

REMR Management Systems— Navigation Structures User's Manual for Inspection and Rating Software, Version 2.0

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Preface

The program documented herein was authorized by Headquarters, US Army Corps of Engineers (HQUSACE), as part of the Operations Management problem area of the Repair, Evaluation, Maintenance, and Rehabilitation (REMR) Research Program. The work was performed under Civil Works Research Unit 32880, "Development of Uniform Evaluation Procedures and Condition Index for Deteriorated Structures and Equipment," for which Dr. Anthony M. Kao is Principal Investigator. Mr. James E. Crews (CECW-O) is the REMR Technical Monitor for this study.

Mr. William N. Rushing (CERD-C) is the REMR Coordinator at the Directorate of Research and Development, HQUSACE. Mr. Crews and Dr. Tony Liu (CECW-EG) serve as the REMR Overview Committee. Mr. William F. McCleese (CEWES-SC-A), US Army Engineer Waterways Experiment Station (WES), is the REMR Program Manager. Dr. Kao is the Problem Area Leader for the Operations Management problem area.

The REMR Tools software described in Chapters 3 and 4 was developed by the Automation Support Center, University of Illinois under the general supervision of Dr. Paul A. Howdyshell, Chief, Engineering and Materials Division (CECER-FM), Infrastructure Laboratory (CECER-FL), of the US Army Construction Engineering Research Laboratories (USACERL). The technical editor was Gloria J. Wienke, USACERL Information Management Office.

Iowa State University used the REMR Tools Software to produce the Data Entry and Modification forms in Chapter 4. The Maintenance and Repair Analysis framework in Chapter 5 was written by USACERL personnel. Software that computes the condition index, the revised condition index for consequence modeling, and the economic analysis were written by Iowa State University personnel. Documentation of the inspection and condition index rating rules for the lock's individual substructures are provided in separate technical reports. Iowa State University was responsible for bringing the various software segments together to form a complete operational program.

LTC David J. Rehbein was Commander of USACERL, and Dr. L.R. Shaffer was Director.

Background

REMR Management Systems

The US Army Corps of Engineers operates approximately 270 navigation lock chambers. Many of these structures require, or will require, significant repairs to ensure safe and efficient operations. The Repair, Evaluation, Maintenance, and Rehabilitation (REMR) Research Program was created to identify and develop effective and affordable technology for maintaining and extending the service life of existing Corps Civil Works structures.

Modern engineering technology is providing procedures for performing condition surveys, consistent and quantitative condition assessment, and data base management. Combined with economic analyses, these procedures afford efficient maintenance and repair (M&R) budget planning through evaluation of the current condition and comparison of various M&R alternatives based on life cycle costs. Collectively these procedures are called the REMR Management Systems. By using the REMR Management Systems, many of the subjective elements in the decisionmaking process are removed from M&R planning. Components of the systems address the REMR aspects of the major substructures of lock structures.

This User's Manual describes how to use the software associated with the REMR Management Systems. The technical background to the inspection process, condition index rules, and maintenance and repair analysis are provided in the associated technical reports:

Maintenance and Repair of Steel Sheet Pile Structures, Technical Report REMR-OM-09 (Greimann and Stecker 1990).

Management System for Miter Lock Gates, Technical Report REMR-OM-08 (Greimann, Stecker, and Rens 1990).

Condition Rating Procedures for Sector Gates, Technical Report REMR-OM-13 (Greimann, Stecker, and Rens 1993).

Condition Rating Procedures for Tainter and Butterfly Valves, Draft Technical Report REMR-OM-14 (Greimann, Stecker, and Veenstra 1993).

Because the software programs for analyzing these lock and dam substructures are essentially parallel, a single User's Manual will sufficiently describe the software. Software for other substructures such as Emptying and Filling Valves is under development and will also be described by this User's Manual. Note: Substructures is used throughout this User's Manual as a collective term referring to Miter Lock Gates, Emptying and Filling Valves, Sector Gates, and Steel Sheet Pile.

Software disks are available from the US Army Construction Engineering Research Laboratories (USACERL), ATTN: CECER-FMM, P.O. Box 9005, Champaign, IL 61826-9005 (telephone 217/398-5486) or from the US Army Waterways Experiment Station, ATTN: CEWES-IM-DS, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199 (telephone 601/634-2581).

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CHAPTER 1 INTRODUCTION

Hardware Requirements

The REMR Maintenance Management System was developed for operation on an IBM*-compatible personal computer (PC) that runs MS-DOS version 3.0 or higher. A hard disk drive is required with a recommended 20 megabytes or more storage capacity. Memory of 640K RAM is also required.

If the computer has memory resident utilities, such as PC Tools, you need to unload them before running the Maintenance Management System.

If the Maintenance Management System is to be run on a slow PC, a system for disk caching is highly recommended. Many available shareware or proprietary utilities can improve disk performance substantially.

Chapter 2 discusses the system configuration and installing and starting the module.

Maintenance Management System

The software for the Maintenance Management System is a microcomputer-based application. As in most data-base-orientated programs, the software performs data base administration, calculations, and generates reports. The following fundamental activities are briefly described: Inventory, Condition Assessment, Maintenance and Repair Alternatives, and Economic Analysis.

Inventory

The program houses an inventory of all waterway systems and navigation lock structures and substructures contained within any given Corps of Engineers Division.

The first-time condition inspection data is entered for a given substructure; the software prompts you to select each substructure by providing lists of the rivers, structures, and substructures. This one-time process ensures that substructure identification will remain consistent for different inspection teams.

Condition Assessment

The condition inspection data is gathered by visual observation and by performing simple measurements. The inspection catalogs such items as anchorage movement, elevation changes, gaps, movement, cracks, and dents. Other forms of distress such as leaks, boils, corrosion, noise, jumping and vibration are also noted. The data is accepted and stored by the software which uses an algorithm to produce a condition index (CI) for each substructure. The CI ranges from 0 to 100 with 100 reflecting an "as built" condition. A CI of 39 indicates a "Poor" condition. The CI algorithm is designed to produce condition indexes that

* IBM is a trademark of International Business Machines Corporation and MS-DOS is a registered trademark of Microsoft Corporation.

reflect those conditions shown in Figure 1. Engineering and management actions associated with the CI are described in the same figure. Great care is taken in the development of the algorithm and inspection procedure to ensure that the results are consistent and repeatable. It is such uniformity that allows an objective comparison of the condition of one substructure to that of another.

Maintenance and Repair Alternatives

Some information regarding maintenance and repair operations for the various distresses in the substructures has been accumulated and stored in the software. The maintenance and repair alternatives information should be continually updated as new information is collected. Some of the information will be district dependent.

Zone	Condition Index	Condition Description	Recommended Action
1	85 to 100	Excellent: No noticeable defects. Some aging or wear may be visible.	Immediate action is not required.
	70 to 84	Very Good: Only minor deterioration or defects are evident.	
2	55 to 69	Good: Some deterioration or defects are evident, but function is not significantly affected.	Economic analysis of repair alternatives is recommended to determine appropriate action.
	40 to 54	Fair: Moderate deterioration. Function is still adequate.	
3	25 to 39	Poor: Serious deterioration in at least some portions of the structure. Function is inadequate.	Detailed evaluation is required to determine the need for repair, rehabilitation, or reconditioning. Safety evaluation recommended.
	10 to 24	Very Poor: Extensive deterioration. Barely functional.	
	0 to 9	Failed: No longer functions. General failure or a complete failure of a major structural component.	

Figure 1. Condition Index Scale

Economic Analysis

The program has an economic analysis utility that can be directly tied to the CI inspection data base. All economic analyses for maintenance planning require a standard input: interest rate, required life of overall maintenance, beginning year of maintenance plan, individual maintenance activity description, cost of individual maintenance activity, expected life of individual maintenance activity, and beginning year of individual maintenance activity. The standard output is a financial schedule showing the required present worth dollars to implement each individual maintenance activity.

Using This Manual

This User's Manual is written to document the use of Maintenance Management System for steel sheet pile, miter lock gates, sector gates, and emptying and filling valves.

Almost all of the software for these substructures is essentially the same and has the same fundamental pieces. The software instructions that follow apply to all programs. From time to time, specific examples such as sample menus will be illustrated within the document. For these examples, the Miter Lock Gate software has been used. Sample menus for the other substructures will appear similar except that the words "Miter Lock Gate" will be replaced with names of other substructures such as "Steel Sheet Pile." The specific inspection information that is input into the software and the calculation algorithm for the condition index are, of course, different for each substructure.

This User's Manual describes how to use the software associated with the REMR Management Systems. The technical background to the inspection process, condition index rules, and maintenance and repair analysis are provided in the associated technical reports:

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CHAPTER 2 USING THE MAINTENANCE MANAGEMENT SYSTEM

This chapter explains the steps required before entering the inspection data into the Maintenance Management System.

Typographical Conventions

Throughout this manual, the following typographical conventions will be used:

BOLD	indicates	User input
		Type MITER
		Press Ctl-Alt-Del
		Press Enter
ALL CAPS	indicates	Directory filename, or command
		D:\MITER
		CONFIG.SYS
		CHKDSK

Using the Maintenance Management System

The following operating conventions are used throughout the manual:

Most entries must be followed by pressing **ENTER**. If an input field is filled with the maximum number of characters, the cursor will automatically advance to the next input field.

The box at the bottom of the screen is the information box. When applicable, this box provides a short description of the current highlighted entry or explains the function of the keys available for that menu.

Some data fields may be optional; however, most must be completed for the condition index calculation to be valid. All data entry fields to be used in the CI calculation must be completed before the data can be saved.

Use the **Ctl-Enter** combination to save all data entered on each screen. Use the **Esc** key at any time during program operation to exit the current process and escape back to a previous menu. Be careful because the **Esc** key generally will not save data entries or prompt you to save the data.

Setting Up the Proper Configuration

A file called CONFIG.SYS must be present in the root directory of the PC with the following commands for the system to run properly.

BUFFERS=30

FILES=30

DEVICE=path\ANSI.SYS where "path" is the directory where the DOS files are located.

The CONFIG.SYS file can be detected by typing **DIR CONFIG.SYS** in the root directory. If the file exists, the PC will list the file name, size, and date created. If a CONFIG.SYS file does not exist, create one using a text editor (not a word processor unless the information can be saved in an ASCII DOS text format). Include the above commands. Place the file in the root directory. After creating a new CONFIG.SYS file or editing an existing CONFIG.SYS file, reboot the PC by pressing **Ctl-Alt-Del**. To ensure that the PC has at least 640K of available RAM memory, type the command **CHKDSK** to receive a disk and memory status report. The last two lines displayed on the screen are those to check. They should read:

BYTES TOTAL MEMORY

BYTES FREE

The number of bytes total memory should be 640K or greater. The number of bytes free should be 570K or greater; if fewer bytes are available, check for and unload any memory-resident utility. For further explanation of CONFIG.SYS, BUFFERS, DEVICE, and FILES commands, consult a DOS manual.

Installing the Maintenance Management System

The systems for each substructure are available in three different formats: 360k, 5.25 in. diskettes; 1.2 Mb, 5.25 in. diskettes; or 1.44 Mb, 3.5 in. diskettes. The number of diskettes varies with the substructures.

The program is distributed in compressed files. The installation routine will copy the files to the target disk drive specified and then expand them. The installation routine will also create the necessary directory and subdirectory structure for program operation and data storage. The installation routine will copy the program files to the drive path specified in the **INSTALL** command. Typically you would install the program directly off the root directory of a disk drive such as C:. However, you can install the program in a deeper level directory by including the path to that directory in the **INSTALL** command (refer to the section titled **Change the Program Path**).

To begin the installation procedure:

Insert the program disk in the floppy disk source drive and then change the system to the source drive.

Type **INSTALL** and then press the **Return** or **Enter** key to begin the program installation. Directions will be displayed on the monitor to guide you in specifying:

- the target drive for the installed program (i.e., C, D, F, etc.)
- the structure data for the appropriate Division (i.e., NCD, etc.)
- an optional deeper level directory. This does not need to be specified if you do not intend to install the program into a deeper level directory.

The directions on the monitor screen direct you to issue a **SETUP** command at the system prompt and include the three parameters in the command line string. The format for the command line string is shown in the following example:

Type **SETUP C NPD [dir]**

where **C** is the target drive,
NPD is the selected division, and
[dir] is the optional subdirectory.

Press the **Return** or **Enter** key to continue the program installation. The program would then copy the files to drive **C:** and select river and structure data for the division.

Note: The program is distributed to run directly off the root directory on drive **C:**. Installing the program on a different drive, such as **D:** or in a deeper level directory, such as **C:\TOM**, will require editing the program path in the batch file that starts the program.

Remove and save the program disk and proceed to run the program. You do not need to install a monitor or printer; the program will detect a color monitor and will default to a draft mode printer.

Change the Program Path

If you do not intend to install the program in a deeper level directory, skip this section and go to the next section. The program files for any of the substructure management systems have a startup batch file that begins the program. Each of the substructure management systems has specific files, but also share common program files in a separate directory called **REMRTOOL**. It is necessary to have the correct drive name and path in the startup batch file. For example, if you installed the program for **MITER** on drive **D:**, go to the directory **D:\MITER** and edit the file **MITER.BAT** with the following changes:

On line 3, change **C:** to **D:**

On line 6, change the path **C:\REMRTOOL** in the statement **C:\REMRTOOL\libeddsc files.dta miter.pgm** to **D:\REMRTOOL\....**

If you installed the program on a deeper level directory such as **C:\TOM**, make the following changes:

On line 5, change the path to the **\MITER** directory to include any other directory structure preceding **\MITER**, (for example **C:\TOM\MITER**)

On line 6, change the path **C:\REMRTOOL** in the statement **C:\REMRTOOL\libeddsc files.dta miter.pgm** to **C:\TOM\REMRTOOL\....**

Accessing the Maintenance Management System

When you want to access the system, you must be in the **SUBSTRUCTURE** directory. To change to the **SUBSTRUCTURE** directory, type **CD SUBSTRUCTURE** at the **C:** prompt. After the system prompt **C:\>SUBSTRUCTURE** type **SUBSTRUCTURE** to run the program.

Note: As mentioned earlier, this user's manual documents the use of the software for several substructures. The word SUBSTRUCTURE in the above instruction should be replaced by the following for the various substructure names.

MITER for Miter Lock Gates

SECTOR for Sector Gates

SSP for Steel Sheet Pile

VALVE for Emptying and Filling Valves

For example, to access MITER, change to the MITER directory and type MITER. The first substructure screen will appear.

Getting Started With the Maintenance Management System

When you access the Maintenance Management System, a title screen is displayed to show the program has been initiated. The Corps of Engineer Division data set that is accessible is also shown. The banner screen displays authorship and acknowledgement information as well. The structure data set distributed with the program is currently limited to a division. Press any key to continue to the next screen, which is the main menu. All options begin at this menu. The system is menu-driven.

Editing Keys

The editing keys are used to edit data being entered into the system. The following keys are used:

Backspace Key	~	Backspace one space (destructive).
Delete Key	Del	Deletes the character at the cursor position.
Insert Key	Ins	Toggles the Insert Mode on/off.
Left Arrow Key	←	Backspace one space (nondestructive).
Right Arrow Key	→	Forward one space (nondestructive).

Data Entry Keys

The data entry sections of the system use a number of keys for cursor movement, data selection, and special functions. Key availability and function is displayed in a box at the bottom of the screen or at the bottom of a window. The data entry keys are:

Return Key	Enter	Accepts the data and moves the cursor to the next data field.
Escape Key	Esc	Exits the current process and returns to the previous screen.

Ctl-Enter	Ctl-Enter	Pressing these two keys concurrently saves the data, exits the current process, and returns to the previous screen.
Up Arrow Key	↑	Places the cursor on the data entry field above the current field.
Down Arrow Key	↓	Places the cursor on the data entry field below the current field.
Right Arrow Key	→	Places the cursor on the next data entry field.
Left Arrow Key	←	Places the cursor on the previous data entry field.

Note: To move about freely in the different data entry sections using the keys defined above, realize that all data entry fields must contain a value. For example, if you are just beginning the data entry for a new inspection date, the first data entry field must contain a value before the second data entry field can be entered. However, once the second is entered, you can edit the first or the second data entry field using the various keys. You will not be able to enter or edit the fifth data entry field until all previous fields contain values.

CHAPTER 3 RIVER / STRUCTURE DATA

This chapter details the processes by which the existing data base lists can be modified or added to. Three types of data base lists are in place when the system is loaded. These are:

- River Data This data base contains a list of rivers for the division.
- Structures Data This data base contains the structures located within the division.
- Substructures Data This data base contains the substructures located within the division.

To begin, select Manage System Lists from the screen shown in Figure 2.

Note: Figure 2 and all subsequent figures are specific to Miter Lock Gates. The screens for other substructures such as Sector Gates and Valves will show minor variations.

Adding and Editing River Data

To add a river name, choose Add/Edit Rivers from the screen shown in Figure 3. Press **Ins** and type in the river name and code for the new river.

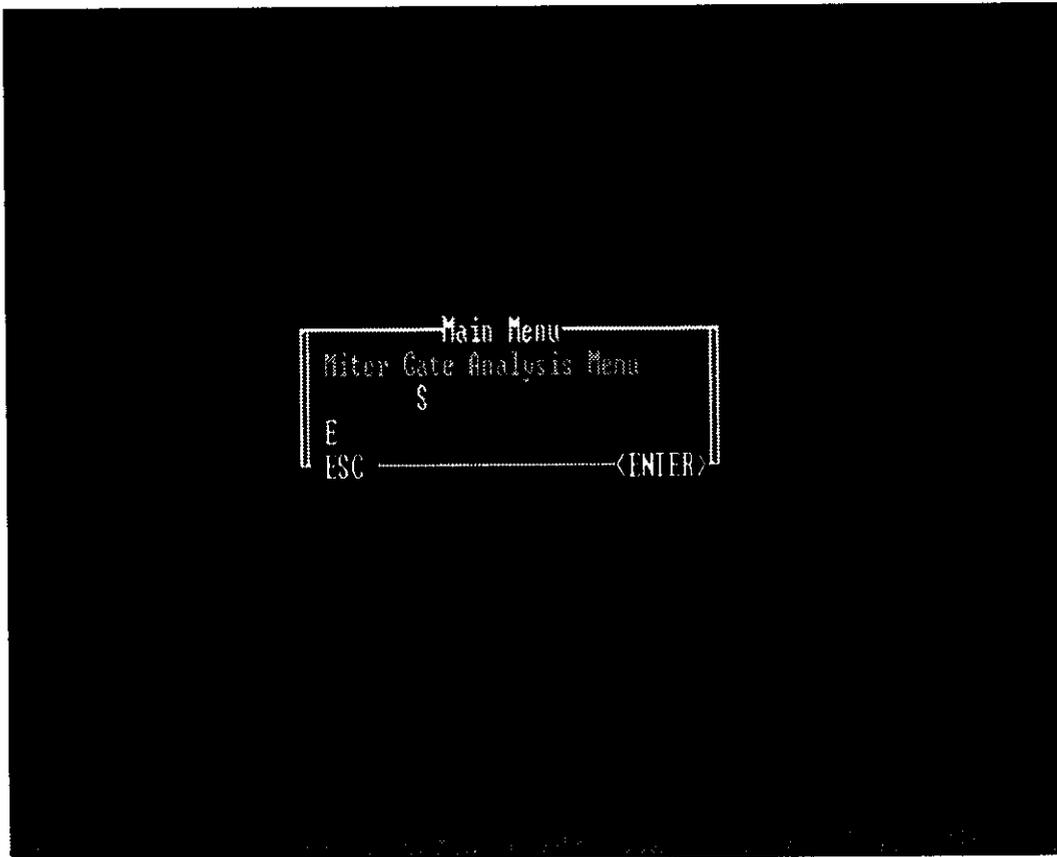


Figure 2. Main Menu (Miter Lock Gate example)

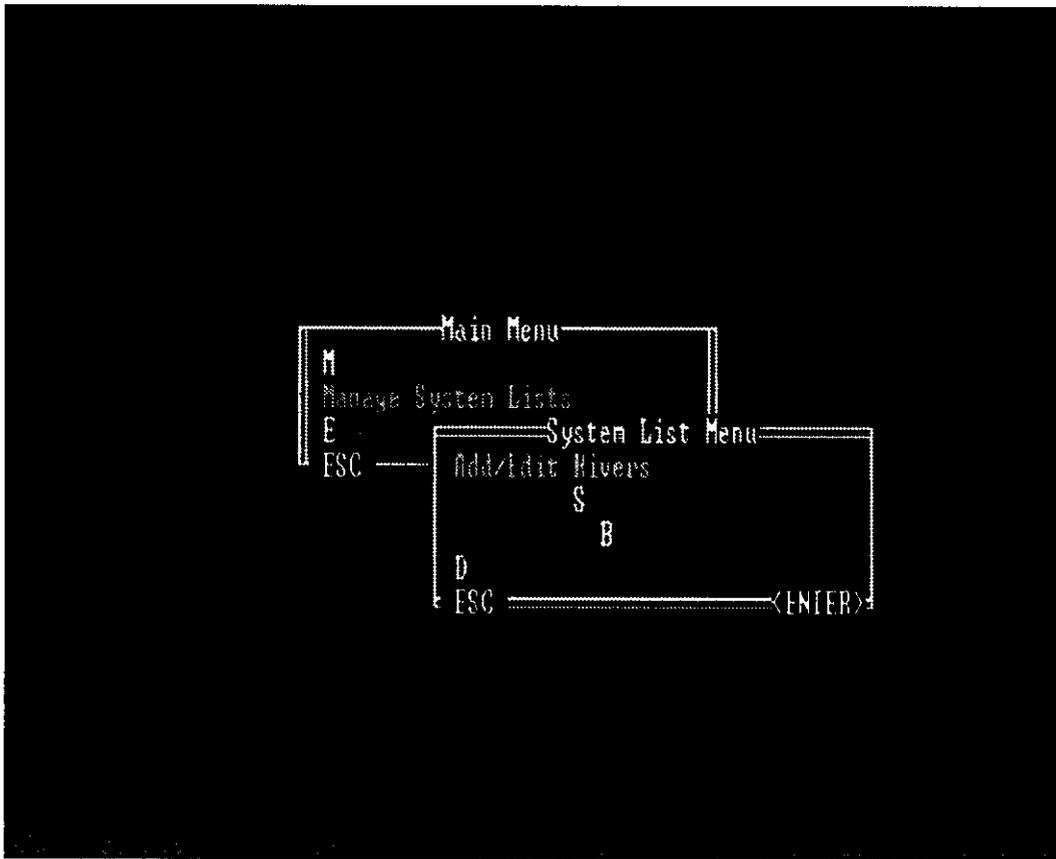


Figure 3. System List Menu (Miter Lock Gate example)

Note: The codes are preassigned numbers for specific rivers and structures designated by the Corps of Engineers. Corrections may be made by using the backspace key and retyping either the river name or the code. Once the river and code have been entered, press Ctl-Enter to save the river name and thereby add it to the existing list of rivers. To edit an existing river use the up and down arrow keys to highlight the river to be edited and press Enter. Make any necessary changes. Press Del to delete an existing river.

Adding and Editing Structure Data

Adding and editing structures is different from rivers only in respect to the information needed. Structures prompts for a structure code, structure name, and river. Press Ins to add a structure name to the existing list. Type in the new structure code and name. Generally, structure codes are supplied with the software. If a structure is added, a unique three-character code should be typed in. After typing the structure name, a list containing the available rivers will appear. The river that you select from this list will be typed in the space provided and from then on will be associated with the structure name previously entered. To save the structure press Ctl-Enter.

Adding and editing substructures requires the structure name, substructure code, and a description. When prompted for the structure name, a list of structures will appear. Select the structure that will be associated with the substructure and it will be typed in the space provided. Type in a substructure code and a description of the substructure. A list of known substructure codes is supplied with the software. If a substructure is added, a unique five-character substructure code should be typed in. Press Ctl-Enter to save the substructure.

CHAPTER 4 DATA ENTRY AND MODIFICATION

Types of Data Entry

This chapter details the processes by which data is entered and modified by the system. The process of calculating a condition index for a substructure requires historical data and inspection data to be stored by the system.

Historical Data To handle inspection data properly, historical data on the inspection form should be filled out before to the site visit in preparation for entry into the system.

Inspection Data The field inspection data for the final pages of the inspection form is collected during an inspection of the substructure. Some information such as component sizes and structural information is available from drawings and should be completed before the site inspection and verified or changed during the inspection.

Entering Inspection Form Data

To begin inspection data entry, select Miter Gate Analysis Menu from the Main Menu (Figure 2). In succeeding popup windows, you are asked to categorize the inspection data records by River, Structure, Substructure, and finally Inspection Date. This selection process will define the data to be entered as unique for that Inspection Date on that particular Substructure. Continue with the data entry by selecting a River, Structure, and Substructure from the lists.

The next menu, Inspection Date Menu (Figure 4) allows the pages of an existing inspection listing for a particular inspection date to be viewed and/or edited. If no inspection dates exist, a prompt to create a new inspection date will appear. Responding **Yes** to the prompt results in another prompt for the mm-dd-yy (month-day-year) of the new inspection date. The default when creating a new inspection date is always the computer's current date. After entering a new date, a response of either **Yes** or **No** is required. Responding **No** allows the inspection date to be changed. If the response is **Yes**, the date entered will be stored in a list that will appear in all future runs of the system. Any data entered in the current session will be identified by this date. If a list of inspection dates exists, pressing **Enter** accepts the highlighted inspection date. Pressing **Ins** allows a new date to be created as described earlier.

Once you have selected the appropriate Substructure and Inspection Date, the program proceeds to the Add/Edit/View Data Menu (Figure 5). This menu prompts you to enter the data for the pages of the inspection form. The order in which the data is entered into the system is optional; it does not require that all the data be entered during one sitting. The program may be exited at any time during data entry. However, for greater efficiency it is recommended that the data for all the pages of the inspection sheet be entered in order and in one sitting. This decreases the chances of leaving an incomplete data field in the system. Always remember to save the data before exiting by pressing **Ctrl-Enter**.

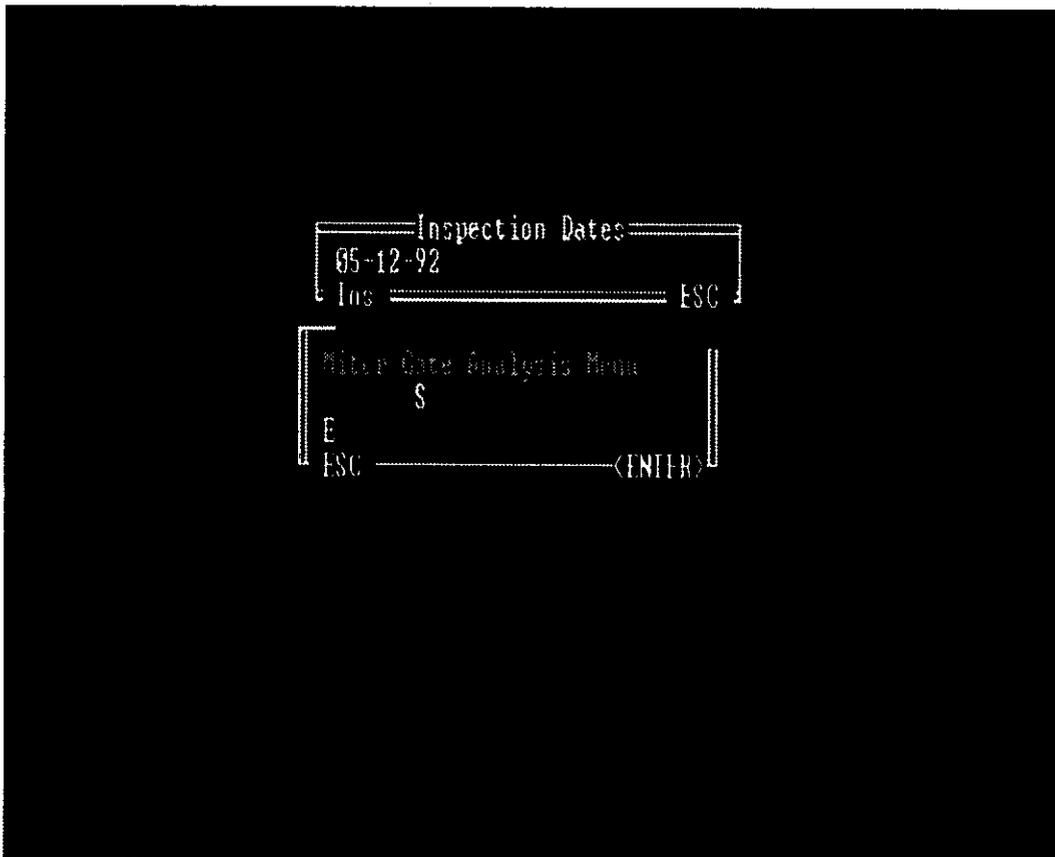


Figure 4. Inspection Data Menu (Miter Lock Gate example)



Figure 5. Add/Edit/View Data Menu (Miter Lock Gate example)

Select View/Edit Historical Data (Pages 1-2) from Figure 5. A popup window will appear as shown in Figure 6. This window allows you to work with the first two pages of the inspection form for the case of Miter Lock Gates. Select Add/Edit Header Data (Page 1) from this popup window to work with the first page of the inspection form.

The first page of the inspection form is shown in Figure 7. Begin entering the data for this page. The system is designed such that data entry follows the pages of the inspection form to make the process as efficient as possible. Save the data by pressing **Ctrl-Enter**. If all the data for page 1 is not entered, pressing **Esc** results in a prompt asking if the changes made are to be saved. Responding **Yes** saves the data and exits back to the previous menu.

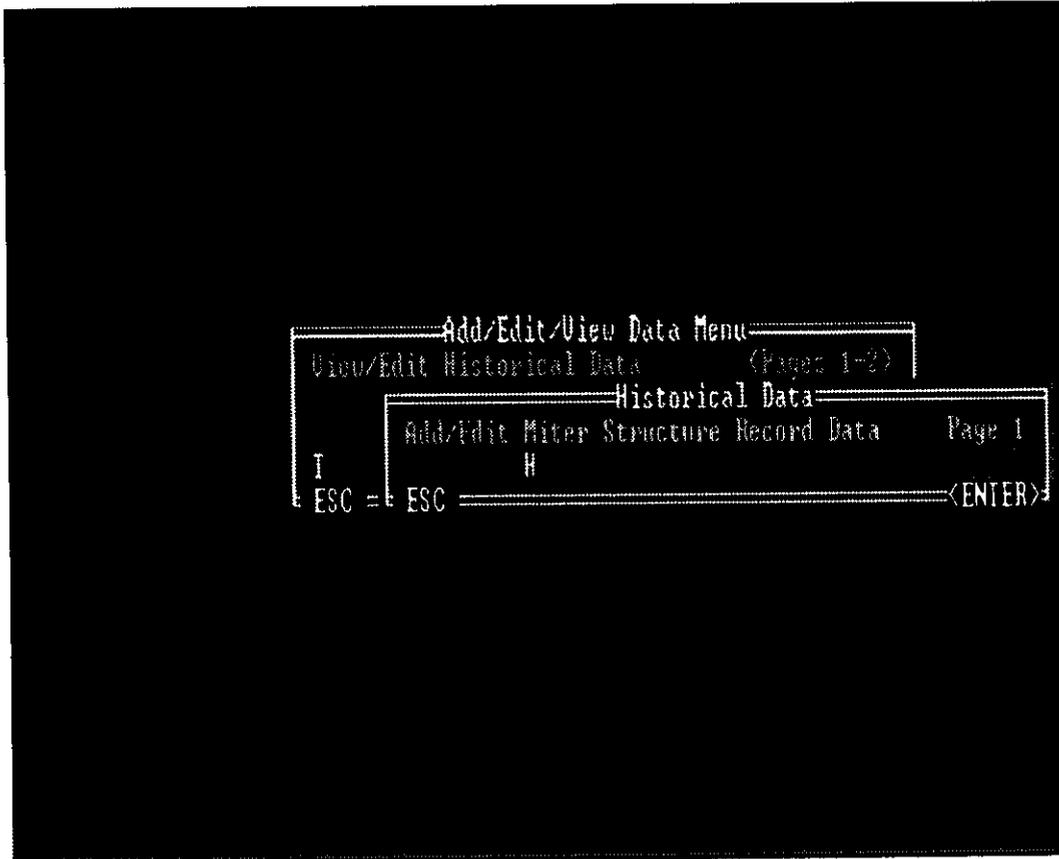


Figure 6. Historical Data Menu (Miter Lock Gate example)

Edit			
Upper Gate	Markely Lake		
	Greinsan, Stecker, Rem		
	1.Horizontal	1.Fixed	1.Single
	800		110
	50		61.25
		352.1	300.3
		354.0	300.0
		370.8	347.3
		Yes	
	1980		5 YRS
1966			
ESC Ctl Enter			

Figure 7. Page 1 of the Inspection Form (Miter Lock Gate example)

Select Add/Edit History Data (Page 2) from Figure 6. This option brings Page 2 of the inspection form to the screen as shown in Figure 8. For this page of the form you will be prompted to press Enter to fill out some segments of the page. The data for this type of entry is stored in the background and does not appear on the screen until you press Enter. For example, press Enter to identify the Current Gate History and a data field will popup with room for comments. After typing in the comments, press Ctl-Enter to save the comments and return to the next data field.

Pressing Enter to fill out the Past 10-year History results in the popup data field shown in Figure 9. This data field prompts you for a date and a description of the maintenance, repairs, or other modification. Press Ins to fill in a new entry or to add another entry to the current entries. Press Del to delete the current highlighted entry. Press Enter to edit the current highlighted entry. Press Esc to save the current entries and exit back to the next data field.

Complete the rest of Page 2 and save it. This completes all historical data entries.

Return to the Add/Edit/View Data Menu to select View/Edit Inspection Data (refer to Figure 5). Enter the inspection data for the pages of the inspection form listed under this option. After completing the pages and saving them, return to the Add/Edit/View Data Menu and select View/Edit Structure Safety Data. Complete each page listed under this submenu and save them. This completes the data entry for every page of the inspection form.

Substructures Analysis

After all data has been entered, select Transfer Data to Evaluation Module from Figure 5. Transferring the data to the evaluation module requires time. The percent completion of the transfer will be displayed as the data is being transferred. Once the transfer is complete the Analysis Menu shown in Figure 10 will appear.

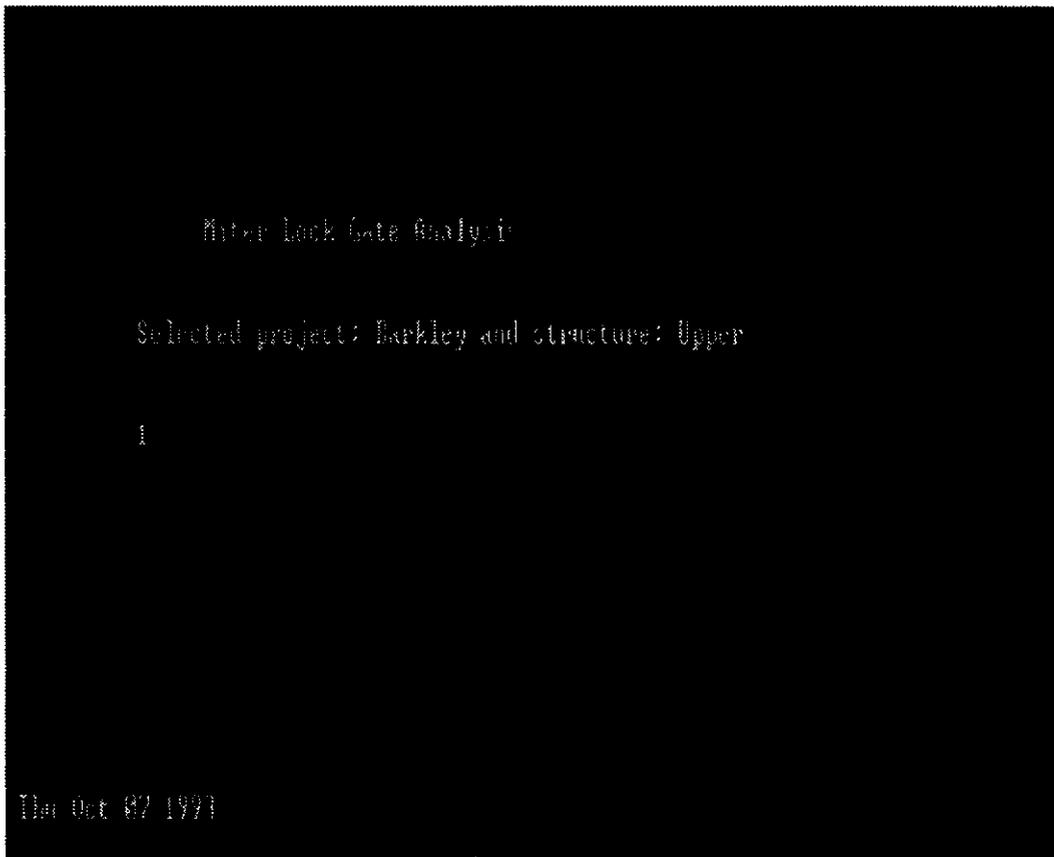


Figure 10. Analysis Menu (Miter Lock Gate example)

To select one of the options from the menu shown in Figure 10, either highlight an option and press **Enter** or select the number associated with an option. The options for this menu are defined as follows:

- 1 - Compute condition index reveals the calculated condition indexes for each distress as well as the combined CI for each leaf. Pressing any key exits back to the Analysis Menu in Figure 10.
- 2 - Print current structure data files brings up a window with three options for printing input files and an option to exit back to the Analysis Menu (see Figure 10). The Results Summary Page can also be printed from this option.
- 3 - Compute component factor of safety computes the minimum factor of safety for the primary structural components. The computed condition indexes and the location of the most critical sections are displayed in this window. Pressing <p> initiates a warning window that tells how long the report will be if printed. Pressing any other key exits back to the Analysis Menu.

Note: This option applies to only Miter Lock Gate substructures and requires that pages 6 through 9 of the Miter Lock Gate inspection form be entered into the system. Since this option does not apply to other substructures, the total number of options associated with the Analysis Menu (see Figure 10) for the other substructures will contain one less option.

- 4 - Display summary report provides a screen display of basic project identification, a summary of the condition indexes, and structural notes. This selection is a quick way to see more data about the project without performing a large number of separate operations.
- 5 - Perform maintenance and repair analysis is described thoroughly in the next chapter.
- 6 - Return to data management menu returns you to the Add/Edit/View Data Menu shown in Figure 5.

CHAPTER 5 MAINTENANCE AND REPAIR ANALYSIS

Performing a Maintenance and Repair (M&R) Analysis

If you are not already at the Analysis Menu (see Figure 10) select the River, Structure, Substructure, and Inspection Date worked on in Chapter 4. When prompted with the Add/Edit/View Data Menu (see Figure 5), select the last option to get to the Miter Lock Gate Analysis Menu.

Selecting option 5 - Perform maintenance and repair analysis in the Analysis Menu (see Figure 10) allows multiple scenarios for maintenance and repair (M&R) of problems or deficiencies observed in the inspection or identified by the condition index evaluation to be defined. Each of these scenarios, or M&R solutions, enables you to fix, correct, or replace problems or deficiencies by selecting alternatives and building M&R solutions. The solutions may be little fixes, like gate adjustment, or big fixes, like adding intercoastals. Each of the M&R solutions can be modeled to evaluate the improvement in the condition index as a result of the fix. You can also perform economic analyses to evaluate relative costs of each scenario or M&R solution.

Figure 11 illustrates the menu to begin the M&R Analysis. The selected project is displayed and five menu choices are available to control the M&R procedure:

- 1 - Analyze Current Problems is the selection to create or add new M&R solutions to the project files.
- 2 - Review Previously Selected Alternatives is the selection to review the list of previously defined solutions.

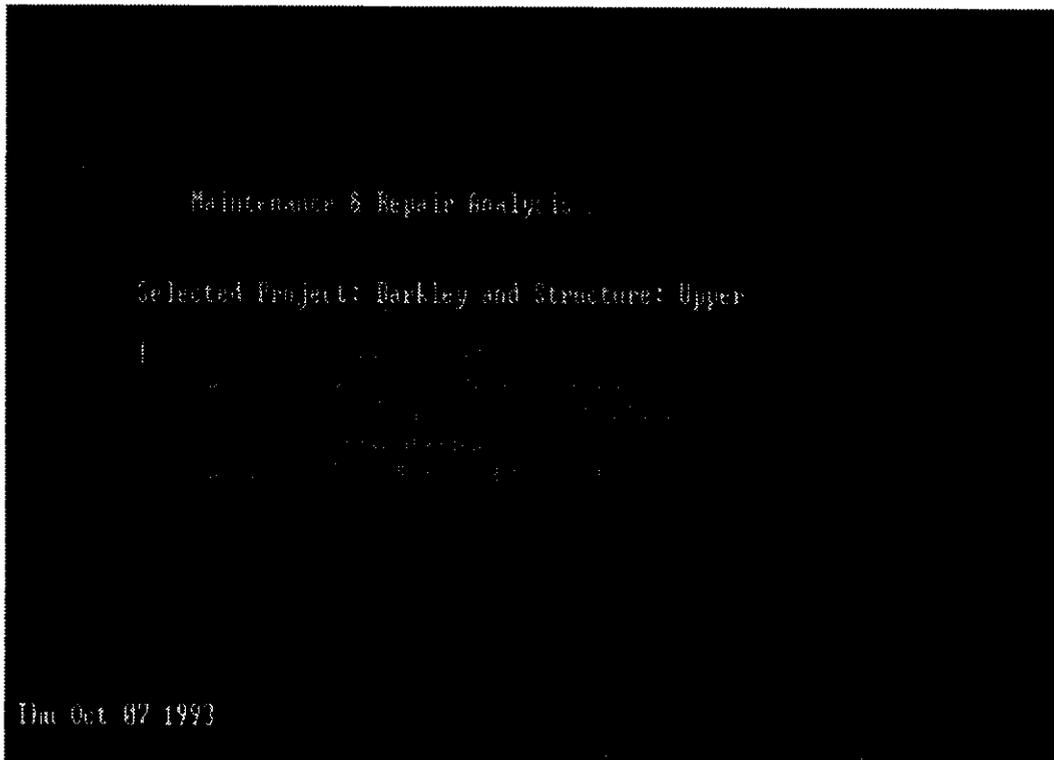


Figure 11. Maintenance and Repair Analysis Menu (Miter Lock Gate example)

Note: A maximum of five M&R solutions can be active on a file for any one project structure. You may edit existing M&R solutions to redefine another M&R solution or delete alternatives from an existing M&R solution and start fresh.

3 - Consequence Modeling of M&R solutions allows you to analyze the impact of each M&R solution and is discussed in detail later in the manual.

4 - Update Problems/Alternatives Data Base allows you to edit or add to the initial M&R alternatives data base.

Note: This particular function must be used carefully. The problem list is predefined for a structure type. Only the M&R alternatives should be added to or revised. This process will be described in more detail later in the manual.

5 - Return to the Miter Analysis Menu allows you to back up one level to the Analysis Menu.

M&R Solutions

Selecting 1 - Analyze Current Problems displays the blank screen (Figure 12) used to begin developing an M&R solution. The first procedure is to select several specific analysis parameters. You are prompted to input or edit the parameters.

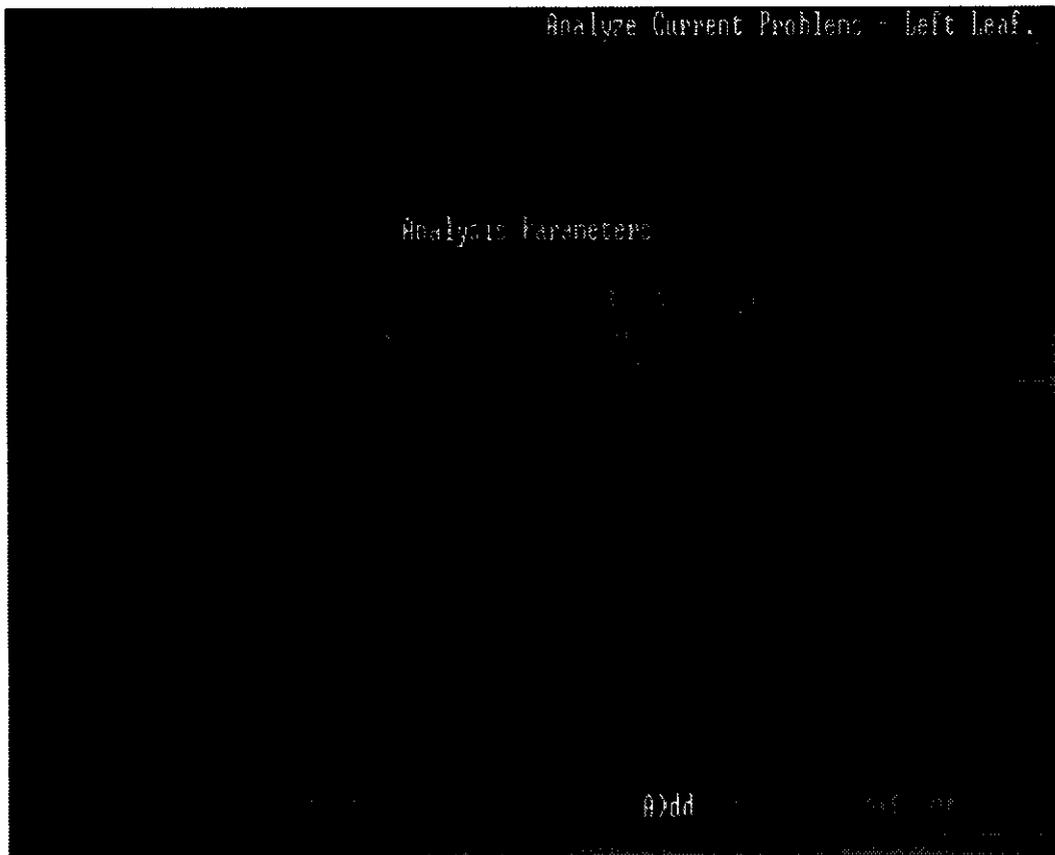


Figure 12. Analysis Parameters Menu (Miter Lock Gate example)

The parameters are:

Today's Date: Date of the analysis, for future reference.

Present Worth Year: Year for the analysis period. It can be the current year or a future year. This date is used as the present year in the present worth analysis.

Analysis Period: Length of the analysis period; for example, 10 years, or 20 years.

After the analysis parameters are correct, select **Yes** and the program automatically goes to the next selection level, where the Problem List window appears.

M&R Solution Form

At this point, a brief explanation of the background form is in order. Figure 13 shows the blank form that is the basic building block for each M&R solution.

The normal operation will not display this screen with all blank rows. Normal operation will have a selection window displayed, such as the Problem List shown in Figure 14, or will have selected alternatives displayed for action.

Type	Description	Exp. Life	Cost (\$)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Figure 13. M&R Solution Form Menu (Miter Lock Gate example)

Year	Description	Exp. Life	Cost (\$)
1	1. Miter Lock Gate	10	100
2	2. Miter Lock Gate	10	100
3	3. Miter Lock Gate	10	100
4	4. Miter Lock Gate	10	100
5	5. Miter Lock Gate	10	100
6	6. Miter Lock Gate	10	100
7	7. Miter Lock Gate	10	100
8	8. Miter Lock Gate	10	100
9	9. Miter Lock Gate	10	100
10	10. Miter Lock Gate	10	100

Figure 14. Problem List Window (Miter Lock Gate example)

Features of the form (Figure 13) follow:

The title line informs you if the form is in a mode to Analyze Current Problems (for creating a new solution), or in a mode to Review Current Problems (edit an existing solution).

Columns allow input of the year, description, expected life, and cost (\$) of the selected alternative. A more detailed description of the input in each column will be given in a later section.

Active option keys are displayed at the bottom of the screen and described in the following paragraphs.

If all the selections in the row are highlighted, it means all the selection keys are active. If only one is highlighted, for example, Edit, the form is in edit mode at the location of the cursor. The default location of the cursor is in the first column of row one. The cursor can be moved to other locations in the form to execute option keys. The cursor movement keys act as follows:

Arrow keys move the cursor from row to row or field to field.

PgUp or PgDn moves the cursor between window pages.

Ctl-PgUp and Ctl-PgDn moves the cursor only if there is more than one page of alternatives. Ctl-PgUp will return the cursor to the default location at row one. Ctl-PgDn will move the cursor to the top row of the last full screen display.

The remaining option key actions depend on the location of the cursor within the M&R solution form. When the cursor is in a row that is not blank, then:

Esc or **Edit** enters edit mode at the cursor location.

Add inserts a blank row at the cursor location and displays the Problem List window (Figure 14) for selection of an alternative.

Quit ends the selection process and exits to save the M&R solution.

When the cursor is in a row that is blank (e.g., the row below a list of alternatives or a blank form), then:

Esc, **Add**, or **Edit** displays the Problem List window for selection of an alternative.

Quit ends the selection process and exits to save the M&R solution.

Continue to the next selection level where the Problem List window appears.

Problem List

A typical problem list (see Figure 14) has been developed for a project substructure; in this case, miter lock gates. The typical problem list for miter lock gates includes 10 problem definitions that are displayed each time this screen appears. The list of problems may be more than one page long, as is the case with miter lock gates. Other substructures will have different numbers and types of problems. You can view or select from the problems on the second page with cursor movement. The project inspection data file is used to generate this list. The example window lists the problems and the corresponding condition indexes.

Active user keys, including cursor movement keys and option keys, are displayed at the bottom of the Problem List window. The cursor movement keys act as follows:

Arrow(s) up and down move the cursor from line to line on the displayed window page.

PgUp and **PgDn** move the cursor between window pages.

The option keys act as follows:

Esc returns to the background M&R solution form.

Select calls for the M&R Alternative List window to be displayed. The contents of this list depend on the problem list (see the next section). Select the problem by moving the cursor to the specific problem line and pressing **Enter**.

View notes is an option to see more information about a problem. This option is activated by typing **V** to select view notes and then pressing **Enter**. A window will display notes pertaining to the selected problem (see Figure 15).

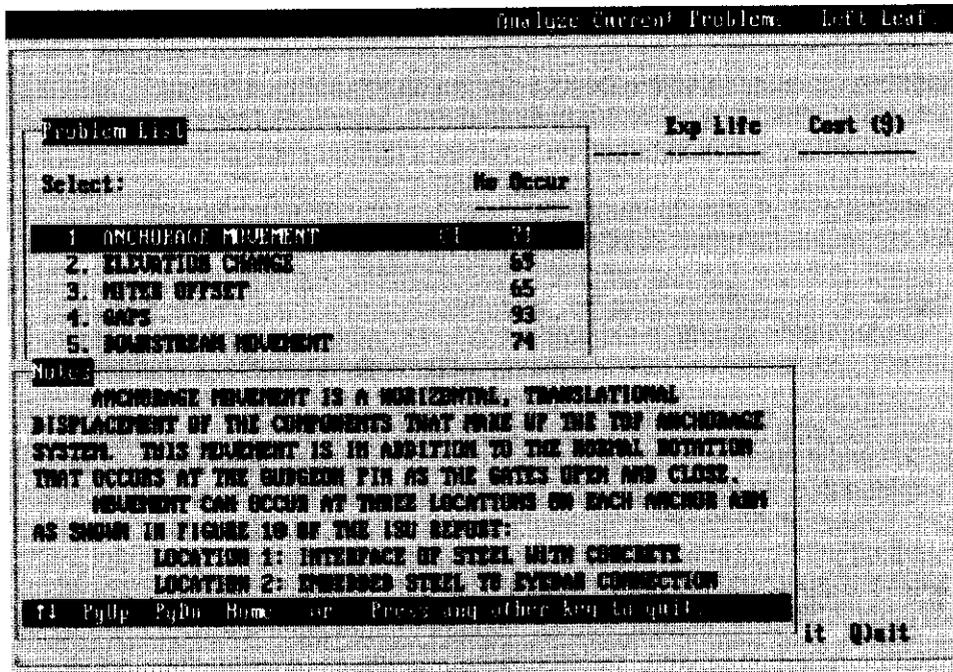


Figure 15. Notes Window (Miter Lock Gate example)

Developing an M&R Solution

Develop an M&R solution by selecting a problem from the Problem List and a corresponding maintenance or repair procedure from the M&R Alternatives List (see Figure 16). Refer to the inspection form to identify specific details about the problem location, severity, and so on, and then make decisions about which problems to solve in a specific M&R solution. Up to five different M&R solutions can be defined for analyzing in consequence modeling. Each M&R solution can be edited, added to, etc., before consequence modeling or after modeling, to study a different approach.

M&R Alternative List

The M&R Alternative List, which is the right-hand window in Figure 16, is a list read into the M&R system from the problems and alternatives data file. The data list is typical for all projects of like structure type; in this case Miter Lock Gates. The list of M&R alternatives that appears may be more than one page. The description of each M&R alternative is brief and is intended to be edited and made specific to an M&R solution. The right-hand column is an estimate of the expected service life of the alternative. Figure 17 displays an example of an alternative selected to fix a problem like a low girder factor of safety.

When an alternative on the list is selected, it is added to the M&R solution form. You are prompted to enter the Year the alternative would start, edit the Description of the alternative, edit the Exp(ected) Life, and finally enter an estimate of the current Cost to implement the alternative. Once the cost is entered, the program automatically returns to the Problem List window, allowing you to select another alternative to add to the M&R solution. This continues until you are finished selecting alternatives. To stop the selection process, select Esc at the Problem List. This returns you to the M&R solution form. Then select Quit to exit and save the defined M&R solution.

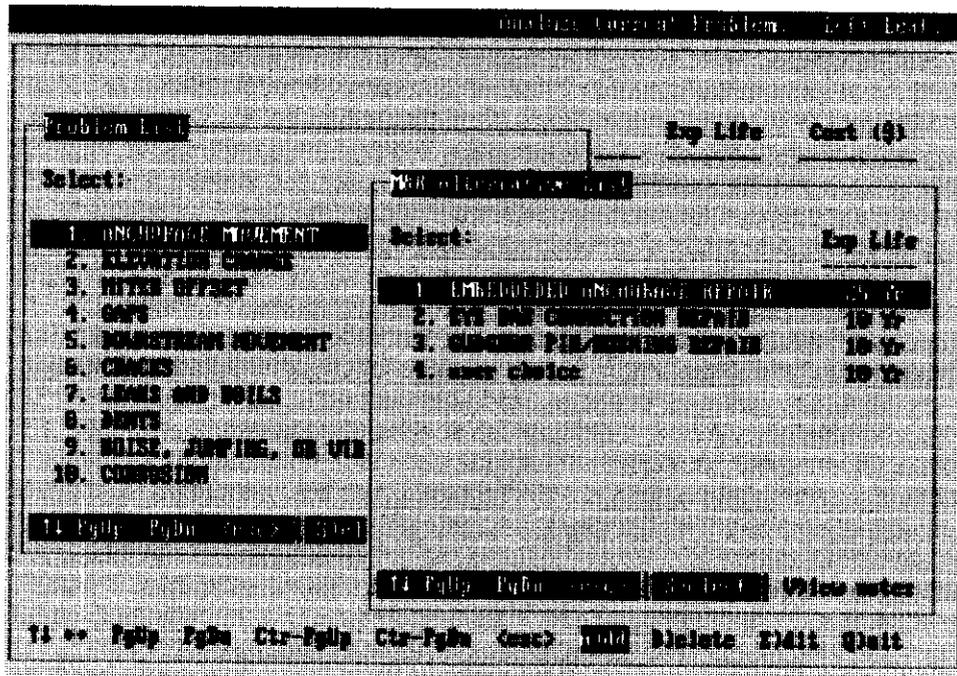


Figure 16. M&R Alternative List Window

Year	Description	Exp Life	Cost (\$)
1.	ADD SUBSTITUTED FLANGE COVER PL	75 Yr	1,250.00
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			

Figure 17. Example of Selected M&R Alternatives (Miter Lock Gate example)

Input of an estimate of the current cost is optional. This information is required to perform an economic analysis in consequence modeling, but is not required to evaluate changes in the condition index.

The cost entry can be bypassed to perform condition index evaluation in consequence modeling and be returned to later to edit the cost estimate into the M&R solution.

Saving an M&R Solution

When you select **Quit**, the system prompts you to select a solution number and enter a name to describe the M&R solution. Figure 18 illustrates the selection of solution number 1. The description **Minor Repair** has been affixed to the M&R solution with two alternatives (displayed behind the window). After saving the M&R solution, you are prompted to **Add/Edit another version? (y)**. You can enter **y** to continue and enter another M&R solution, or enter **n** and return to the **Maintenance and Repair Analysis** menu. If **y** is selected, the M&R solution form will be displayed and new analysis parameters must be defined for the new M&R solution.

Another choice is available when beginning to save an M&R solution. Selecting **Esc** (instead of a number) will let you abandon an M&R solution that has just been created or edited. You are prompted to confirm the intent to discard the data or to back up and save the M&R solution.

Returning to the **Maintenance and Repair Analysis** menu (Figure 11) and selecting **2 - Review Previously Selected Alternatives**, will display a window (see Figure 19) that allows you to select from the list of M&R solutions previously defined and saved to the project structure file. Once a selection of an M&R solution is made, the completed M&R solution form and defined parameters will be displayed. You can then edit or add to the M&R solution by changing analysis parameters, selecting additional alternatives, or deleting previously selected alternatives from the list.

Consequence Modeling of M&R Solutions

After at least one M&R solution has been defined and saved, selecting **3 - Consequence modeling of M&R solutions** (from Figure 11) initiates a "What if?" scenario in the M&R system. This modeling permits you to correct the problems or deficiencies observed in the inspection or identified by the condition index evaluation. You are directed to model each of the previously defined M&R solutions to analyze the consequences of the maintenance and repair scenario in two ways.

1. What will be the change in the condition index of the structure if the fixes are made?
2. What will be the present worth of this M&R solution? Economic analysis is optional. You must enter cost at the M&R Alternative selection level for this calculation to be executed.

Note: Consequence Modeling does not have any effect on the original structure inspection data files or on the actual computed condition index values. The condition index values calculated in this model are stored in a temporary file structure and are not accessed by any routines outside of consequence modeling.

Review Current Problem 1-01 Leaf

Year	Description	Exp Life	Cost (\$)
1. 1991	EMERGENCY REPAIR	50 Yr	10,000.00
2. 1991	REPAIR WELD CRACKS	25 Yr	1,200.00
3.			
4.	Save solution data to 4 or press to exit Select: 1 1. Minor Repair 2. Structural Repair M&R Solution Description Minor Repair		
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			

11 -- PgUp PgDn Ctr-PgUp Ctr-PgDn <esc> Add Delete **EXIT** Quit

Figure 18. Saving an M&R Solution (Miter Lock Gate example)

Review List of Previously Selected Alternatives Select: 0 1. Minor Repair 2. Structural Repair 3. 4. 5.			
---	--	--	--

Figure 19. Review of List of Previously Selected Alternatives (Miter Lock Gate example)

Selecting 3 - Consequence Modeling displays all of the M&R solutions and allows you to make one of these choices:

1 to 5 - Choose one of the five M&R solutions for consequence modeling.

6 - Print the M&R solutions - This prints a brief schedule of the alternatives that are components of the M&R solutions. This print selection is also used to get a final print report of the M&R solutions after all the solutions have been modeled and the revised indexes and annual costs have been posted to the data file.

7 - Return to Maintenance & Repair Analysis menu.

Figure 20 illustrates a typical display of M&R solutions. Each solution displays the old CI (from MITER evaluation), the new CI, and Present Worth (\$) if these have been previously computed.

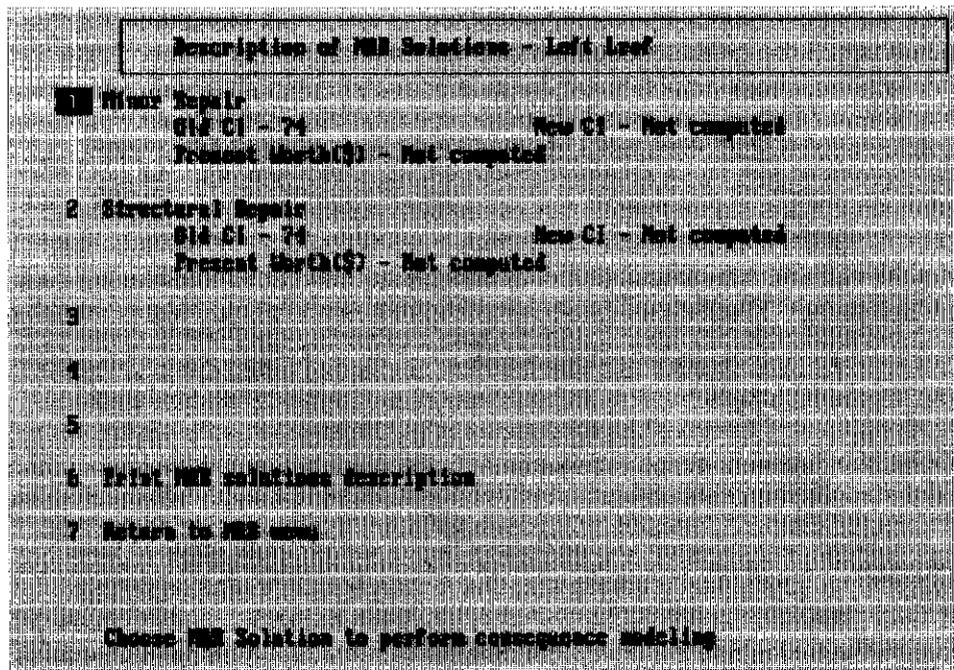


Figure 20. Description of M&R Solutions (Miter Lock Gate example)

After an M&R solution is selected, the next screen (see Figure 21) displays more detail about the condition indexes and lists all of the alternatives attached to the M&R solution. At the bottom of the screen is a menu that allows you to choose condition index modeling, economic analysis, or to print reports of the selected M&R solution.

The menu choices are:

1 - Perform Condition Index modeling - This calls you to edit the data file to reflect changes that would occur to the condition index if this solution were implemented.

2 - Perform economic analysis - This calculation yields present worth of the proposed M&R solution.

3 - Print consequence modeling report - This selection produces a hard copy of the current M&R solution data. To get a complete printout of the consequence model report, perform options 1 and 2 before selecting this print option. This is the only print call that will produce documentation of the changes made to the data, the changes made to structural parameters, and the backup cost data for the economic analysis in the current M&R solution. Many of the edited changes in the modeling routines are not recorded to a permanent data file. The temporary data is overwritten the next time a new M&R solution is modeled.

4 - Return to solution select menu - This returns the program to the M&R solutions illustrated earlier.

5 - Return to maintenance and repair analysis menu is the last menu and selection point in the consequence modeling module. Choices 1 through 4 will each return to this menu for further selection. This selection exits from consequence modeling.

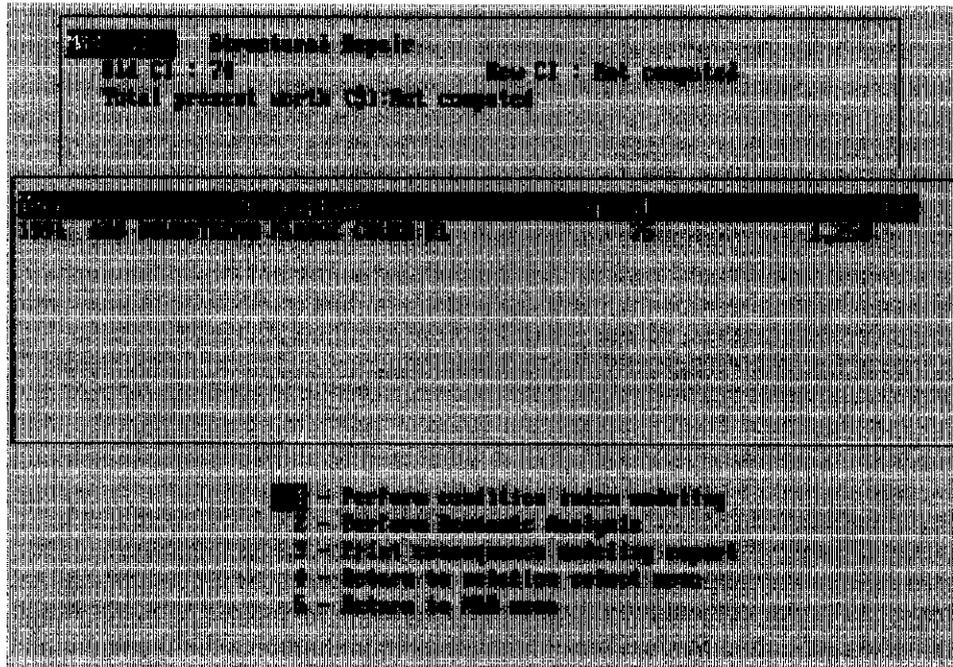


Figure 21. M&R Modeling Menu (Miter Lock Gate example)

Condition Index Modeling

Selecting 1 - Perform CI modeling displays the screen shown in Figure 22. The problems with condition indexes less than 100 for either gate are displayed in Figure 19, also.

Problems with condition indexes of 100 for both gate leaves are omitted. Edit each of the displayed functional distresses by modifying the data corresponding to each distress (see Figure 23). The magnitude of the data reduction (if any) should correspond to the alternatives proposed in the M&R solution being modeled. After the last distress is modified, the model recalculates the condition index and displays it for review.

After following screen instructions to continue, the program returns to the M&R Modeling menu. Make another modeling choice 1 or 2; return to the just-completed model to change a parameter; select the print option; or return to another menu.

The following distresses will be displayed for review and edit of current inspection conditions.

The remaining distresses already have a calculated Condition Index equal to 100 for both gate leaves

CONDITION INDEX : MANUALLY ENTERED

Condition Index	Left Leaf	Right Leaf
ANCHOR SYSTEM	: 71	69 N
FOUNDATION SETTLEMENT	: 74	74 Y
WEAR SURFACE	: 65	65 N
GAP	: 33	82 N
CRACKS	: 71	71 N
ROTS	: 100	100 N
LEAKS & SEEPS	: 54	73 N
ELEVATION CHANGE	: 69	83 N
CI	: 74	70

Hit any key to continue

Figure 22. Problems (Miter Lock Gate example)

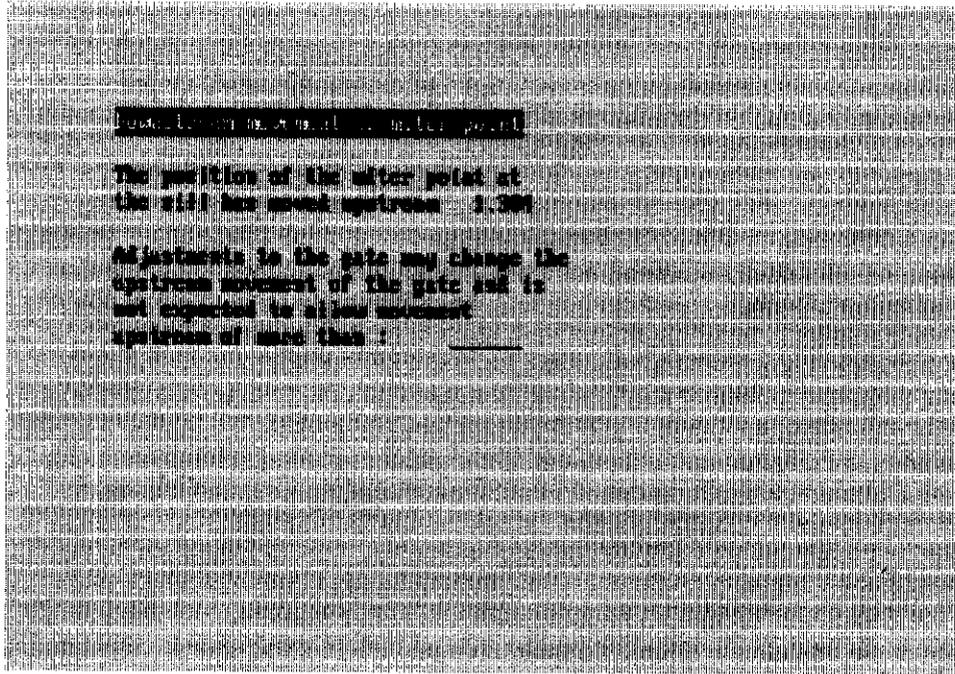


Figure 23. Edit Distresses (Miter Lock Gate example)

Economic Analysis

Selecting 2 - Perform Economic Analysis (from Figure 21) will direct the program to the Analysis Parameters window, which can be confirmed or edited. Figure 24 illustrates the type of data that must be provided to perform an economic analysis.

Newman (1991) describes the method for calculating the present worth. The first three parameters were entered at the beginning of the M&R solution development. They can be changed at this time. The interest rate must be entered at this time. A second window (Figure 25) displays a schedule of cost and present worth.

Following screen instructions to continue, the program returns to the M&R Modeling menu. Make another modeling choice 1 or 2; return to the just-completed model to change a parameter; select the print option; or return to another menu.

Problem and Alternative Data Base

The problem and alternative data base is a single large file designed to be a single source file for M&R alternatives selection. The problem list in the problems and alternatives data base is a standard list of problems or safety deficiencies that have been identified and related to substructures. The alternative list in the problems and alternatives data base is a standard list of M&R alternatives that can be applied to a substructure.

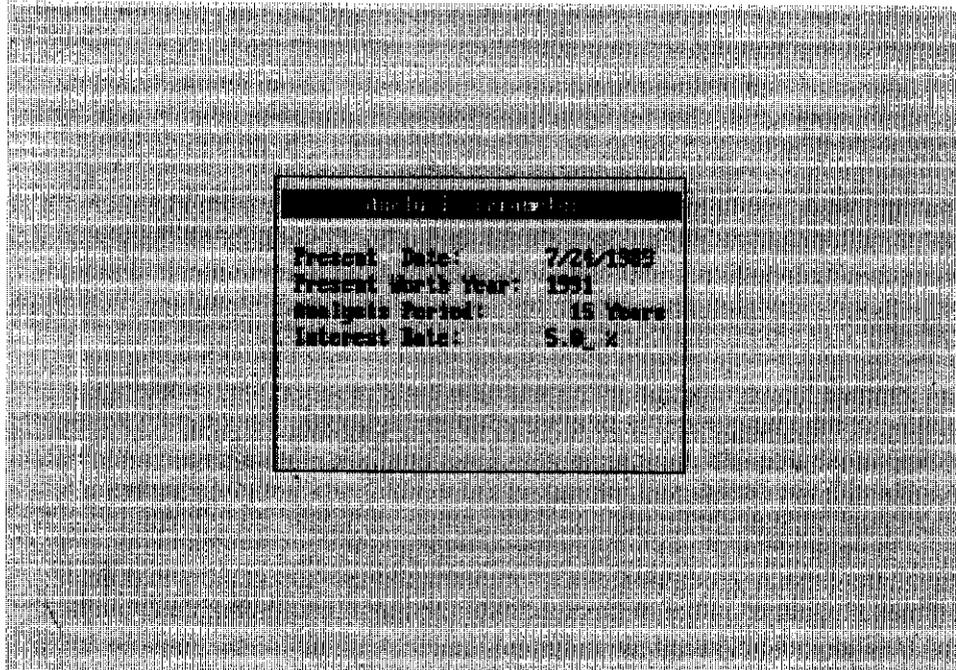


Figure 24. Economic Analysis Parameters

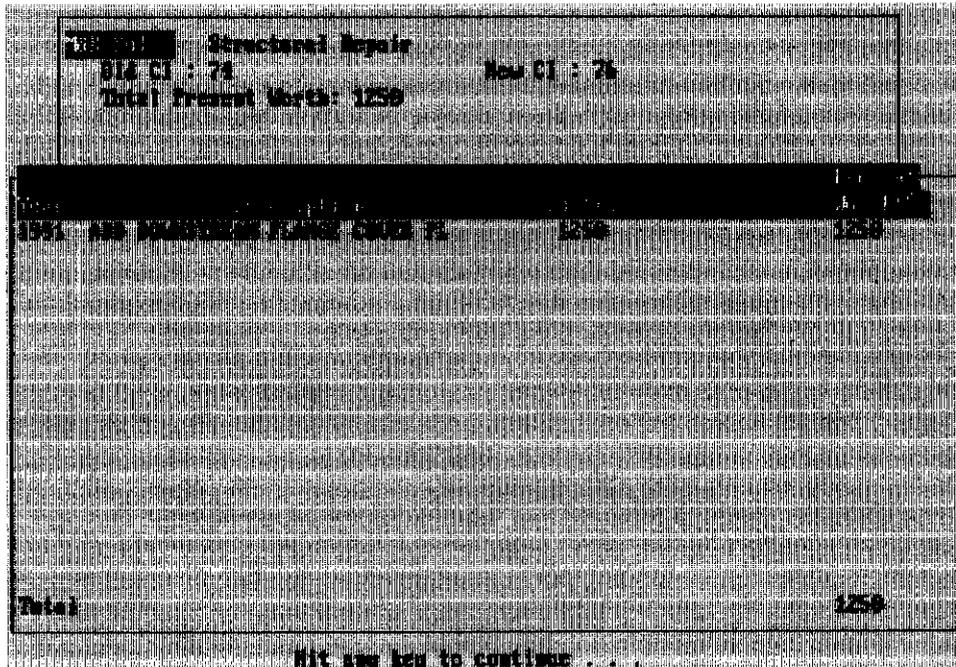


Figure 25. Economic Analysis Data (Miter Lock Gate example)

Problem List

The list of problems for a substructure consists of several items. The number of occurrences passed to the Problem List in maintenance and repair analysis is relative to a fixed order of problems in analysis data. The description and order of problems are shown in Figure 26.

The problems correlate to the distresses identified on the inspection form. The condition indexes for all problems are listed in the Problem List in Figure 14.

Each project problem list is unique to the particular substructure. The uniqueness of the list is defined by the identified distresses and structural deficiencies from the inspection data files for the particular substructure.

M&R Alternatives

The list of M&R alternatives is the part of the problems and alternatives data base that is designed to be updated by you. The program is distributed with a short list of M&R alternatives that can be used to formulate M&R solutions. However, the real intent of the list is for you to add to the list of M&R alternatives from personal experience with successful projects or new technology and product solutions. The problems and alternatives data base can be made a personal resource of information about maintenance and repair alternatives.



Figure 26. Ordered Problems (Miter Lock Gate example)

Update Problem or Alternative Data Base

Selecting 4 - Update Prob/Alt Database from the Maintenance and Repair Analysis menu (Figure 11) calls up a program routine to allow you to edit or add to the initial M&R alternatives data base. The initial screen display lists the structure types included in the data base. For this distribution, all substructures are included (see Figure 27). Selecting the substructure proceeds to the next option. Selecting Esc returns to the maintenance and repair analysis menu.

Continuing to the next screen (Figure 28) allows you several options to edit substructure data. The options are displayed at the bottom of the screen.

Type **P** to edit problems and display the list of problems identified with various substructures. Do not change the order of the problem list. This will cause erroneous reporting of problem occurrences.

Note: It is possible to add undefined problems to the end of the list and tag M&R alternatives to the problem. However, these added problems will never report a condition index out of the inspection data file. This can be used for defining very specific problems for a substructure.

Type **A** to edit alternatives and display the list of maintenance alternatives identified with a substructure. This will be the primary selection for you to change, update, and improve the M&R alternatives list.



Figure 27. Select Structure Type (Miter Lock Gate example)



Figure 28. Edit Structure Data (Miter Lock Gate example)

Edit Problems

Selecting Edit Problems by typing **P** displays the screen shown in Figure 29. The option keys at the bottom of the screen do the following:

(A)dd will insert a row at the location of the cursor to create a new problem description. You will be prompted to enter a note to further describe the problem (see Figure 30). This is the same note that can be viewed in M&R solution development when viewing a note attached to a problem.

(C)hange will edit the description of the problem and the note attached to the problem.

(D)elete will delete a problem from the list.

(P)rint will generate a printout of the problem list.

(V)iew alternatives will display a window titled Alternatives for this problem. Selecting the alternative that is highlighted will display a note window describing the alternative (see Figure 31).

Esc will return to the initial structure type selection.

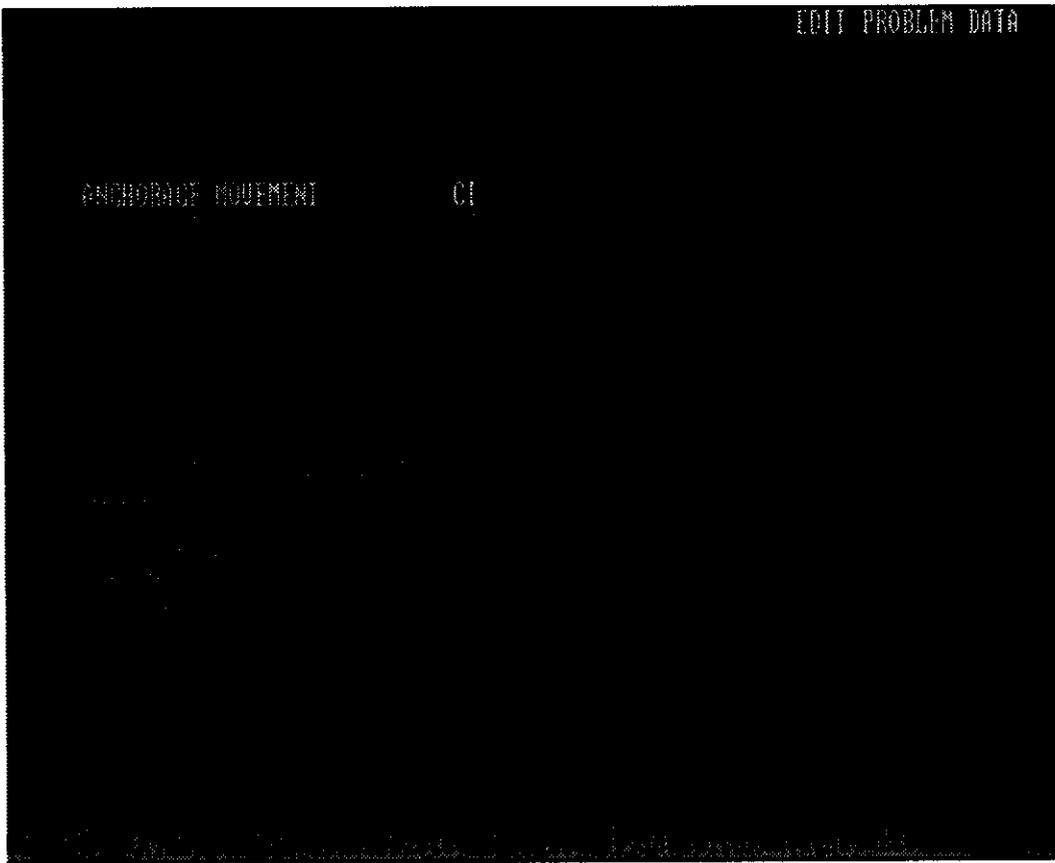


Figure 29. Problem List (Miter Lock Gate example)

Edit Alternatives

Returning to Edit Structure Data and selecting Edit Alternatives by typing A displays the Maintenance Alternatives screen. The option keys at the bottom of the screen do the following:

(A)dd will insert a row at the location of the cursor to create a new alternative description. You will be prompted to enter the Expected Life of the alternative. The system asks you to identify problems this alternative can solve by adding them to further describe the alternative (see Figure 32). This is the same note that can be viewed in M&R solution development when viewing a note attached to an alternative.

(C)hange will edit the description of the alternative, the expected life, the attached problem list, and also the note attached to the alternative.

(D)elete will delete an alternative from the list.

(P)rint will generate a printout of the alternative list.

(V)iew problems will display a window titled Possible problems list. Selecting the problem that is highlighted will display a note window listing the problems solved by this alternative (see Figures 33 and 34.)

Esc will return to the initial substructure type selection.

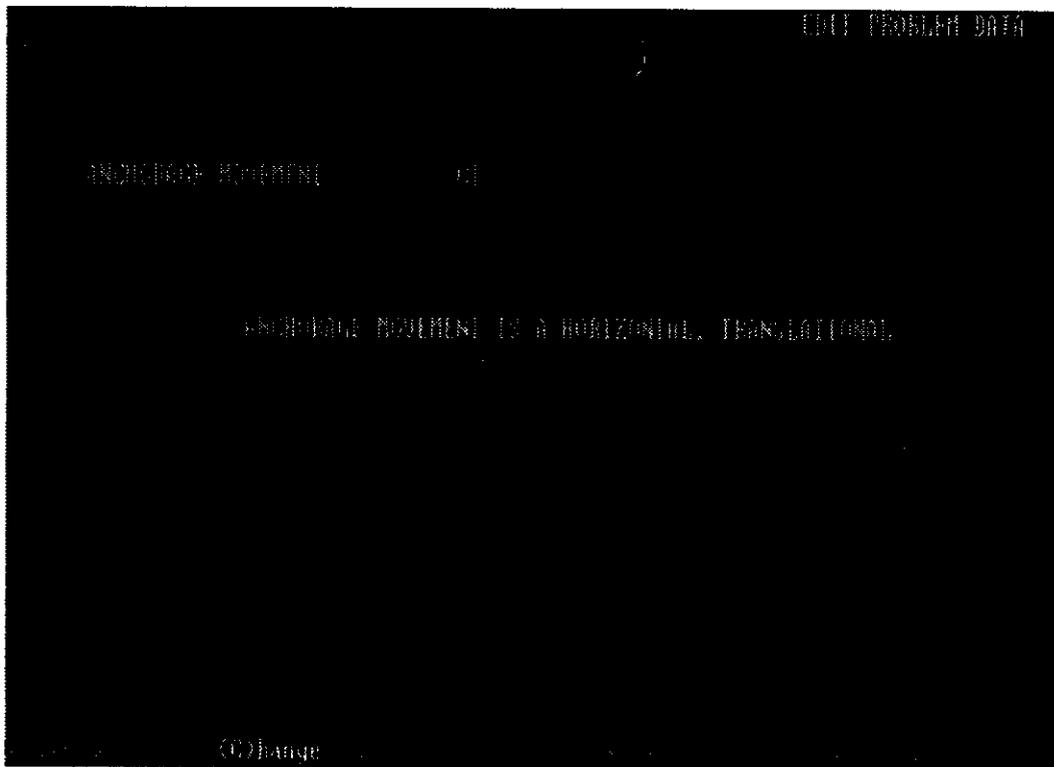


Figure 30. Problem Notes (Miter Lock Gate example)

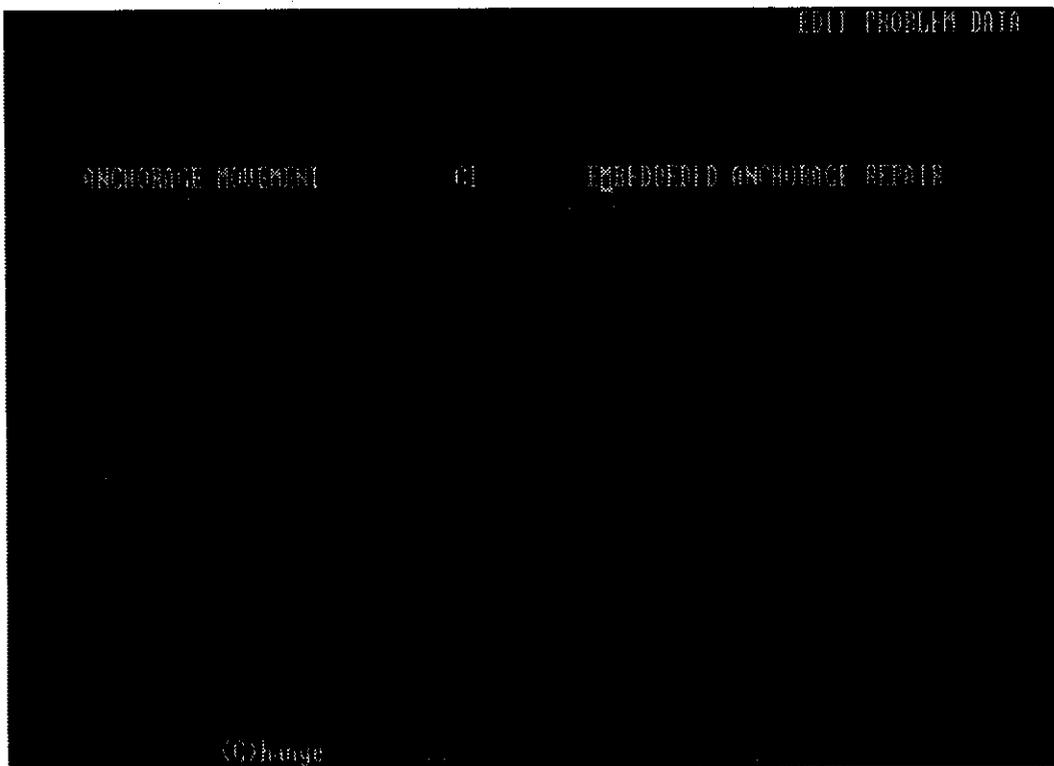


Figure 31. Alternatives For This Problem (Miter Lock Gate example)



Figure 32. Edit Alternative Data (Miter Lock Gate example)

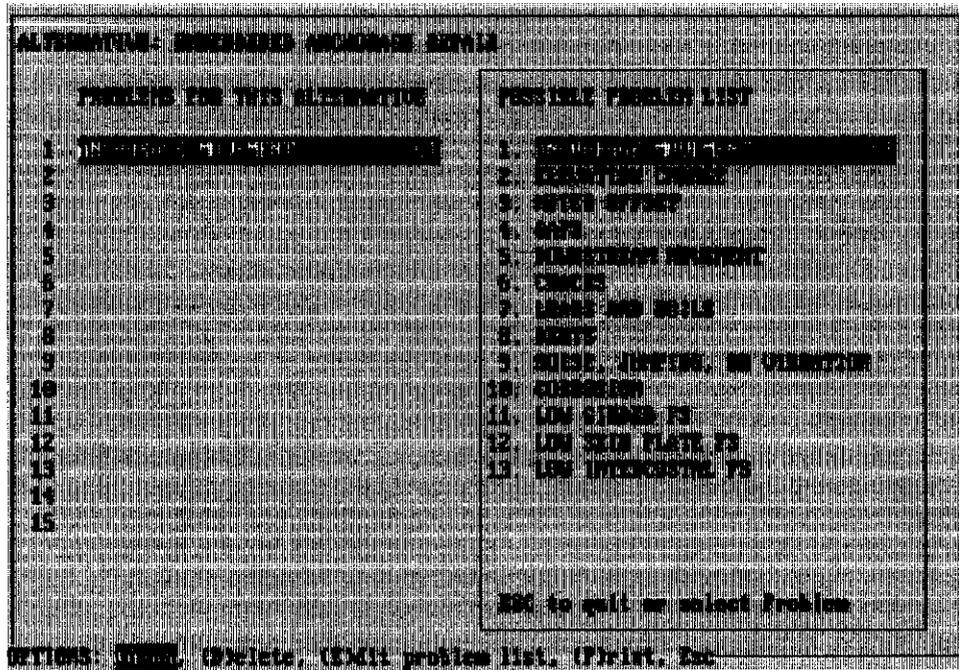


Figure 33. Add Problem to Alternative List (Miter Lock Gate example)

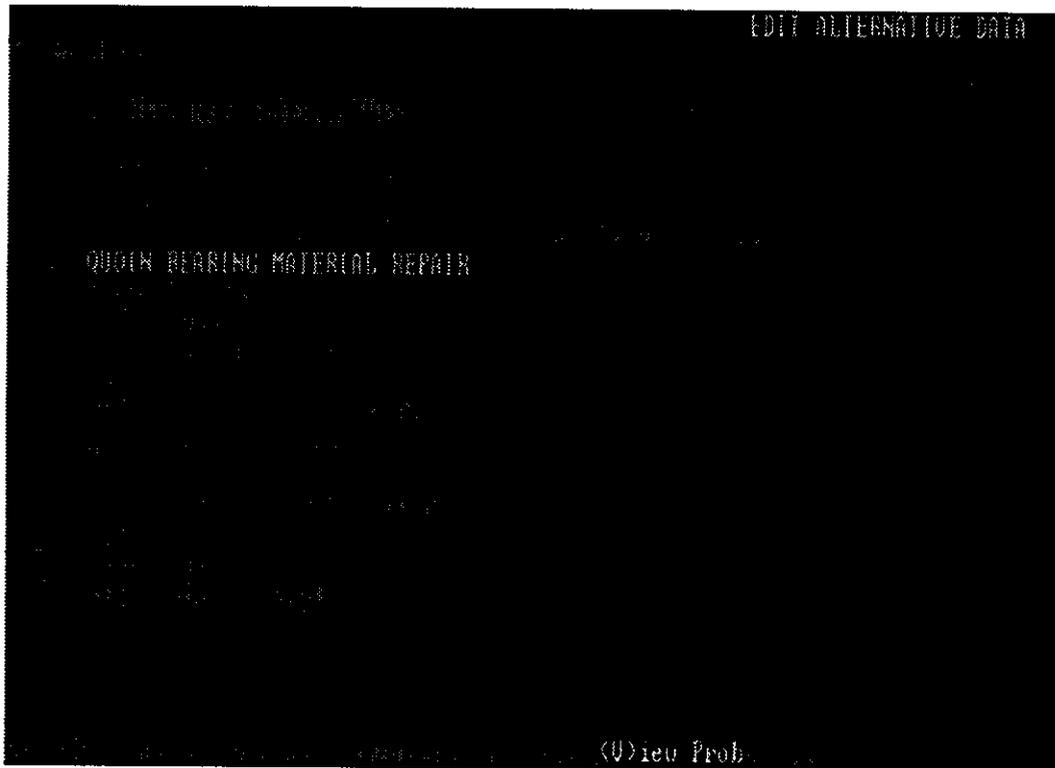


Figure 34. Problem Solved by M&R Alternative (Miter Lock Gate example)

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Appendix A: Sample Reports

The following pages illustrate the report output available from MITER.

Inspection Report - output file of data that corresponds to the inspection forms pages 1 through 5.

Summary Report - summary data of the structure condition index.

Description of M&R Solutions Report - summary output of the defined M&R solutions and a listing of the selected alternatives for each solution. Also lists the status of condition indexes and costs for each M&R solution.

Consequence Modeling Report - detail output for a specific M&R solution that includes data on economic analysis of each alternative, the status of condition indexes, and finally the backup parameters and temporary changes made to data files to generate the results in the current model.

MITER data sheet 1

NAME OF CIVIL WORKS PROJECT:

(1): Barkley Lock and Dam

(2): Upper Gate

LOCATION OF CIVIL WORKS PROJECT:

(1): Grand River

(2): Barkley Gate

DATE OF INSPECTION : 10-25-88

INSPECTED BY : G,S,R

GATE IDENTIFICATION:

1. Upper Gate

2. Lower Gate

GATE ID (no.) : 1

TYPE OF STRUCTURAL FRAMING PRESENT:

1. Horizontal

2. Vertical

STRUCTURE TYPE(no.) : 1

TYPE OF PINTLE:

1. Fixed

2. Floating

PINTLE SYSTEM(no.) : 1

TYPE OF SKIN PLATE:

1. Single

2. Double

SKIN TYPE(no.) : 1

LENGTH OF LOCK CHAMBER(ft) : 800
 WIDTH OF LOCK CHAMBER(ft) : 110
 HEIGHT OF GATE LEAF(ft) : 50
 WIDTH OF GATE LEAF(ft) : 61.75

POOL LEVELS	UPPER POOL(ft)	LOWER POOL(ft)
PRESENT POOL WATER LEVELS	: 357.1	303.3
RECORD LOW WATER LEVEL	: 354.0	300.0
RECORD HIGH WATER LEVEL	: 370.8	347.3

DO YOU ROUTINELY DEWATER THE LOCK CHAMBER (*Y/N) : Y
 *IF YES, WHAT YEAR WAS THE LOCK LAST DEWATERED? : 1983
 * INTERVAL PERIOD : 5

CONSTRUCTION DATE : 1966

MITER data sheet 2

ARE THE ORIGINAL GATE LEAVES CURRENTLY IN PLACE (*Y/N)? Y

*If not, identify current gate leaf history:

==>

ARE DRAWINGS AVAILABLE FOR GATE LEAVES IN PLACE (Y/N)? Y

ARE THE DRAWINGS INCLUDED WITH THIS FILE (Y/N)? No

PAST 10 YEAR HISTORY OF:

=====

MAJOR MAINTENANCE, REPAIRS, OR OTHER MODIFICATIONS.
Date Description

==> x

PREVIOUS INSPECTION OR REVIEWS.
Date Description

==> x

TYPE OF FENDER PROTECTION AND CONDITION OF FENDERS:

==> Dent in steel fender.

TYPE OF WALKWAY ON GATE LEAF AND CONDITION OF WALKWAY:

==>

OTHER COMMENTS

==>

MITER data sheet 3

FACING DOWNSTREAM AT UPPER GATE, IDENTIFY LEAF AS LAND OR RIVER SIDE

LEFT GATE LEAF = land
 RIGHT GATE LEAF = river

OPENING AND CLOSING OF GATE LEAVES

	Left Leaf (Y/N)	Closed				Right Leaf (Y/N)	Closed			
		25	50	75	100		25	50	75	100
DO THE DIAGONALS FLAP? :	Y			0		Y			0	
DOES THE GATE JUMP? :	N			-		N			-	
IS THERE GATE NOISE? :	N			-		N			-	
DOES THE GATE VIBRATE? :	N			-		N			-	

ELEVATIONS OF GATE LEAF

LEFT LEAF REF. ELEVATION : 4.654
 RIGHT LEAF REF. ELEVATION : 4.830

	Recessed	Near Miter	Miter 1' head	Miter Full head
Left leaf				
Quoin :	4.46	4.47	4.47	4.47
Miter :	4.51	4.54	4.55	4.53
Right leaf				
Quoin :	4.46	4.47	4.47	4.48
Miter :	4.53	4.56	4.55	4.54

ANCHORAGE SYSTEM MEASUREMENT

Is the anchorage system rigid or flexible? (R/F)R
 If flexible, length of flexible anchor bar: (in.) 0

	Spalled Concrete		Anchor Corrosion	
	Left leaf	Right leaf	Left leaf	Right leaf
Parallel(Y/N) :	N	Y	N	N
Perpendicular(Y/N) :	Y	Y	N	N

	Recessed	Near Miter	Miter 1' head	Miter Full head
Left leaf				
Arm Dim.(in)				
Parallel 1 :	0.438	0.438	0.440	0.441
Parallel 2 :	43.125	43.125	43.125	43.125
Parallel 3 :	12.875	12.813	12.813	12.813
Perpendicular 1 :	0.324	0.319	0.318	0.320
Perpendicular 2 :	24.5	24.563	24.563	24.5
Perpendicular 3 :	18.563	18.563	18.563	18.563

	Recessed	Near Miter	Miter 1' head	Miter Full head
Right leaf				
Arm Dim.(in)				
Parallel 1 :	0.345	0.347	0.348	0.349
Parallel 2 :	43.375	43.375	43.375	43.313
Parallel 3 :	12.625	12.563	12.563	12.5
Perpendicular 1 :	0.193	0.193	0.194	0.199
Perpendicular 2 :	20.25	20.25	20.25	20.156
Perpendicular 3 :	21.75	21.813	21.875	21.875

MITER data sheet 4

OFFSET OF MITER BLOCKS WITH GATE AT MITER (1'HEAD), (Dim. 4,5 Fig. 11)

Location	Measurement(in)	From top girder (ft)	Leaf downstream
Top	: 0.25	3.75	L
DSWL	: 0	24	L

DSWL : Down stream water level
Bearing block width : (in.) 4

GAP BETWEEN BEARING BLOCKS AT MITER (1'HEAD), (Dim. 6, 7 Fig. 12)

Location	Measurement(in)	From top girder (ft)
Left quoin @ Top	: 0	6
Left quoin @ DSWL	: 0.0157	26
Right quoin @ Top	: 0	6
Right quoin @ DSWL	: 0.0396	26
Miter @ Top	: 0	3.75
Miter @ DSWL	: 0	26

LONGITUDNAL POSITION OF MITER POINT (Dim. 8 Fig. 12)

Location	Measurement (in)		From top girder (ft)
	1'head	Full head	
Top	: 4.875	4.5	3
DSWL	: 0.875	1.25	24.0

LOCK CHAMBER FILLING (OR EMPTYING)

Does the leaf vibrate?

Left leaf(Y/N) : Y
Right leaf(Y/N) : Y

DOES A LEAK FOLLOW THE RISING (OR EMPTYING)
WATER LEVEL AND THEN CLOSE AS THE WATER
CONTINUES TO RISE (EMPTY)?

Left Quoin (Y/N) : N
Miter (Y/N) : N
Right Quoin (Y/N) : N

DOES THE GAP BETWEEN MITER BLOCKS CHANGE?

(Y/N) : Y

If yes, select from the following choices the most accurate description of the change.

1. Top gap initially open but closes under full head.
2. Top gap opens wider but closes under full head.
3. Top gap opens and remains open.
4. Top of miter is closed but gap opens between water line and top.
5. Top of miter is closed and gap between water line and top closes.

Choice No. : 4

Estimate the maximum width of gap (in) : .3

Estimate the location of the maximum
gap from top girder (ft) : 14

MITER data sheet 5

OBSERVATIONS FROM BOAT

CORROSION AT SPLASH ZONE (LEVEL 0,1,2,3,4, OR, 5)

	Left Leaf		Right Leaf	
	Upstream	Downstream	Upstream	Downstream
Skin	:1	1	1	1
Girder	:1	1	1	1
Intercostal	:1	1	1	1

DENTS -- SKIN PLATE(S), GIRDERS(G), OR INTERCOSTALS(I)

Leaf	Component	Location, Distance From:		Size (ft)	
RG or LG	S, G, or I	Top Girder(ft)	Quoin (ft)	Height	Width
==> R	G	3	58	1	.5
==> x					

CRACKS -- SKIN PLATE(S), GIRDERS(G), OR INTERCOSTAL(I)

Leaf	Component	Location, Distance From:		Size (ft)
RG or LG	S, G, or I	Top girder(ft)	Quoin (ft)	Length
==> x				

BEARING BLOCK LEAKS @ LEFT (L), MITER (M), or RIGHT (R)

Type R,M,L	Distance From Top girder(ft)	Length(ft)
==> R	40	0.5
==> M	28	0.25
==> x		

SKIN LEAKS @ LEFT (L) OR RIGHT (R)

Leaf	Type	Shortest Distance From :		Length
R or L	Hor(H) or Vert(V)	Top girder(ft)	Quoin(ft)	
==> x				

BOILS @ LEFT (L), RIGHT (R) OR MITER (M)

Type (R,L or M)	Distance from Quoin(ft)
==> M	61
==> L	40
==> x	

SUMMARY REPORT

PROJECT NAME:

Barkley Lock and Dam
Upper Gate

LOCATION:

Grand River
Barkley Gate

INSPECTION DATE: 10-25-88

INSPECTED BY: G,S,R

The overall condition has been analyzed and compiled in the following indices:

CONDITION INDEX:

Right Leaf : 70
Left Leaf : 74

CONDITION INDEX

Distress	Left Leaf	Right Leaf
ANCHOR SYSTEM	: 71	60
DOWNSTREAM MOVEMENT	: 74	74
NOISE JUMP VIBRATION	: 100	100
MITER OFFSET	: 65	65
GAP	: 93	82
CORROSION	: 74	74
** DENTS	: 100	40
CRACKS	: 100	100
LEAKS & BOILS	: 54	73
ELEVATION CHANGE	: 69	83
CI	: 74	70

Structural Notes

**** DENTS**

1 girder dent(s) were recorded on the right leaf.
Further investigation may be necessary.

STRUCTURAL FACTOR OF SAFETY

LC	INTERCOSTAL	PNL #	SKIN	PNL #	GIRDER	GRDR #
1	2.7	10	2.7	6	1.7	7
2	2.7	10	2.7	6	1.9	7
3	144.0	2	108.0	2	100.0	2
4	55.4	2	41.5	1	37.5	2
6	2.6	10	2.5	6	1.9	7

DESCRIPTION OF M&R SOLUTIONS

PROJECT NAME:

Barkley Lock and Dam
Left Upper gate

LOCATION:

Barkley Gate
Grand River KY

M&R Solutions and Alternatives:

M&R SOLUTION - Minor Repair

Year	Description	Exp Life	Cost (\$)
1991	EMBEDDED ANCHORAGE REPAIR	50	10,000
1991	REPAIR WELD CRACKS	25	1,200

Old Condition Index = 74
New Condition Index = 78
Total Present Worth (\$) = 9143

M&R SOLUTION - Structural Repair

Year	Description	Exp Life	Cost (\$)
1991	ADD DOWNSTREAM FLANGE COVER PL	75	1,250

Old Condition Index = 74
New Condition Index = Not computed
Total Present Worth (\$) = Not computed

CONSEQUENCE MODELING REPORT

PROJECT NAME:

Barkley Lock and Dam
Left Upper gate

LOCATION:

Barkley Gate
Grand River KY

M&R SOLUTION - Minor Repair

Year	Description	Cost(\$)	Present Worth(\$)
1991	EMBEDDED ANCHORAGE REPAIR	10000	8163
1991	REPAIR WELD CRACKS	1200	980

Old Condition Index = 74
New Condition Index = 78
Total Present Worth (\$) = 9143

LCCA PARAMETERS

Beginning Year = 1988
Period of Analysis (years) = 10
Interest Rate(%) = 7.00

THE FOLLOWING DATA REFLECTS CHANGES MADE DURING MODELING
TO CONDITION INDEX PARAMETERS:

Anchor System Movement and Tolerances

Repairs to the anchor system allow the following movement at
embedded steel and tolerances at the pins.

Left Leaf - Parallel

- 1: Embedded Steel = 0.001
- 2: Connection Link = 0.000
- 3: Gudgeon Pin = 0.003

Left Leaf - Perpendicular

Cracked concrete at embedded steel was repaired

- 1: Embedded Steel = 0.001
- 2: Connection Link = 0.000
- 3: Gudgeon Pin = 0.000

Right Leaf - Parallel

Cracked concrete at embedded steel was not repaired

- 1: Embedded Steel = 0.004
- 2: Connection Link = 0.062
- 3: Gudgeon Pin = 0.125

Right Leaf - Perpendicular

Cracked concrete at embedded steel was not repaired

- 1: Embedded Steel = 0.006
- 2: Connection Link = 0.094
- 3: Gudgeon Pin = 0.125

Condition Index : MITER GATE

Distress	Left Leaf	Right Leaf
ANCHOR SYSTEM	: 97	60
DOWNSTREAM MOVEMENT	: 74	74
NOISE JUMP VIBRATION	: 100	100
MITER OFFSET	: 65	65
AP	: 93	82
CORROSION	: 74	74
DENTS	: 100	40
CRACKS	: 100	100
LEAKS & BOILS	: 54	73
ELEVATION CHANGE	: 69	83
CI	: 78	70

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