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 (I), 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-
A 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 (7–3).

**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 (7, 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 51/4-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
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...
FIGURE 4 Turnout inspection form.
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.

RAILER I data base diagram.

Menu routing diagram.

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)?

Title screen.

Report generation menu.
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.
(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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**FIGURE 12** Inspection report.
### Figure 13: Track segment inventory report.

<table>
<thead>
<tr>
<th>SEGMENT #</th>
<th>LOCATION</th>
<th>LOCATION</th>
<th>LENGTH</th>
<th>TRACK CATEGORY</th>
<th>TRACK USE</th>
<th>TRACK RANK</th>
<th>SEGMENT#(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M13</td>
<td>304+79</td>
<td>309+06</td>
<td>875</td>
<td>427</td>
<td>TF</td>
<td>A</td>
<td>AUXILIARY</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TRACK SEGMENT #</th>
<th>DEPTH</th>
<th>COMMENTS</th>
</tr>
</thead>
</table>

### Figure 14: Car type information report.

<table>
<thead>
<tr>
<th>TRACK SEGMENT #</th>
<th>CAR TYPE</th>
<th>HEAVIEST LOAD (TONS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M13</td>
<td>FLAT</td>
<td>80.000</td>
</tr>
<tr>
<td></td>
<td>GONDOLA</td>
<td>98.000</td>
</tr>
<tr>
<td></td>
<td>6 AXLE LOCOMOTIVE</td>
<td>130.00</td>
</tr>
<tr>
<td></td>
<td>4 AXLE LOCOMOTIVE</td>
<td>110.00</td>
</tr>
</tbody>
</table>

### Figure 15: Work history information report.

<table>
<thead>
<tr>
<th>TRACK SEGMENT #</th>
<th>YEAR</th>
<th>COST</th>
<th>WORK DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>M13</td>
<td>1973</td>
<td>$5,000.00</td>
<td>Track surfacing accomplished. 6&quot; lift of ballast added.</td>
</tr>
<tr>
<td>M13</td>
<td>1981</td>
<td>$1,000.00</td>
<td>Spot tie replacement.</td>
</tr>
</tbody>
</table>

### Figure 16: Repair cost information 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.
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

CAMP EXAMPLE B

Relation Codes(s): EX111

Serving Railroad(s):

UNION PACIFIC RAILROAD

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### Installation Trackage

<table>
<thead>
<tr>
<th>Track #</th>
<th>Length (TF)</th>
<th># of Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7887</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>1427</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1095</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>1752</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>1037</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>865</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>4517</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>3516</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>1477</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>3255</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>2681</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>34887</td>
<td>16</td>
</tr>
<tr>
<td>13</td>
<td>2658</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>4368</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>3775</td>
<td>1</td>
</tr>
</tbody>
</table>

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

![Figure 19](image_url)

**FIGURE 19** Installation information report.

This 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.

**ACKNOWLEDGMENTS**

The authors would like to acknowledge those who made significant contributions to the development of the RAILER I system. Their support and effort were important factors in the creation of a successful system.

U.S. Army Forces Command sponsored system development, initially through the effort of Bill Taylor and later by that of Jeff Blackwood and Carole Jones. Much support also came from Bob Williams (Office of the Chief of Engineers), Russ Golderman (Army Materiel Command), and the entire Army Pavements and Railroads Maintenance Committee.

Special appreciation goes to the group at USA-CERL who worked on RAILER I development. Their personal commitment to the project greatly helped in the successful development and field testing of the system. Special thanks go to Debra Piland who thoughtfully, creatively, and patiently led the computer programming effort; and also to Dave Brown for his ideas and support of other project members.

**REFERENCES**


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The views expressed are those of the authors and do not purport to reflect the position of the Department of the Army or the U.S. Department of Defense.

Publication of this paper sponsored by Committee on Railway Maintenance.