Seismic Design Parameters
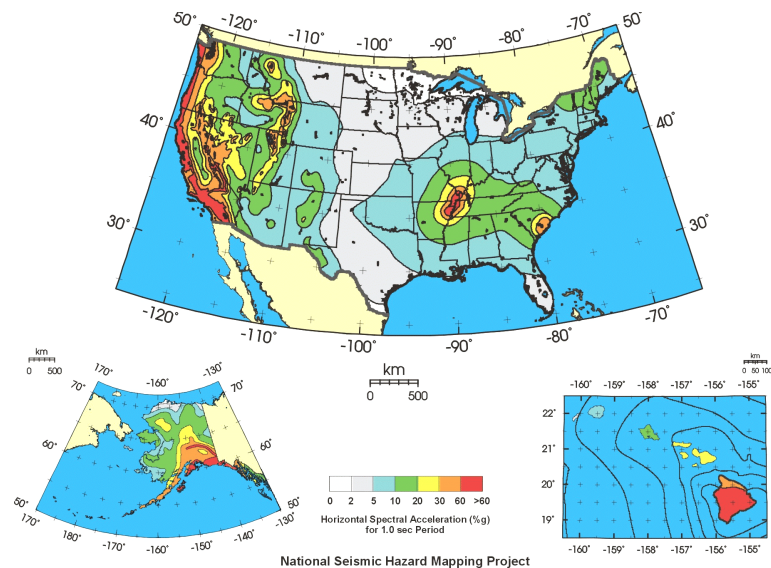
by E.V. Leyendecker, A.D. Frankel, and K.S. Rukstales

A User Guide to Accompany
Open-File Report 01-437

2001

National Seismic Hazard Mapping Project

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards or with the North American Stratigraphic Code. Any use of trade firm or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Seismic Design Parameters

A User Guide to Accompany Open-File Report 01-437

E.V. Leyendecker[1], A.D. Frankel[2], and K.S. Rukstales[3]

ABSTRACT

The 1997 *NEHRP Recommended Provisions for Seismic Regulations for New Buildings* (1997 *NEHRP Provisions*) introduced seismic design procedure that is based on the explicit use of spectral response acceleration rather than the traditional peak ground acceleration and/or peak ground velocity or zone factors. The spectral response accelerations are obtained from spectral response acceleration maps accompanying the report. Maps are available for the United States and a number of U.S. territories. Since 1997 additional codes and standards have also adopted seismic design approaches based on the same procedure used in the NEHRP Provisions and the accompanying maps.

The design documents using the 1997 NEHRP Provisions procedure may be divided into three categories - (1) Design of New Construction, (2) Design and Evaluation of Existing Construction, and (3) Design of Residential Construction. A CD-ROM has been prepared for use in conjunction with the design documents in each of these three categories. The spectral accelerations obtained using the software on the CD are the same as those that would be obtained by using the maps accompanying the design documents.

The software has been prepared to operate on a personal computer using a Windows (Microsoft Corporation) operating environment and a point and click type of interface. The user can obtain the spectral acceleration values that would be obtained by use of the maps accompanying the design documents, include site factors appropriate for the Site Class provided by the user, calculate a response spectrum that includes the site factor, and plot a response spectrum. Sites may be located by providing the latitude-longitude or zip code for all areas covered by the maps. All of the maps used in the various documents are also included on the CDROM.

---

[1] Research Civil Engineer, U.S. Geological Survey, MS 966, Box 25046, DFC, Denver, CO, 80225
[2] Geophysicist, U.S. Geological Survey, MS 966, Box 25046, DFC, Denver, CO, 80225
[3] Physical Science Technician, U.S. Geological Survey, MS 966, Box 25046, DFC, Denver, CO, 80225

INTRODUCTION

The 1997 NEHRP Recommended Provisions for Seismic Regulations for New Buildings (NEHRP Provisions, BSSC, 1998a) introduced a seismic design procedure based on the explicit use of spectral response accelerations rather than the traditional peak ground acceleration and/or peak ground velocity or zone factors. The design procedure requires a minimum of two spectral response accelerations, for 0.2 sec and 1.0 sec periods, to obtain design values for a site. A series of maps for the spectral response accelerations for these two periods were prepared for use with the procedure. The 1997 NEHRP Guidelines for the Seismic Rehabilitation of Buildings, (NEHRP Guidelines, ATC, 1997) also adopted the spectral response acceleration approach. A single map package accompanies the two NEHRP reports. The package includes a set of Maximum Considered Earthquake ground Motion Maps (MCE maps) and a set of ground motion maps based on a 10% probability of exceedance in 50 years (10%/50 yr maps). The 1997 NEHRP Provisions use only the MCE maps while the 1997 NEHRP Guidelines uses both sets of maps.

Since 1997 additional codes and standards have also adopted seismic design approaches based on the spectral response acceleration procedure used by the 1997 *NEHRP Provisions*. These design documents may be divided into three categories - (1) documents used for Design of New Construction, (2) documents used for Design and Evaluation of Existing Construction, and (3) documents used for Design of Residential Construction. These are listed in Table 1 divided according to these three categories.

All of the New Construction documents use the MCE maps although the *International Building Code* (ICC, 2000) and the standard *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2000) use a different number and size of maps than those used in the 1997 *NEHRP Provisions*. The 2000 *NEHRP Provisions* uses the same set of maps accompanying the 1997 *NEHRP Provisions*. The Existing Construction documents all use the same set of maps that accompany the *NEHRP Provisions* and the *NEHRP Guidelines*. The *International Residential Code* (ICC, 2000) uses a single map that was derived from the MCE maps used in the *NEHRP Provisions*. The map was modified for the default site class (Site Class D) and only includes contours according as required for the special needs of the *IRC*. The maps used with all of the documents were derived from the same database and give the same results, regardless of size.

Although simple in approach, it can be cumbersome to work with multiple maps. In order to simplify use of the maps and the new design procedure, a CD-ROM has been prepared that allows obtaining spectral response accelerations by latitude-longitude or zip code. This report describes use of the CD-ROM and how the values obtained from it may be used with the aforementioned design documents. This report does not provide background to the development of the maps. The reader is referred to Appendices A and B of FEMA 303 (BSSC, 1997, 2001) and Leyendecker, et al (2000) for the rationale and details of the map development. The general background for the map development is described by Frankel, et al (1996).

```
╔══════════════════════════════════════════════════════════════╗
║              Table 1.   Design Documents                       ║
║                                                                ║
║   (1)  Design of New Construction                              ║
║                                                                ║
║       1997  -  NEHRP Recommended Provisions for Seismic        ║
║               Regulations for New Buildings and Other          ║
║               Structures (1997 Edition), (Building Seismic      ║
║               Safety Council, 1997)                            ║
║                                                                ║
║       2000  -  International Building Code (2000 Edition),      ║
║               (International Code Council, 2000)               ║
║                                                                ║
║       2000  -  Minimum Design Loads for Buildings and Other    ║
║               Structures, ASCE 7-98, (American Society of      ║
║               Civil Engineers, 2000)                           ║
║                                                                ║
║       2000  -  NEHRP Recommended Provisions for Seismic        ║
║               Regulations for New Buildings and Other          ║
║               Structures (2000), (Building Seismic Safety      ║
║               Council, 2001)                                   ║
║                                                                ║
║   (2)  Design and Evaluation of Existing Construction          ║
║                                                                ║
║       1997  -  NEHRP Guidelines for the Seismic Rehabilitation ║
║               of Buildings, (Applied Technology Council, 1997) ║
║                                                                ║
║       1998  -  Handbook for the Seismic Evaluation of          ║
║               Buildings - A Prestandard, (American Society of   ║
║               Civil Engineers, 1998)                           ║
║                                                                ║
║       2000  -  Prestandard and Commentary for the Seismic      ║
║               Rehabilitation of Buildings, (American Society    ║
║               of Civil Engineers, 2000)                        ║
║                                                                ║
║   (3)  Design of New Residential Construction                  ║
║                                                                ║
║       2000  -  International Residential Code (2000 Edition),   ║
║               (International Code Council, 2000)               ║
╚══════════════════════════════════════════════════════════════╝
```

MAPS

The maps used in the each of the design documents are included on the CDROM in PDF (Adobe Systems Incorporated) format. The maps cover all fifty states of the United States as well as Puerto Rico, Culebra, Vieques, St. Thomas, St. John, St. Croix, Guam, and Tutuila. The maps can be viewed full-size or the user can select an area for blow up and printing.

SOFTWARE AND USER GUIDE

An overview of the software is described in the following paragraphs. Operating details and features are described in greater depth in Figures 1 through 17. These figures are prints of various screens obtained during operation of the software and are used to provide guidance to the user in the operation of the software. The figures are described in some detail in the figure captions.

Software on the CDROM is written in Visual Basic 6.0 (Microsoft Corporation) to operate on a PC with a Windows 95 or later operating system, the program version is 3.10. It self installs and uses the usual mouse and point-and-click approach. The data are interpolated for a specific latitude-longitude or zip code that the user enters. Output for an entry uses the included database to interpolate for the specific site. Tabulated data, which are viewed on screen, includes the spectral ordinate data for the site. These data may be printed in hard copy or saved in an ASCII comma-delimited file. This type of file can be brought into a wide variety of software, such as a spreadsheet program, for additional processing. Additionally the user can request a plot of the spectrum for on-screen viewing. These plots can also be printed. The software can also be used to view the various maps by selecting from a list of the maps. Once brought up the maps can be blown up and printed using Acrobat Reader (Adobe Systems Incorporated) that the program accesses for the user.

The maps were prepared from gridded data sets. The software uses these data to obtain values by latitude-longitude and zip code. Comparison of the map values against the values obtained from the software provides a good check against possible input errors such as an incorrect latitude-longitude. Data include the MCE ground motion data and the 10% in 50 year probabilistic ground motion data. The same information can be obtained from the maps included on the CD but it would likely require more time and effort.

New Construction - The MCE spectral accelerations output for a site are two spectral values required for design. The user can request that site factors be included in the two spectral values. The user can also use the program to calculate an MCE response spectrum, including site factors. This response spectrum can also be viewed on screen and printed. Soil factors can be calculated and included in calculations by simply selecting the site class, the program then calculates the soil factor based of the MCE parameters. Note that the design documents for New Construction multiply the MCE values obtained from the CD by 2/3 to obtain so-called design values. This 2/3 factor is not included in the calculations obtained from the CD.

Using the notation in the design documents, the design ground motions are defined as a function of the MCE ground motions S_S and S_1 where S_S = MCE spectral acceleration in the short-period range for Site Class B and S_1 = MCE spectral acceleration at the 1.0 second period for Site Class B *(NEHRP Provisions*, Sec. 4.1.2.4). Other Site Classes are accounted for by applying soil factors to the MCE values. Site Class effects are accounted for by using $S_{MS} = F_a S_S$ for the short period, where F_a is the site coefficient, and $S_{M1} = F_v S_1$ for the long period, where F_v is the site coefficient. Site coefficients are discussed in the *NEHRP Provisions*, Sec. 4.1.2.4. A table of these coefficients is included in the software.Design spectral accelerations *(S_{DS} and S_{D1})* are obtained by multiplying S_{MS} and S_{M1} by 2/3 - that is $S_{DS} = (2/3) S_{MS}$ and $S_{D1} = (2/3) S_{M1}$. The user should review the *NEHRP Provisions* and *other* documents thoroughly to understand proper application of the values obtained from the CDROM.

Figures A and B show the MCE spectrum and the design spectrum and how they are calculated using the two spectral values obtained from the maps or the CD. Other key values used in calculating the spectra are defined in the figures.
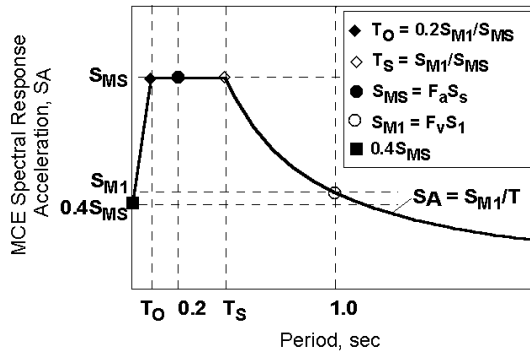

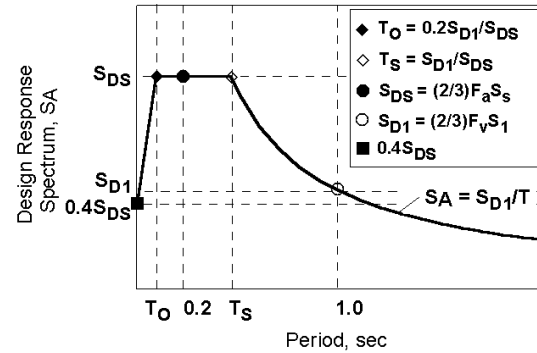**Figure A. MCE Ground Motion Response Spectrum** **Figure B. Design Response Spectrum**

Existing Construction - Both the MCE map data and 10% in 50-year map data are available on the CD. The MCE output is as described for **New Construction** above. The type of output for the 10% in 50-year parameters is the same as the type of output for the MCE parameters. A 10% in 50-year spectrum is calculated by substituting the 10% values for the MCE values in Figure A. Soil factors can be calculated and included in calculations by simply selecting the site class. These two cases provide the user with the data required for the so-called Basic Safety Earthquake 1 (BSE-1) and Basic Safety Earthquake 2 (BSE-2) ground motion hazard as described in FEMA 273 (ATC, 1997). The Basic Safety Earthquake 2 (BSE-2) parameters are the same as the MCE parameters. The Basic Safety Earthquake 1 (BSE-1) parameters are the smaller of either: (1) 2/3 times the MCE parameters or (2) the 10% in 50 year parameters. Refer to FEMA 273, p 2-19 for more precise wording.

Residential Construction - The CD allows entry of the latitude-longitude (or zip code) with the result being the *IRC* category - A, B, C, D1, D2, or E. The output also provides all of the numbers used to obtain the *IRC* category so the designer can decide if a more rigorous design might be warranted. The design category is calculated using the MCE data.

Table 2 shows the general information for installing and operating the software. As mentioned earlier in this text, the CD ROM user guide is developed as a series of figures numbered Figure 1 through 17 following this text. Each figure is a screen copy obtained while running the program contained on the CD. The caption for each figure contains extensive text so the user does not have to go back and forth between text and figure. The figures guide the user through an example in some detail using the **New Construction** documents and then gives a example for **Existing Construction** and **Residential Construction**. It is suggested the user run the software using the information in the figures as a tutorial to gain experience in using the software. Additional information is available in readme.txt files on the CDROM.

```
         Table 2.   General Instructions for the
                        Program


     Installation

         Click on Start.
         Run Setup.exe in the root directory on the CDROM and follow the instructions.
         You may be requested to update selected files.  This is required.
         The program will be installed in the directory Seismic Design 3.10  with an executable
             file named Seismic Design 3.10.exe.

     System Requirements

         A PC (or compatible) with Windows 95, Windows 98, or Windows NT.
         Pentium Processor with 32 MB of RAM,  200 MHZ recommended.
         A minimum screen resolution of at least 800 x 600.
         A hard drive with 30 MB of available for installing the software.

     Operation

         Click on Start.
         Click on Programs.
         Select Seismic Design 3.10 from the Programs list or place an icon on the Desktop.

     Files

         Random Access Data files are in the directory MCE97-Data on the CD.
         PDF Map files are in the directory MCE97-Maps on the CD.
         Adobe Acrobat is required to view the maps.  Acrobat Reader version 4 is included on
             the CD.  Version 4 is recommended for maximum benefit in viewing and printing
             of the PDF map files.
```

CONCLUDING REMARKS

The CD-ROM has been developed to simplify obtaining design ground motions for use in the design documents intended for use with new construction, existing construction, and residential construction. The CD is intended to be as user friendly as possible and to quickly give the designer the data needed for design so more time can be spent on actual design and not looking up the "load" data. The intent of USGS, BSSC, and FEMA is to simplify and reduce the time required for at least part of an already complex process.

Comments and suggestions are always welcome and may be sent to:

Copies of comments and suggestions should be sent to:

ACKNOWLEDGMENTS

REFERENCES

American Society of Civil Engineers, 2000, Minimum Design Loads for Buildings and Other Structures, ASCE 7-98, Reston, Virginia.

American Society of Civil Engineers, 2000, *Prestandard and Commentary for the Seismic Rehabilitation of Buildings*, prepared by the American Society of Civil Engineers for the Federal Emergency Management Agency, FEMA Publication No. 356, Washington, D.C.

American Society of Civil Engineers, 1998, *Handbook for the Seismic Evaluation of Buildings - A Prestandard*, prepared by the American Society of Civil Engineers for the Federal Emergency Management Agency, FEMA Publication No. 310, Washington, D.C.

Applied Technology Council, 1997, *NEHRP Guidelines for the Seismic Rehabilitation of Buildings*, prepared by the Applied Technology Council for the Building Seismic Safety Council and the Federal Emergency Management Agency, FEMA Publication No. 273, Washington, D.C.

Building Seismic Safety Council, 2001, *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures, 2000 Edition,* Part 1- Provisions, prepared by the Building Seismic Safety Council for the Federal Emergency Management Agency, Washington, D.C.

Building Seismic Safety Council, 1998a, *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures, 1997 Edition,* Part 1- Provisions, prepared by the Building Seismic Safety Council for the Federal Emergency Management Agency, FEMA Publication No. 302, Washington, D.C.

Building Seismic Safety Council. 1998b. *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures,* Part 2 - Commentary, prepared by the Building Seismic Safety Council for the Federal Emergency Management Agency, FEMA Publication No. 303, Washington, D.C.

Frankel, A.D., Mueller, C.S., Barnhard, T.P., Perkins, D.M., Leyendecker, E.V., Dickman, N.C., Hanson, S.L., and Hopper, M.G., 1996, *National Seismic Hazard Maps, June 1996: Documentation*, U.S. Geological Survey, Open-file Report 96-532.

Leyendecker, E.V., Hunt, R.J. , Frankel, A.D., and Rukstales, K.S. 2000,. *Development of Maximum Considered Earthquake Ground Motion Maps*, Earthquake Engineering Research Institute, *Spectra*.

International Code Council, Inc. 2000a, *International Building Code*, *2000 Edition*, Building Officials and Code Administrators International, Inc., International Conference of Building Officials, and Southern Building Code Congress International, Inc.

International Code Council, Inc, 2000b, *International Residential Code*, *2000 Edition*, Building Officials and Code Administrators International, Inc., International Conference of Building Officials, and Southern Building Code Congress International, Inc.
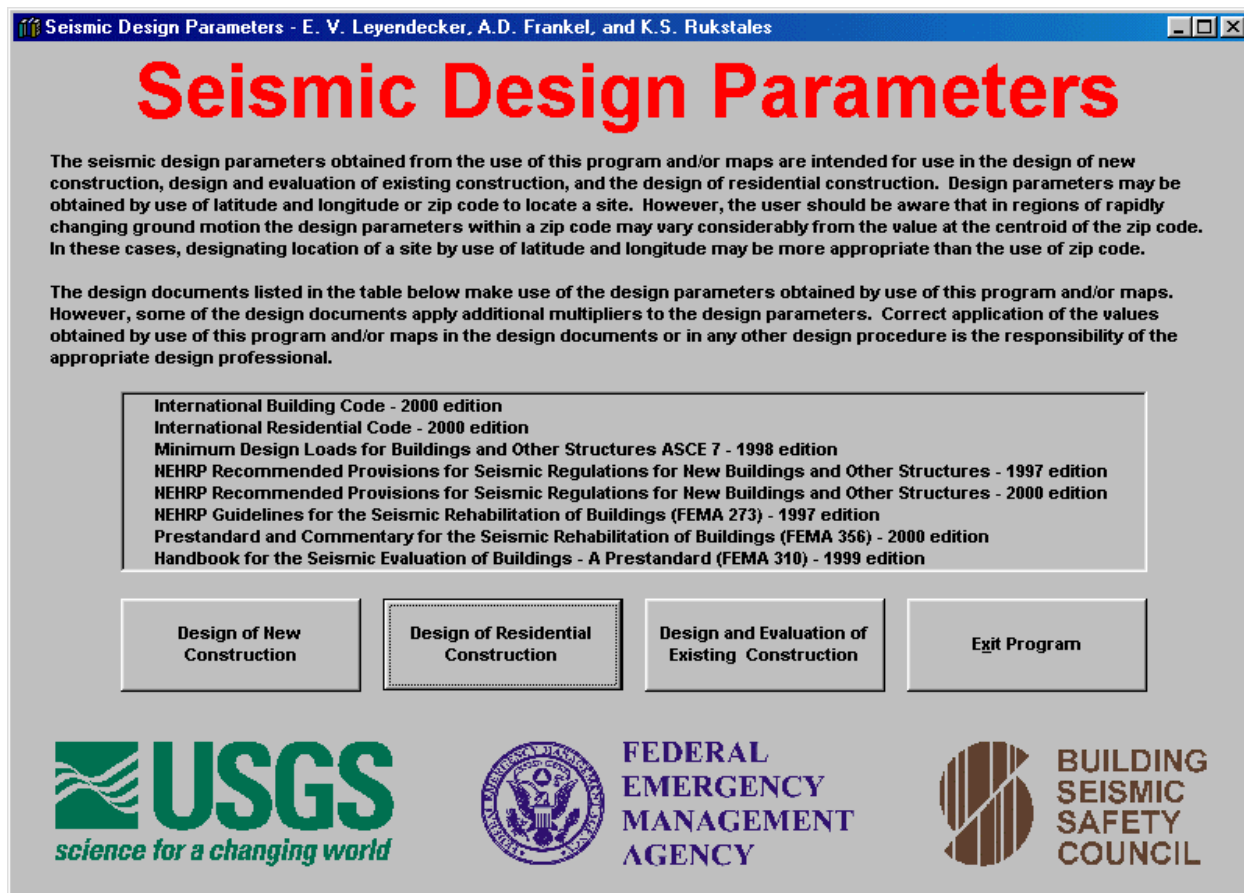
Figure 1. **Seismic design parameters.** The opening screen contains controls for obtaining seismic design parameters for Design of New Construction, Design of Residential Construction, and Design and Evaluation of Existing Construction. A fourth control, Exit Program, allows the user to close the program. This latter control is used throughout the program for this purpose. The box near the center of the screen lists the current codes, standards, and other design documents that use the seismic design parameters that may be obtained using this CD ROM. Some cautions on use are pointed out.

Typically a control is accessed in one of three ways - (1) using the Mouse to place the cursor over the control and pressing the left mouse button, (2) using the Tab key to cycle through the controls and pressing the Enter key, or (3) holding down the Alt key and pressing the underlined character on the key. Combinations of these three methods are a convenient way to move rapidly between controls and/or screens.

One of the controls - **Design of New Construction -** is used to illustrate many of the features of the software on the CD ROM. Selecting the control opens the screen shown in Figure 2. The other two controls are briefly described later.

Figure 2. **New construction design parameters.** Selecting the **Design of New Construction** control discussed in the Figure 1 caption opened the screen shown above. The contents of the screen are accessed sequentially the first time a site is selected. In general, the options selected or the data entered do not change unless the user changes them. Options or entries that cannot be accessed are grayed out. For the first site entry the user is guided through the program by the use of titles in red and controls with titles in black. This procedure indicates which control or option should be selected next. At the point shown in the figure above, the user may choose the options for entering a name and date or proceed directly to the **Open File Selection Menu** control. Although not required, use of the name and date options is a convenient way to include a user name or a project description in the output - along with the date and time the calculations were made. The name and date options are followed by selecting the **Open File Selection Menu** control. Throughout the program, "tool tips" (notes with a yellow background that explain the meaning or use of a control) will appear if the cursor is held over a control or option.

Selecting the **Opening Menu** control returns the user to the screen shown in Figure 1. The **Exit Program** control closes the program.

Figure 3. **Optional name and date entry.** The name and date option have been selected. Both will be included in the box entitled **Output for All Calculations**. If only one is selected, then only one will be included. The date and time are the computer time. In order to proceed, the user must select the **Open File Selection Menu** control.
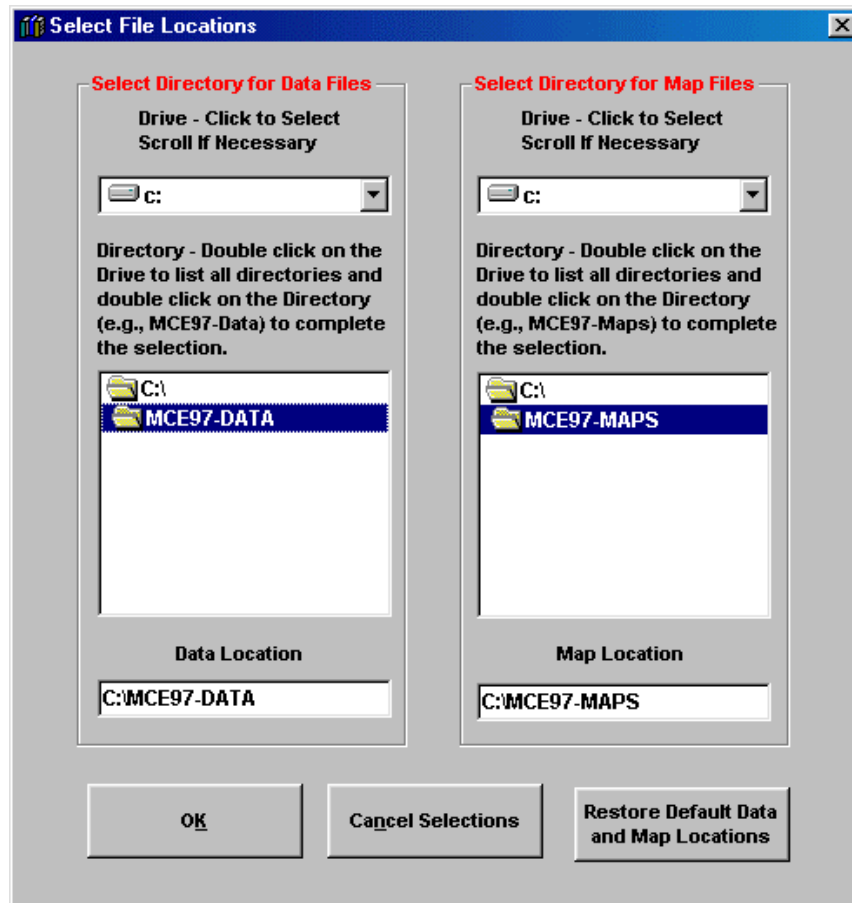
Figure 4. **Select file locations.** The data files and the map files may be accessed on the CD ROM or from a location on a hard drive or any other drive with sufficient space to hold them. In the case shown the directories containing the files have been copied to the C: drive. Location on a hard drive will usually allow faster access time than using the files located on the CD ROM. If the files are relocated, the names of the directories containing the files should be the same as those on the CD ROM, although this is not necessary. The user may also manually enter the location of files in the text boxes. An error message will appear if an incorrect drive is selected. The software checks to be sure that each data file and map file is in the designated directory. If the files have not been properly referenced, an error message or messages will be listed.

Once the location of the files has been entered, that location is remembered for future runs of the software. However, if the files are moved, a new path must be entered. Press **OK** to return to the main menu. As long as the correct file locations are shown in the text boxes, all the user has to do is click on **OK**, regardless of what is shown elsewhere on the screen.

Figure 5. **Select Geographic Region**. Geographic Regions may be selected by clicking on the text. The selected region is highlighted in blue. Additional regions may be seen by using the scroll bar. Site locations for the conterminous 48 states, Alaska, and Hawaii may be specified by latitude-longitude or zip code as shown in the **Select Site Location** frame. The so-called "radio buttons" may be used to select either method of locating a site. The buttons are shown in white and their descriptions are shown in blue. The control **View Maps**, which becomes accessible after the files have been located, allows the user to access the maps used in the various design procedures.

13

Figure 6.   **Select Site Location.**   Site locations may be specified by either latitude-longitude or zip code (except for the territories).   The latitude-longitude option has been selected in this screen. Notice that the latitude-longitude range is shown adjacent to the text box for entering values. The range changes according to the geographic region selected. If the site is specified by zip code, the central values of the zip code are computed and shown in the text boxes. It is important to be aware that when the zip code option is selected, the design parameters are determined at the central values shown. They are not maximum or minimum values for the zip code. In some areas, such as coastal California, there may be significant variation within a zip code. The user may get an idea of the variation by entering different latitude-longitude pairs near the central values or looking at contours on the spectral acceleration maps. The maps, included on the CDROM, will be discussed later.

The control **Clear Selections** clears the data related to specifying a site.

14

Figure 7.   **Calculate S_s and S_1.** The short and long period MCE parameters are calculated by pressing the **Calculate S_s and S_1** control. Notice the optional name and date are shown with the output. The latitude and longitude used to calculate the values are also shown so there is a record of the input with the corresponding output. The values are calculated by interpolation using four surrounding grid points. Data are gridded at different spacing for different regions. In the case shown the grid spacing is 0.01 deg. In the central and eastern United States the spacing is 0.1 deg. This latter spacing would not be adequate for a region such as the southwest where there are many faults.

There are four additional controls shown below the output box that are now active. These are explained below:

Clear Output clears the contents the contents of the output box.

Clear All combines **Clear Selections** and **Clear Output**.

Save To File saves the contents of the output box to an ASCII comma-delimited file.

Print sends the contents of the output box to a printer. A print dialogue box will open to allow the user the opportunity to select a printer.

Soil Factor

Soil Factors as a Function of Site Class and Spectral Accelerations

Values of Fa as a Function of Site Class and 0.2 sec MCE Spectral Acceleration

Site Class	Ss <= 0.25	Ss = 0.50	Ss = 0.75	Ss = 1.00	Ss >= 1.25
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	a	a	a	a	a

Values of Fv as a Function of Site Class and 1.0 sec MCE Spectral Acceleration

Site Class	S1 <= 0.1	S1 = 0.2	S1 = 0.3	S1 = 0.4	S1 >= 0.5
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	a	a	a	a	a

Notes:
Use straight-line interpolation for intermediate values of Sa and S1.
Note a: Site-specific geotechnical investigation and dynamic site response analyses shall be performed.

Select Soil Factor

Spectral Accelerations

Ss, g   1.7612
S1, g   0.9718

Design Documents
NEHRP 2000
NEHRP 1997
ASCE 7-98
IBC 2000

Explanation

Site Class
Site Class A
Site Class B
Site Class C
Site Class D
Site Class E
Site Class F

Select Soil Factors
Interpolated soil factors for the conditions shown. Values may also be entered manually.

Fa 1.00   Fv 1.30

OK

Figure 8.   **Select Soil Factor.**   The select soil factor menu opens after clicking the **Select Soil Factor** control shown in Figure 7. The default site class is Site Class B. If the site is a different class, select the new one by clicking on the appropriate text. Site factors for the new Site Class are computed immediately by selecting a site class. Other site factors such as those based on a site-specific study may also be used by entering them in the site factor text boxes. Selecting **OK** saves the soil factors and returns to the screen shown in Figure 9.

The Design Documents are those listed in the list box shown in Figure 1. The **Explanation** control provides the reference for each design document and provides additional information.

Figure 9.   **Calculate Spectrum.**   A design spectrum may be calculated selecting the **Calculate Spectrum** control. The calculated spectrum is based on the two MCE design parameters and the two soil factors. If a spectrum is not required, another site may be entered. Sites may be located by either latitude-longitude or zip code. Different soil factors may be selected by selecting the **Select Soil Factor** control. Output will be accumulated unless the **Clear Output** is selected.

New Construction

Optional

Show Name and Date/Time on Output

☑ **N**ame `Design Example`

☑ Include **D**ate and Time in Output

Select File Location

Open File Selection Menu

Select Geographic Region

Conterminous 48 States
Alaska
Hawaii
Puerto Rico
Culebra

Calculate MCE Spectrum

Ground Motion

MCE Ground Motion

Select Site Location

⦿ **Latitude**
(50.0 to 24.6) `34.123456`

Longitude
(-125.0 to -65.0) `-119.123456`

○ **5**-Digit Zip Code

Calculated Central Values
Latitude   Longitude

○ **T**erritories

Calculate Ss and S1

Select Soil Factor

Calculate Spectrum

View Spectrum

Output for All Calculations

```
MCE  Ground Motion - Conterminous 48 States
Latitude = 34.123456,  Longitude = -119.123456
 Period    MCE Sa
 (sec)     (%g)
  0.2      176.1    MCE Value of Ss, Site Class B
  1.0      097.2    MCE Value of S1, Site Class B
Spectral Parameters for Site Class C
  0.2      176.1    Sa = FaSs,  Fa = 1.00
  1.0      126.3    Sa = FvS1,  Fv = 1.30
Spectrum for Site Class C
 Period    MCE Sa
 (sec)     (%g)
 0.000     070.4    T = 0.0, Sa = 0.4FaSs
 0.143     176.1    T = To, Sa = FaSs
 0.200     176.1    T = 0.2, Sa = FaSs
 0.717     176.1    T = Ts,  Sa = FaSs
 0.800     157.9
 0.900     140.4
 1.000     126.3    T = 1.0, Sa = FvS1
 1.100     114.9
 1.200     105.3
 1.300     097.2
```

Clear Selections   **Clear Output**   **Clear All**

Save To File   **Print**   **View Maps**

Opening Menu   **Exit Program**

USGS
science for a changing world

FEDERAL EMERGENCY MANAGEMENT AGENCY

BUILDING SEISMIC SAFETY COUNCIL

Figure 10. **Spectrum Calculations.** A response spectrum is calculated after selecting **Calculate Spectrum** in Figure 9. The spectrum is calculated at 0.1 sec intervals. The 0.0 sec period is a placeholder for peak ground acceleration which is approximated as 0.4FaSs using the equations in the design documents. Other key points on the spectrum are shown in Figure 10. These values are used to plot a response spectrum that may be viewed in Figure 11 by selecting **View Spectrum**.
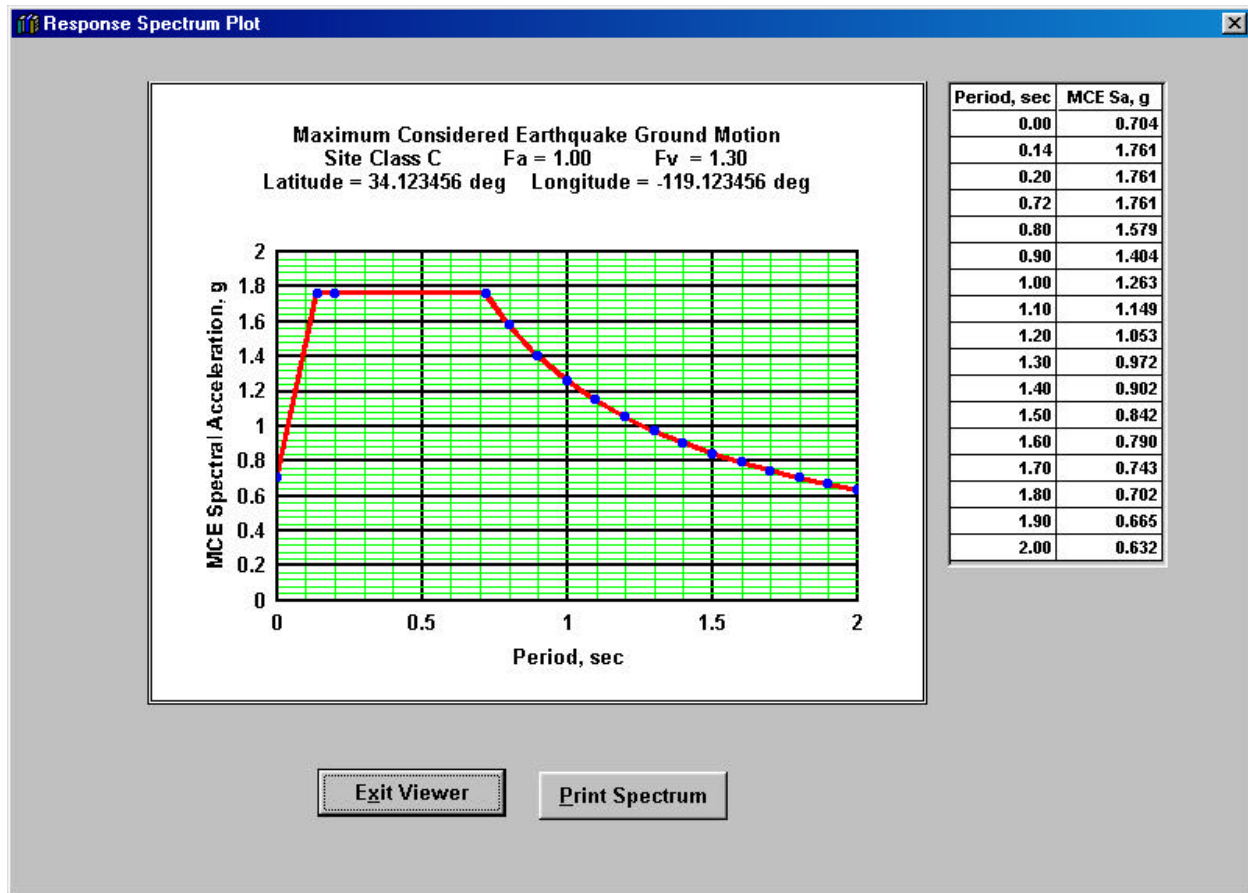
Figure 11. **Response Spectrum Plot.** A spectrum based on the calculations in Figure 10 is shown in the plot. The calculated points are shown as solid blue circles. The values used to prepare the plot are shown in the adjacent list box. These are the same as those in the output box shown in Figure 10. The plot includes data, site location, soil factors, and type of ground motion (MCE in this case). The plot and its data points are may be printed by selecting **Print Spectrum**. A print dialogue box will open to allow the user the opportunity to select a printer. An option to save the figure as a file is not available in this release of the software. The image may be captured by using the Alt key plus "print screen" (this is a readily available Windows option) for pasting into other documents.

Figure 12. **International Residential Code.** The Residential Construction portion of the program operates the same as the New Construction portion of the program. However, there is no design spectrum or selection of soil factor. These do not apply to residential construction. Instead the program computes the Seismic Design Category, in this case it is Category E. All factors used to determine the category are also shown for the information of the designer.

Figure 13. **Existing Construction Design Parameters.** The Existing Construction portion of the program operates almost exactly as the New Construction portion of the program. In this procedure, the user can select either the MCE or 10% in 50 yr ground motion. Both are used in the design and evaluation of existing construction.
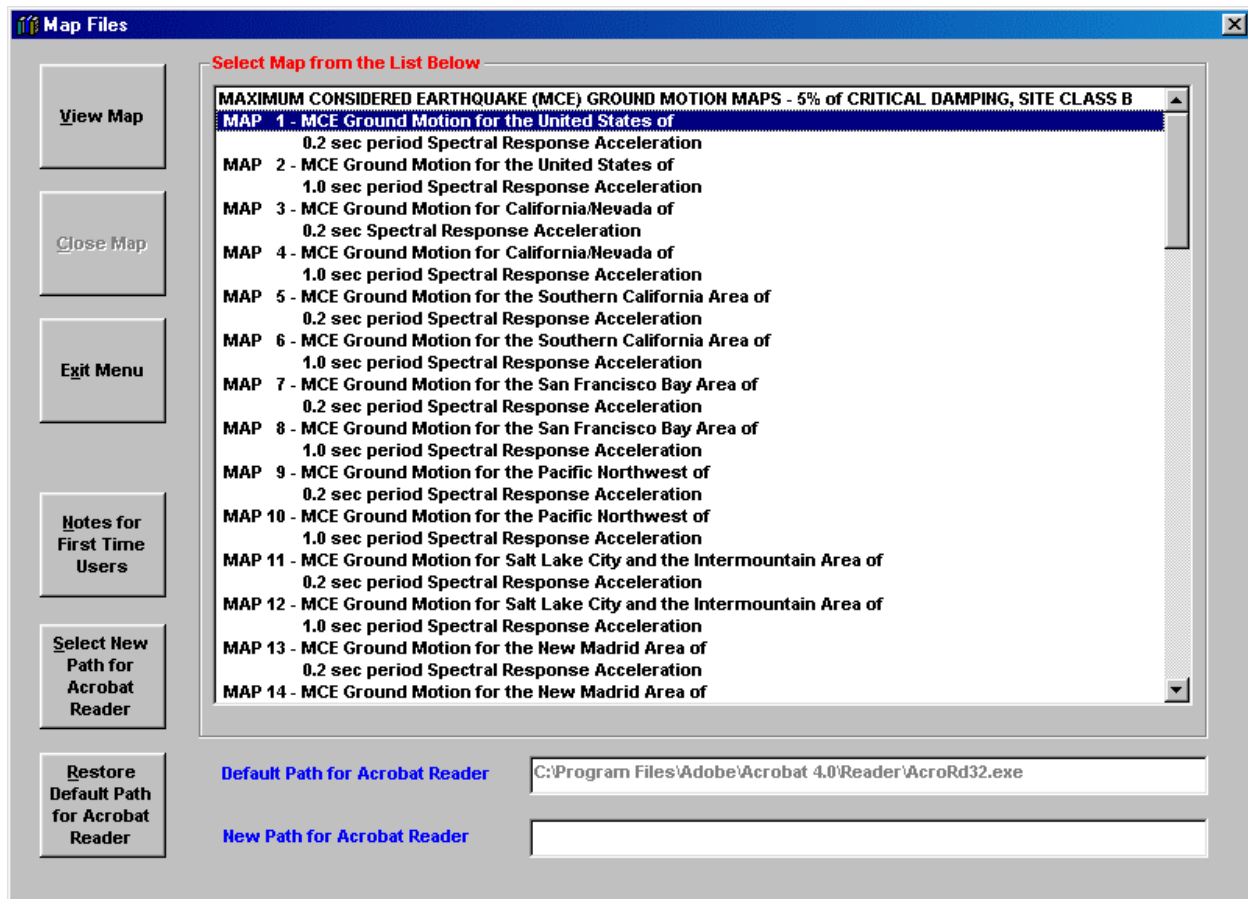
Figure 14.   **Select Map File.** The maps used in the design procedures may be viewed at anytime after the file locations have been specified. Clicking on the **View Maps** control shown in Figures 5, 12, or 13 opens the menu shown in this figure. Click on a map name to enable the **View Map** control. Click the **View Map** control to load the map. The map set includes the entire set of maps included with the any of the design procedures. The map list may be accessed by using the scroll bar or clicking on a map name at the top or bottom of the list.

Selecting the control **Notes for First Time Users** opens the screen in Figure 16. Selecting the control **Select New Path for Acrobat Reader** opens the screen in Figure 17.
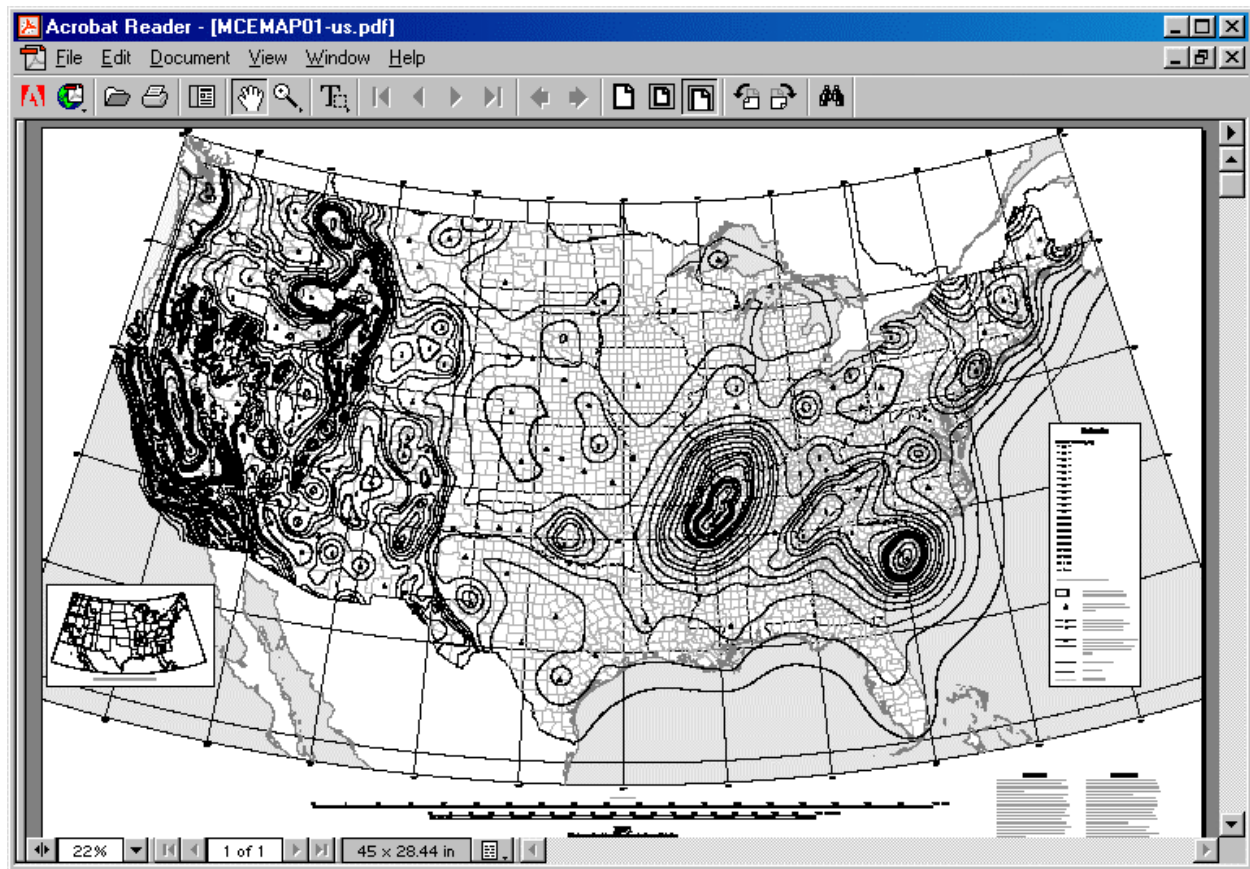
Figure 15. **Acrobat Reader.** The program automatically opens Acrobat Reader (assuming it has been installed on the computer) and loads the map file. The graphics select tool is used to select portions of the map for printing. Use the **Close Map** control to close the reader. The zoom option may be used to view the maps with greater clarity.

Notes for Acrobat Reader Installation

Adobe Acrobat is required to run the map viewer. Although map viewer will not function with all releases of Acrobat Reader, it will function with the version included on the installion CD-ROM. Additionally,the SPECIAL INSTRUCTIONS described below must be followed for map viewer to function.

GENERAL INSTRUCTIONS
 1. Exit this program and close all Windows
 2. From the Start Icon, select Run
 3. Enter R:\ar40eng.exe, R is the drive containing the installation CD-ROM
 4. This is the installation file. Follow the instructions.
 5. It is recommended that Acrobat Reader be installed in C:\Program Files\Adobe\Acrobat 4.0
    since this is used as the default in this program. This is also the default installation location.

SPECIAL INSTRUCTIONS - After this installation, or any previous installation,
  two settings must made in Acrobat preferences.
 1. Open Acrobat
 2. Select Files
 3. Select Preferences
 4. Select General
 5. Clear the Check Marks (if any) from the following two items or the map viewer will not work.
    Specifically the last items are:
     Clear check mark (if checked) from - Display Splash Screen at Startup
     Clear check mark (if checked) from - Display Open Dialog at Startup
 6. Close Adobe Acrobat

INSTALLATION PATH
 1. It is recommended that Acrobat be installed in the path - C:\Program Files\Adobe\Acrobat 4.0\Reader\AcroRd32.exe
 2. If the Reader is located in a different path, this path must be entered on the
    Select Map File form. The new path will be saved until changed.

[Close Acrobat Notes]   [Print Acrobat Installation Notes]   [Exit Program]
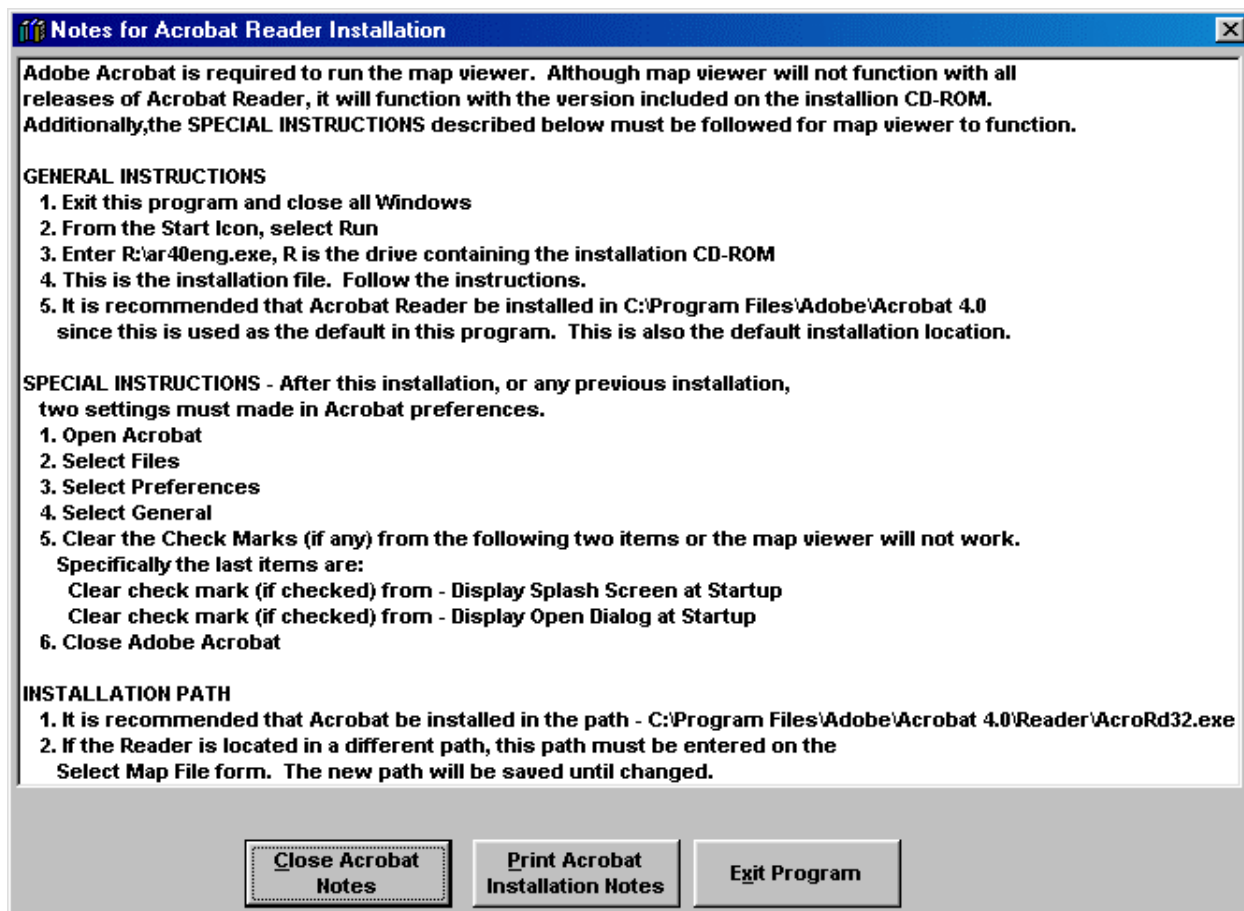
Figure 16. **Adobe Acrobat Reader Installation.**   Acrobat Reader 4.0 is necessary to view and print the maps or portions of the maps. Earlier releases of the Reader give unpredictable results in line weights and do not allow printing selected portions of the maps. Special instructions must be followed to allow automatic loading of map files. This screen with the installation instructions is accessed by selecting the control **Notes for First Time Users** in Figure 14.
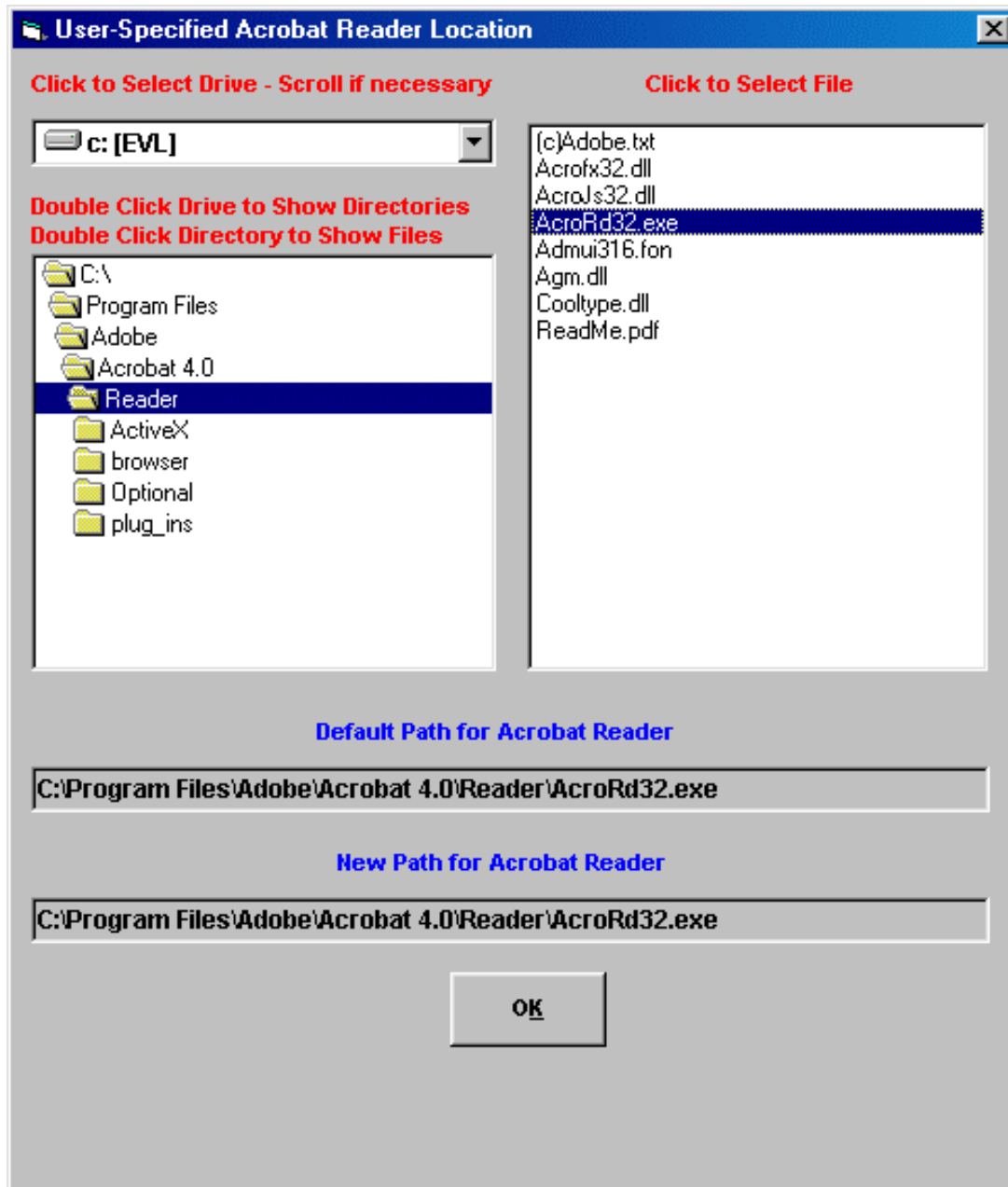
Figure 17. **Selecting a new path for Adobe Acrobat Reader.** This screen is accessed by selecting the control **Select New Path for Acrobat Reader** shown in Figure 14. It is not necessary to enter a path if the default path is the correction installation location. In the selections shown above, the default path has been selected. Notice that the default path has been shown as a guide to user to find the correct path for the Reader. The version of the Reader included with this CDROM will automatically be installed in this location.