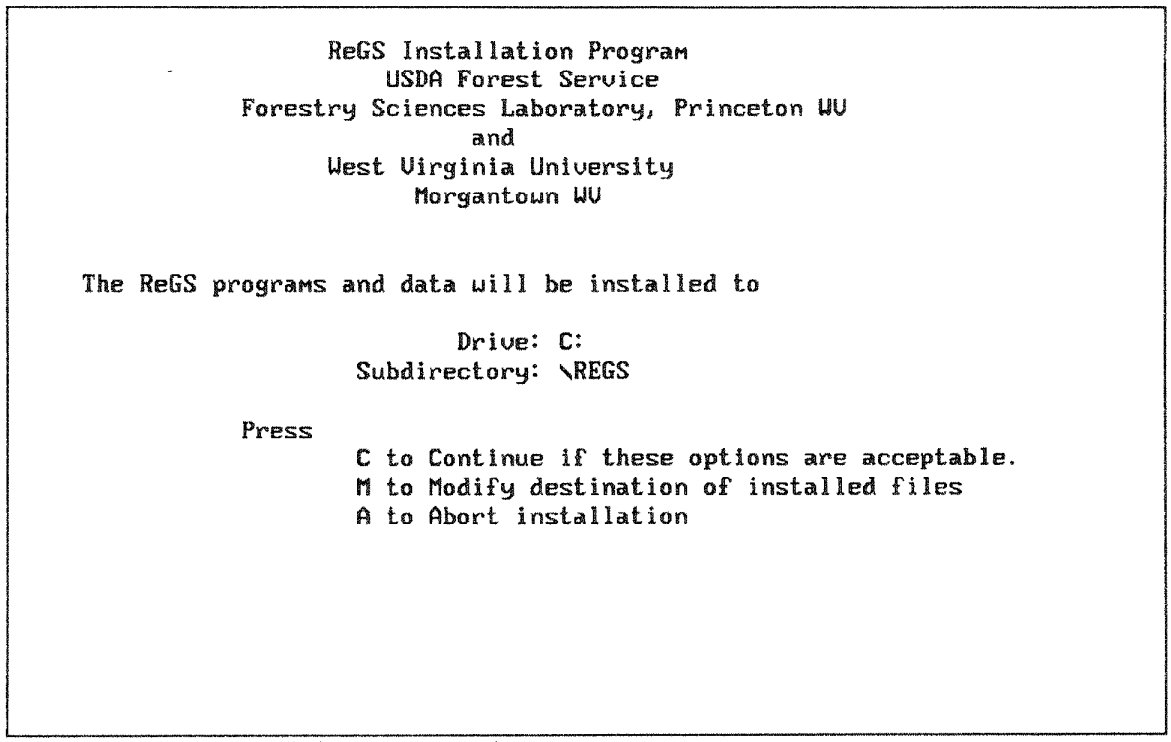

Figure 1.2-2. ReGS installation program options screen.

3. Modifying the Install Destination

This step allows you to customize the installation of ReGS. You are first presented with a choice of destination drives. The install program first checks the computer system to determine the valid choices for hard disks. These are displayed on the screen. Enter the number of the drive on which you want to install ReGS.

After selecting the destination drive, you are prompted to enter the name of the destination subdirectory. This subdirectory can be a new subdirectory or an existing one. When entering the name of a subdirectory, give the complete path of the subdirectory starting with the root directory. For example, to install ReGS in the subdirectory \YLDSTUDY\REGS, enter at the destination subdirectory prompt:

\YLDSTUDY\REGS

If you have previously installed AGARIS, do not install ReGS to the same subdirectory. Although the data sets contain the same data, they are stored in different formats and existing data sets will be overwritten. Figure 1.2-3 is the modification screen showing these entries. After you have entered your choice, the computer will display the screen shown in Figure 1.2-2 with the modified destination subdirectory. Refer back to the instructions for step 2 to continue.

```
                ReGS Installation Program
                    USDA Forest Service
            Forestry Sciences Laboratory, Princeton WV
                            and
                    West Virginia University
                        Morgantown WV

            ReGS Custom Installation


      A check of your system indicates the following drives:

    1. C:

      Enter number identifying destination drive: 1


      Enter the name of the destination subdirectory: \YLDSTUDY\REGS
```

Figure 1.2-3. ReGS installation program customized destination.

4. Installing and Decompressing the Distribution Files

This step performs in-depth error checking as it copies and decompresses the files from the distribution diskette. The install program keeps you informed as to which task it is currently performing. The first step is the creation of the destination subdirectory. Several errors can occur during this step. The error message "Invalid or non-existent drive selected." will cause the installation program to abort. This error will occur if the source drive is used as the destination drive or if the drive does not exist. A related error message, "Unable to create destination subdirectory.", occurs when an invalid pathname for the destination subdirectory is entered. The message "Destination subdirectory already exists, continue? (Y/N):" is displayed only when a preexisting destination subdirectory is selected. If you answer "Y", ReGS will be installed to the selected subdirectory. The installation will not delete existing files in the subdirectory. If you answer "N", the installation will halt.

5. Configuring Your System

The CONFIG.SYS file defines devices and run-time parameters for your personal computer system. When installation is complete, check to see that your CONFIG.SYS file includes the following lines:

```
FILES=20
BUFFERS=20
```

The sequence, location, and spacing of the lines are not important. It is only important that the values for the FILES and BUFFERS settings are at least 20. If the settings are less than 20, you

must edit the CONFIG.SYS file and correct the settings. Once you have finished editing, you must re-boot your computer. Revised CONFIG.SYS parameters will not take effect until the computer is rebooted.

1.3 Running ReGS

To run ReGS, change to the ReGS subdirectory and type "REGS". For example, if ReGS is installed on the hard drive in the subdirectory, "C:\REGS", type "CD \REGS" to change to the subdirectory that contains ReGS followed by typing "REGS" to run the ReGS program.

ReGS will greet the user with an introductory screen (Fig. 1.3-1) on which will be displayed the version number and the copyright notice of the software displayed. The user can click a mouse button or press any key to advance to the next screen.

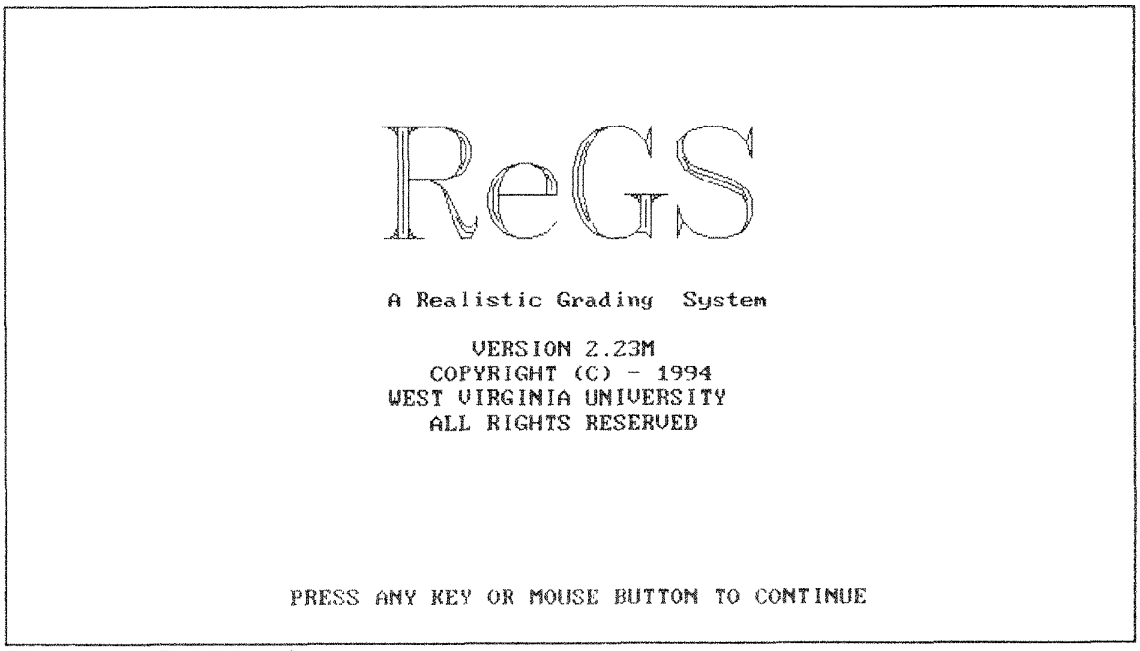

Figure 1.3-1. ReGS introductory screen.

1.4 Setting the Timer

ReGS provides a timer that limits the amount of time spent grading boards. It is set to the maximum time (up to 999 seconds) the user wants ReGS to spend on grading a single board. If the timer expires while ReGS is grading a board, ReGS will terminate processing of the board and continue with the next operation. Most boards can be graded in less than a minute, though this time varies according to the processing power of the computer being used.

If you want ReGS to spend unlimited time on board grading, click on ABO (which corresponds to ABORT) using the mouse, or press the letter 'A,' or press 'ESC' (the escape key). ReGS will prompt the user to confirm by asking:

ABORT - ARE YOU SURE (Y/N)

You must press "Y" or "N" to answer the question (other keys on the keyboard and clicking the mouse will have no effect). You can abort the timer by pressing "Y" and ReGS will spend an unlimited time grading boards. If you choose not to abort and would like to continue by setting the timer, press 'N". This will return you to the screen shown in Figure 1.4-1.

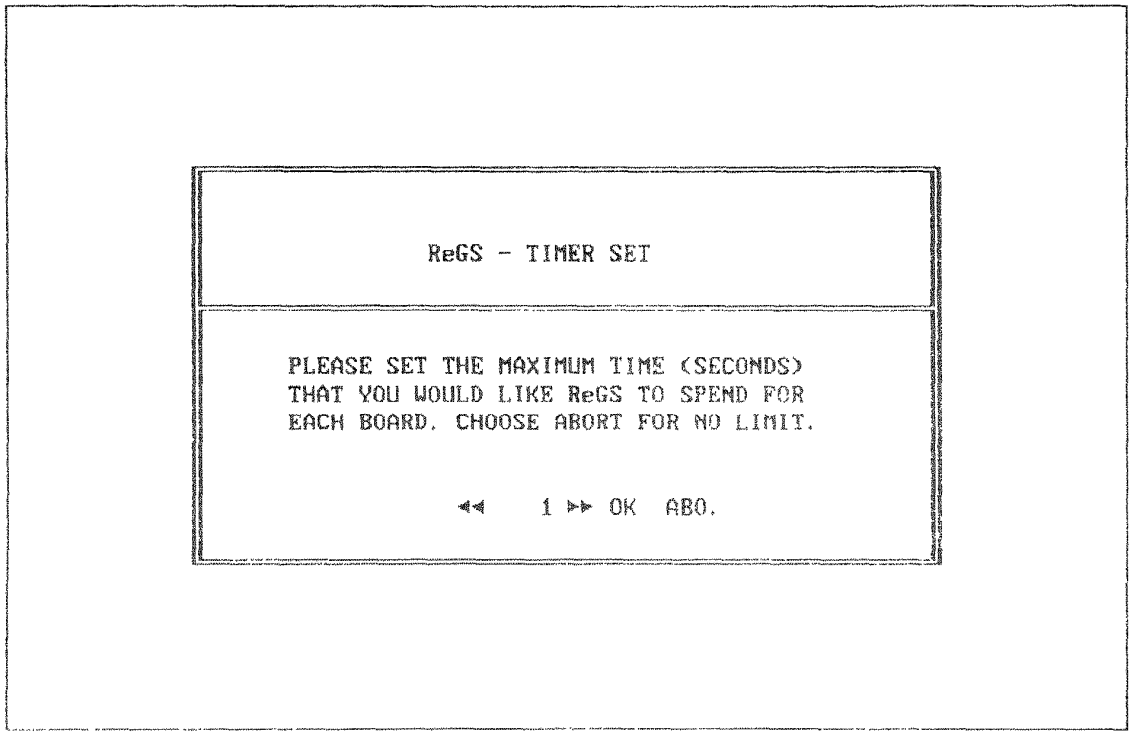

Figure 1.4-1. Timer adjustment screen.

If you do not wish ReGS to spend an unlimited amount of time grading boards, you can set a limit of from 1 to 999 seconds. The timer can be set by: 1) typing in the number of seconds using the numeric keys on the keyboard, 2) using the left and right arrow keys to decrement and increment the figure on the screen, or 3) clicking the mouse on the left and right arrow keys on the screen.

Once you have set the timer, the "OK" option on the screen should be chosen by clicking on it using the mouse, or by pressing "O", or by choosing the "ENTER" key.

1.5 Scant Board Option

When grading lumber, up to 10 percent of the boards can be one-quarter inch less than the minimum allowable width for a grade (see Paragraph 10 of the NHLA grading rules). ReGS provides the option of allowing scant boards to be accepted for a grade. For example, the grade of FAS has a minimum allowable width of 6 inches; however, if scant boards are allowed, boards of 5-3/4 inches also can receive a grade of FAS.

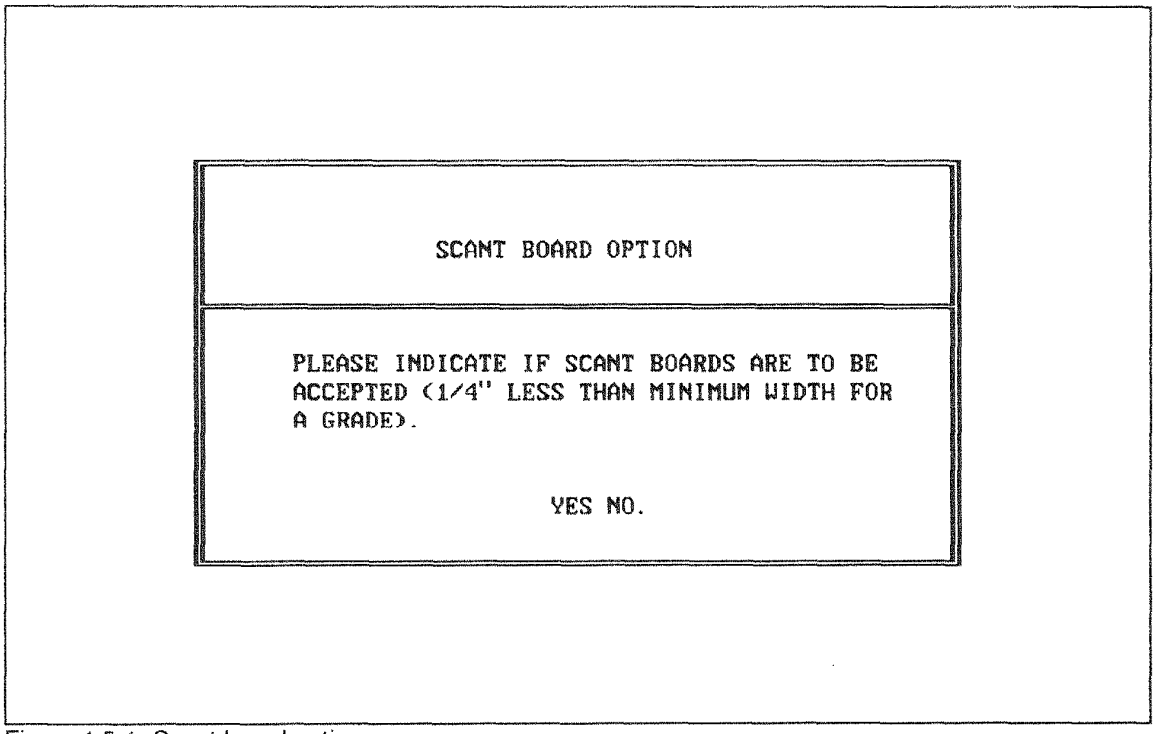

Figure 1.5-1. Scant board option

When ReGS displays the scant board option screen (Fig. 1.5-1), you must select "Yes" (allowing scant boards) or "No" (disallowing scant boards). Type "Y" or "N" or click on "Yes" or "No".

1.6 Main Menu

The main menu of ReGS is shown in Figure 1.6-1. You can click on the desired option using the mouse, or press the function keys F1 through F4, or the ESC key.

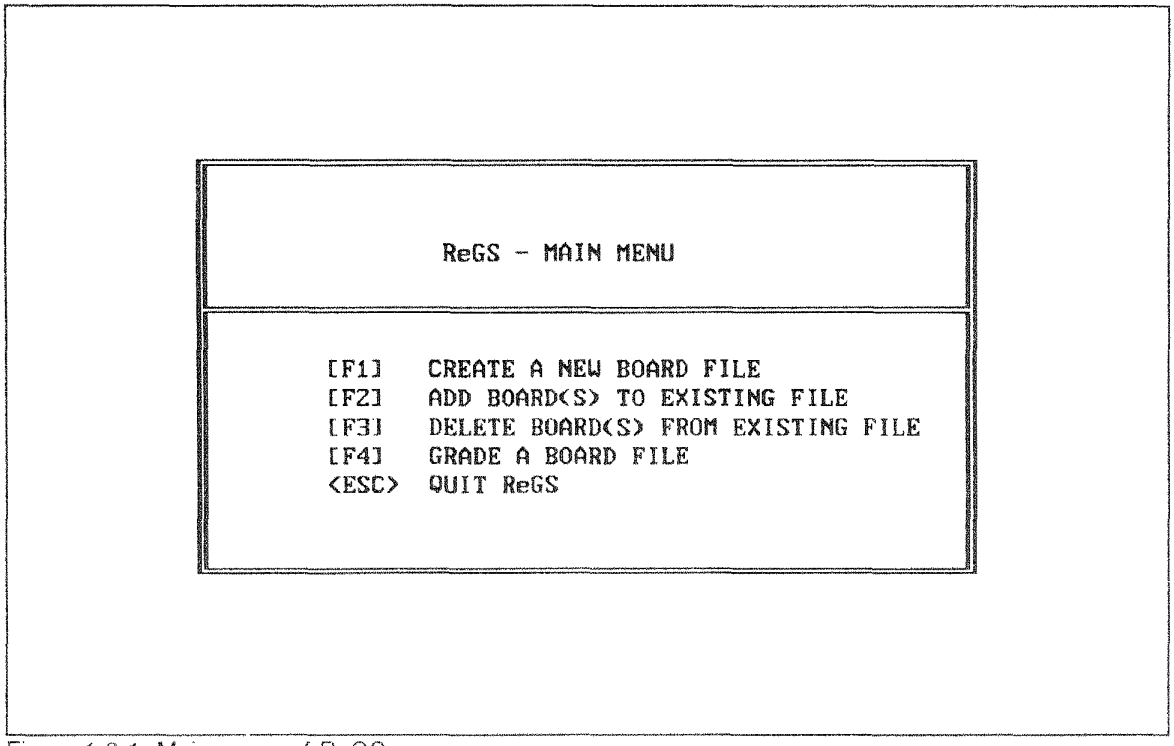

Figure 1.6-1. Main menu of ReGS.

In general, the ESC key will terminate most functions and allow you to return to the main menu (or exit the program if already at the main menu). However, the ESC key will not function in all circumstances. In these cases, you can complete the current function and then use ESC to return to the main menu or immediately exit from ReGS to the DOS prompt. You can exit from ReGS to the DOS prompt at any time by simultaneously pressing the CTRL and C keys (abbreviated CTRL-C). **Note that CTRL-C will exit from the program and will not complete any work or save files before returning to the DOS prompt.** The use of CTRL-C should be avoided if possible. For example, if a mistake is made while creating a board (described elsewhere), saving the flawed board and deleting it later is recommended. If CTRL-C is used, you must restart ReGS as described in section 1.3.

The options provided by the main menu are discussed in Sections 2 through 4. The grading of a board file is discussed in Section 2. Creating a board file and the addition/deletion of boards within it is discussed in Section 3. The format and structure of the data within a board file is discussed in Section 4. If the utilities provided within ReGS are used to create the board files, you will not need the information in Section 4. However, this information is necessary if board files are to be created outside of ReGS and then used for ReGS computer-based grading.

2. Grading Boards

This section assumes the user wishes to grade the supplied board data files. Options for creating and modifying original board files are discussed in Sections 3 and 4. The option for grading a board file on the ReGS main menu is accessed by pressing the F4 key or clicking on "GRADE A BOARD FILE".

2.1 How ReGS Grades a Board

Within limitations, ReGS grades a board much like a human grader would. It examines each board and attempts to give it the best possible grade without violating NHLA grading rules. Initially, it attempts to grade a board as FAS. If this is not possible, it then attempts to grade it as Selects. This process continues through each grade of lumber until the appropriate grade is found. The following are the grades considered in the order in which they are examined:

FAS
Selects (First One Face grading package available upon request)
No. 1 Common
No. 2A Common
No. 3A Common
Below Grade

ReGS first examines the length, width, and surface measure of the board to see if they meet the requirements for the grade under consideration. If length and width requirements are met, each face is then evaluated to determine the better and worse faces. Then pith is considered. Next, the edges are examined for wane. Then the ends are examined for splits. Each face is then examined for oversize knots and holes. When a defect is found that prevents the board from meeting FAS requirements, analysis for FAS grading is terminated. If no defect is found, the better face is evaluated to determine if it contains enough clear-face area cuttings of the required sizes using no more than the allowable number of cuttings.

If the board does not meet FAS requirements, it will next be examined for the grade of Selects. Although this grade allows narrower and shorter boards, the board is examined in much the same manner as that for FAS except that the Selects board is graded from the better face. All wane exceptions are examined, including those for worse faces to be graded as No. 1 Common or better. If no defect is found that prevents the grade of Selects from being obtained, the board is examined first for a grade of Selects with Sound Back (including the provisions of the 97-percent rule). If Selects with Sound Back is not possible, the board is examined for a grade of Selects with No. 1 Common Back.

If the grade of Selects cannot be obtained, the board analysis continues with the requirements for No. 1 Common. If this grade is not possible, the grades of No. 2A Common and No. 3A Common are attempted, respectively. If the requirements for the grade of No. 3A common cannot be met, the board is classified as Below Grade. When grading No. 3A Common, ReGS first looks for a sufficient amount of clear-face cuttings on the worse face. Failing that, it determines whether the better face grades are at least No. 2A Common with the reverse side of the grading cuttings sound.

The process ReGS uses in assigning a grade to a board is as follows:

1. ReGS begins by determining the standard length, width, and surface measure of the board.

2. Next, ReGS determines the amount of overlength (the length of the board which exceeds the standard length). If overlength exists, ReGS determines which overlength (left or right end of board) has the most defective area. The end that contains the most surface area occupied by defects on both faces combined is chosen as the overlength end of the board and will be disregarded in the calculations for the various defect types. However, grading cuttings may extend into the overlength.

3. ReGS next checks for defects accepted on the sound back of clear-face cuttings (i.e., undersize knots, holes, stain, sound knots of any size, and similar defects).

4. Defects are examined on each face of the board. Defects within the first foot from the right and left ends also are tallied. The order in which they are examined is:

   a. Greatest size of single defect
   The average diameter of each defect is determined and the largest is chosen for FAS and Selects grading.

   b. Pith on board
   The total length of pith on both faces is determined.

   c. Splits
   End split length is determined for FAS and Selects grading. When defects are encoded as polygons (see Section 4), splits also are examined to determine if the slope exceeds 1 inch per foot.

   d. Wane
   The total area of wane on the board is calculated along with the lineal amount of wane on the top and bottom edges of the board.

5. From the length, width, and defect information collected above, a preliminary grade is assigned to each face of the board. Note that this grade does not depend on the amount of cutting units available.

6. If the board has the potential to grade Selects, defects pertaining exclusively to the Selects grades are evaluated at this time. These include wane restrictions and the 97-percent rule.

7. ReGS assigns a preliminary grade to the board based on the amount of clear-face cutting units available and the initial grade assigned to each face.

8. If the board receives a preliminary grade of FAS, ReGS searches each face of the board for the necessary grading cuttings area to confirm the grade. If the required amount of area is found, the board is assigned a final grade of FAS. If only one face of the board has enough area to grade as FAS, the board is downgraded to a preliminary grade of Selects and processed in step 9.

9. If the board receives a preliminary grade of Selects, each face of the board is searched for the necessary grading cuttings area to confirm the grade. First, the board is checked for the grade of Selects with Sound Back (including the provisions of the 97-percent rule). If the board cannot grade as Selects with Sound Back, the board is examined for the grade of Selects with No. 1 Common Back provided that the No. 1 Common face does not exceed the wane specifications as per Paragraphs 68 and 69 in the NHLA rules. If the board fails to grade as Selects with No. 1 Common Back, because the back face is not No. 1 Common, it is downgraded to No. 2A Common and graded according to Common rules in step 10.

10. If the board receives a preliminary grade of No. 1 Common or lower, the board is examined for a Common grade. It is first examined for the grade of No. 1 Common based on the presence of No. 1 Common qualities, surface measure, and accumulated pith. If the board fails to grade as No. 1 Common, it is downgraded to No. 2A Common and examined. If the board fails to grade as No. 2A Common, it is downgraded to No. 3A Common and examined.

11. If the board fails to grade as No. 3A Common, it is assigned a final grade of Below Grade.

2.2 Selecting a Board File and Grading Sequence

After selecting the "Grade A Board File" option, you will be presented with a data file selection menu. At this point, you can select the desired board file using one of three methods:

1) You can click on one of the displayed file names using the mouse (only files with the extension DAT that are in the current directory will be displayed)

2) You can press the right and left arrow keys to highlight the desired file and, once the desired file is highlighted, press ENTER.

3) You can press the F1 key and then type in the name of the desired file.

At any point during the file selection menu, you can press ESC to return to the main ReGS menu.

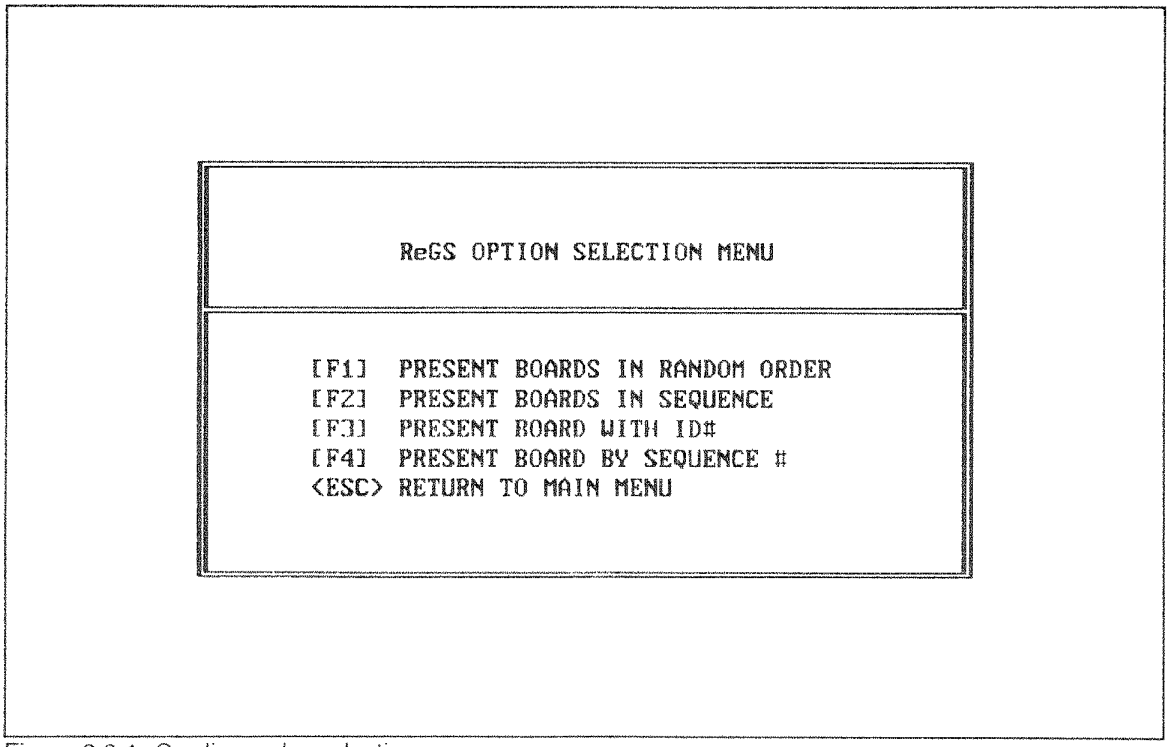

Figure 2.2-1. Grading order selection.

After the desired board file has been selected, the ReGS program will present another menu to allow you to select the order in which the boards will be presented from the board file (Fig. 2.2-1).

Clicking on "PRESENT BOARDS IN RANDOM ORDER" or pressing F1 will randomly select a board for grading from the board file. After selecting the random option, you will be prompted to enter the number of boards to be processed out of the total number stored in the file. Clicking on "PRESENT BOARDS IN SEQUENCE" or pressing F2 will present the boards in the order in which they are stored in the board file. Clicking on "PRESENT BOARD WITH ID#" or pressing F3 allows you to select the

desired board based on the identification assigned to it when the board was created (see step 3.2). Finally, clicking on "PRESENT BOARD BY SEQUENCE #" or pressing F4 allows you to select the board based on the position of the board within the file (i.e., you could choose the third board stored in the file.).

2.3 Grading a Board File

Once the board file has been chosen and the grading order selected, the actual grading of boards will begin. Initially, you will see a screen showing Face 1 of the board and a list of defects on that face. At this point, you can click the mouse or press a key to view the second face and a list of defects on it. A typical screen during the actual board grading is shown in Figure 2.3-1. If you wish to follow along with the examples, the board file "REGSTEST.DAT" should be selected as indicated in the previous section. The board in this file with an ID of "532" will be used throughout the remainder of the illustrations.

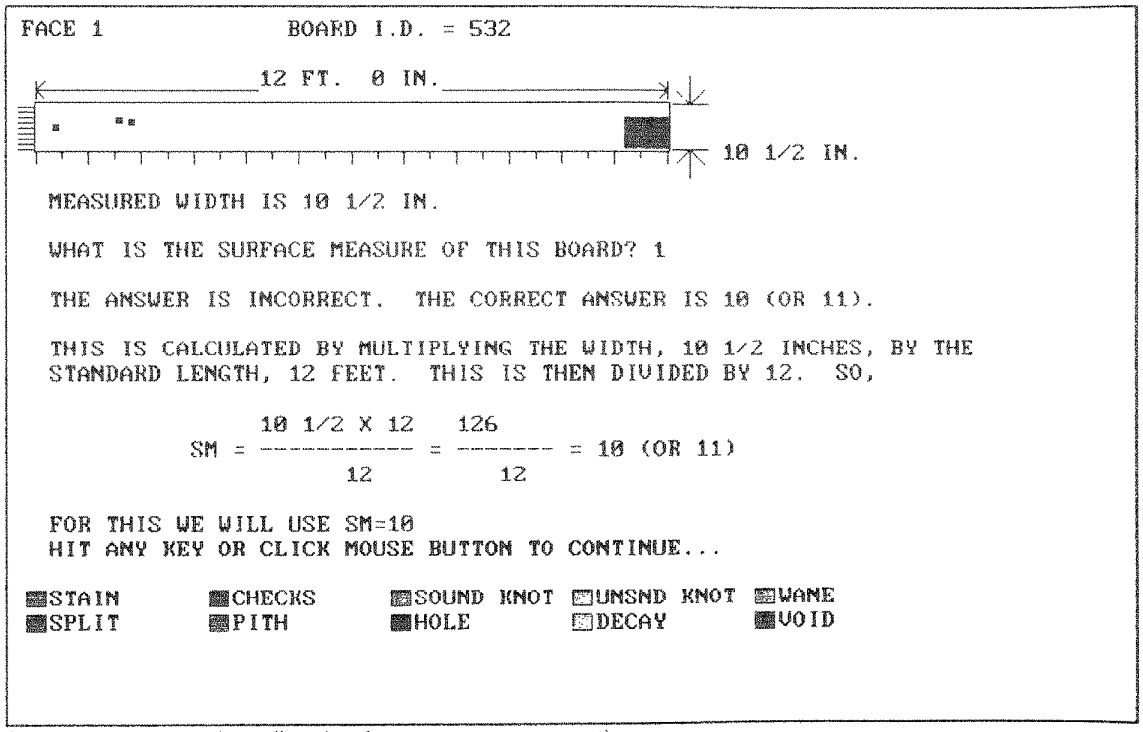

Figure 2.3-1. Board grading (surface measure request).

Click again and ReGS will present two more options. Clicking on "VIEW OTHER FACE" or pressing F1 will display the other face of the board. Clicking on "EXAMINE EXPANDED VIEW" or pressing F2 will show an expanded view of the board in the lower half of the screen (Fig. 2.3-2).

During the display of the expanded view, you can change sides of the board (pressing F1 or clicking "CHANGE FACES") and scan along the length of the board by pressing the left and right arrow keys or clicking on arrow symbols in the lower right corner of the screen. The upper half of the screen displays the entire board and a marker underneath indicating what section of the board is being viewed. To return to the standard view, press ENTER or click on "CONTINUE".

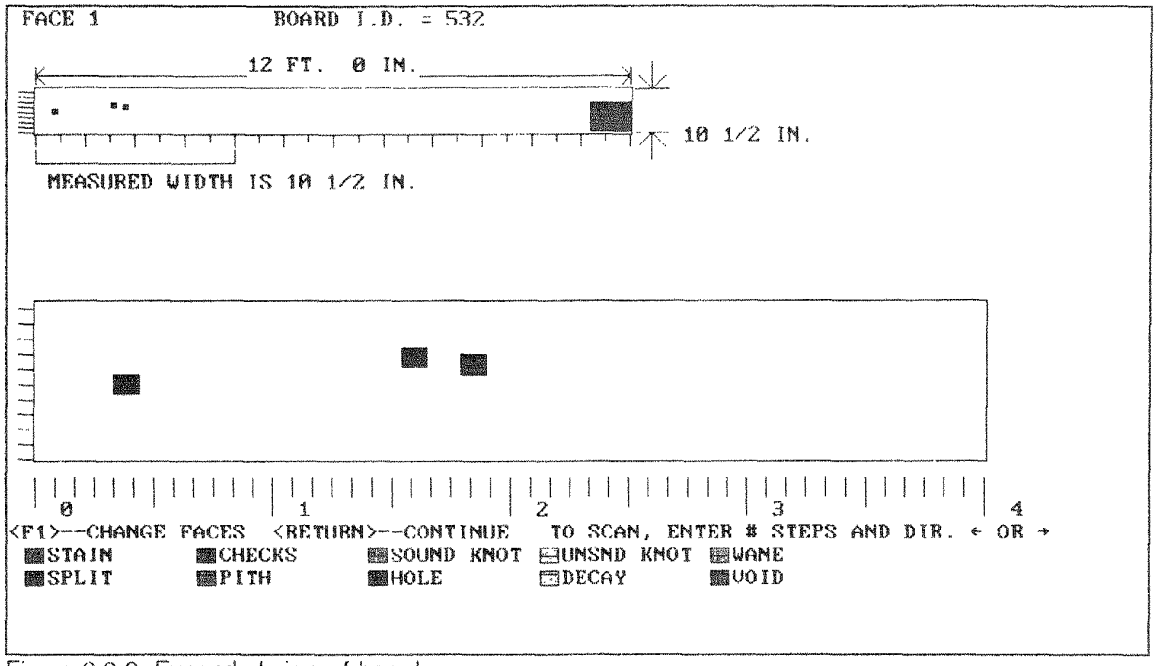

Figure 2.3-2. Expanded view of board.

As shown in Figure 2.3-1, you will be prompted to enter the surface measure of the board being displayed by entering the surface measure of the board using the numeric keys on the keyboard. If the answer is correct, you will be prompted to press any key to continue. In the case of halfway surface measures, ReGS always uses the smaller number by default. If the answer is incorrect, the program provides the correct answer and an explanation as to how it was calculated.

When initially grading a board, specifying an obviously incorrect answer allows you to determine whether the board is halfway between two surface measures. In cases where the surface measure is exactly halfway between two whole numbers (e.g., 12-1/2), you can enter either the smaller or larger number (12 or 13) and have the answer accepted as correct. However, you will not be informed of the other possibility. If the entered surface measure is incorrect, both surface measures will be shown.

After the surface measure is entered, you will be presented with the option of changing the width to a value different than that contained in the board file. The value for the width can be changed by pressing the "+" and "-" keys. Doing this repeatedly allows you to increase the width of the board to any value; however, the width cannot be decreased below the original value. This allows you to force ReGS to grade the board based on a different width and, consequently, different surface measure.

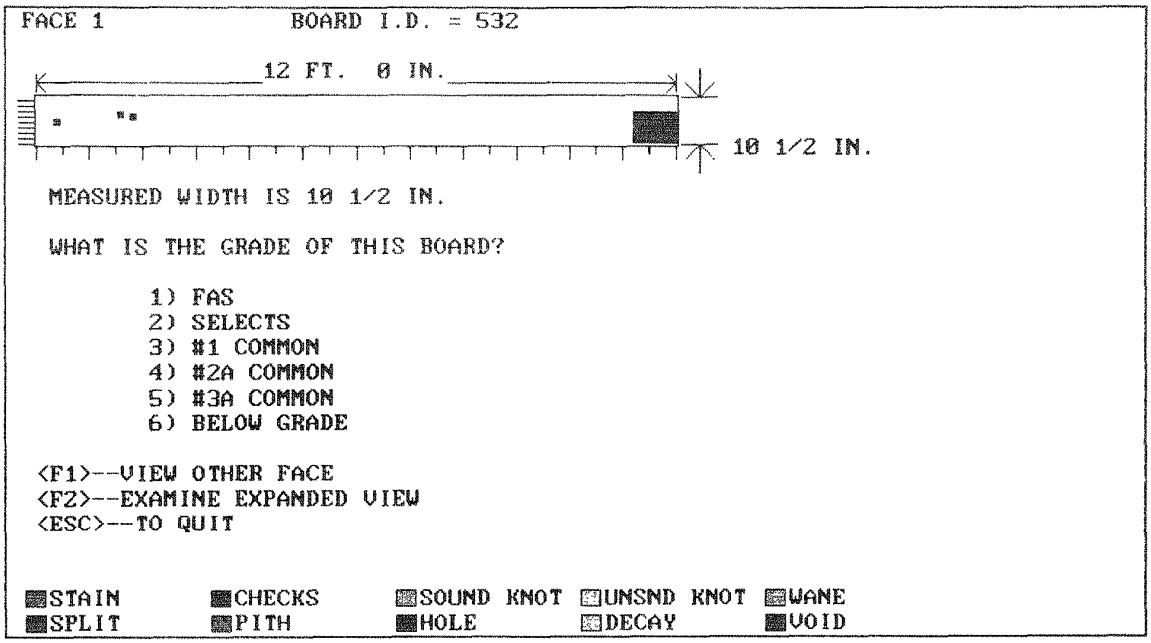

Figure 2.3-3. Grade selection screen.

You will then be prompted to specify the grade of the board. Figure 2.3-3 is a typical grade selection screen. You can press the number associated with the selected grade or click on the desired grade. After the grade is selected, you will be informed whether the chosen answer is correct or incorrect. You can continue with the next board or request an explanation for the assignment of the correct grade.

If an explanation is requested, you will be given the requirements to meet a grade (the face of the board to be examined, the total number of cutting units, and the allowable number of cuttings). You will then be shown the first set of cuttings found that will meet the grade. Figure 2.3-4 depicts the final explanation screen.

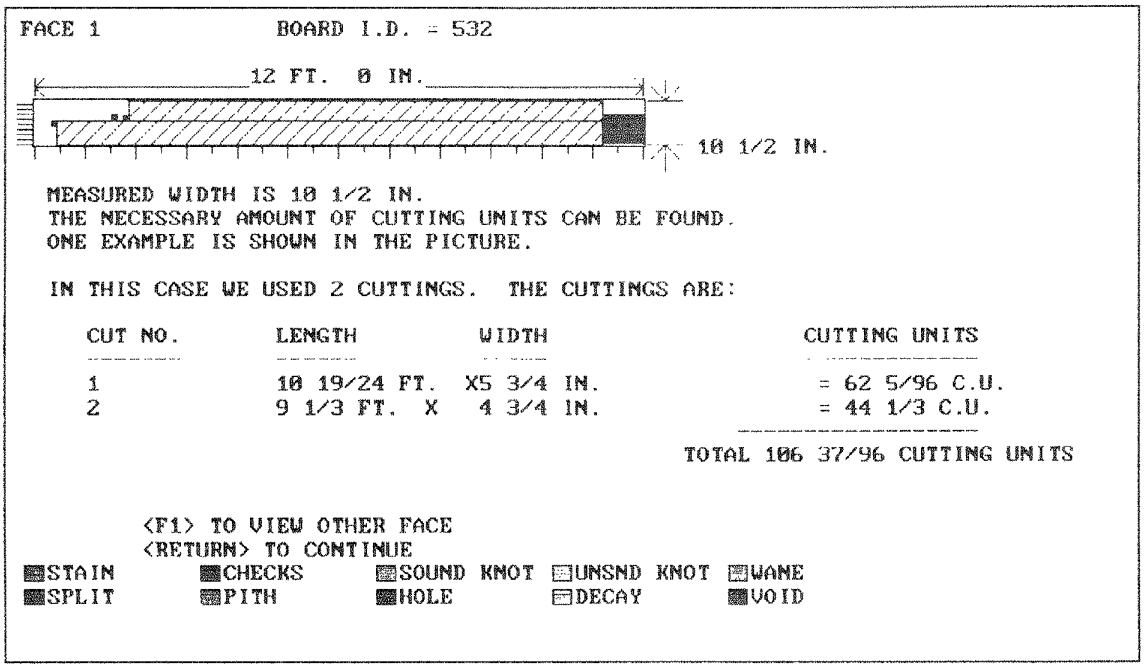

Figure 2.3-4. Explanation of grade selection screen.

3. Entering Board Data With ReGs

In this section, the ReGS main menu options for creating and modifying board files are described. If these options are used, you can create the board files within the ReGS program and need not worry about the format of data stored in the files. If the board files are to be created outside of ReGS, the information in Section 4 should be reviewed.

3.1 The Three Widths of a Board

For computer-aided grading, a board must be placed in a rectangle whose sides touch the sides and ends of the board. When the board is a perfect rectangle, the sides and ends of the board and the enclosing rectangle are the same. For real boards, particularly air- or kiln-dried boards affected by differential shrinkage, or tapered boards, there often will be gaps or spaces between the board perimeter and the enclosing rectangle. In ReGS, this gap or space is labeled as "void".

Void is not a true defect because it occurs outside the board. Therefore, size and length of void are not evaluated as, for example, the size of a knot or length of wane would be when calculating FAS or Selects grade. When creating boards, it is important not to use a defect instead of void. If a defect is substituted between the board edge and the enclosing rectangle, the defect size limitations of FAS and Selects may easily be exceeded. Also, using the surface measure of the enclosing rectangle may require more cutting units per grade than are available on the board.

The inclusion of void along the outside edge of a board means that there are three widths that must be acknowledged for purposes of grading the board as shown in Figure 3.1-1. There is the enclosing rectangle width, the width at the narrower end, and the measured width. The enclosing rectangle width is not important to the user of ReGS, but it is necessary for the working of the program and is referred to as the bounding width. The width of the narrow end is the width used in selling the board. The measured width is the width used to calculate the surface measure of the board. For tapered boards, it is taken one-third of the length from the narrow end of the board. For perfectly rectangular boards, all three widths are the same.

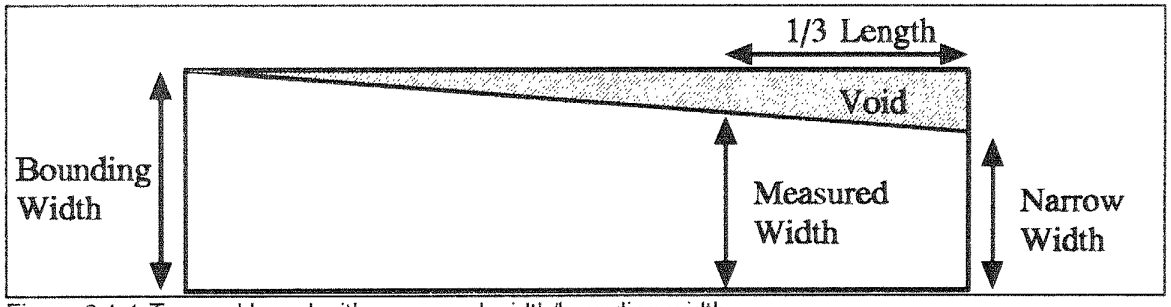

Figure 3.1-1 Tapered board with measured width/bounding width.

3.2 Creating a Board File

The main menu of ReGS provides the option of creating a new board file (see Figure 1.6-1). To select this option, click on "CREATE A NEW BOARD FILE" or press the F1 key.

The next screen ReGS presents is shown in Figure 3.2-1. On this screen, the user is prompted for the file name of the new board file to be created. The name for the new board file can be any legal DOS file name. A legal DOS file name consists of up to 11 characters, 8 before a period (the actual name) followed by 3 characters after the period (the extension). A typical file name might appear as ABCDEFGH.DAT. The 11 characters within the file name can be any combination of letters and numbers and some special characters (DOS makes no distinction between upper and lower case letters). If an extension is not specified, ReGS adds a "DAT" to the file name. For instance, if the board file name is specified as XYZ, ReGS creates a board file, XYZ.DAT. It is recommended that all board files be given the extension "DAT" to simplify selection when performing the actual grading.

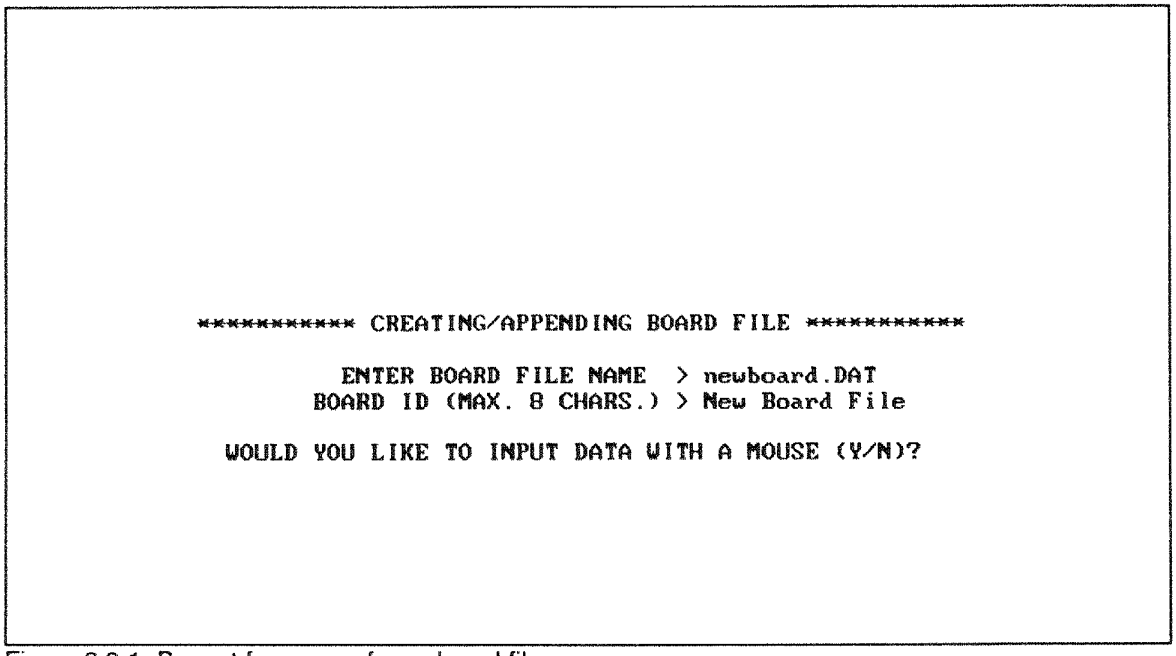

Figure 3.2-1. Prompt for name of new board file.

If the board file already exists, the ReGS program will ask you whether you want to overwrite (and destroy) the original board file.

FILE EXISTS. OVERWRITE (Y/N) ?

If you respond "N", ReGS will return to the screen shown in Figure 3.2-1 prompting you for a new file name. If you enter "Y", ReGS will continue to create the board file by overwriting the existing board file. **It is important to note that the existing file will be completely deleted and all information within it will be lost.**

ReGS next asks the user to specify the board identification, which can be from one to eight characters. If you enter a character sequence longer than eight characters, the name is truncated to 8 characters. Or you can press the "ESC" key and ReGS will assign the board identification "UNKNOWN". ReGS will then ask if the board data is to be entered using a mouse or the keyboard:

WOULD YOU LIKE TO INPUT DATA USING A MOUSE (Y/N) ?

If you choose "Y", the board data is entered using the mouse. Answering "N" indicates that the keyboard will be used.

3.3 Entering Board Data Using a Mouse

If you choose to enter board data using a mouse, ReGS proceeds to the screen shown in Figure 3.3-1. Initially, ReGS displays a board with an initial length of 120 inches and a bounding width (width of the bounding rectangle of the board) of 12 inches. You can adjust the width to values from 1 to 15 inches, and the length to values from 1 to 200 inches.

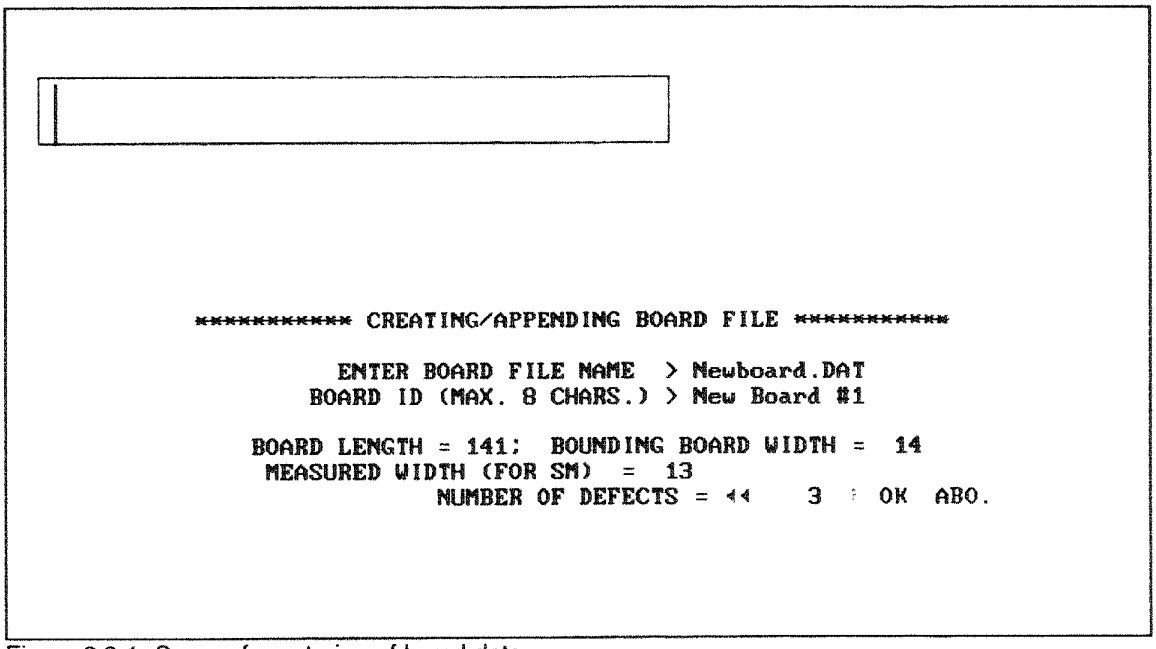

Figure 3.3-1. Screen for entering of board data.

Movement of the mouse horizontally and vertically will change the length and bounding width of the board. The values of the length and width are displayed on the screen as the rectangle size is changed. Once the length and width are set to the desired values, press the left or right mouse button for ReGS to register the length and width of the board. Next a vertical line will be displayed that indicates the measured width of the board. This width can be adjusted by moving the mouse vertically but it cannot be greater than the bounding width of the board. Unless the board is tapered or crooked, the measured and bounding widths should be the same. Once a satisfactory measured width is found, either mouse button can be pressed to register the selected measured width.

Following selection of the board dimensions, ReGS will prompt you for the number of defects on the board. If at this point you do not wish to enter the board data, press the "ESC" key or "A" (which stands for abort) or click on "ABO". Following confirmation, ReGS will return to the main menu.

When you are ready to enter board data, the first step is to indicate the total number of defects on the board. ReGS begins with a default value of zero defects on the board. A maximum of 100 defects is allowed on each board. The number of defects on the board can be decremented or incremented using the left and right arrow keys or by clicking on the "<<" or ">>" symbols displayed on the screen. Once the number of defects is chosen, you can click on "OK" or hit "ENTER" or "O" (stands for OK).

ReGS will then prompt for information on each defect specified by the user. Prompting for defect information on defect #1 is shown in Figure 3.3-2. ReGS first prompts for the number of vertices that make up the defect. The minimum number of vertices is 3 and the maximum is 10. The vertices can be specified using the mouse or the numeric keys. Once the number of vertices is entered, the type of defect is specified. This is accomplished by clicking on one of the defect types specified in the legend on the screen. Next, the user is asked whether the defect is on Face 1 or Face 2 or on both faces. The face on which the defect is present is specified using the mouse or keyboard. This procedure is identical to specifying the number of defects. Numeral 1 corresponds to Face 1, 2 corresponds to Face 2, and 3 corresponds to both Faces 1 and 2.

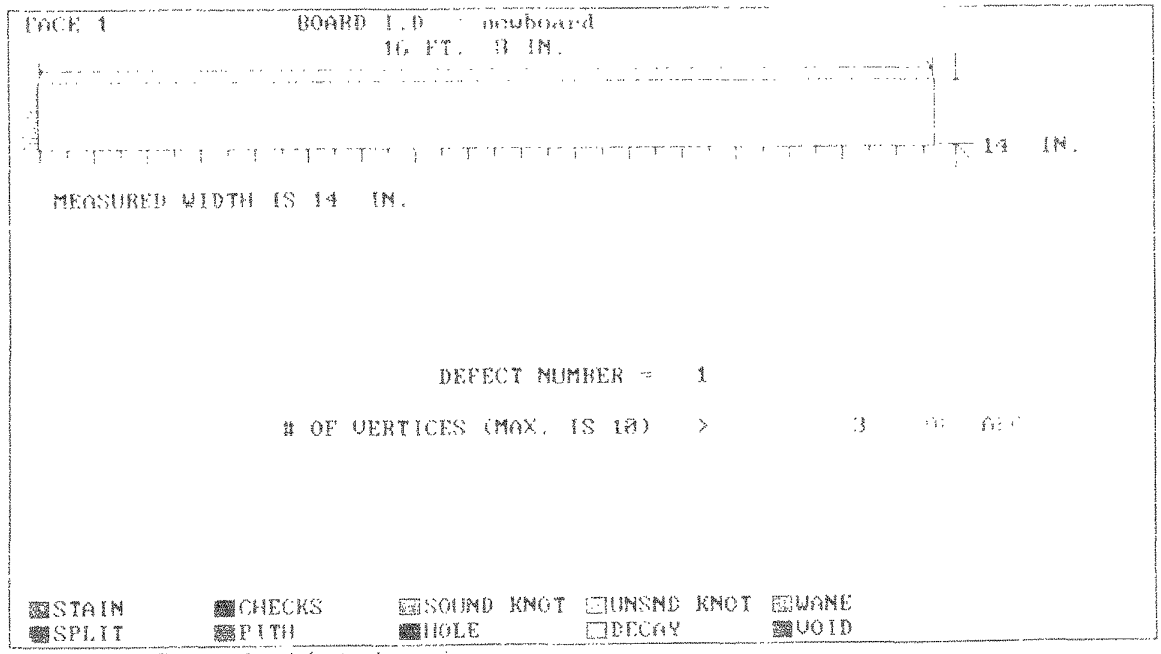

Figure 3.3-2. Prompt for defect information.

Following specification of the number of vertices and the face on which the defect is located, ReGS prompts for the coordinates of each defect. The user must enter the location of each vertex of the defect. When entering the coordinates, ReGS will display the defect number and the vertex number on the screen. As the mouse is moved on the screen, the coordinates of the mouse pointer with respect to lower left corner of the board (which is taken to be the origin) are displayed (Fig. 3.3-3). Click at each location where a vertex is to be located until all the vertices are specified. Once all vertices are specified for the defect, ReGS will offer two options:

View the other side of the board with function key F1
Continue additional defect specification with function key F2

If F2 is pressed, ReGS prompts for information on the next defect in a similar manner. This process is repeated until all defect information has been entered.

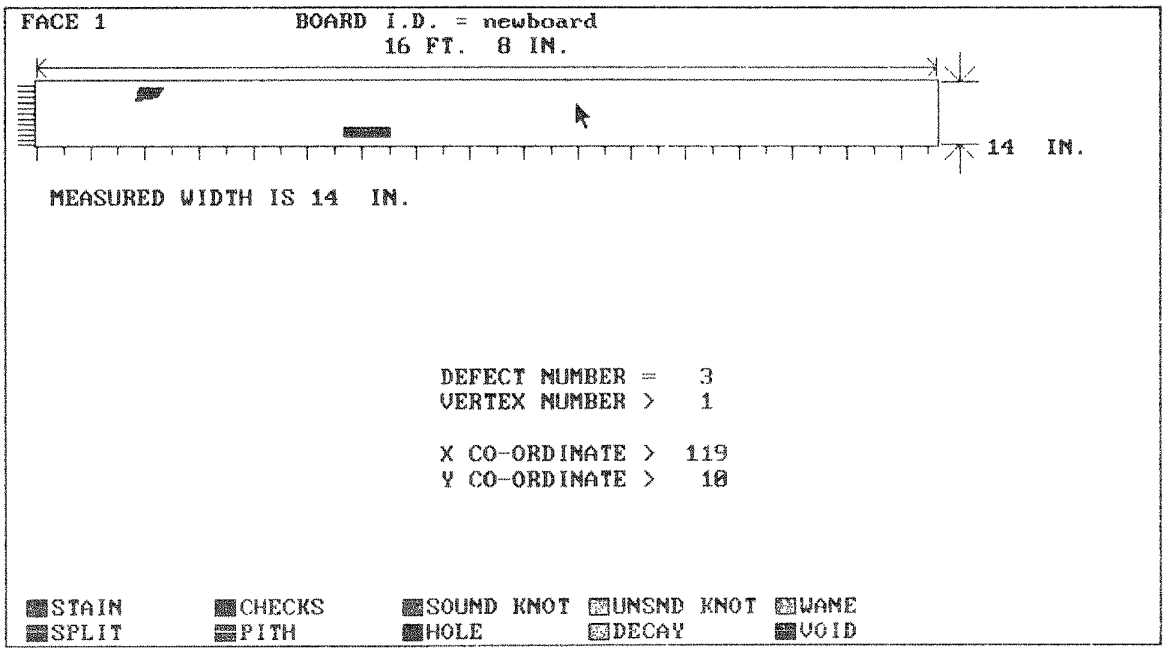

Figure 3.3-3. Entering of vertex locations with mouse.

ReGS then will offer two options. You can continue to enter information for additional boards by selecting F1 or save the work already completed and exit to the main menu by selecting F2.

If you find that an error has been made while creating a board file, there are two options. You can save the work that has been completed and return to the main menu. The option to "DELETE BOARD(S) FROM EXISTING FILE" can then be selected (see step 1.5) and the board containing the error can be deleted. Or the work can be saved and the associated board file can be edited outside of the ReGS program to correct the error (see Section 4 for board file data formats).

3.4 Entering Board Data Using Keyboard

Entering board data using the keyboard is similar to entering data with the mouse. ReGS will begin by prompting for the board identification (see step 3.3). Once the identification of the board is entered, the board length in inches is requested. The number entered should range from 1 to 200 inches. Next, the bounding width of the board in inches is requested. The entered width should be from 1 to 15 inches, inclusive. The measured width will be entered next and should be from 1 inch up to the bounding width. ReGS next prompts for the number of defects on the board. The number of defects should be from 0 to 100, inclusive (Fig. 3.4-1).

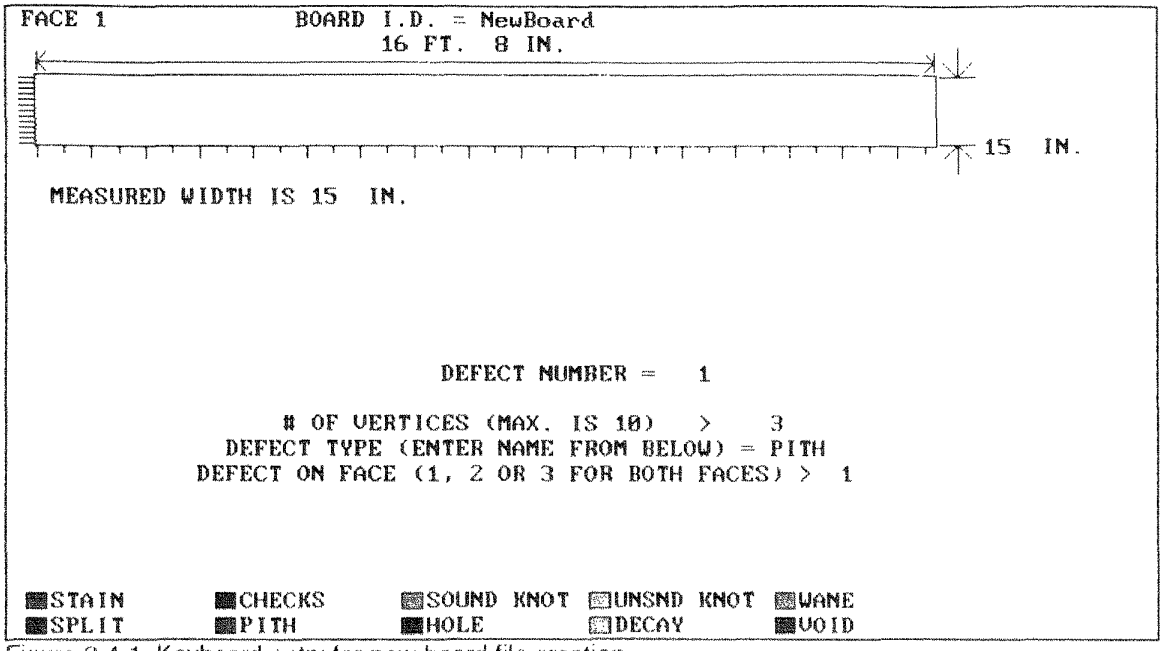

Figure 3.4-1. Keyboard entry for new board file creation.

Once the number of defects is specified, ReGS prompts for the information associated with each defect. While entering the defect information, the defect number is displayed on the screen. The first piece of information is the number of vertices. The number of vertices entered should be from 3 to 10. The defect type is then specified by entering the name of one of the defects from the legend displayed on the screen. The face on which the defect resides is requested next. The face will be indicated by an integer value of one or two. Face 1 or 2 is specified by typing "1" or "2", respectively.

Finally, the x and y coordinates of each of the vertices are requested. The x coordinate must not be greater than the length of the board and the y coordinate must not be greater than the width of the board. If a number is entered that violates either length or width restrictions, ReGS will ask you to reenter the figure. This process is then repeated until all information for all defects is specified. ReGS then provides two options: 1) to specify data for the next board using the F1 key, and 2) to save the data specified to this point and return to the main menu by pressing F2.

3.5 Adding Boards to an Existing File

The option, "ADD BOARD(S) TO AN EXISTING FILE" can be selected from the main menu by clicking on it with the mouse or by pressing the F2 key. This option allows the user to open an existing board file and add more boards to it. If this option is selected, ReGS will prompt you for the name of the board file which will have boards added to it. Once the board file is specified, it will be opened and the board data specified will be added to the existing file. The board data is entered as described in steps 3.2 through 3.4.

3.6 Deleting Boards from a File

The option, "DELETE BOARD(S) FROM AN EXISTING FILE" can be selected from the main menu by clicking on it using the mouse or by pressing F3. This option allows the user to delete boards from an existing board file. If this option is selected, ReGS will display all of the files in the current directory ending with the extension .DAT (DAT is the default extension for board files). You can select one of these files by clicking on it or specify another file by pressing F1 and then typing the desired board file. Pressing the "ESC" key will abort the process and return you to the main menu.

Once a board file has been selected, ReGS will display a submenu with four options. The first option displays the boards in a file sequentially, the second displays boards by their identification, the third displays boards by the number in the file, and the fourth returns you to the main menu.

The first option can be selected by pressing the F1 key or by clicking on "SHOW BOARDS SEQUENTIALLY". This option displays one board after another as they appear in the board file. Once the board is displayed, you will be given two options:

F1 to view the other face of the board
F2 to continue.

If F2 is pressed, ReGS provides two additional choices:

F1 to delete the selected board from the file
F2 to not delete the board.

If F1 is chosen, the board is deleted from the file. If F2 is chosen, ReGS gives the user two additional options. F1 will show the next board and ESC will return to the board deletion menu.

The next option in the board-deletion utility is "SHOW BOARD WITH ID" and can be selected by pressing F2 or using the mouse. If this option is chosen, all board identifications in the board file are displayed as shown in Figure 3.6-1. You can choose one of the identifications by clicking on it or by pressing F1 and selecting the board identification. Once the board ID number has been specified, the board is displayed on the screen with similar options described earlier. Once the board is completed, you can choose another ID or press ESC to return to the main menu.

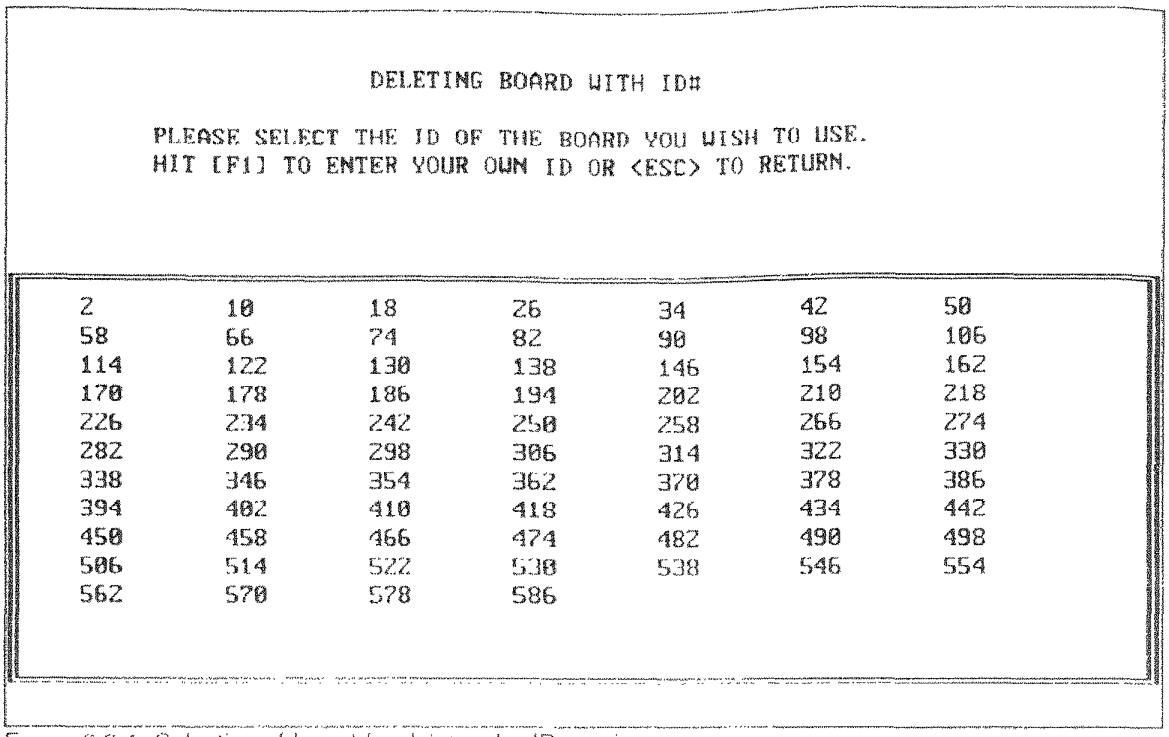

Figure 3.6-1 Selection of board for deletion by ID number.

The next option in the deletion utility is to delete the boards in a file based on the position of the board within the file (i.e., first board in file, second, third, etc.). This option will display the total number of boards in a file and prompt for the board number to be deleted. When you specify the number of the board in the file to be deleted, ReGS will display the board on the screen with similar options described earlier. Once you have deleted the board, ReGS will return to the "DELETE BOARDS BY NUMBER" menu prompting for another number. You also can return to the board deletion menu by pressing the ESC key.

4. ReGs Data-File Structure for Boards

To be read properly by ReGS, board data files must follow one of two formats based on the method used to specify board data. The two methods differ from each other in that one describes defects as rectangles (referred to as rectangular board data) while the other describes defects as polygons (referred to as polygonal board data). Internally, ReGS processes both rectangular defect data and polygonal defect data in the same way; however, ReGS displays the data differently. In the case of rectangular data, ReGS processes the data as rectangular and also displays the defects as rectangles. In the case of polygonal defect data, ReGS first converts the polygonally described defects into rectangles and then processes the data as if they were rectangular; however, ReGS displays the defects as polygons. If a board is created using the ReGS "Board Creation" utility (described in Section 3), defects will be created using the polygonal format. Both file formats are described in this section. Any deviation from the specified file formats will cause ReGS to abort, or, worse, generate erroneous results.

4.1 Rectangular Board Data

For the rectangular defect description, the board data file contains five types of data that are read in one line at a time:

1) The first line of data in the data file is expected to contain an eight (or less than eight but greater than zero) character name or number used to identify the board. This name may contain any character that can be entered from a standard computer keyboard.

2) The second line of the data file contains the value in inches assigned to each unit used to specify the coordinates of the defects on the board. This resolution is not fixed as this program might be used with a computer-aided vision system. The resolution with which each system measures defects may vary, so this value is allowed to vary. For example, if the defects are specified in quarter-inch units, the value entered in this record would be 0.25.

3) The third line of the data file contains the length and width of the board as an integer number of the units cited. The first number should be the length followed by the width. These two numbers must be separated by a separator (either a space or a comma). The maximum length and width of the board are 200 and 15 inches, respectively; the minimum length and width are 1 inch each. For example, suppose the data are specified in quarter-inch units (grading resolution = 1/4 = 0.250) and the board is 10 feet long and 8 inches wide. The third record of the data file would read as 480 32 or 480, 32.

   The final part of this field is optional and contains the measured width of the board (as opposed to bounding width). The concept of measured width is discussed in step 3.1. The measured width always is less than or equal to the bounding width of the board. The measured width can be specified by means of two additional fields on the same line as that of length and width. After length and width have been specified, a negative number is specified to tell the program that it is a non-rectangular board and the next field is the bounding width. If the measured width of a board is 7 inches and the length and the width are 10 feet and 8 inches, respectively, at quarter-inch resolution, the data are specified as:

   480 32 -1 28 or 480, 32, -1, 28.

4) The fourth record of the data file contains the number of defects that the board contains. This is an integer. The maximum number of defects allowed by ReGS is 100. This is followed on the same line by a negative number to indicate that it is rectangular board data. If there are seven defects, the data are specified as 7 -1 or 7, -1.

5) The fifth and each subsequent line describe the defects themselves. There must be as many lines as the number of defects specified or the program will abort. If there are more lines, ReGS will abort or, worse, provide erroneous results. The line containing the defect information consists of six integers. They are listed from left to right and should be separated by a space or comma. The numbers, listed in the order they must appear from left to right, are:

   a) The x coordinate of the left boundary of the defect;
   b) The y coordinate of the lower boundary of the defect;
   c) The x coordinate of the right boundary of the defect;
   d) The y coordinate of the top boundary of the defect;
   e) The defect type specified by its integer code (Table 1);
   f) The face on which the defect appears.

Table 1. Defect codes recognized by ReGS

Defect type	Defect code
STAIN	1
CHECKS	2
SOUND KNOT	3
UNSOUND KNOT	4
WANE	5
SPLIT OR SHAKE	6
PITH	7
HOLE	8
DECAY	9
VOID	11

As an example of rectangular defect description, the board in Figure 4.1-1 will be encoded using the rectangular defect file format.

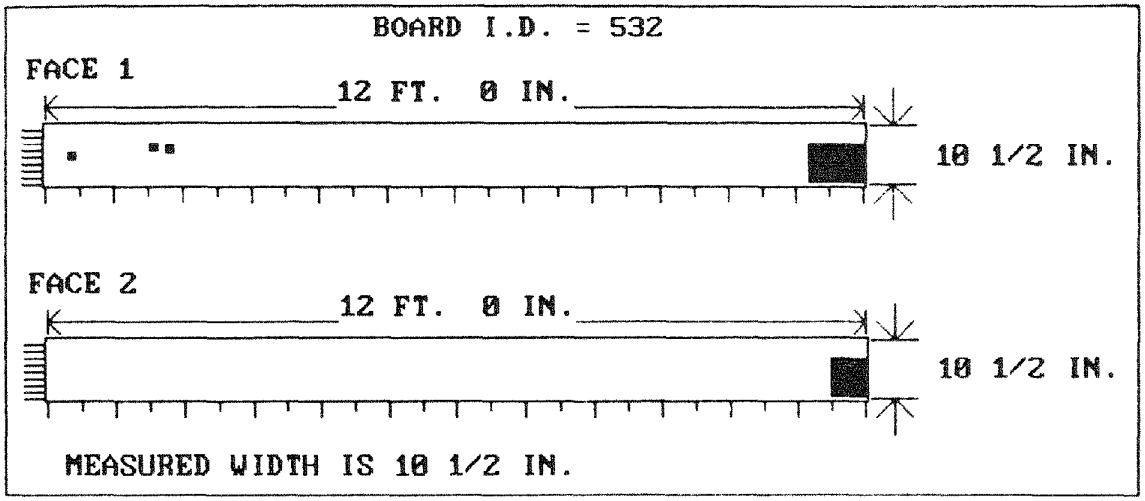

Figure 4.1-1. Sample board for data-file creation.

The locations of the defects on the board are specified in Cartesian coordinates using the lower left corner of the board as the origin. The face that is used is irrelevant so long as the same corner is used for both faces. For this discussion we will assume that the board face "facing" the user is Face 1 and that the other side is Face 2. When specifying the defects on the reverse face, ReGS assumes that they are transparent (can be brought through) to the front face and share the same coordinate system used to specify defects on the front face.

The coordinate plane used in specifying the defects is marked out in integer units in the x and y direction. Each unit corresponds to the unit of resolution used in specifying the defects. The procedure used to specify the location of defects is illustrated by an example. Figure 4.1-1 shows the two faces of a sample board. The board is 12 feet long and 10 1/2 inches wide. We will assume that the resolution used to specify the defects is one-quarter inch. The board is 576 units long and 42 units wide. Notice that Face 1 contains four defective areas: an unsound knot in the middle of the left end, two small unsound knots further to the right, and split/shake on the right end. If void is present on the board, it must be identical on each face since it represents the absence of lumber.

On Face 2 there is one defect, split/shake on the right end. In specifying the location of the split/shake on this face, ReGS assumes that it is viewed looking through the board from the front. Thus, the split/shake on the right end side of Face 2 would fall beneath the split/shake on Face 1.

Specifying the rectangular defects that lie on the two faces of the board requires that the user specify three pieces of information: the type of defect, the face on which the defect appears, and the location of the defect. The location of the defect is determined by the rectangular region that encloses it. The location of the rectangular region is described by specifying the lower left and upper right hand corners. Additionally, large, irregular defects can be broken into adjacent and smaller rectangles to more accurately represent the defect. When specifying the defective regions, the user should recall that the grading program regards all of the area enclosed within each rectangle as defective.

Assuming that the board is given the identification "532", the encoded rectangular data for the board in Figure 4.1-1 are as follows (note that within the data file itself, data entry should begin in column 1):

532	(board identification)
0.250	(resolution of units)
576 42 -1 42	(length and width of board, negative number, and measured width)
5 -1	(number of defective regions, negative number for rectangular data)
19 20 21 21 4 1	(left end unsound knot on Face 1)
88 24 89 25 4 1	(left end unsound knot on Face 1)
90 23 91 24 4 1	(left end unsound knot on Face 1)
539 2 576 29 6 1	(right edge split/shake on Face 1)
552 2 576 29 6 2	(right edge split/shake on Face 2)

If desired, the board data file can contain information for more than one board. This is accomplished by listing the next set of board data directly after the preceding board.

4.2 Polygonal Board Data

For the polygonal defect description, the board data file contains five types of data that are read in one line at a time:

1) The first line of data in the data file is expected to contain an eight (or less than eight but greater than zero) character name or number used to identify the board. This name may contain any character that can be entered from a standard computer keyboard.

2) The second line of the data file contains the value in inches assigned to each unit used to specify the coordinates of the defects on the board. This resolution is not fixed as this program might be used with a computer-aided vision system. The resolution with which each system measures defects may vary, so this value is allowed to vary. For example, if the defects are specified in quarter-inch units, the value entered in this record would be 0.25.

3) The third line of the data file contains the length and width of the board as an integer number of the units cited. The first number would be the length followed by the width. These two numbers must be separated by a separator (either a space or a comma). The maximum length and width of the board are 200 and 15 inches, respectively; the minimum length and width are 1 inch each. For example, suppose the data is specified in quarter inch units (grading resolution = 1/4 = 0.250) and the board is 10 feet long and 8 inches wide. The third record of the data file would read as 480 32, or 480, 32.

The final part of this field is optional and contains the measured width of the board (as opposed to bounding width). The concept of measured width is discussed in step 3.1. The measured width always is less than or equal to the bounding width of the board. The measured width can be specified by means of two additional fields on the same line as that of length and width. After length and width have been specified, a negative number is specified to tell the program that it is a nonrectangular board and the next field is the bounding width. If the measured width of a board is 7 inches and the length and the width are 10 feet and 8 inches, respectively, at quarter-inch resolution, the data are specified as:

480 32 -1 28 or 480, 32, -1, 28.

4) The fourth record of the data file contains the number of defects that the board contains. This is an integer. The maximum number of defects allowed by ReGS is 100. If there are seven defects, the data is specified as 7. Note that the absence of a negative number (as opposed to the rectangular format), indicates a polygonal board format.

5) The set of lines following the number of defects describes the defects themselves. The first line of each set of lines that describes a defect consists of three integers. They are listed from left to right and should be separated by a space or a comma. The numbers, listed in the order they must appear from left to right, are: a) the number of vertices describing the boundary of each defect, b) the defect type specified by its integer code (see Table 1), c) the face on which the defect appears.

   The following lines contain the coordinates of each vertex of the defect. There should be as many lines as the number of vertices per defect. Each line containing the defect coordinates consists of two integers separated by a space or a comma. The first integer contains the x coordinate and the second contains the y coordinate. Each of the coordinates should be in terms of the number of resolution units as described above.

As an example of polygonal defect description, the board in Figure 4.1-1 will be encoded using the polygonal defect file format.

The locations of the defects on the board are specified in Cartesian coordinates using the lower left corner of the board as the origin. The face that is used is irrelevant so long as the same corner is used for both faces. For this discussion we will assume that the board face "facing" the user is Face 1 and that the back of Face 1 is Face 2. When specifying the defects on the reverse face, ReGS assumes that they are transparent to the front face and share the same coordinate system used to specify defects on the front face.

The coordinate plane used in specifying the defects is marked out in integer units in the x and y direction. Each unit corresponds to the unit of resolution used in specifying the defects. The procedure used to specify the location of defects is illustrated by an example. Figure 4.1-1 shows the two faces of a sample board. The board is 12 feet long and 10-1/2 inches wide. We will assume that the resolution used to specify the defects is one-quarter inch. The board is 576 units long and 42 units wide. Notice that Face 1 contains four defective areas: an unsound knot in the middle of the left end, two small unsound knots further to the right, and split/shake on the right end. If void is present on the board, it must be identical on each face since it represents the absence of lumber.

On Face 2 there is one defect, split/shake on the right end. In specifying the location of the split/shake on this face, ReGS assumes that it is viewed looking through the board from the front. Thus, the split/shake on the right end side of Face 2 would fall beneath the split/shake on Face 1.
Specifying the polygonal defects that lie on the two faces of the board requires that the user specify four pieces of information: the type of defect, the face on which the defect appears, the number of vertices, and the location of the defect. The location of the defect is determined by the polygonal region that encloses it.

The location of the polygonal region is described by specifying the location of each vertex in terms of x and y coordinates. When specifying the defective regions, the user should recall that the grading program regards all of the area enclosed within each polygon as defective.

Assuming that the board is given the identification "532", the encoded polygonal data for the board in Figure 4.1-1 are as follows (note that within the data file itself, data entry should begin in column 1):

532	(board identification)
0.250	(resolution of units)
576 42 -1 42	(length and width of board, negative number, and measured width)
5	(number of defective regions)
4 4 1	(left end unsound knot on Face 1)
19 20	(first vertex left end unsound knot on Face 1)
21 20	(second vertex left end unsound knot on Face 1)
21 21	(third vertex left end unsound knot on Face 1)
19 21	(fourth vertex left end unsound knot on Face 1)
4 4 1	(left end unsound knot on Face 1)
88 24	(first vertex left end unsound knot on Face 1)
89 24	(second vertex left end unsound knot on Face 1)
89 25	(third vertex left end unsound knot on Face 1)
88 25	(fourth vertex left end unsound knot on Face 1)
4 4 1	(left end unsound knot on Face 1)
90 23	(first vertex left end unsound knot on Face 1)
91 23	(second vertex left end unsound knot on Face 1)
91 24	(third vertex left end unsound knot on Face 1)
90 24	(fourth vertex left end unsound knot on Face 1)
4 6 1	(right edge shake/split on Face 1)
539 2	(first vertex right end split/shake on Face 1)
576 2	(second vertex right end split/shake on Face 1)
576 29	(third vertex right end split/shake on Face 1)
539 29	(fourth vertex right end split/shake on Face 1)
4 6 2	(right edge shake/split on Face 2)
552 2	(first vertex right end split/shake on Face 2)
576 2	(second vertex right end split/shake on Face 2)
576 29	(third vertex right end split/shake on Face 2)
552 29	(fourth vertex right end split/shake on Face 2)

If desired, the board data file can contain information for more than one board. This is accomplished by listing the next set of board data directly after the preceding board.

5. Running ReGS in Batch Mode

If you simply want to know the grade of a group of boards and do not wish to take time for the interactive procedures given above, use the batch mode option. After making your working directory the ReGS directory (see 1.3 Running ReGS), enter "REGS -BATCH", instead of "REGS". Capitalization does not matter. ReGS will start as usual. During grading, ReGS will not pause to ask you any questions. The results of the grading process are stored in a file named "GRADE.REG".

To invoke the batch mode and grade an entire file, perform the following steps:

1. At the DOS prompt and with the ReGS subdirectory as your working directory enter

   REGS -BATCH

2. Set the timer (Figure 1.4-1) and choose the scant board option (Figure 1.5-1). At the Main Menu (Figure 1.6-1) choose "[F4] GRADE A BOARD FILE"

3. At the ReGS OPTION SELECTION MENU (Figure 2.2-1), choose "[F2] PRESENT BOARDS IN SEQUENCE". Since ReGS will not pause for any questions, the entire board file will be graded at once.

4. Once the board file has been processed, exit ReGS and rename the output file "GRADE.REG" for storage. For example, entering

   REN GRADE.REG 2COMMON.REG

   at the DOS prompt renames the output file to 2COMMON.REG. If you do not rename the file, you could have two problems. First, if you grade another board file before exiting, the results will be appended to the end of "GRADE.REG" with no indication of where the first file ended and the second file began. This can be useful for making one large report file out of several small ones. Second, if you exit ReGS and fail to rename the file before restarting ReGS, you will lose all the data in it!

Technical support for installation and operation of ReGS can be obtained by contacting Dr. Powsiri Klinkhachorn at:

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