Interim Method of Maintenance Management for U.S. Army Railroad Track Network

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The U.S. Army Construction Engineering Research Laboratory has developed an interim railroad track maintenance management system called RAILER I. Intended for use by engineers, technicians, and planners at U.S. Army installations, RAILER I serves as a decision support tool for identifying physical track assets, inspecting and evaluating track, identifying work needs, and planning and priority setting. RAILER I will be incorporated into a fully capable RAILER II system in approximately 2 years. RAILER I consists of two distinct portions: (a) established procedures and methods for collecting pertinent field and office information and (b) computer software for processing the information so that it can be easily used in network- and project-level decision making. Information collected includes installation information; track segment inventory; inspection, traffic, maintenance, and repair costs; and work history. Specific RAILER I procedures outline what needs to be collected and when. The microcomputer software has been programmed for operation on IBM XT, AT, or compatible systems. The programs are menu driven for ease of use. A variety of report options is available for reporting stored information. Programming permits an analysis of inspection data.

U.S. Army engineers, technicians, and maintenance planners face many questions concerning their railroad track networks. Questions continuously arise about determining what work must be accomplished to meet mission needs, how much it will cost, how work should be priority ranked for planning and budgeting purposes, and the effects of deferring maintenance and repair.

The answers are expected to come from engineering and local experience, a common practice in the commercial railroad sector. However, where experience is lacking, time constraints limit the effort that can be devoted to facility maintenance and repair planning. When other facilities take precedence, decisions are often made without knowledge of the consequences. Premature deterioration of track, accelerated or excessive costs, mission impairment, or all three, may result.

These problems are being addressed through a U.S. Army Construction Engineering Research Laboratory–developed railroad maintenance management system called RAILER. When the system is completed, installation personnel of the Directorate of Engineering and Housing (DEH) will be able to better understand and control the condition of their railroad track.

The idea behind the RAILER system is to provide effective and efficient management of U.S. Army track networks by using systematic procedures. The end result will be that appropriate portions of the network are maintained to an optimum level of condition, at the least possible cost, consistent with the mission. As a decision support tool, RAILER helps the user to (a) locate and identify physical assets, (b) assess conditions, (c) determine maintenance and repair (M&R) needs, and (d) plan and priority rank M&R work.

To accomplish this, RAILER includes standardized inventory, inspection, and other field and office data collection and analysis procedures based on sound civil, railroad, maintenance, and facilities engineering practice. RAILER also has a completely user-oriented microcomputer software package for data storage, reporting, and analysis.

RAILER consists of two generations: RAILER I (*1*), an interim system needed now to support an ongoing, centrally funded, major track rehabilitation program, and RAILER II, a fully capable system scheduled for release within the next 2 years. This paper focuses on RAILER I.

By design, RAILER I lacks some of the data elements and many of the analysis and cost-estimating features planned for RAILER II. It does, however, serve the basic requirement of providing a quick determination of whether or not existing track conditions meet critical portions and levels of the current Army railroad track standards (*2*). When it is combined with inventory and traffic information (*3, 4*), RAILER I makes it possible for installation personnel to develop meaningful annual and long-range work plans.

RAILER I is designed to be fully compatible with RAILER II so that a later conversion can be developed.

BACKGROUND

More than 100 U.S. Army installations have railroad track. Some have fairly active track networks and others experience only infrequent traffic movements. Network sizes range from less than 1 to more than 200 track miles per installation. Also, track conditions and maintenance practices vary widely. A common feature, however, is that the vast majority of this track is needed for mobilization readiness. These networks must be able to sustain large volumes of heavy traffic on, potentially, quite short notice. Thus an adequate but econom-

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ical maintenance program is necessary. RAILER is intended to be a decision support tool in the accomplishment of that task.

NETWORK DIVISION AND LOCATION REFERENCING

The first step in using the RAILER system is to break the railroad network into logical pieces. Branches of the network are designated as separate tracks, and tracks are divided into management units called track segments. Tracks and track segments are assigned their own identification numbers (Figure 1), as are all turnouts and curves in the network. In the RAILER system, the track segment is the basis for the collection and reporting of most information.

In addition to identifying tracks and track segments, there is a need to establish a system for locating points anywhere on the railroad network. This is done by applying standard surveyor's stationing to each track. Thus any point may be specified by its track number and station location. Station location markers are permanently affixed every 200 ft. This is discussed in greater detail elsewhere (*1–3*).

INVENTORY PROCEDURES

When the network has been divided and stationed, the next step is to collect inventory information. This one-time process consists of gathering information about the basic physical and operational characteristics of the railroad. Information is collected generally for the network as a whole and specifically for each track segment. The various RAILER I inventory elements are addressed more completely elsewhere (*1, 3, 4*). The inventory elements for RAILER II are still undergoing refinement.

TRACK INSPECTION

The inspection process requires that certain observations and measurements be made along the track and roadway and recorded on standard forms. This information is then fed into the RAILER I computer program, which compares it with the criteria established in the Army railroad track standards (*2*). The RAILER I program will note any defective conditions and determine the relative severity of those defects. The resulting list of defects is then categorized according to the five established condition levels: No Defects, No Restrictions, 10 mph, 5 mph, and No Operation.

The visual inspection forms are designed to guide the inspector through the inspection process, and are intended for use with the RAILER I computer program. When information is being entered into the computer, the screen format follows the form format. Figures 2–4 show tie, vegetation, and turnout inspection forms, respectively.

In the RAILER I system, inspection forms often use "number of occurrences" for reporting observations. An occurrence will have one of two interpretations. Using the tie inspection form (Figure 2) as an example, single, specific, "countable" observations (such as defective ties) are recorded each time that observation is made. For vegetation inspection (Figure 3), this occurrence definition is applied differently. In this case, there may be long, continuous conditions that need to be noted. In such cases, an occurrence is any observation of the condition within the previously stationed 200-ft interval. If the condition extends past a 200-ft mark, then a second (or third, etc.) occurrence is recorded.

In addition to visual inspection, the RAILER I system allows for input from an automated track geometry collection system. The data from the measuring system are copied to a standard 5¼-in. computer disk, which is then read by the RAILER I program. The RAILER I data base retains those values that fall outside of specified limits. The results from an

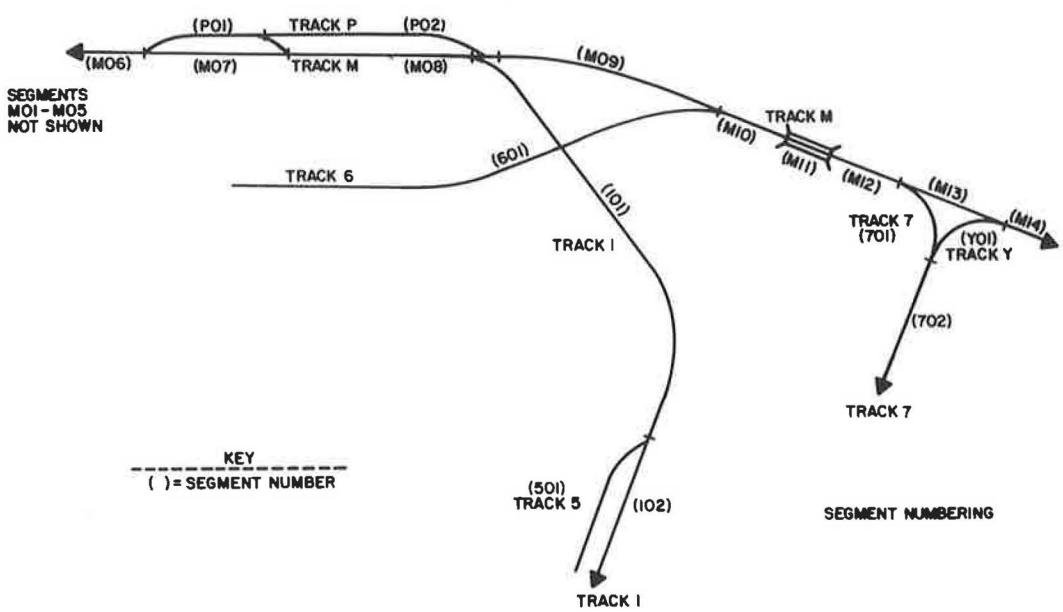

FIGURE 1 Track and segment numbering.

RAILER I INSPECTION
TIES

DATE: 2/11/88
INSPECTOR: R. HARRIS

TRACK SEGMENT #	DEFECTIVE TIE CONDITIONS: CONSECUTIVE DEFECTIVE TIES 2	3	4	5 or more	ALL JOINT TIES DEFECTIVE	AVERAGE SPACING PER RAIL LENGTH > 22 in.	SKEWED TIES	MISSING/ BUNCHED/BADLY SKEWED TIES (tie spacing along either Rail > 48 in.)	TOTAL DEFECTIVE TIES
M13	~~IIII~~ III					I			
TOTAL	8	0	0	0	0	1	0	0	40
COMMENTS:									

FIGURE 2 Tie inspection form.

RAILER I INSPECTION
VEGETATION

DATE: 2/11/88
INSPECTOR: R. HARRIS

TRACK SEGMENT#	DEFECTS	LOCATION * Left Occurrences	Left Total	Center Occurrences	Center Total	Right Occurrences	Right Total
M13	No Defects	II	2	II	2		0
	Insufficient, where needed		0		–		0
	Growing in Ballast		–	I	I		–
	Prevents Track Inspection		0		0		0
	Interferes with Walking		0		0		0
	Interferes with Visibility of Signs		0		–	I	I
	Brushes Sides of Rolling Stock		0		0	II	2
	Interferes with Trains or Track Vehicles		0		0		0
	Presents a Fire Hazard	I	I		0		0
	COMMENTS:						

FIGURE 3 Vegetation inspection form.

internal rail defect inspection can also be put into the RAILER I data base.

OTHER FIELD AND OFFICE DATA

In addition to inventory and inspection data, the RAILER I system also handles information about the types of cars and tonnage normally run over the network. Also, within the data base, there are places to store information about planned and completed maintenance and repair work for each track segment.

COMPUTER ENVIRONMENT

RAILER I is microcomputer based, and the hardware requirements include an IBM-XT, AT, or 100 percent compatible microcomputer; a 20-megabyte hard disk; 640K RAM; and a dot matrix 80-column printer (with IBM standard character set).

Computer programming links the data elements to the decision support applications. The computer programs are built on the R:Base 5000 relational data base management system. This makes possible a flexible approach to data entry and report generation. A knowledge of R:Base 5000 is not needed because RAILER I is menu driven.

Figure 5 shows the main data base structure of RAILER I. Within each box the data elements are organized according to the groups described earlier. Figure 6 shows the basic decision tree/menu structure available to the user for creating, altering, manipulating, and reporting this data base. A complete description of the computer operations has been published (*5*).

After the data have been entered and automatically manipulated within the computer, they are available through reports

RAILER I INSPECTION
TURNOUTS

TRACK SEGMENT #: M12
TURNOUT ID #: LT7

DATE: 2/10/88
INSPECTOR: R HARRIS

GENERAL		TIES	
Rail Weight changes within Turnout limits	N (Y)	# of Defective Ties in a row (worst case)	2
Reversing Tangent Past Frog Less than 50 Feet	(N) Y	# of Occurrences where Joint Ties are Defective	1
Switch Difficult to Operate	N (Y)	# of Occurrences where Tie Spacing > 22 in.	0
		# of Skewed Ties	3
	Good	# of Missing/Bunched/Badly Skewed Ties	0
Line & Surface	Fair	(Tie spacing along either rail > 48 in.)	
	(Poor)	TOTAL # of Defective Ties	7

	COMPONENTS	NO DEFECTS	IMPROPER SIZE/ TYPE/POSITION (Y or #)	LOOSE (Y or #)	CHIPPED/WORN/BENT/ CRACKED/BROKEN/ CORRODED/ALTERED (Y or #)	MISSING (Y or #)
S	Switch Stand		Y	Y	(Y)	Y
W	Point Lock/Lever Latch		Y	Y	Y	(Y)
I	Connecting Rod		Y	Y	(Y)	Y
T	Switch Point - Left		Y *	Y	(Y)	Y
C &	Switch Point - Right		Y *	Y	(Y)	Y
H	Switch Rods				2	
S	Clip Bolts		4			
T	Slide Plates			2		
A	Braces			2		3
N	Heel Filler & Bolts					2
D	Cotter Keys			4		
F R O G	Point & Top Surface		Y	Y	(Y) *	Y
	Bolts			4		
G R U A A I R L D S	Guard Rails	X				
	Filler & Bolts	X				

	MEASUREMENTS (inches)	STRAIGHT SIDE	TURNOUT SIDE
F + R O G	Gage at Point	56.1	57.2
	Guard Check Gage	54.4	54.4
	Guard Face Gage	52.8	53.1
	Flangeway Width	1.6	1.6
	Flangeway Depth	1.6	1.6
G R + U A A I R L D S	Flangeway Width	1.6	1.6
O T H E R	Gage at Switch Points	57.2	
	Gage at Joints in Curved Closure Rails	56.1	

COMMENTS:

FIGURE 4 Turnout inspection form.

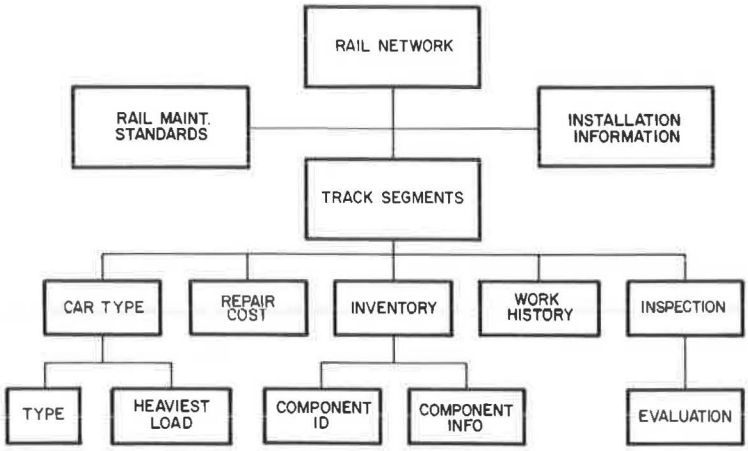

FIGURE 5 RAILER I data base diagram.

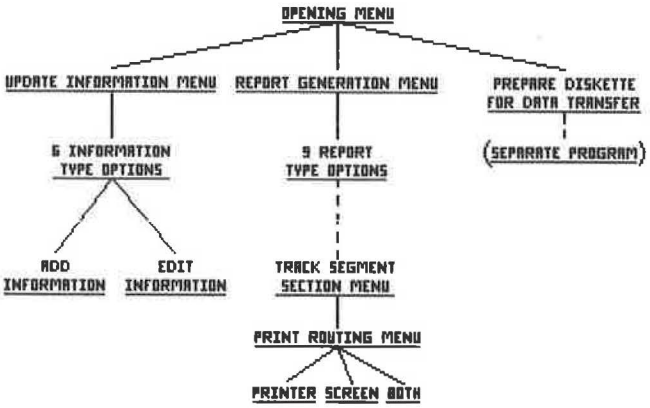

FIGURE 6 Menu routing diagram.

for decision support applications. The strength of RAILER I as a decision support tool is largely a function of the flexibility and ease with which reports are generated even by users with very limited microcomputer experience. The opening screen and the report generation menu are shown in Figures 7 and 8.

RAILER I REPORTS AND MAINTENANCE MANAGEMENT

Network- and Project-Level Management

Network-level management consists of activities associated with the installation track network as a whole. This consists primarily of the development of a multiyear work plan. Activities include inspection, condition evaluation, work identification, priority ordering of work, and budgeting.

```
RRRRRR      AA      IIIIIIII   LL        EEEEEEEE   RRRRRR       IIIIIIIII
RR   RR    AA  AA      II     LL        EE         RR   RR      IIIIIIIII
RR  RR    AA    AA     II     LL        EE         RR  RR          III
RRRRR     AAAAAAAA     II     LL        EEEEEE     RRRRR           III
RR RR     AA    AA     II     LL        EE         RR RR           III
RR  RR    AA    AA     II     LLL       EE         RR  RR       IIIIIIIII
RR   RR   AA    AA  IIIIIIII  LLLLLLLL  EEEEEEEE   RR   RR      IIIIIIIII

                RAILROAD MAINTENANCE MANAGEMENT SYSTEM
                          Version: 3.0
                        December 22, 1987

                          developed by
                   U. S. Army Corps of Engineers
             Construction Engineering Research Laboratory
                        Champaign, Illinois

        Do you wish to see a summary description of the system (y/n) ?
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FIGURE 7 Title screen.

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                          REPORT GENERATION
(1)  Installation Information
(2)  Track Segment Inventory Information
(3)  Track Segment Inspection Information
(4)  Car Type Information
(5)  Repair Cost Information
(6)  Work History Information
(7)  Information by Setting Parameters
(8)  Missing Information                                  F[10] HELP
(9)  Condition Comparison To Maintenance Standards        [ESC] TO EXIT
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FIGURE 8 Report generation menu.

EX111 RAILER I Page: 1
CAMP EXAMPLE B CONDITION SUMMARY
02/17/88

TRACK SEGMENT#	MAINTENANCE STANDARD CONDITION	IFS CONDITION
M01	OUT OF SERVICE	C3 - UNSATISFACTORY
M02	5 MPH LIMIT	C3 - UNSATISFACTORY
M03	NO DEFECTS	C1 - SATISFACTORY
M04	OUT OF SERVICE	C3 - UNSATISFACTORY
M05	OUT OF SERVICE	C3 - UNSATISFACTORY
M06	OUT OF SERVICE	C3 - UNSATISFACTORY
M07	5 MPH LIMIT	C3 - UNSATISFACTORY
M08	OUT OF SERVICE	C3 - UNSATISFACTORY
M09	OUT OF SERVICE	C3 - UNSATISFACTORY
M10	5 MPH LIMIT	C2 - MARGINAL
M11	5 MPH LIMIT	C2 - MARGINAL
M12	10 MPH LIMIT	C2 - MARGINAL
M13	NO RESTRICTIONS	C1 - SATISFACTORY
M14	OUT OF SERVICE	C3 - UNSATISFACTORY
M15	5 MPH LIMIT	C2 - MARGINAL
M16	OUT OF SERVICE	C3 - UNSATISFACTORY

FIGURE 9 Condition summary report.

Project-level management focuses primarily on determining and making final the work tasks, segment by segment, that will be accomplished under the upcoming annual work plan.

RAILER I Reports

The various reports that are used for these network- and project-level tasks are obtained by selecting the appropriate option from the report generation menu (Figure 8).

Condition Comparison with Maintenance Standards (Comparison Report)

This report consists of three options: a condition summary, a condition summary by inspection type, and a detailed comparison. The difference is the amount of detail provided. Figures 9–11 show each option. The Comparison Report is the only true RAILER I analysis report. It compares the results from the latest track segment inspection with the Army railroad track standards. The summary option also codes the track segments to the U.S. Army work management condition standard (IFS) based on track use.

At the network level, this report serves, in part, to determine the condition of the track segments and classify the work

EX111 RAILER I Page: 1
CAMP EXAMPLE B CONDITION COMPARISON BY
INSPECTION TYPE
02/17/88

TRACK SEGMENT#	OUT OF SERVICE	5 MPH SPEED LIMIT	10 MPH SPEED LIMIT	NO RESTRICTIONS	NO DEFECTS
M11	-0-	TIES	-0-	VEGETATION	-0-
M12	-0-	-0-	TIES TURNOUTS	VEGETATION	-0-
M13	-0-	-0-	-0-	TIES VEGETATION	-0-
M14	TURNOUTS	-0-	-0-	TIES VEGETATION	-0-

FIGURE 10 Condition comparison by inspection type report.

EX111 RAILER I Page: 1
CAMP EXAMPLE B DETAILED COMPARISON
02/17/88

TRACK SEGMENT #	MAINTENANCE STANDARD CONDITION	QUANTITY
M13		
	*** NO RESTRICTIONS ***	
	TIES - 2 CONSECUTIVE DEFECTIVE TIES	8
	TIES - AVERAGE SPACING PER RAIL LENGTH > 22 INCHES	1
	TIES - PERCENTAGE OF TOTAL DEFECTIVE TIES	17%
	TIES - TOTAL DEFECTIVE TIES	40
	VEGETATION - CENTER - GROWING IN BALLAST	33%
	VEGETATION - RIGHT - INTERFERES WITH VISIBILITY OF SIGNS	33%
	VEGETATION - RIGHT - BRUSHES SIDES OF ROLLING STOCK	66%
	VEGETATION - LEFT - PRESENTS A FIRE HAZARD	33%

FIGURE 11 Detailed comparison report.

(major M&R or maintenance and minor repair). The condition summary option of the report provides a quick overview of the network condition on a track segment basis. The other report options, comparison by inspection type and detailed comparison, provide additional information on the nature and number of defects. The overall condition of each track segment as well as the types and amounts of defects present will indicate whether major M&R or maintenance and minor repair are needed.

The RAILER I track evaluation procedure is based on current, not future, conditions. RAILER I has no condition forecasting capabilities.

Another network-level task, priority ranking of work, uses the condition summary option of this report (Figure 9) if a "worst first" ranking approach is desired.

At the project level, this report enables the user to prepare work orders on specific tasks that need to be accomplished in order to raise the track segment to a given condition level.

Track Segment Inspection Information (Inspection Report)

This report (Figure 12) provides additional detailed information on the track segment. The actual results of any past inspection may be obtained. Included are visual inspection items, automated track geometry, internal rail flaw, and track deflection information. Useful at both the network and project levels, the report provides a baseline for the next inspection and detailed information for work order preparation.

Track Segment Inventory Information (Inventory Report)

This report (Figure 13) is primarily used at the project level when it is necessary to know the attributes of the various track components that make up the track segment. Included are such items as track segment length, turnout characteristics, culverts, and rail weight. Track use and category of the segment can also be obtained from this report.

Pertinent inventory information is important to developing a work order. Lengths, sizes, and other physical dimension data are needed when ordering parts and materials to match existing components.

Car Type Information (Car Type Report)

This report (Figure 14) provides information on types of cars and the tonnage that they carry. At the network level, this information is useful for performing traffic studies. At the project level, this information is needed for structural analysis of the track or when strengthening of track components (e.g., subgrade stabilization, rail weight increase) is contemplated.

Work History Information (Work History Report)

At the network level, this report is useful for performing maintenance studies. Knowing what work was accomplished

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EX111                          RAILER I INSPECTION                    Page:    1
CAMP EXAMPLE B                   TIE INSPECTION
                                    02/17/88

 TRACK          CONSECUTIVE          JOINT     AVE.            MISSING/    | TOTAL
SEGMENT# -----DEFECTIVE TIES----     TIES   SPACING SKEWED BUNCHED/BADLY|DEFECT
/DATE      2     3     4    >=5   DEFECTIVE  > 22"   TIES   SKEWED TIES | TIES
======== ===== ===== ===== ===== ========= ======= ====== ============|======
M13        8     0     0     0        0         1      0           0  |    40
03/30/87 -0-
                                                                      |
         ----- ----- ----- ----- --------- ------- ------ ------------|------
           8     0     0     0        0         1      0           0     40
```

```
EX111                          RAILER I INSPECTION                    Page:    1
CAMP EXAMPLE B                 VEGETATION INSPECTION
                                    02/17/88
 TRACK
SEGMENT #                      DEFECTS                          LEFT   CENTER   RIGHT
========= ============================================= ======  ======  ======
 M13      NO DEFECTS . . . . . . . . . . . . . . . .      66 %    66 %     0 %
 03/30/87 INSUFFICIENT, WHERE NEEDED . . . . . . . .       0 %     0 %     0 %
          GROWING IN BALLAST . . . . . . . . . . . .       0 %    33 %     0 %
          PREVENTS TRACK INSPECTION . . . . . . . .        0 %     0 %     0 %
          INTERFERES WITH WALKING . . . . . . . . .        0 %     0 %     0 %
          INTERFERES WITH VISIBILITY OF SIGNS . . .        0 %     0 %    33 %
          BRUSHES SIDES OF ROLLING STOCK . . . . . .       0 %     0 %    66 %
          INTERFERES WITH TRAINS OR TRACK VEHICLES .       0 %     0 %     0 %
          PREVENTS A FIRE HAZARD . . . . . . . . . .      33 %     0 %     0 %
COMMENTS: -0-

*******************************************************************************
NO INFORMATION SATISFIES CONDITION FOR: TRACK GEOMETRY; RAIL INSPECTION;
TURNOUT INSPECTION; TRACK DEFLECTION;
*******************************************************************************
```

FIGURE 12 Inspection report.

EX111 RAILER I TRACK SEGMENT INVENTORY Page: 1
CAMP EXAMPLE B 02/17/88

SEGMENT IDENTIFICATION

TRACK SEGMENT#	BEGIN LOCATION	END LOCATION	LENGTH	TRACK CATEGORY	TRACK USE	TRACK RANK	PRECEDING TRACK SEGMENT#(S)
M13	304+79	309+06	427 TF	A	AUXILIARY	0.1200	M12
	-0-						-0-

BALLAST

TRACK SEGMENT #	DEPTH	COMMENTS
M13	20 inches	6" LIFT IN 1973.

PLATES/FASTENINGS

TRACK SEGMENT #	TIE PLATES	RAIL ANCHORS (#/200 TF)	GAGE RODS	COMMENTS
M13	Y	80	N	-0-

RAIL

TRACK SEGMENT #	WEIGHT	SECTION	BEGIN LOCATION	END LOCATION	LENGTH	COMMENTS
M13	90 lbs/yd	AS	304+79	309+06	854 LF	-0-

FIGURE 13 Track segment inventory report.

EX111 RAILER I Page: 1
CAMP EXAMPLE B CAR TYPE INFORMATION
02/17/88

TRACK SEGMENT #	CAR TYPE	HEAVIEST LOAD (TONS)
M13		
	FLAT	80.000
	GONDOLA	98.000
	6 AXLE LOCOMOTIVE	190.00
	4 AXLE LOCOMOTIVE	110.00

FIGURE 14 Car type information report.

in what year and how much it cost helps in evaluating the performance and cost-effectiveness of past techniques and methods. At the project level, having specific information on past work accomplished can aid the engineer in choosing solutions to current problems. Figure 15 shows this report.

Repair Cost Information (Repair Cost Report)

This report (Figure 16) lists the cost to maintain or repair given track segments. The year in which the estimate was prepared and a brief description are also provided. This data file is updated after any network- or project-level tasks are performed that affect cost or the scope of the work that needs to be accomplished. This is the information that makes up the annual and long-range work plans.

A network-level management task that is accomplished with the aid of this report is budgeting. There is no specific budget-planning feature in RAILER I; however, summing all of the track segment costs from annual and long-range work plans creates a budget.

In addition, by summing the costs for all of the track segments the total dollar backlog can be quickly computed.

EX111 RAILER I Page: 1
CAMP EXAMPLE B WORK HISTORY INFORMATION
02/17/88

TRACK SEGMENT #	YEAR	COST	WORK DESCRIPTION
M13	1973	$5,000.00	Track surfacing accomplished. 6" lift of ballast added.
M13	1981	$1,000.00	Spot tie replacement.

FIGURE 15 Work history information report.

EX111 RAILER I Page: 1
CAMP EXAMPLE B REPAIR COST INFORMATION
02/17/88

TRACK SEGMENT #	DATE	COST/SEGMENT	COST/100 TF	COMMENTS
M13	03/31/87	$2,050.00	$480.09	Replace 40 ties, vegetation spraying, trim trees along right side of track.

FIGURE 16 Repair cost information report.

```
*****************************************************************************
YOU HAVE SELECTED Rail WHERE Weight IS LESS THAN OR EQUAL TO 70 AND Tie
Inspection WHERE 3 Consecutive Defective Ties IS GREATER THAN 0 OR WHERE 4
Consecutive Defective Ties IS GREATER THAN 0 OR WHERE >=5 Consecutive
Defective Ties IS GREATER THAN 0 OR WHERE All Joint Ties Defective IS GREATER
THAN 0
*****************************************************************************

                          RAILER I
                   COMMON TRACK SEGMENT #
                   ======================

                          1001
                          501
                          901A
                          901B
                          902

*****************************************************************************
                                 RAIL
                                 ----
 TRACK                        BEGIN     END
SEGMENT #   WEIGHT    SECTION LOCATION LOCATION  LENGTH   COMMENTS
========= ========== ======= ======== ======== ========  =====================
 1001      60 lbs/yd  6017   0+85     14+27     2684 LF  -0-
 501       60 lbs/yd  6017   0+89     8+65      1552 LF  -0-
 901A      60 lbs/yd  6017   1+60     12+83     2246 LF  -0-
 901B      60 lbs/yd  6017   12+83    26+35     2704 LF  -0-
 902       60 lbs/yd  6017   26+35    32+55     1240 LF  -0-


*****************************************************************************
                              TIE INSPECTION
                              --------------
 TRACK        CONSECUTVIE          JOINTS    AVE.          MISSING/   ¦ TOTAL
SEGMENT# -----DEFECTIVE TIES----    TIES   SPACING SKEWED BUNCHED/BADLY¦DEFECT
/DATE      2     3     4    >=5  DEFECTIVE  > 22"   TIES   SKEWED TIES ¦ TIES
======== ===== ===== ===== ===== ========= ======= ====== =============¦======
1001       23    17     3     0         0       0      0            0 ¦   179
03/30/87 -0-

501        12     3     0     0         0       0      0            1 ¦    76
03/30/87 -0-

901A       12     2     0     0         0       0      0            0 ¦    94
03/30/87 -0-

901B       17     2     0     0         0       0      1            0 ¦   117
03/30/87 -0-

902        12     3     0     0         1       0      1            0 ¦    67
03/30/87 -0-
```

FIGURE 17 Parameter report.

TRACK USE	CONDITION RATING			
	OUT OF SERVICE	5 MILE/HR LIMIT	10 MILE/HR LIMIT	NO RESTRICTION
LOADING	1	4	7	11
ACCESS	2	5	8	14
AUXILIARY	3	9	12	17
STORAGE	6	13	15	19
SERVICE	10	16	18	20

FIGURE 18 Track segment ranking matrix.

The difference between the funding needs and the amount allocated in the annual work plan represents the unfunded requirement, which is the backlog of maintenance and repair.

Information by Setting Parameters (Parameter Report)

The Parameter Report is an extremely flexible RAILER I feature that combines the results from any of the other reports in such fashion that only the desired information is provided. For example, it may be desired to search the data base to determine if a situation exists in which light rail (inventory) is in combination with bad tie clusters (inspection). This report will first provide the common track segment that meets the desired parameters. Further detail regarding the parameters is then provided. Figure 17 shows this report.

The network-level management task of priority ranking work was previously discussed in conjunction with the Comparison Report for "worst first" ranking. If, however, a different method of work ranking were preferred, the Parameter Report would be used. For example, if ranking based on condition and track use is desired, the matrix shown in Figure 18 can be used. The common track segment portion of the Parameter Report would provide the input to the matrix. All track segments needing work would be assigned somewhere on the matrix. They would be ranked in increasing numerical sequence.

Installation Information (Installation Report)

As is shown in Figure 19, this report provides information not specific to any track segment. Used at the network level, this

RAILER I

02/17/88 CAMP EXAMPLE B OR Page: 1

Installation #(s): EX111 -0- Relation Codes(s): EX111 -0-

Serving Railroad(s)

UNION PACIFIC RAILROAD
-0-
-0-
-0-

Installation Trackage

Track #	Track Length (TF)	# of Segments
1	7887	4
10	1427	1
2	1095	1
3	1752	2
4	1037	1
5	865	1
6	4517	1
7	3515	3
8	1477	1
9	3255	3
I	2681	1
M	34867	16
P	4368	2
Y	775	1

Total # of Installation Tracks = 14
Total # of Segments = 38
Total Track Feet (TF) = 69518

FIGURE 19 Installation information report.

report provides track numbers, total track lengths, numbers of segments for each track, and certain other information needed for mobilization planning.

Missing Information Report

This report lists the missing data fields by track segment. It provides a simple way of doing that task instead of searching through reports or data files in an attempt to determine if some information is missing.

FIELD TESTING

To date, the RAILER I system has been tested at several Army installations. The tests were performed by people with and without previous railroad maintenance experience. The intent was to ensure that (a) the objectives of the system, when used as a decision support system, were met; (b) all procedures were clear and usable by those with limited track maintenance experience; (c) the inspections resulted in the proper identification of conditions that were unsatisfactory and proper recognition of conditions that were satisfactory; (d) the information collected could be easily fed into the computer program; (e) computer reports were easily generated and presented information in a meaningful and convenient format; and (f) the system, as a whole, worked well.

CONCLUSIONS

The field test has shown that the RAILER I field procedures and computer programming perform as intended. This initial system will also provide a good basis for an enhanced RAILER II system with more features and greater capabilities.

The RAILER II system will include a complete inspection process, a basic track structural evaluation, and enhancements to existing features and report generation.

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