# Component Identification and Inventory of U.S. Army Railroad Trackage

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**Recognizing the need to effectively plan track maintenance and rehabilitation of the U.S. Army's 3,000 track miles at 81 installations, the U.S. Army, through the Construction Engineering Research Laboratory, has developed a preliminary maintenance management system called RAILER I and is developing an improved system called RAILER II. Both systems define what needs to be managed through component identification and inventory and determine track condition through inspection. Network- and project-level management activities can then be accomplished. Component identification and inventory are the basic first steps in the management process. In this paper, the track component identification procedures for both systems are explained and the RAILER I system track inventory elements are defined along with a method for field data collection. The fundamental component is a track segment, a relatively uniform portion of track that constitutes the basic management unit. Other components identified are track networks, tracks, turnouts, and curves. Surveyor 100-ft stations are used for locating key component and inventory elements. A summary of field test and implementation results is given. The procedures proved simple to implement by personnel with limited experience and training and were well received by those personnel tasked with railroad maintenance management.**

Because of the need for a railroad maintenance management system (*1*), the U.S. Army Construction Engineering Research Laboratory is in the process of developing an overall system called RAILER (*2*) that consists of a preliminary and interim railroad maintenance management system called RAILER I and a more fully capable system called RAILER II. Portions of RAILER are currently undergoing field testing, and the system will be ready for widespread implementation in approximately 2 years. RAILER I is currently being implemented at selected installations where it will be used in the decision-making process for developing critical railroad repair projects during the next 2 or 3 years.

Patterned after the highly successful PAVER pavement maintenance management system (*3*), RAILER (both I and II) is a decision support system designed as a tool to help installation personnel perform network- and project-level analyses of their track. Network-level analysis includes inspection (scheduling and accomplishment), evaluation, budgeting, project development, arranging projects in priority order, and budget and project justification. Major project-level tasks include detailed inspection, evaluation, and selection of the best rehabilitation alternative for selected portions of the track network.

The basic subsystems for RAILER are network definition, data collection, data storage and retrieval, network-level data analysis, and project-level data analysis (*2*). This paper is focused on network definition concepts that are inventory elements for the RAILER I system. The inventory elements of the RAILER II system have yet to be put in final form.

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## BACKGROUND

On paper, the U.S. Army has more than 3,000 mi of track located at 81 installations, including National Guard installations, within the United States. In reality, the actual amount of track is unknown because some installations have abandoned or removed portions or all of their track because of disrepair and lack of need. Rather than being managed as a single commercial railroad of 3,000 track miles, the U.S. Army trackage is analogous to having 81 short-line or industrial railroads, each with its own "president" (the installation commander) who controls the engineering and maintenance forces (in-house or contract) that plan and perform the work. These short lines vary in size from approximately 1 mi to just over 200 mi, with most in the range of 10 to 30 mi.

Daily traffic is generally light (less than one car per day, average) by commercial standards although selected installations do receive considerably more (more than 10 cars per day, average). However, much of the U.S. Army trackage would be subject to large volumes of traffic in the event of a national emergency. It is to meet such emergencies, in addition to the daily traffic, that the trackage must be retained and economically maintained. It is for this purpose that RAILER is needed.

U.S. Army railroad trackage is generally old and, because of low daily traffic levels and low funding priority, in many instances in need of major maintenance and repair. Many of the networks were built to meet World War II traffic needs and, because of the nonavailability of new materials at the time, the tracks were constructed with secondhand materials and light rail weights (average <90 lb). Also, because numerous material sources were used, rail weights, manufacturers, and so forth vary widely even at a given installation.

## NETWORK COMPONENTS

Fundamental to the maintenance management process is knowing just what and how much needs to be managed. Accordingly, the railroad network at each installation must be inventoried and the various components of the network need to be uniquely identified. Five network components have been identified. These are defined in the following list and discussed in the next section of this paper.

- Track network is all of the government-owned railroad track or track constructed to support military operations that is maintained as part of a U.S. Army installation,
- Track is an identifiable portion of the track network serving a distinct purpose,
- Track segment is a division of a track representing the basic unit for railroad maintenance management,
- Turnout is an arrangement of a switch and frog with closure rails used to divert trains from one track to another, and
- Curves are horizontal bends in the track designed to change the direction of travel.

## COMPONENT IDENTIFICATION

### Dividing Track Network into Tracks

The trackage enters the base at one or more connections with one or more commercial railroads. Within the installation, the trackage branches out into a loose tree structure. Each branch of the tree constitutes a track.

### *Track Identification*

Individual tracks are labeled with unique track numbers so they can be easily identified. Where numbers have been previously assigned to Army tracks, those numbers are retained as part of the identification. Should tracks not be numbered, a logical numbering scheme is assigned during system implementation. A consecutive sequence is used, based on network layout, geography, and train operations. An example of a track numbering sequence is shown in Figure 1.

### *Stationing*

When tracks have been identified, a location reference system, using surveyor 100-ft stations, is established to assist in locating inventory items and track deficiencies. The use of mileposts was considered impractical because of the short lengths of the majority of U.S. Army tracks. As defined, a track originates at the point of switch of the turnout leading to the track. This point of origin, by definition, is station 0 + 00. Consecutive stations are designated and permanently marked at 200-ft intervals with the aid of a measuring wheel. Tracks terminate and, therefore, the last station is at the point of switch of the turnout where the track joins another track or at a stub end. Figure 2 shows this stationing sequence.

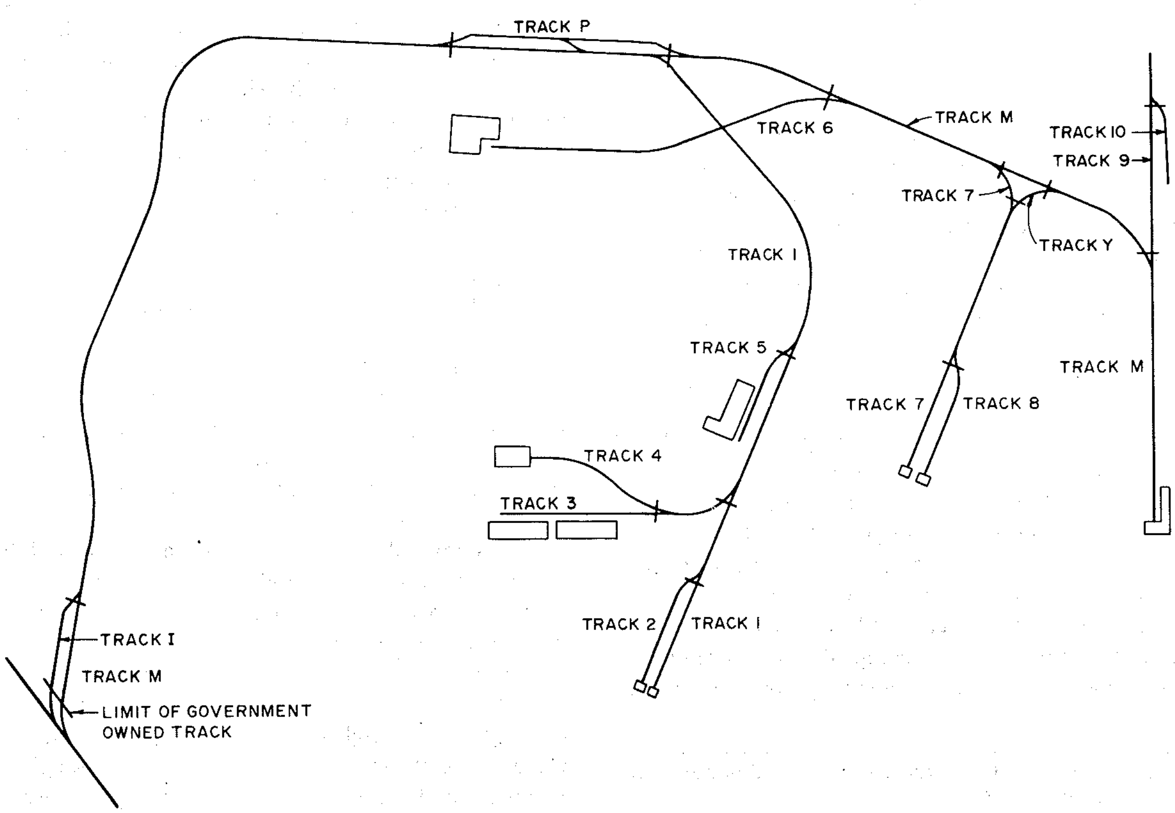


**FIGURE 1 Track numbering sequence.**

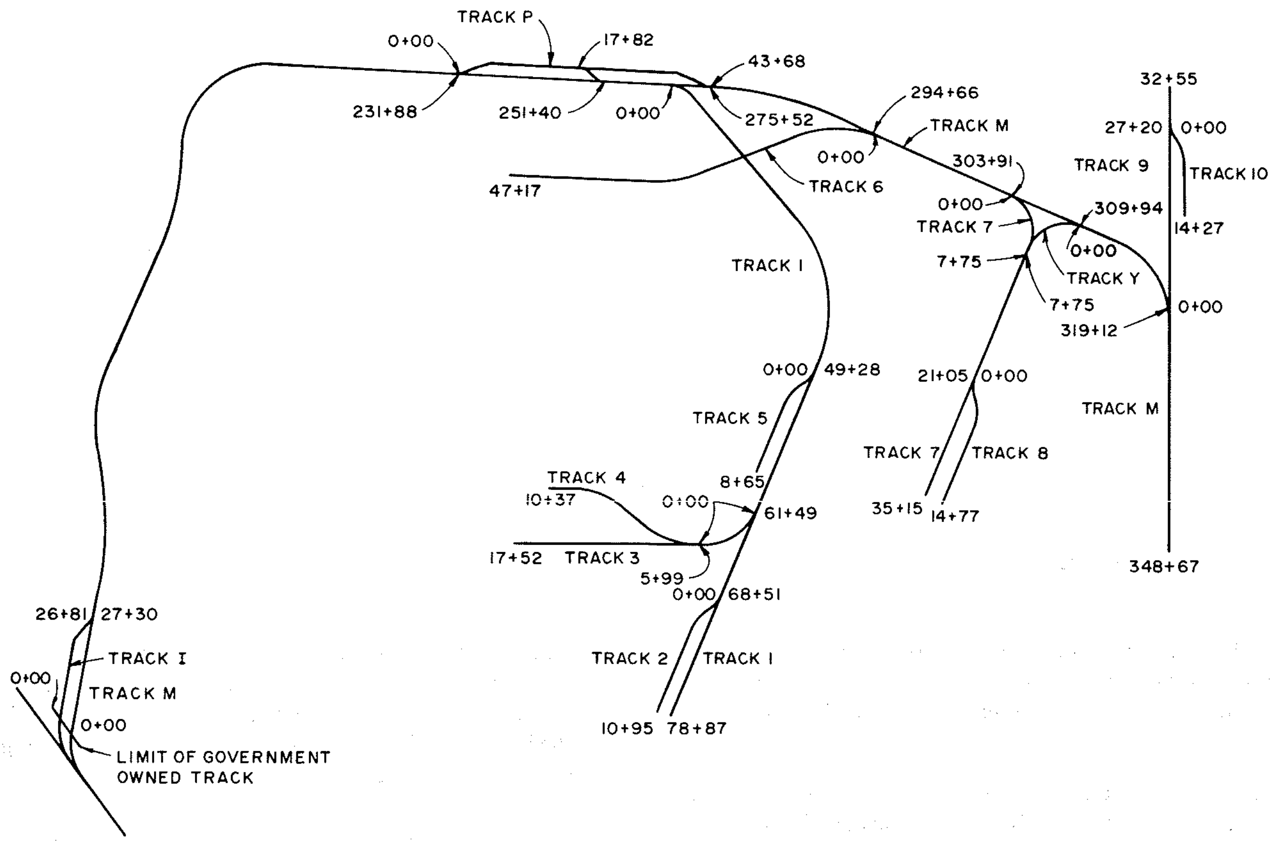


**FIGURE 2 Track stationing sequence.**

Exceptions to this stationing sequence include crossover tracks, back-to-back turnouts, and connections linking installation trackage with commercial railroads. In the latter instance, the point where government ownership begins is designated station 0 + 00. The other exceptions are discussed under "turnouts" later in this paper.

### Dividing Tracks into Track Segments

For effective management and network identification, tracks are divided into units called track segments. Each track must have at least one track segment.

#### *Criteria*

Two required and two optional criteria are used for determining track segment differentiation: train operations, track use, rail weight (optional), and bridges (optional).

**Train Operations** This criterion requires that segments begin or end at virtually every turnout because a turnout allows a choice of routes. In addition, tracks may exist that do not commonly have train operations over their entire length. In such cases, the active and inactive portions of the track may be designated as separate segments.

**Track Use** Although many specific track functions may exist within a network, five general categories are used for management purposes:

1. Loading: tracks used for loading and unloading equipment and supplies;
2. Storage: tracks used for long- or short-term storage of freight cars, including classification yard tracks and interchange tracks;
3. Service: tracks used for servicing either general installation operations or railroad equipment including tracks leading to a power plant, engine house, or car shop;
4. Auxiliary: tracks used to aid train operations including passing sidings, wye tracks, and run-around tracks; and
5. Access: tracks that provide connections between the other types of tracks, as well as those that link the installation and a commercial route.

Figure 3 shows a network with track uses assigned.

**Rail Weight** Sometimes when tracks are divided into track segments on the basis of the foregoing criteria, portions of the segment have rail of a weight that is significantly different from that of other portions. Because track performance is partly a function of rail weight, it may be advantageous for work-planning purposes, at times, to use rail weight as a segmenting criterion. Because rail weight can be quite

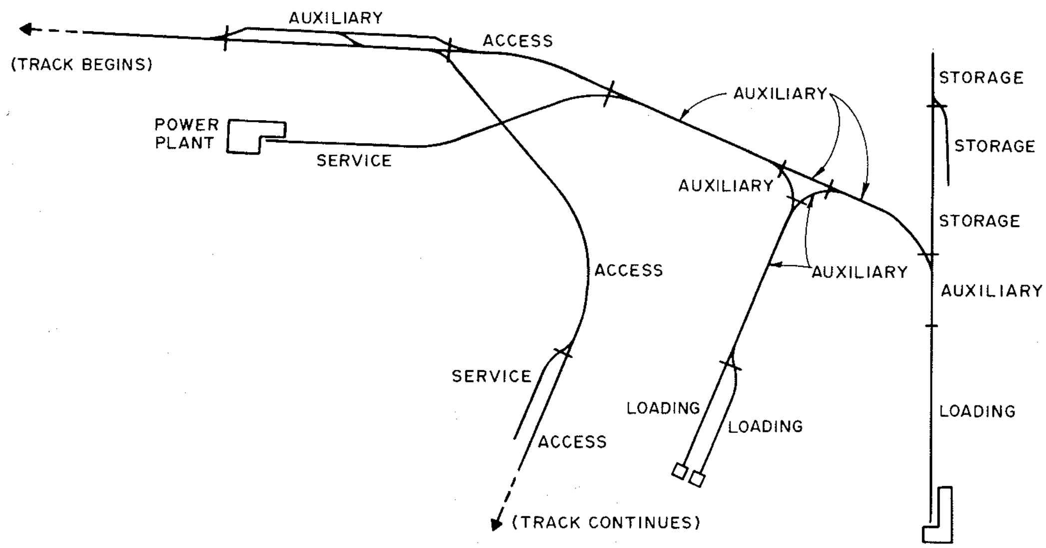


**FIGURE 3 Track uses.**

variable and may change every two or three rail lengths, using rail weight as a segmenting criterion should not normally be considered. It should be reserved for special cases.

**Bridges** Because of the unique maintenance requirements of track on bridges, as well as of the bridge itself, the track on a bridge may be considered a separate segment. The limits of a track segment on a bridge are shown in Figure 4.

**Other Factors** Ideally, the track in any segment should have uniform traffic and physical characteristics over its entire length. Where significant changes in these characteristics occur, new segments should be created. In addition to the four parameters discussed, segments may also be differentiated on the basis of ballast type, subgrade soil type, tie spacing, or overall track condition.

### *Track Segment Identification*

When tracks have been divided into appropriate track segments they must be numbered. The track segment number is created by adding a two-digit suffix to the track number. Numbers are generally consecutive for all track segments

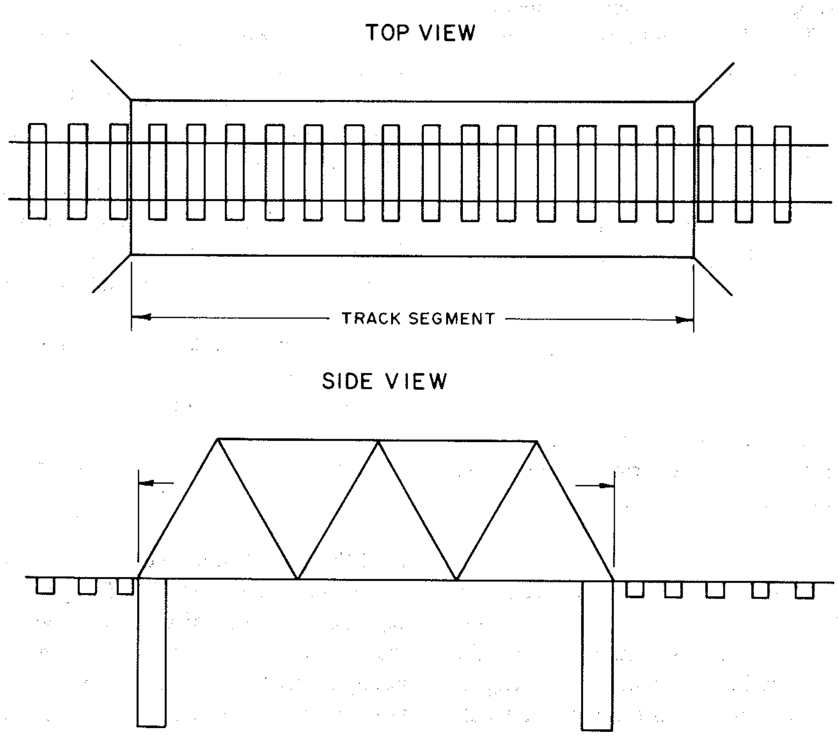


**FIGURE 4 Track segment on a bridge.**

within a given track. For example, M03 indicates the third segment of track M. Examples of track segment numbering are shown in Figure 5.

## Turnouts

Each turnout is located in one and only one track segment, and the location of the switch points determines the track segment in which the turnout resides (Figure 6).

Crossover tracks are divided at the center of the connecting tangent if there is less than 50 ft of track between the last switch ties of the turnouts leading to the crossover. Each half of the crossover is included in the track segment containing the turnout. If there are more than 50 ft, the track is treated like any other track. The same logic is used when turnouts are located back to back (Figure 7).

### *Turnout Identification*

Turnouts are numbered individually within track networks. Where an existing numbering system has been established, it is retained. Otherwise, all turnouts are numbered as follows:

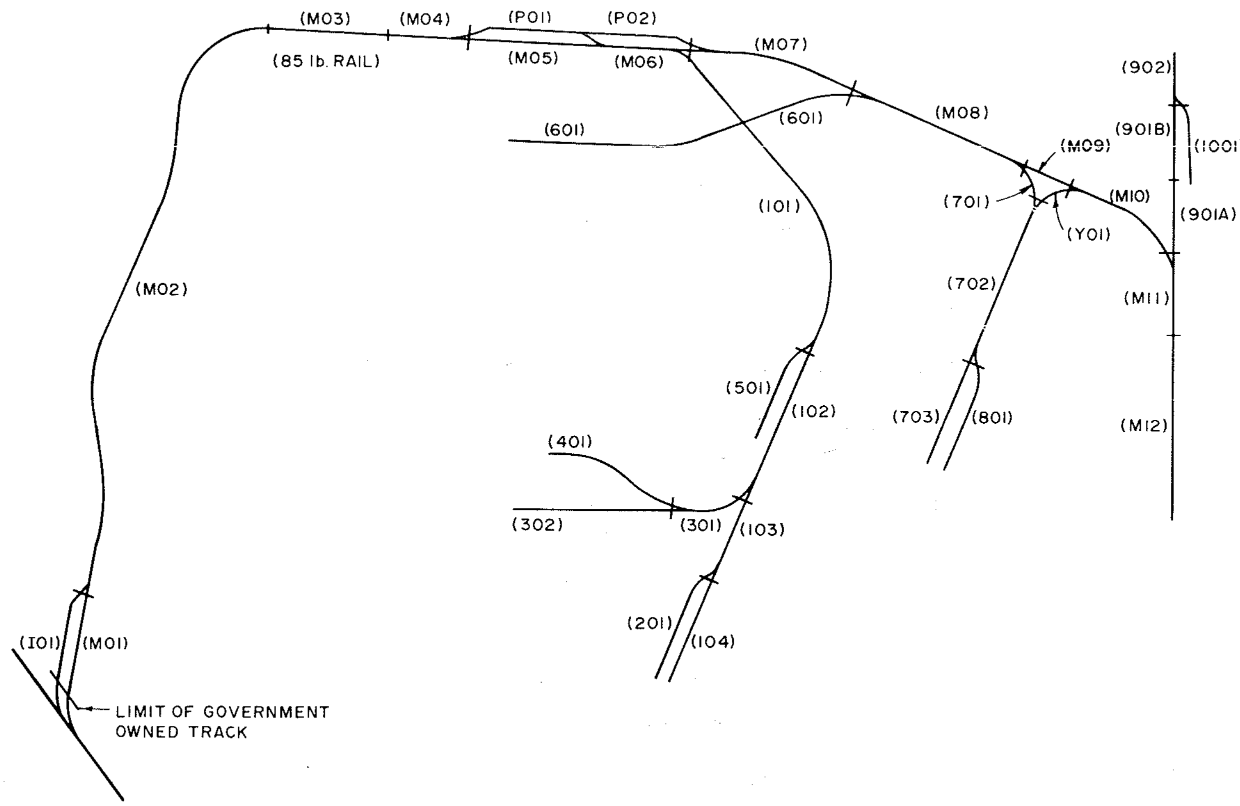


**FIGURE 5 Track segment numbering sequence.**

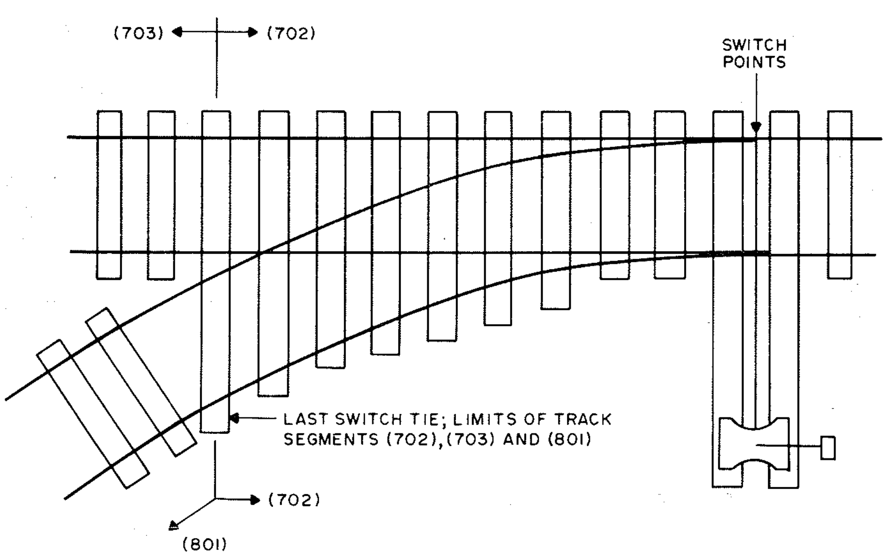


**FIGURE 6 Segmenting a turnout.**

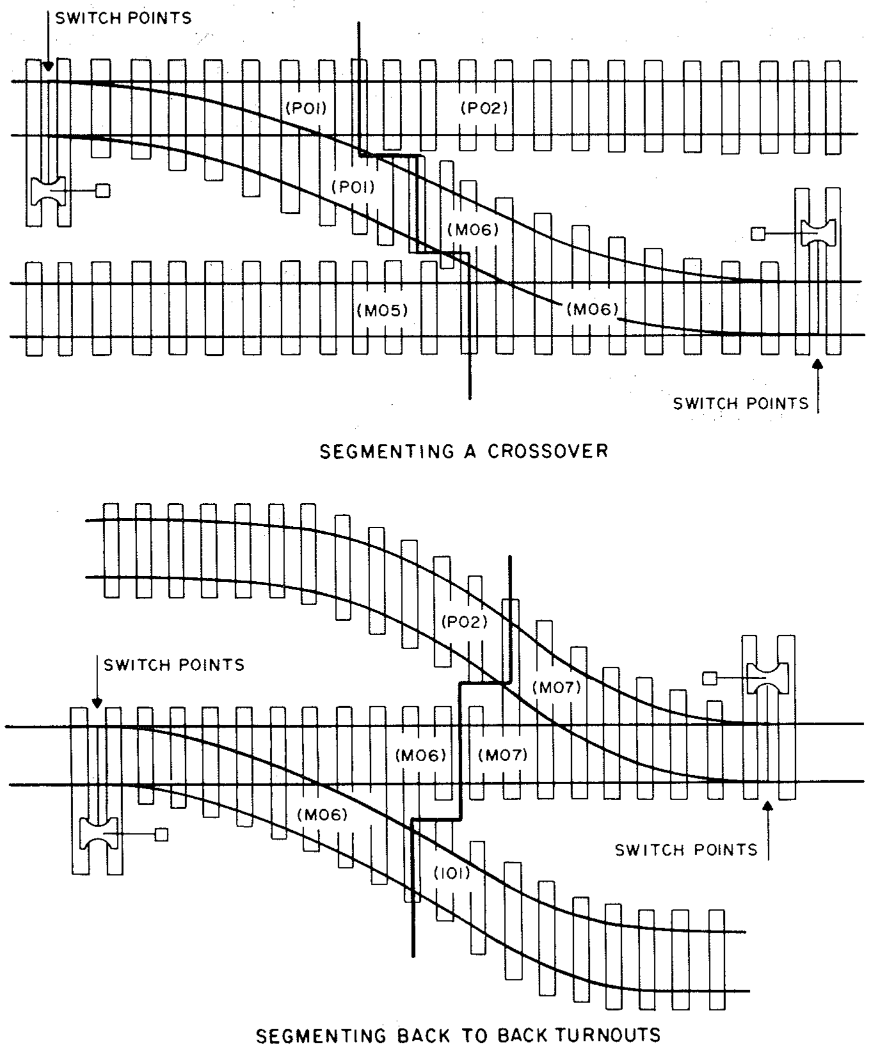


**FIGURE 7 Track segmenting at crossovers and back-to-back turnouts.**

(Integer) T (Diverging track number). This three-part number is established as follows.

1. Integer: 1 is reserved for the turnout where the diverging track begins. The point of switch location for the diverging track is usually 0 + 00. All other turnouts leading to the same track are designated consecutively (2, 3, . . . ) in an order corresponding with increasing station location.
2. T: used to indicate that a turnout (rather than a track, track segment, or curve) is being identified.
3. Diverging track number: the track that the turnout diverges or leads into.

For example, 1TP indicates the first turnout leading into track P. Examples of turnout numbering are shown in Figure 8.

### Curves

A curve may reside in one or more track segments, depending on where the division between track segments occurs. Connecting curves (those that allow a track to run parallel to its originating track) are usually not designated as curves and are not included in the curve numbering sequence or curve inventory. Curves are numbered individually within track networks. Because there is no existing numbering system, all curves are numbered (Integer) C (Track number). This three-part number is established as follows.

1. Integer: the curves in each track are numbered beginning with 1 for the first curve encountered and continuing consecutively to the end of the track.
2. C: used to indicate that a curve (rather than a track, track segment, or turnout) is being identified.
3. Track number: the track that contains the curve.

For example, 1C1 indicates the first curve in Track 1. Examples of curve numbering are shown in Figure 9.

## INVENTORY

### Network Inventory

Inventory items include installation number, installation name, name of commercial railroad serving the installation,

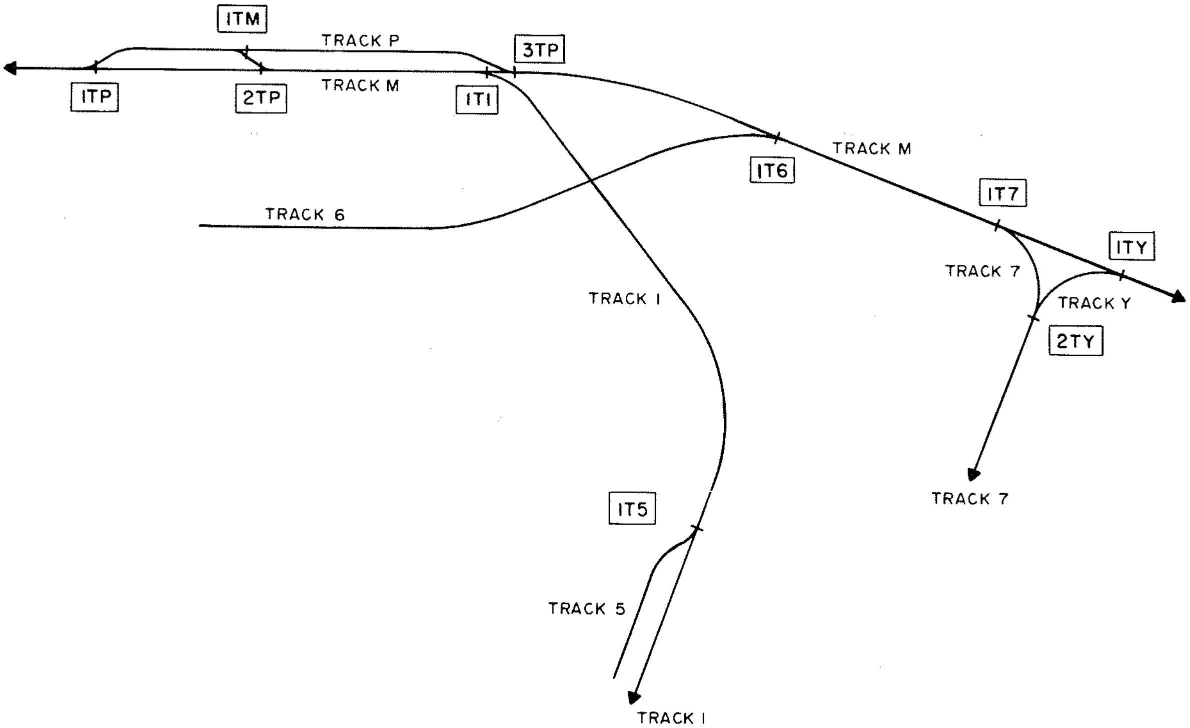


**FIGURE 8 Turnout numbering.**

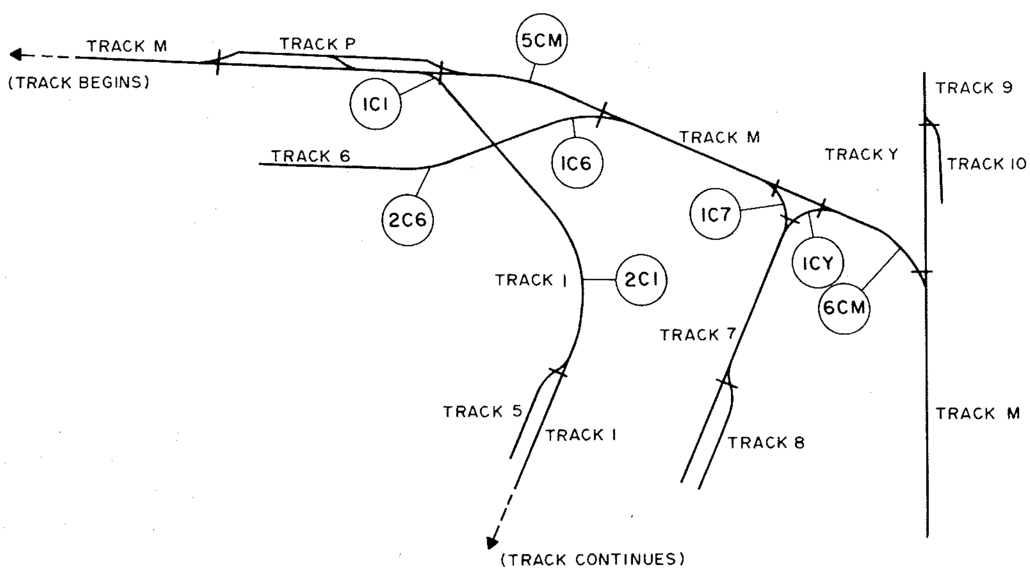


**FIGURE 9 Curve numbering.**

length of each track, and number of track segments for each track. This information uniquely identifies a given installation track network.

## Segment Inventory

The track segment inventory provides an identification and description of track and roadway components, as well as structures and facilities directly associated with a track segment.

Specific data elements for the following items are collected: segment identification, ballast, bridges, culverts, curves, plates and fastenings, rail, rail crossings, road crossings, and turnouts. Table 1 is a list of the data elements that represent minimal requirements for proper maintenance management. Of these, most are self-explanatory or have been previously discussed with the exception of track category, track rank, and preceding track segment number. These have been developed or modified specifically for U.S. Army usage and are discussed in the following list.

TABLE 1 RAILER I TRACK SEGMENT INVENTORY ELEMENTS

| Item No. | Description | Item No. | Description |
|---|---|---|---|
| Segment Identification | | 22. | Rail anchors (No./200 track ft) |
| | | 23. | Gage rods (no, yes) |
| 1. | Track segement number | 24. | Comments |
| 2. | Begin location (station) | Rail | |
| 3. | End location (station) | | |
| 4. | Track category | | |
| 5. | Track use | 25. | Weight (lb/yd) |
| 6. | Track rank | 26. | Section |
| 7. | Preceding track segment number | 27. | Begin location (station) |
| 8. | Comments | 28. | Comments |
| Ballast | | Rail Crossings | |
| 9. | Depth (in.) | 29. | Centerline location (station) |
| 10. | Comments | 30. | Crossing segment number |
| | | 31. | Rail weight (lb/yd) |
| Bridges | | 32. | Frog type |
| | | 33. | Crossing angle (degrees) |
| 11. | Facility number | | |
| 12. | Construction type | Road Crossings | |
| 13. | Deck type | | |
| 14. | Comments | 34. | Road name |
| | | 35. | Centerline location (station) |
| Culverts | | 36. | Crossing length (ft) |
| | | 37. | Crossing type |
| 15. | Centerline location (station) | 38. | Bolted joints (no, yes) |
| 16. | Comments | | |
| | | Turnouts | |
| Curves | | | |
| | | 39. | Turnout identification number |
| 17. | Curve identification number | 40. | Switch point location (station) |
| 18. | Curvature (degrees) | 41. | Direction (left hand, equilateral, right hand) |
| 19. | Maximum desired speed (mph) | 42. | Point length (linear ft) |
| 20. | Comments | 43. | Rail weight (lb/yd) |
| | | 44. | Frog type |
| Plates and Fastenings | | 45. | Frog size |
| | | 46. | Guard rail length (linear ft) |
| 21. | Tie plates (no, yes) | 47. | Comments |

- Track category: A or B. A for active track or track required to support mobilization. B for all other trackage.
- Track rank: A numerical relative value ranking derived analytically from other inventory data, used for priority ordering of work. (Its development, calculation, and use are beyond the scope of this paper.)
- Preceding track segment number: The track segment that a train must pass in order to travel on the current track segment as the train travels into the installation. This may be multiple when passing track or wyes precede current track segments. This information is used for priority ordering of work. (A description of its use is beyond the scope of this paper.)

## IMPLEMENTATION PROCEDURES

The following steps are used in identifying components and inventorying the trackage at specific installation networks as part of a RAILER implementation.

1. Determine initial track, turnout, and curve numbers. With the help of a map or track diagram, and information from someone familiar with the network, determine track, turnout, and curve numbers. This is done in the office.
2. Divide tracks into track segments. Divide each track into logical track segments, assign consecutive track segment numbers, and indicate track, track segment, turnout, and curve numbers on existing network maps or diagrams. This marked-up map will serve as a guide for the field work. This work is also performed in the office.
3. Verify track network and track use. When track, track segment, turnout, and curve numbers have been established, verify this information in the field, along with track uses, with the help of someone familiar with the network. This will ensure that all identification numbers and track uses are clear, logical, and accurate. Obtain the concurrence of the installation railroad maintenance manager.
4. Station the track. With the aid of an appropriate measuring device, such as a measuring wheel, station and

permanently mark each track at 200-ft intervals. Temporarily mark station locations at the track segment origins, turnouts, culverts, rail and road crossings, and bridge ends. As an alternative to temporary marks, the station locations can be immediately written on the track segment inventory forms.

5. Complete the inventory. Use the track segment inventory form (Figure 10) to complete the inventory for each segment. It is especially helpful when conducting the inventory to have the marked-up map present. As each segment is inventoried, it should be checked off on the map, thus ensuring that no omissions or duplications of segments occur. The map will also aid in identifying segments, turnouts, curves, and other items in the field.

6. Final acceptance. Check the inventory sheets for errors, consistency, and omissions, and correct as required. Load data into the RAILER data base. Prepare new station maps on which all segments and components are clearly identified. The inventory sheets should be checked daily and the maps should be redrawn when all inventory is complete.

## FIELD TESTS AND IMPLEMENTATION EXPERIENCE

The component identification and inventory procedures described have been field tested at Fort Belvoir, Virginia; Fort Devens, Massachusetts; and the Consolidated Rail Corporation (Conrail) yard in Urbana, Illinois. Full implementation has occurred at Fort Campbell, Kentucky; Fort Wingate, New Mexico; Fort Carson, Colorado; Camp

TRACK SEGMENT #: 1Ø1 RAILER I DATE: 4 FEB 87
INSTALLATION NAME: FT EXAMPLE TRACK SEGMENT INVENTORY INFORMATION

| SEGMENT IDENTIFICATION | | | | | | BALLAST |
|---|---|---|---|---|---|---|
| Begin Location (station) | End Location (station) | Track Category | Track Use | Track Rank | Preceding Track Segment Number (s) | Depth (inches) |
| 1 + 11 | 50 + 16 | A B | Acc Aux L Se St | | MØ8 | 14 |
| Comments: | | | | | | Comments: 6" LIFT IN 1973 |

| BRIDGES | | | CULVERTS | CURVES | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Facility Number | Construction Type | Deck Type | Centerline Location (Station) | Curve ID Number | Curvature (Degrees) 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Avg | Max Desired Speed (m.p.h.) |
| | | Open Ballast | 47+41 | 1C1 | | | | | | | | | 8 | 15 |
| | | Open Ballast | | 2C1 | | | | | | | | | 4.5 | 20 |
| Comments: | | | Comments: TWIN 36" CMP | Comments: CURVATURE DATA FROM "AS BUILT" DRAWINGS | | | | | | | | | | |

| PLATES/FASTENINGS | | | RAIL | | | RAIL CROSSINGS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Tie Plates | Rail Anchors (#/200 TF) | Gage Rods | Weight (lbs/yd) | Section | Begin Location (Station) | Centerline Location (Station) | Crossing Segment Number | Rail Weight (lbs/yd) | Frog Type | Crossing Angle (degree) |
| N Y | 80 | N Y | 90 | AS | 1 + 11 | 12 + 29 | 6Ø1 | 90 | B MI SM | 60 |
| N Y | | N Y | | | | | | | B MI SM | |
| N Y | | N Y | | | | | | | B MI SM | |
| N Y | | N Y | | | | | | | B MI SM | |
| Comments: | | | Comments: | | | Comments: | | | | |

| ROAD CROSSINGS | | | | |
|---|---|---|---|---|
| Road Name | Centerline Location (Station) | Crossing Length (feet) | Crossing Type | Bolted Joints |
| BRADLEY BLVD | 36 + 48 | 24 | TIMBER/ASPHALT | N Y |
| | | | | N Y |
| | | | | N Y |
| Comments: | | | | |

| TURNOUTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Turnout ID Number | Switch Point Location (Station) | Direction | Point Length (LF) | Rail Weight (lbs/yd) | Frog Type | Frog Size | Guard Rail Length (LF) |
| 1T5 | 49 + 28 | LH EQ RH | 13 | 90 | B SG RBM SP | 7 | 11 |
| | | LH EQ RH | | | B SG RBM SP | | |
| Comments: | | | | | | | |

**FIGURE 10 Track segment inventory form.**

Roberts, California; Camp Edwards, Massachusetts; and the Tooele Army Depot, Utah. Each site has served to improve the procedures and the data-gathering process to ensure efficient use of time and usefulness of data collected. The current version has been described in this paper.

The office work of identification numbering and segmenting was easily accomplished by one person. Accurate maps made the defining process quite simple. Inaccurate maps led to many revisions during the validation step.

For the field work it was found that a two-person crew works most efficiently and that two passes over the track are necessary to complete the stationing and inventory process. The first pass should serve to validate the segments and all assigned identification numbers. Track stationing can be easily accomplished concurrently. The inventory itself is best done during the second pass.

The stationing procedure must be accomplished with great care. To date, this has been accomplished with a measuring wheel. Different procedures were used including walking with the wheel on the rail, the wheel mounted to a track cart with the wheel on the rail, and the wheel mounted to a track cart with the wheel riding on the wheel of the cart. In some cases the cart was pulled or pushed manually, with a motor car, or with a locomotive. In general, all worked well, except walking with the wheel on the rail is slow. Accordingly, this should only be used for short tracks where it is inconvenient or impossible to use the other methods. When the measuring wheel is mounted on a cart, productivity can be 9 to 10 mi/day.

A problem encountered with measuring wheels is the inherent inaccuracy associated with them. The wheels used were checked against a steel tape and the error determined. Errors within 1 percent were accepted or the wheel was not used. Some had error as high as 5 percent. All station markings were taken to the nearest foot. This is a reasonable degree of accuracy for maintenance management purposes.

Different methods were employed for marking the stations in the field. Paint, lumber crayons, and metal plates nailed to ties were all used. The stamped metal plates (nailed to the nearest tie) worked best as far as permanency and ease of installation were concerned, but they were also the most expensive because of their manufacture. When paint or crayons were used, the station was written on the rail base. Paint could, at best, be considered semipermanent and crayon markings are considered temporary. The use of permanent markers is considered essential and saves time when locating track deficiencies later in the management process. Also, the marked stations made it possible to easily post flags or other temporary markers trackside every 1,000 ft to aid in location referencing when performing automated track geometry or rail flaw testing, or both.

The inventory itself was quick and easy to accomplish. Between 2 and 5 mi/day were covered depending on number of segments, variability of data elements, and whether the crew was riding or walking. The most time-consuming data element to collect was the determination of rail weight. U.S. Army rail is generally quite old (most was manufactured between 1880 and 1945), and rail brands can be difficult to read. Also, weights vary greatly and each time a pair of compromise joints is encountered the location (average station for staggered joints) must be recorded and the new weight recorded. This procedure, although a bit slow, is necessary to get an accurate compilation of the amounts of different weights present. Ballast depths were estimated on the basis of the knowledge of local personnel.

## CONCLUSIONS

Under field test and implementation conditions, the component identification and inventory procedures described worked well with few problems. The data required were not unreasonably difficult to collect and did not require extensive knowledge of railroad track. In general, the procedures, identification numbering, and inventory list were well received by the installation personnel tasked with the actual maintenance management of the track network.

## ACKNOWLEDGMENTS

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