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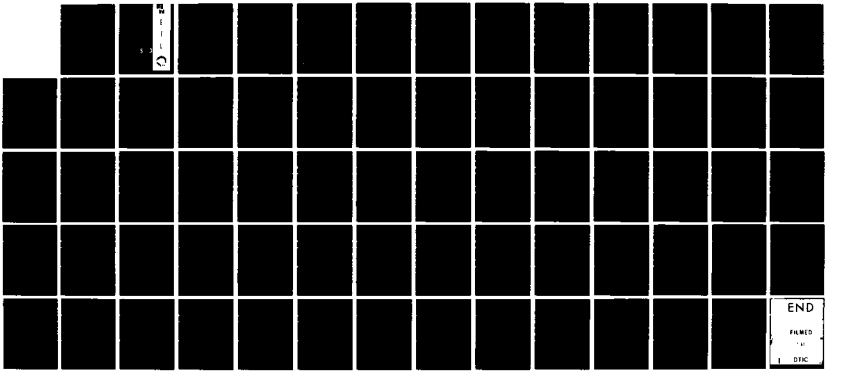

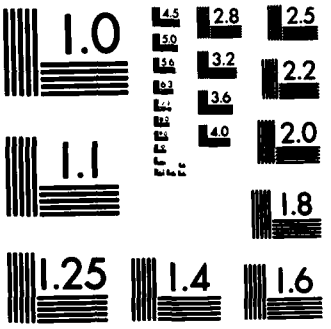

ETL-0311

Terrain analysis procedural guide for railroads

James Tazelaar

DECEMBER 1982

U.S. ARMY CORPS OF ENGINEERS
ENGINEER TOPOGRAPHIC LABORATORIES
FORT BELVOIR, VIRGINIA 22060

E T L

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PREFACE

This guide for railroads is one of a series of Analysis and Synthesis Guides to be produced. It is anticipated that after some modifications, the guides will be published as Department of Army manuals. For this reason, critical comments and suggestions are requested by the author.

The published guides in this series are

Number	Authors	Title	AD Number
ETL-0178	Jeffrey A. Messmore Theodore C. Vogel Alexander R. Pearson	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR VEGETATION (Report No. 1 in the ETL Series on Guides for Army Terrain Analysts)	AD-A068 715
ETL-0205	Theodore C. Vogel	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR ROADS AND RELATED STRUCTURES (Report No. 2...)	AD-A090 021
ETL-0207	James Tazelaar	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR GEOLOGY (Report No. 3...)	AD-A080 064
ETL-0220	Alexander R. Pearson Janet S. Wright	SYNTHESIS GUIDE FOR CROSS-COUNTRY MOVEMENT (Report No. 4...)	AD-A084 007
ETL-0247	Roland J. Frodigh	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR CLIMATE (Report No. 5...)	AD-A095 158
ETL-0254	Janet S. Wright Theodore C. Vogel Alexander R. Pearson Jeffrey A. Messmore	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR SOIL (Report No. 6...)	AD-A107 048
ETL-0263	James Tazelaar	SYNTHESIS GUIDE FOR LINES OF COMMUNICATION (Report No. 7...)	AD-A104 208
ETL-0285	Jeffrey A. Messmore	TERRAIN ANALYSIS PROCEDURAL GUIDE FOR DRAINAGE AND WATER RESOURCES (Report No. 8...)	AD-A118 318
ETL-0283	Robert A. Falls	SYNTHESIS GUIDE FOR OBSTACLE SITING (Report No. 9...)	AD-A118 347

This study was conducted under DA Project 4A762707A855, Task C, Work Unit 21, "Military Geographic Analysis Technology."

This study was done under the supervision of A.C. Elser, Chief, MGI Data Processing and Products Division; and K.T. Yoritomo, Director, Geographic Sciences Laboratory.

COL Daniel L. Lycan, CE and COL Edward K. Wintz, CE were the Commanders and Directors, and Mr. Robert P. Macchia was Technical Director of the Engineer Topographic Laboratories during this report preparation.

CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U.S. Customary Units of Measurement used in this report can be converted to metric (SI) as follows:

Multiply	By	To Obtain
inches	25.4	millimeter
feet	30.48	centimeter
miles	.6093	kilometer
pounds	0.4536	kilogram
ton, long	1.0160	metric ton
ton, short	0.9072	metric ton
gallon	3.785	liter
Fahrenheit degrees*	5/9	Celsius degrees, Kelvin

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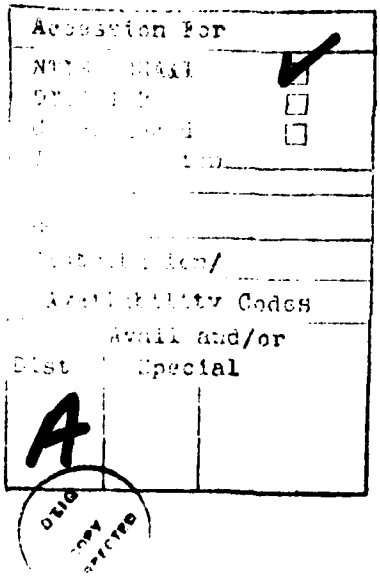
*To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula:

$$C = (5/9)(F-32)$$

To obtain Kelvin (K) readings, use formula:

$$K = (5/9)\ (F-32) + 273.15$$



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REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: ETL-0311	2. GOVT ACCESSION NO.: AD-A123452
	3. RECIPIENT'S CATALOG NUMBER:
4. TITLE (and Subtitle): TERRAIN ANALYSIS PROCEDURAL GUIDE FOR RAILROADS (Report No. 10 in the ETL Series on Guides for Army Terrain Analysts)	5. TYPE OF REPORT & PERIOD COVERED: Technical Report
	6. PERFORMING ORG. REPORT NUMBER: NA
7. AUTHOR(s): JAMES TAZELAAR	8. CONTRACT OR GRANT NUMBER(s): NA
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U.S. Army Engineer Topographic Laboratories, Fort Belvoir, VA 22060	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 4A762707A855 C 21
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Engineer Topographic Laboratories, Fort Belvoir, VA 22060	12. REPORT DATE: December 1982
	13. NUMBER OF PAGES: 63
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office):	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This document serves as a supplement to the Terrain Analysis Procedural Guide for Roads and Related Structures (ETL-0205, October 1979).

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Terrain Analysis
Military Geographic Information
Data Fields
Data Elements
Factor Overlays

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides U.S. Army Terrain Analysts with methods and procedures to produce railroad factor overlays and accompanying data tables from available sources such as maps, aerial photographs, and literature.

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TABLE OF CONTENTS

LIST OF FIGURES

TERRAIN ANALYSIS PROCEDURAL GUIDE FOR RAILROADS

I. INTRODUCTION

Railroads are the most important type of inland transportation in practically every country in the world. From the Military Geographic Information (MGI) standpoint this importance is due to the direct logistic support afforded military operations. As a highly desirable adjunct to extended military operations, railroads are of primary concern to personnel at the highest levels of command.

The present concept of warfare, with its emphasis on dispersal and the requirements for more and smaller rear installations, also lends importance to secondary and feeder railway lines.

Railroads naturally assume increased military importance in areas where the soils are generally untrafficable, roads are poor, and rail transportation facilities are extensive. Frequently railroads can be used as substitute roads for vehicles.

A. PURPOSE. The purpose of this guide is to provide terrain analysts with suitable procedures for collecting, analyzing, and recording information on railroads. This guide also serves as a supplement to the Terrain Analysis Procedural Guide for Roads and Related Structures (ETL-0205, October 1979). In sparsely inhabited study areas, railroad data may be combined with the roads and related structures factor overlay. The sources used include maps, aerial photographs, and where applicable, literature.

B. BACKGROUND. The first step in extracting data from source materials, reducing and recording it in the desired form, is the most laborious and time-consuming step in the production cycle. If, however, this step is performed by terrain analysts in advance and the data are maintained in a data base, the time required to respond to a production requirement can be greatly reduced. The factor overlay concept, a method of preformatting information for the MGI data base, is an eminently practical method of providing this information. Figure 1 shows the factor overlay concept for preformatting data in the form of factor overlays that are intermediate products intended primarily as tools for the terrain analyst and are not customarily distributed outside the MGI community.

Under this concept, data are extracted from various sources and recorded on a factor overlay(figure 2) and, if necessary, on supporting data tables (figure 3). In this report, only railroad data are considered. Accordingly, the information presented will address this data field only.

The railroad factor overlay and supporting data tables are used as input to generate factor-complex overlays that become the manuscripts for the special purpose products such as Lines of Communication (LOC) and other graphics.

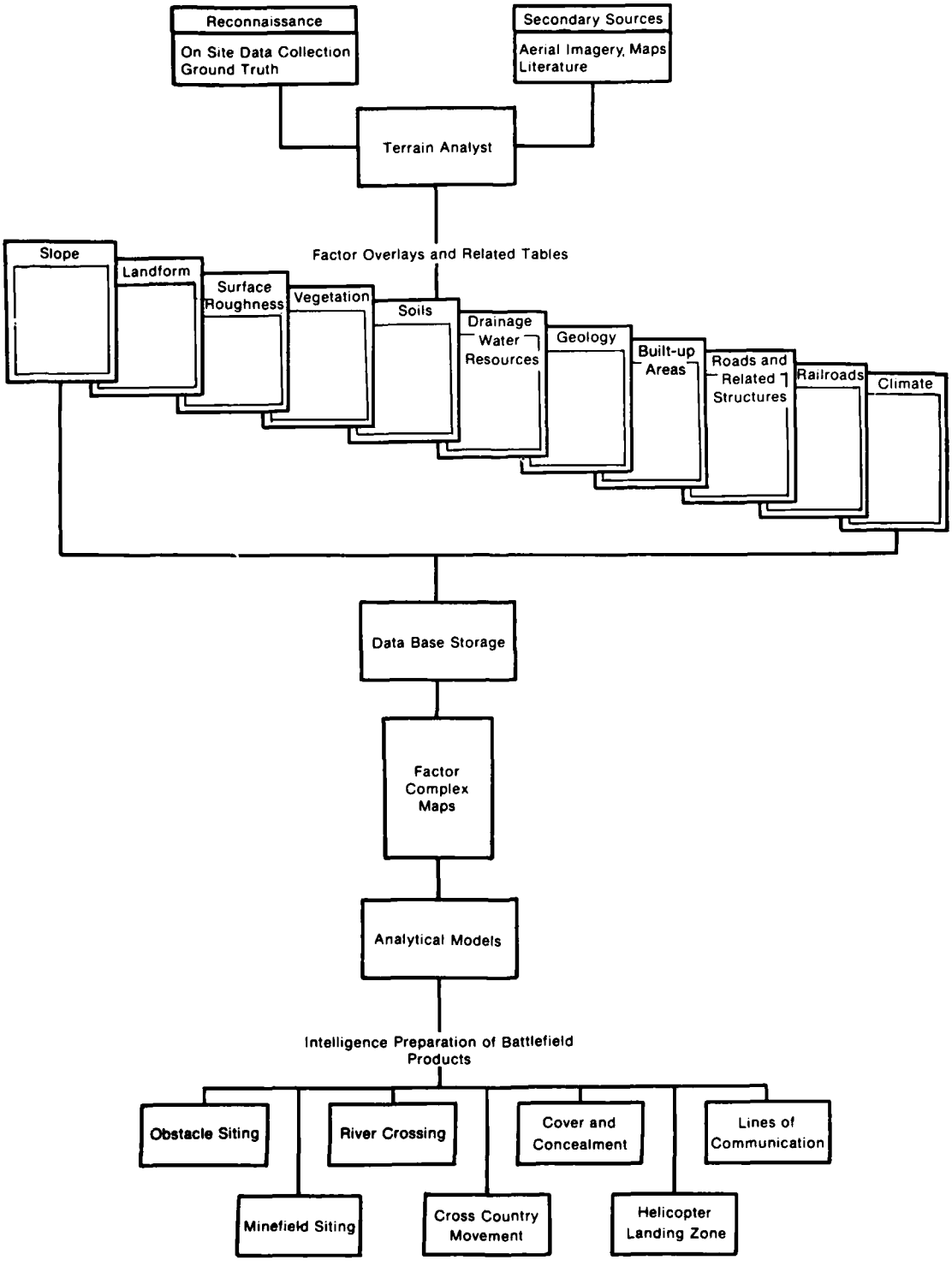

Figure 1. Production and Use of Factor Overlays and Data Tables.

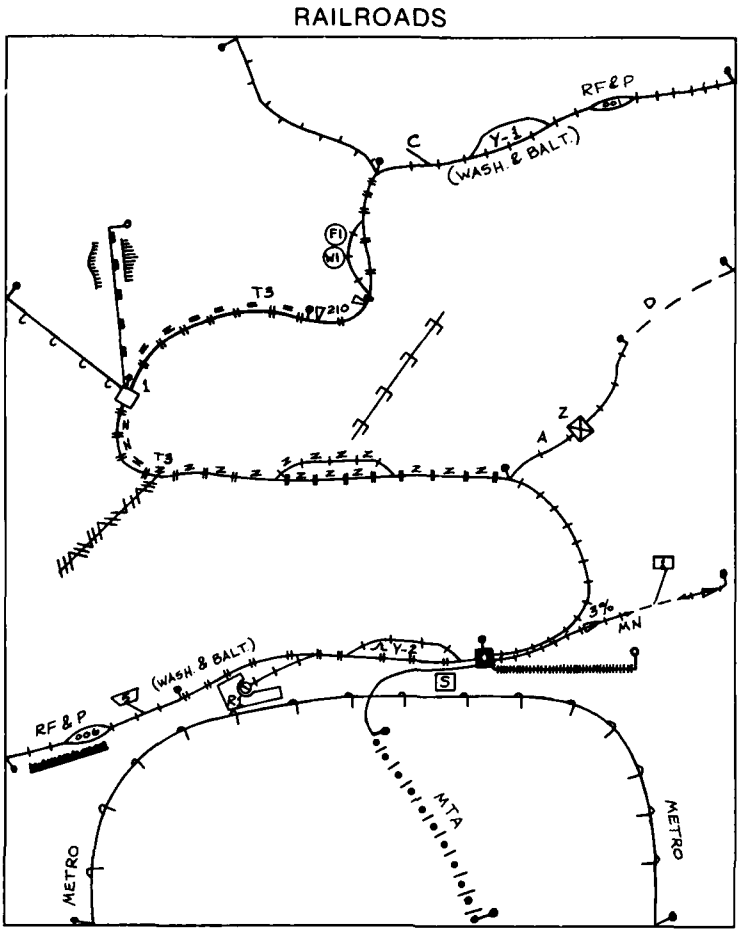

Figure 2. Sample Railroad Factor Overlay.

SCALE OF BASE MAP 1:50,000
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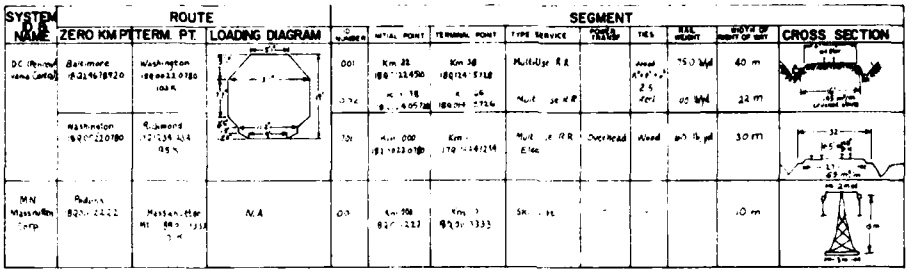
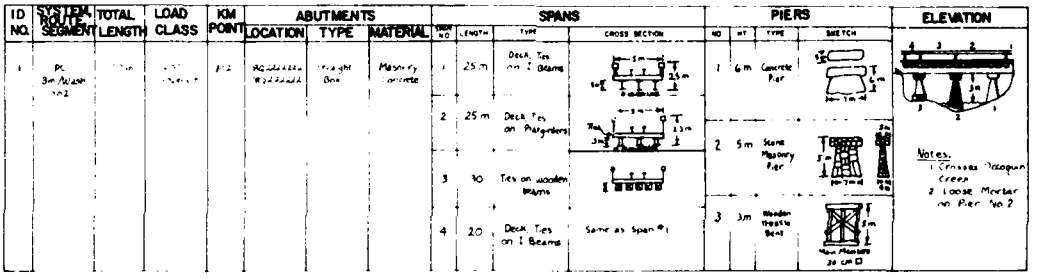
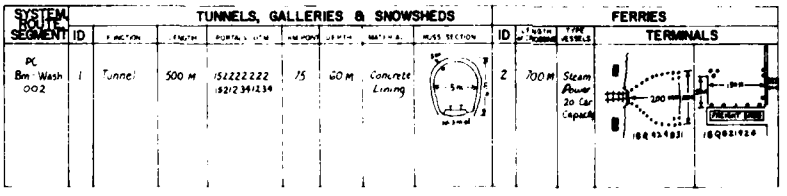
DATA TABLE 1 - TRACKAGE



DATA TABLE 2 - BRIDGES



DATA TABLE 3 - TUNNELS & FERRIES



DATA TABLE 4 - STATIONS, YARDS & FACILITIES

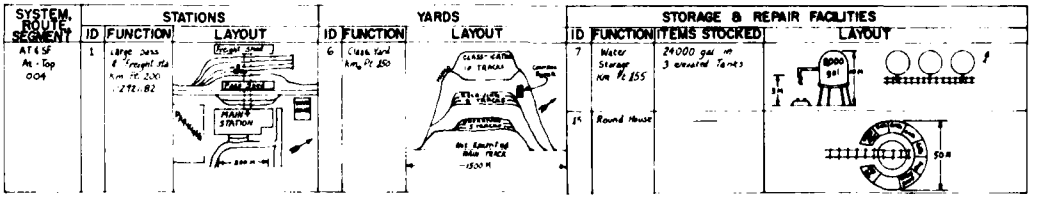


Figure 3. Sample Data Tables.

The railroad factor overlay with data tables becomes a part of the MGI data base mentioned previously. Generally, the amount and type of railroad data collected will depend on the analyst's training, amount of literature available (if any), the scale of the maps examined, and the availability of aerial imagery. Table 1 provides a partial list of railroad information that is generally shown on the factor overlay and data tables.

Table 1. Data Elements for Railroads - General.

System ID & End Points	Tunnels, Galleries, Snowsheds, Underpasses
Route ID & End Points	Ferries
Segment ID & End Points	Stations
Gage of Tracks	Yards
Number of Tracks	Maintenance & Repair Facilities
Maximum Gradients	Fuel & Water Storage Facilities
Radius of Curvature	Cuts & Fills
Bridges, Overpasses, Viaducts, Causeways	Special Railroads

The railroad data tables are comprehensive and list those data considered essential to railroad factor overlay preparation. If, for instance, information about a specific railroad bridge is available from Roads Data Table II - Bridges[1], it is added to Railroad Data Table 2. If the Built-Up Area factor overlays[2] and associated data tables have been compiled previously by analysts, railroad data for table entry and for factor overlay compilation can be extracted from the Built-Up Area products for the larger cities within the study area.

In general, three major sources of information are available that will be helpful in the production of factor overlays for railroads. These sources include tourist and government road maps; aerial and ground photography; and historical, technical and tourist literature. The technical literature includes all specifications and "as built" drawings that are produced after the construction of every railroad or related structure, regardless of country of origin. Even though some of these source materials are available through U.S. Government agencies, the best information can usually be obtained through direct contact with local governments and tourist bureaus.

C. MAPS. Current military topographic maps are the ideal source to use when starting the production of factor overlays for railroads. When maps are obtained from other sources, however, the map legends should be

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[1]Theodore C. Vogel, Terrain Analysis Procedural Guide for Roads and Related Structures, Engineer Topographic Laboratories, Fort Belvoir, VA 22060, ETL-0205, October 1979, AD-A080 021.

[2]Terrain Analysis Procedural Guide for Built-Up Areas, Engineer Topographic Laboratories, Fort Belvoir, VA 22060. Report in progress.

studied before being used as a source of information, since the scale, format, and symbology will vary with each publisher. When possible, these maps should be compared with the most recent aerial photography available to confirm their accuracy.

D. AERIAL AND GROUND PHOTOGRAPHY. Reconnaissance photography, including vertical and oblique aerial photographs, is an excellent source of information, particularly when ground access is denied or map sources are known to be out of date. Both vertical and oblique aerial photography acquired in a manner that permits stereo or three-dimensional viewing will enable the analyst to obtain fairly accurate measurements of railroads, including the physical condition of the rail lines and facilities.

E. LITERATURE. The terrain analyst will seldom be able to obtain suitable or useful written material about railroads. If, however, this material can be obtained, the analyst will find the Railroad Checklist (table 5, section III) to be very helpful in extracting pertinent data. The literature may include blueprints and drawings of station location, main and secondary tracks, yard capacities, details on grades, railroad company operation rules, and operating timetables.

Before proceeding further, the analyst should obtain and maintain for reference the following training manuals, field manuals, and texts:

TM S-1, "Specifications for Military Maps," Defense Mapping Agency, Topographic Center, Vol. I and Vol. II, 1973.

PS/3AA/101, "Product Specifications for 1:50,000 Scale Topographic Maps of Foreign Areas," Defense Mapping Agency, First Edition, July 1980.

TM 5-248, "Foreign Maps," Headquarters, Department of Army, 1963.

TM 5-312, "Military Fixed Bridges," Headquarters, Department of Army, Corps of Engineers, Army Map Service, Vol. I and Vol. II, 1973.

TM 30-245, "Image Interpretation Handbook," Vol. I, Departments of Army, Navy, and Air Force, 1967.

FM 5-36, "Route Reconnaissance and Classification," Headquarters, Department of Army, 1970.

FM 21-26, "Map Reading," Headquarters, Department of Army, 1969.

FM 21-33, "Terrain Analysis," Headquarters, Department of Army, 1978.

FM 30-10, "Military Geographic Intelligence (Terrain)," Headquarters, Department of Army, 1972.

FM 21-31, "Topographic Symbols," Headquarters, Department of Army, 1961.

EIG 29, "Collection of Information on Railroads," Department of Army, September 1959.

DMS 216, "Railroads," (Student Pamphlet), Department of Defense, October 1977.

SupR 62800, "Imagery Interpretation, Entry Zones and Lines of Communication," Department of Army, August 1976.

Interpretation of Aerial Photographs, 2nd Edition, T.E. Avery, Burgess Publishing Company, Minneapolis, Minnesota, 1968.

II. PROCEDURAL OUTLINE

The approach used in preparing this Terrain Analysis Procedural Guide for Railroads has been to assume that 1:50,000 scale topographic map coverage(U.S. Military or foreign) is available to the terrain analyst, and that the analyst can obtain pertinent aerial photography. Because of the problems in determining the amount, type, and availability of source materials other than these most commonly used sources, this section of the procedural guide provides instructions for obtaining railroads data from only these two sources.

An excellent survey of the data elements encountered in the interpretation of railroads and facilities is presented in the following paragraphs excerpted from the U.S. Army Intelligence Center and School's Imagery Interpretation supplemental manual. It provides a broad overview of the components and functions of most railroads, domestic and foreign.

"It is necessary to consider those facilities that are required for carrying out the railroad's basic mission, the movement of passengers and freight. Railroad facilities can conveniently be divided into three basic groups: routes, yards and terminals, and vehicles or rolling stock.

ROUTES are the facilities of a railroad over which passengers and freight are moved between places. Route components include the roadbed, rails and ties, bridges, tunnels, signaling devices, and control equipment. The complexity of routes may vary from the multitrack installations commonly used between large, closely-spaced cities to the hastily improvised single-track line used for forward military operations.

YARDS AND TERMINALS represent the fixed points in the network of railroad facilities at which passengers and freight are loaded and unloaded. The activities at yards and terminals can be classified as passenger and freight handling, vehicle handling, and vehicle service and repair. Passenger handling includes accommodating incoming and departing passengers, loading and unloading mail and baggage, and servicing and repairing passenger vehicles. Freight handling includes loading, unloading, storing, transloading, and transshipping commodities of all types. Vehicle handling includes the making up and disassembling of trains and special operations such as rail ferrying. Service and repair activities include the servicing, repairing, and maintenance of freight cars and locomotives. It should be apparent that although the handling of passengers and freight is of primary importance in yards and terminals, such activities as service and repair are necessary to support the primary operation.

ROLLING STOCK forms the third group of railroad facilities. It can be classified according to use as passenger, freight, military, or special purpose. Passenger and freight vehicles are used to perform the basic mission of the railroad. Military vehicles can be passenger or freight

vehicles that have been adapted for military use, or can be specially designed to handle a specific type of military materiel, such as a railroad gun. Special purpose vehicles include snowplows, railroad cranes, tracklayers, right-of-way weeders, and so forth."

General procedures for a topographic map analysis and photo analysis are briefly outlined in paragraphs A and B as follows:

A. TOPOGRAPHIC MAP ANALYSIS - GENERAL.

By careful map analysis the terrain analyst can obtain many of the railroad data elements listed in table 2. For a satisfactory analysis, however, additional data identified in table 1 are usually required. These additional data are generally obtained from aerial photo and/or literature analysis.

Table 2. Railroad Data Elements - Maps

Data Elements	Comments
Routes	Single track, multitrack. Map legend often very helpful. Bridges, tunnels, many crossings are usually shown. Culverts need estimating.
Yards	Location by UTM or geographic coordinates. Configuration and classification, depending on scale of map. Repair areas, depending on map scale.
Critical areas	Rock cuts, slide-prone sections, tunnels, bridges.

The information obtained is penciled onto the railroad base mylar (factor overlay) and/or onto the data tables.

The terrain analyst is encouraged to obtain as much data as possible from the map before proceeding to obtain additional data elements from aerial photos. The benefits to the analyst are (1) it provides a needed familiarity with the map sheet, (2) it will later aid in locating those areas of the map that require updating, and (3) the map information will assist the interpretation of the aerial photos.

Although procedures for obtaining data element information from both map and aerial photo source materials are contained in this section of the procedural guide, it is understood that not all of the data required can be obtained from these sources. Other sources, including on-site information, may have to be employed. Although the terrain analyst is encouraged to seek out and use all sources of information about railroads, it is important to use the data at hand to produce the factor overlay, realizing that it will have to be updated as more information becomes available.

B. AERIAL PHOTO ANALYSIS - GENERAL.

The steps required to analyze aerial photos for their railroad content are listed below. The data derived from the analysis are penciled onto the base mylar and/or onto the railroad data tables.

Table 3. Checklist of Photointerpretation Tasks for Railroads.

1. Assemble railroad coverage.
2. Determine route components: roadbed, rails, ties, gage, bridges, tunnels, crossings, galleries, snowsheds.
3. Determine yard types: marshalling, freight.
4. Determine terminal types: passenger, freight (including transfer and/or storage).
5. Determine electrical system, if applicable.
6. Determine rolling stock.
7. Determine miscellaneous facilities.

Because engineering design and construction principles are universal, railroad facilities throughout the world look much alike. There are, however, regional variations that the image interpreter should be familiar with. Routes and vehicles in particular may vary from one geographic region to another. Railroad routes have definite characteristics that enable the terrain analyst to distinguish them from roads and highways on reconnaissance imagery. Some of these characteristics are:

Long smooth curves - there are no angular bends on railroad routes.

Cuts and fills - to keep the track as level as possible because of the difficulty trains have in negotiating excessive grades. Rolling terrain leads to the blasting of cuts, the construction of fills, and the drilling of tunnels to maintain a fairly level route.

Railroad routes follow a contour line course to avoid excessive gradient - railroads seldom have more than 3 or 4 percent gradient.

There will be very few houses or other buildings along the right-of-way of a rail line except possibly within the city limits of larger cities.

The presence of very long, straight line segments is a very distinctive feature of railroad routes and is extremely useful in distinguishing them from other forms of transportation or communication routes.

Crossings, such as roads or highways and rivers and canals, may pass over or under a railroad route to allow uninterrupted traffic movements on both routes. Where roads cross railroad tracks at grades, images of individual tracks are often discernable at the crossings where the tone of the railroad route is changed.

Railroad bridges are usually much narrower than the approaches, which are frequently located on a fill or in a cut. The absence of continuous flooring on many such bridges makes them appear much narrower than they actually are.

The next section, Analysis Procedures, describes steps required by terrain analysts using map analysis and/or aerial photography analysis to obtain data element information for a railroad factor overlay and for supporting data tables.

III. ANALYSIS PROCEDURES

A. MAP ANALYSIS.

Step 1. (a) Review the indexes to the data files and withdraw the source materials dealing with your area and topic of interest. These materials should include the current 1:50,000 scale map, large scale photography, existing road and bridge maps, studies, image interpretation reports, reconnaissance reports, and existing factor overlays and data tables for built-up areas, ports and harbors, and roads and related structures.

(b) Review the sources and determine whether they are adequate for the generation of the overlay. If they do not provide sufficient detail or coverage of the area, initiate action to collect additional materials, and start your analysis with the material on hand.

Step 2. Fasten the draft working copy of the railroad factor overlay over a clean copy of the 1:50,000 scale map. Check registration ticks at each of the four map sheet corners. Although it is not essential, it may be helpful at later stages if the map sheet neatlines and the 10,000-meter grid lines are traced lightly in pencil. Add the map sheet name and number and other required marginal information.

Step 3. Locate all major cities, towns, and built-up areas on the map sheet. Trace their outline onto the overlay with a soft pencil, and label with the proper name. Small towns or villages located at road intersections or along roads should also be outlined and labeled with the proper name. Obtain the village name and symbol from the map.

Step 4. Examine the map and legend. (Appendix F is designed to assist terrain analysts in extracting useful railroad data elements from USSR and FRG topographic maps.) From the legend determine the track route, gages (table 4), and locations of bridges, facilities, and crossings. Tunnels and spurs as well as suspected crossings are to be noted.

Step 5. Start tracing the alinement of the railroad across the entire sheet with a soft pencil. Continue this process until all railroad trackage has been traced onto the overlay. Where the tracks intersect with a built-up area continue the railroad tracing through the area. Mark lightly all pertinent features such as bridges, tunnels, and crossings.

Step 6. If the sheet shows a track siding, trace it to its end. Measure the length in meters of the siding and record on the overlay. If the siding has a building or facility indicated (or suspected), trace its location; annotate. Sometimes certain facilities may provide electrical tracks for their privately-owned siding or spur. It could also happen that the trackage becomes multiple along the siding or spur; the analyst must note this on the overlay.

Table 4. Gage Table for MGI Railroad Terrain Analysis.

Principal Railroad Gages of the World			
Gage	Width		Location
	English Units	Metric Units	
Broad (>1.435m)	5'6"	1 676m	Argentina, Ceylon, Chile, India, Pakistan, Portugal, Spain
	5'3"	1 600m	Brazil, Ireland, So Australia, Victoria
	5'	1 524m	Finland, Panama, U S S R
	4'9¼"	1 45m	Algeria
	4'8½"	1 44m	France, Tunisia
Standard (= 1.435m)	4'8½"	1 435m	Alaska, Algeria, Argentina, Canada (except Newfoundland) Chile, China, Cuba, European continent (except Spain), Finland, Great Britain, Iran, Iraq, Jamaica, Korea, Lebanon, Mauritius, Mexico, Morocco, New So Wales, Paraguay, Peru, Portugal, Saudi Arabia, Syria, Trinidad, Turkey, U A R, U S S R, U S, Uruguay
Narrow (<1.435m)	3'6"	1 067m	Angola, Chile, Republic of the Congo, Costa Rica, Ecuador, Formosa, Ghana, Haiti, Honduras, Indonesia, Japan, Malawi, Mozambique, Newfoundland, New Zealand, Nicaragua, Nigeria, Northern Territory (Australia), Philippines, Queensland, Republic of So Africa, So Australia, Southern Rhodesia, Republic of the Sudan, Sweden, Tasmania, West Africa, Western Australia, Zambia
	3'5⅜"	1.05m	Algeria, Jordan, Syria
	3'3¾"	1 00m	Algeria, Argentina, Bolivia, Brazil, Burma, Cambodia, Chile, China, Columbia, East Africa, Ecuador, Ethiopia, Greece, India, Iraq, Malaysia, Pakistan, Paraguay, Portugal, Spain, Surinam, Switzerland, Thailand, Tunisia, U A R, Vietnam, West Africa, Yugoslavia
	3'1⅛"	0 95m	Eritrea, Italy
	3'	0 914m	Columbia, El Salvador, Guatemala, Ireland, Mexico, Panama, Peru, Spain
	2'11"	0 891m	Sweden
	2'6"	0 762m	Bulgaria, Ceylon, Chile, Formosa, India, Nigeria, Pakistan, Sierra Leonne, Yugoslavia
	2'5⅝"	0 750m	Argentina, Ecuador, Turkey, U A R
	2'	0 610m	India, Republic of So Africa, Venezuela
	1'11½"	0 60m	Algeria, Bulgaria, Chile, Indonesia

Step 7. Wherever the route crosses a stream or creek the analyst must note on the overlay the possibility of a culvert. The same is true of all road or highway crossings; these must be identified on the overlay in pencil and the proper symbol used.

Step 8. Rarely will a railroad grade exceed 3 percent. If the contour interval should suggest a greater gradient, the analyst should note this on the overlay. A slope overlay may be available with the surface configuration overlays if they have been compiled previously. The Terrain Analysis Procedural Guide for Surface Configuration[3] should be referred

[3]Olin Mintzer, Terrain Analysis Procedural Guide for Surface Configuration, Engineer Topographic Laboratories, Fort Belvoir, VA 22060. Report in progress.

to for instructions in determining percent of slope.

Step 9. Locate all railroad cut and fill areas; many will be suspected. Much of this data will be deleted from the final overlay; your draft overlay will be the only record. Cuts are potential railroad traffic interdiction sites because of the possibility of slides induced by demolition of steep side slopes. The analyst should carefully study the terrain adjacent to the potential slide/cut area and mark it along the route.

Step 10. As the analyst familiarizes himself with the route it may occur to him to distinguish segments along the route. If so, determine the beginning and the end of each segment. Determine the UTM or geographic coordinates for each. This data is lightly penciled onto the overlay; a simple symbol is used to mark the end points. For instance, where a major route split occurs or a major siding starts, the analyst should note it initially with the appropriate symbol.

Step 11. Railroad bridges are normally symbolized on topographic maps. Unfortunately, the type of bridge or construction material is seldom stated. The analyst, however, must locate all highway bridges that intersect the railroad route and, of course, all railroad-carrying bridges. Draw the bridge symbol on the overlay adjacent to the site (see table A1, Appendix A for symbol information). Because this analysis is only for railroads, road bridge data will not be a concern. It will be handled during the analysis of roads and related structures. Normally, the only railroad bridge data obtainable from topographic map analysis is bridge length when plotted to scale on the map. An initial measurement in meters is noted beside the symbol and placed in brackets by the analyst. Assign each railroad bridge an ID number. This and any other relevant bridge data marked on the overlay can be transferred to Railroad Data Table 2 (figure 3).

Step 12. The map legend or even the map area itself may have printed data labeling various railroad facilities, e.g., water tower, switching pit, etc. These are to be marked on the overlay for transfer to the data table.

B. AERIAL PHOTOGRAPHY ANALYSIS

The preceding section described steps required by the terrain analyst to prepare a railroad factor overlay and supporting data tables, using map analysis techniques. The following paragraphs describe photo analysis steps required by terrain analysts to supplement and update this map-derived railroad factor overlay and supporting data tables.

By careful photo analysis the terrain analyst can greatly improve the working draft of the railroad factor overlay, especially by providing details on yards, terminals, and rolling stock (figure 4). Terrain analysts need to know about regional or national variations in railroad gages. (The gage of a railroad is the distance between the inner sides of

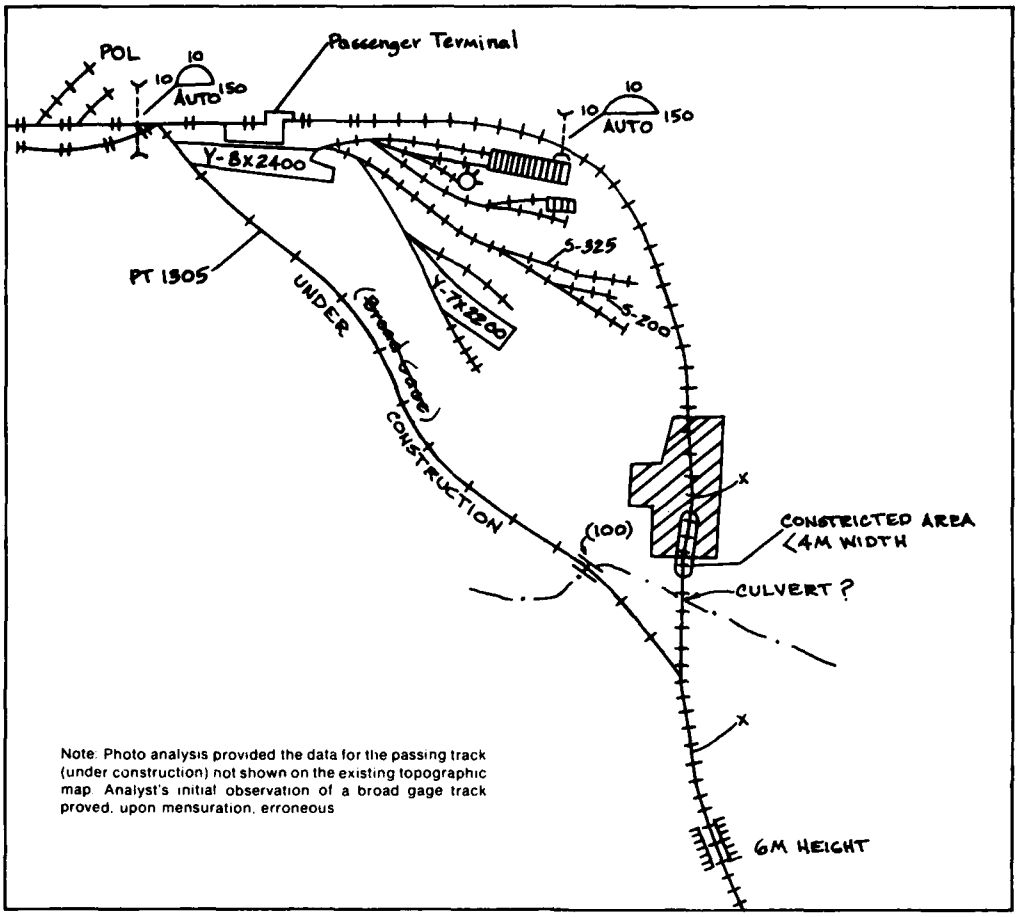

Figure 4. Working Draft of a Railroad Factor Overlay.

the rails on a running track.) Throughout Canada, U.S.A. and most of Europe the standard gage is 1.435 meters. A gage of 1.524 meters or wider, however, is found in U.S.S.R., Iceland, Finland, and Spain. A narrow gage of 1.00 meter is found frequently throughout Latin America. The use of narrow gage is usually limited to mountainous areas, industrial areas, mines, logging areas, supply dumps, and coastal defense areas. Many of the countries that were using narrow gage rail lines are now adopting the standard gage of 1.435 meters because of their imports of U.S.-made rolling stock.

Problems of mensuration, e.g., heights of embankments or tunnel dimensions, or the difficulties of bridge identification are treated in ETL Report 0205.[4] Other photo mensuration techniques are documented in TM 30-245, "Image Interpretation Handbook," Volume I, Department of the Army, Navy, and Air Force, 1967. Photo analysis of rolling stock is treated in the U.S. Army Intelligence Center and School's supplemental manual dated 1976. Terrain analysts are encouraged to examine these documents.

Step 1. Locate and assemble large scale photography of the area. Organize the photos in sequence within each flight line. See ETL Report-0178 for the procedure for mosaicking aerial photos. Make sure there is complete coverage of the map sheet. If oblique photos are available, include them in the collection.

Step 2. Compare the date of the photographs with the date of the last map revision or update. If the photographs are more recent than the map, the photographs should be used. If the map is more recent, greater weight should be given to the map information. However, even if the map is more recent, it should not always take precedence over the photographs. One reason for this is that map information is often generalized; as a result, some features such as sidings are not shown.

Step 3. Determine the scale of the aerial photos. Refer to ETL Report-0205 for the methods of determining aerial photography scales. Orient each photo in sequence and compare with the map sheet. Look for any railroad sidings that are not shown on the map. Compare the outline of all built-up areas on the photos with the map symbolization of the same areas. With the overlay registered to the map, carefully sketch any new alinements or built-up areas onto the overlay with a soft pencil.

Step 4. Study by segment each railroad route. Verify the location of segment end points. If the end points determined from the photo differ from those obtained from the map, use those points obtained from the photos. Relocate the end point symbols on the overlay, renumber the segments if necessary, and determine the coordinates of the relocated points. Change entries in the railroad data tables if necessary.

Step 5. Verify the gradient of each segment that has a grade of 3 percent or greater.

Step 6. Examine those areas on the aerial photography where the map indicates the presence of a culvert or a stream passing beneath the railroad.

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[4]Theodore C. Vogel, Terrain Analysis Procedural Guide for Roads and Related Structures, Engineer Topographic Laboratories, Fort Belvoir, VA 22060, ETL-0205, October 1979, AD-A080 021.

Check these areas to verify the location of a culvert. Also check all areas on the photography where a stream or drainageway intersects a railway. If there are indications of culverts in these areas, annotate the overlay at each of these locations. Make notes in the data tables as necessary.

Step 7. Verify on the aerial photography all road cut or fill areas that are indicated on the map sheet. Be sure to locate the cuts and fills along any new railroad alinement which may have been added to the overlay from the photography. Verify the height (cut) and depth (fill) of each feature. Add these data in pencil to the overlay and to the data tables.

Step 8. Locate the aerial photos of the built-up areas that are shown on the map sheet and orient for stereo viewing. Carefully follow the railroad through-routes through each built-up area on the photos. Locate any zones where buildings, walls, etc. constrict the width of the route to less than 4 meters. Measure these constrictions, and record the data on the overlay in the proper place.

Step 9. Stereoscopically examine all areas previously identified as level crossings. Verify these and make additions, deletions, or changes on the factor overlay as required.

The clearance beneath the catenary is required only if the railroad under study is electrified and uses overhead wires. The catenary clearance is seldom shown on maps. Photos may provide some indication of catenary clearance. If not, place a question mark above the crossing on the overlay to indicate that there are overhead wires but the clearance is unknown.

Step 10. Assemble the vertical photos that provide stereo coverage for each bridge recorded on the factor overlay. If oblique photos are available, place them with the vertical ones. Study the material carefully to become familiar with the general characteristics of the bridge. See ETL Report-0205[5] for an excellent description of various bridges. Determine the number of spans, overhead clearance, etc. Measure the roadbed widths. All data are to be recorded in Railroad Data Table 2 or on the overlay by annotated symbol.

Step 11. Because the variety of rolling stock is too great to be discussed in this report the reader is referred to the treatment found in the U.S. Army Intelligence Center and School Booklet, Imagery Interpretation, SupR 62800, dated August 1976.

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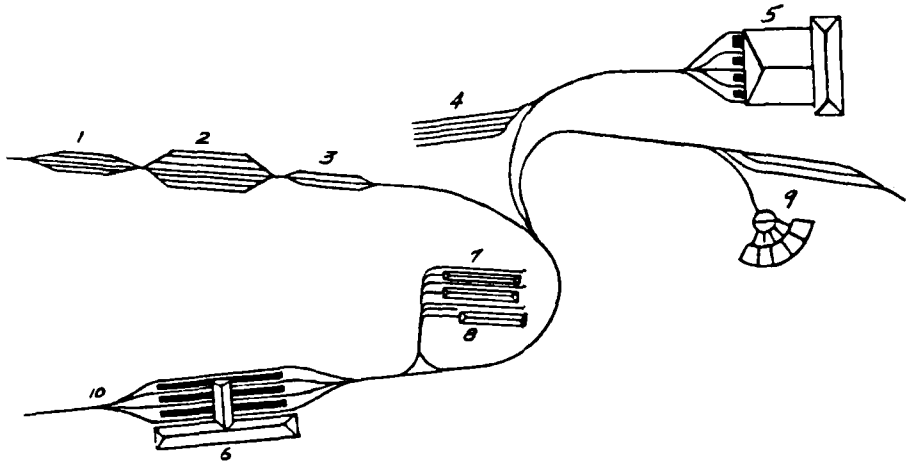
[5]Theodore C. Vogel, Terrain Analysis Procedural Guide for Roads and Related Structures, Engineer Topographic Laboratories, Fort Belvoir, VA 22060, ETL-0205, October 1979, AD-A080 021.

Step 12. The railyards associated with railroads are primarily the receiving, classification, forwarding, and holding yards. These terms are self-explanatory. For purposes of air photo analysis, however, figure 5 shows the general expression of these yards. For a detailed treatment see the reference in step 11.



LEGEND

1. Receiving Yard
2. Classification Yard
3. Forwarding Yard
4. Holding Yard
5. Terminal Passenger Station
6. Through Passenger Station
7. Freight Yards
8. Freight Station
9. Service and Repair Areas
10. Choke Point

Figure 5. Schematic Diagram of Representative Railroad Yards/Features.

Step 13. Within a railyard there are numerous rail facilities, e.g., passenger terminals, freight terminals, transfer stations, and storage areas. Careful air photo analysis will reveal their identity, capacity, etc. See the reference in step 11 for a discussion of these facilities.

C. LITERATURE ANALYSIS.

The following table is modified from FM 30-10 and is included to help analysts evaluate their source materials for railroads. A quick once-over before reading available literature enables the terrain analyst to easily recognize the more important data. When deemed relevant, these are added to the data tables.

Table 5. Checklist for Railroads.

1. Identification: Native, Military, or Other; and Segment Being Studied.
2. Location:
   a. Map Reference — Series and Sheet Number(s).
   b. End Points of Segment — UTM and Geo Coord.
3. Ownership:
4. Total Track Length: Double and Single Tracks in Km.
5. End Points of Double Track Sections.
6. Track:
   a. Gage (millimeters).
   b. Rails.
   c. Roadway (total width and double or single track).
7. Roadbed.
8. Subballast.
9. Ballast.
10. Spacing of Tracks.
11. Ties.
12. Radius of Tightest Curve.
13. Maximum Grade.
14. Bridges.
15. Ferries.
16. Tunnels, Galleries, and Snow Sheds.
17. Underpasses.
18. Minimum Clearances.
19. Axle Load Limit.
20. Culverts.
21. Electrification:
   a. End Points of Electrified Sections (UTM).
   b. Power Feed (Overhead or Third Rail).
   c. Current Characteristics (AC or DC).
   d. Source of Power.
22. Mainline Junctions.
23. Crossovers.
24. Passing Sidings.
25. Stations:
   a. Location.
   b. Function.
   c. Facilities.
26. Freight-Handling Facilities.
27. Yards.
28. Repair Shops/Locomotive Terminals.
29. Fuel Facilities.
30. Watering Facilities.
31. Signals and Train Control.
32. Critical Points:
   a. Type (points subject to rock slides, snow slides, and flooding or subject to interdiction and ambush).
   b. Location.
33. Use: Average Number of Trains Per Day.
34. Sections in Need of Repair.
35. Construction, Maintenance, and Repair Equipment.
36. Maintenance Schedule.
37. Planned Extension and Improvements.
38. Maintenance and Construction Standards.
39. Safety and Security Features.
40. Rolling Stock.

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APPENDIX A. SPECIFICATIONS FOR PREPARING RAILROAD FACTOR OVERLAYS.

I. INTRODUCTION.

A. The purpose of this appendix is to specify the methods of recording the results of the railroad analysis in the form of factor overlays and data tables.

B. The railroad factor overlays will consist of two parts: (1) an overlay registered to a standard 1:50,000 scale map and (2) data tables describing feature conditions shown on the overlay.

C. In congested areas, the basic 1:50,000 scale overlay may be supplemented by overlays registered to larger scale maps. Where the larger scale supplements are used, the area covered by the supplement will be outlined and identified on the basic overlay.

D. Where a standard 1:50,000 scale map is not available as a base for the overlay, a base map at another scale may be used. If it exceeds 26 by 34 inches, the base map will be subdivided and two or more overlays prepared.

E. The data tables will be prepared on material of the same type and size as the overlay.

F. Normally, not all data required by these specifications will be available during the initial preparation of a factor overlay. However, lack of complete data should not preclude preparation of the overlays. The factor overlay concept envisions the systematic recording of data as it is acquired and the accumulating of data through frequent revision and update.

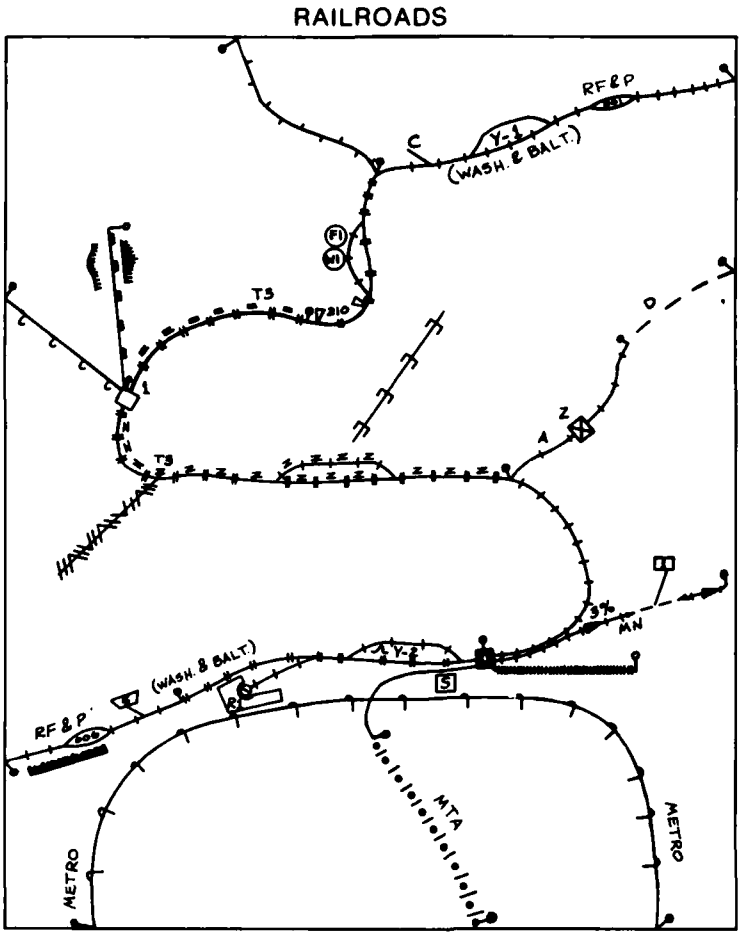
II. RAILROAD FACTOR OVERLAY.

A. An example of a factor overlay is shown in figure A1. Specifications for the format of the overlay are provided in figures A2 and A3. Figure A4 illustrates the format of Data Tables 1 through 4.

B. The symbols to be used on the railroad factor overlays are contained in table A1. Positioning of the symbols should conform with mapping standards. Where the symbols cannot be positioned with mapping accuracy because of deficiencies in the source material, the actual accuracy will be clearly specified in the coverage diagram or reliability statement.

C. System ID and end points (Symbols 1 & 2):

a. A railroad system is defined as that network of railroads operated by a single management entity, governmental or corporate. Examples are the Richmond, Fredricksburg and Potomac (RF&P), and



LEGEND

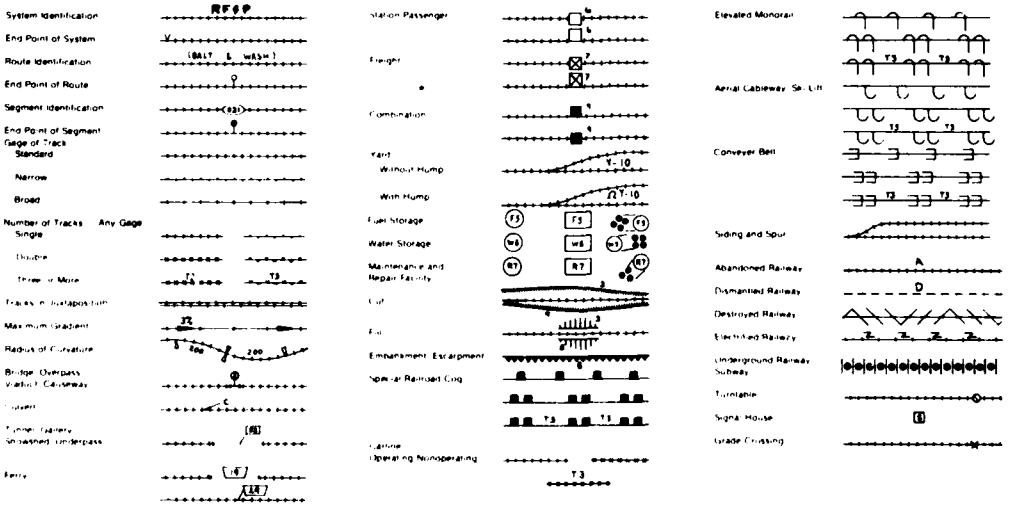


Figure A1. Sample Railroad Factor Overlay.

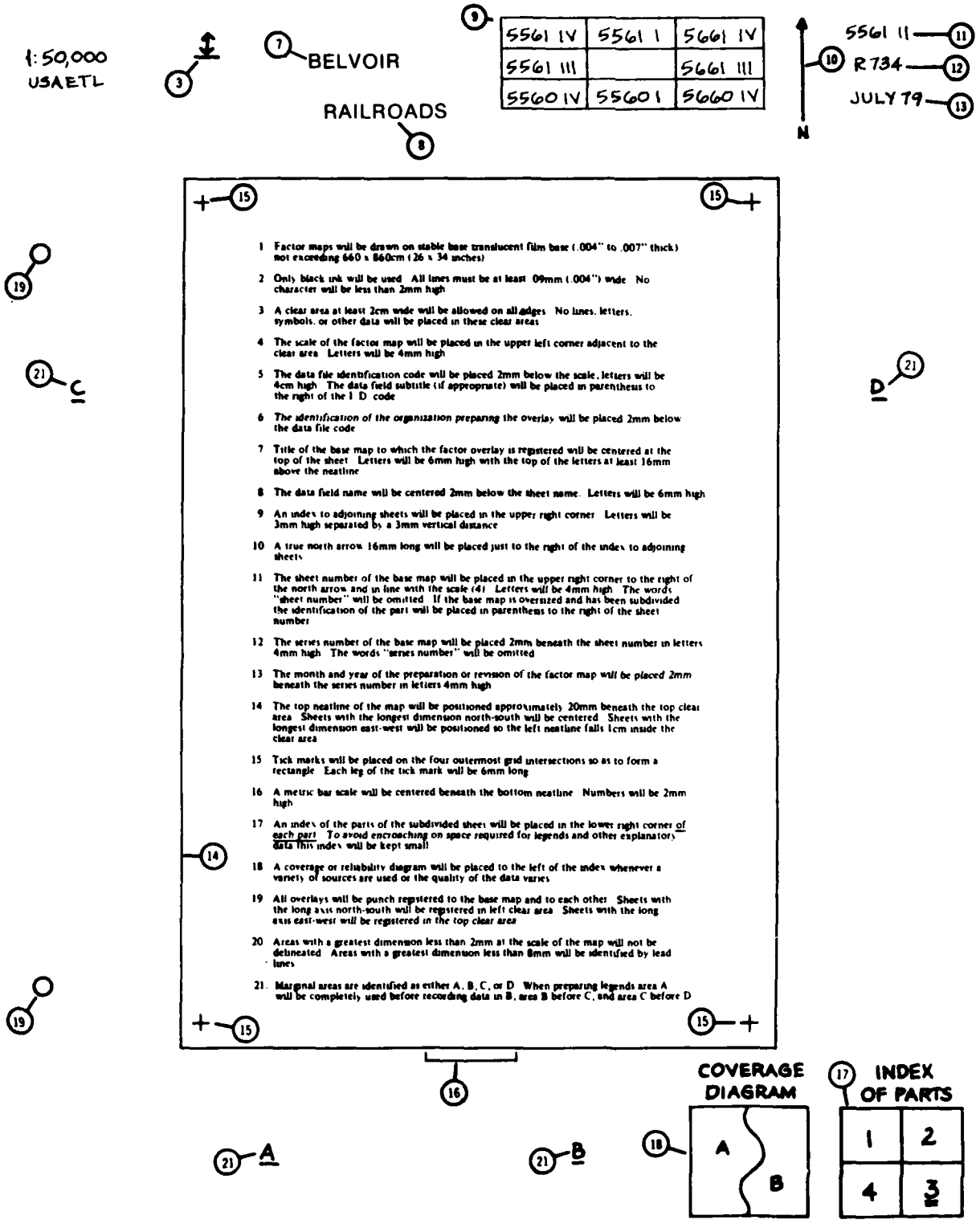


Figure A2. Format for Factor Overlays with Long Axis N-S.

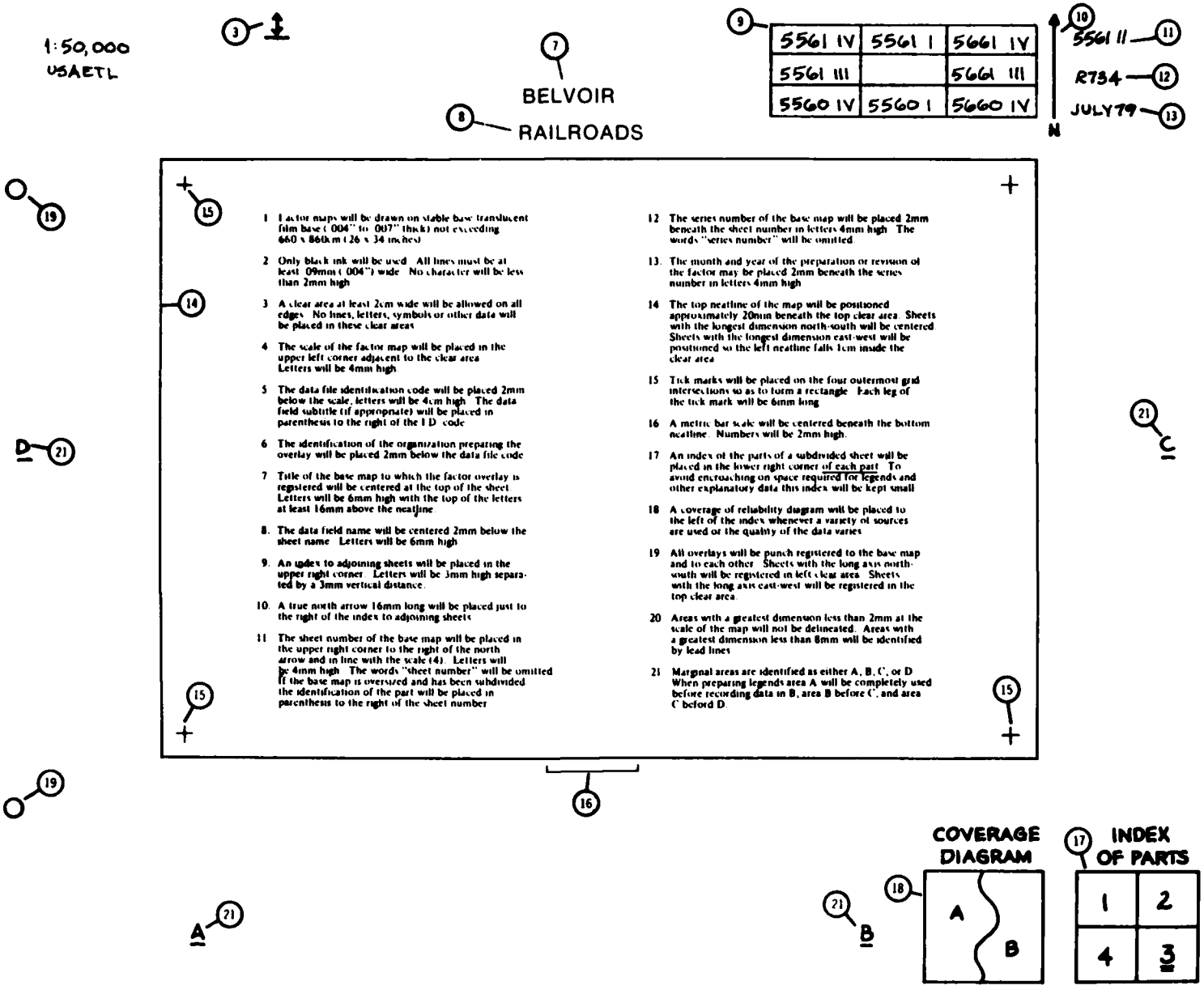
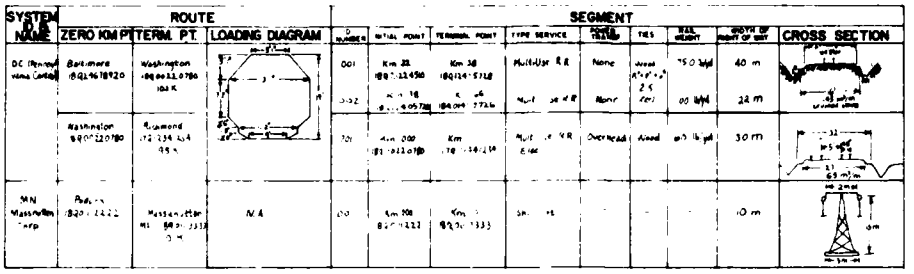


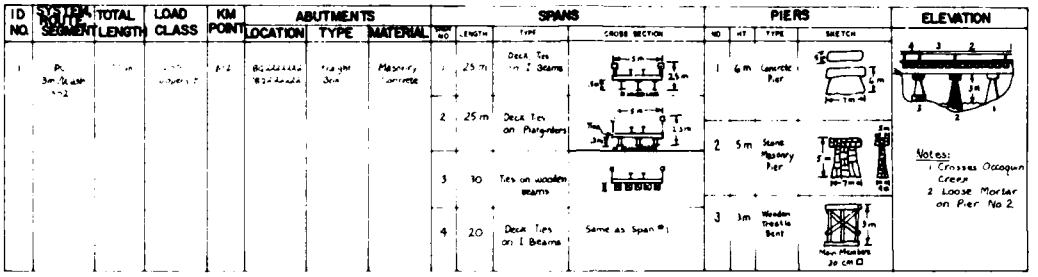
Figure A3. Format for Factor Overlays with Long Axis E-W.

SCALE OF BASE MAP 1:50,000
HA RAILROADS
USAETL

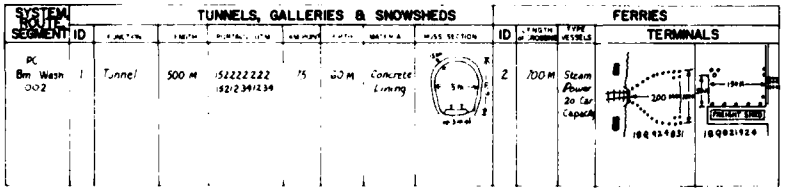
DATA TABLE 1 - TRACKAGE



DATA TABLE 2 - BRIDGES



DATA TABLE 3 - TUNNELS & FERRIES



DATA TABLE 4 - STATIONS, YARDS & FACILITIES

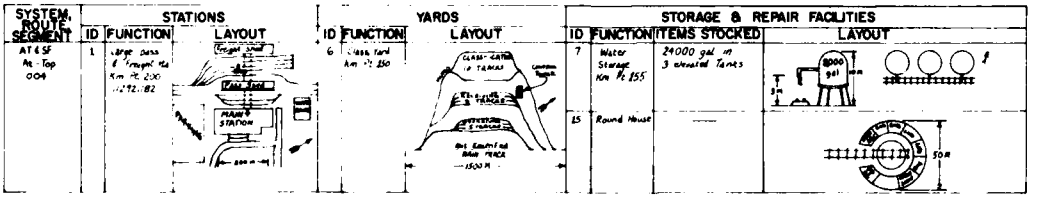


Figure A4. Sample Data Tables.

Table A1. Symbols Specified for Railroads.

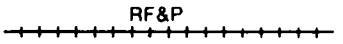
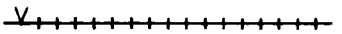
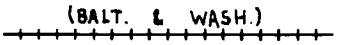
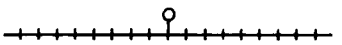
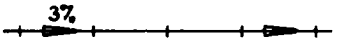
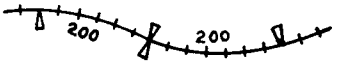
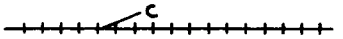
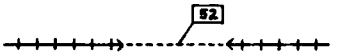
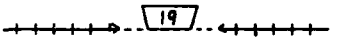
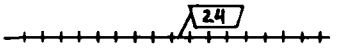
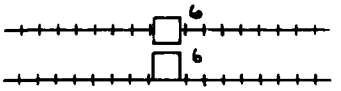
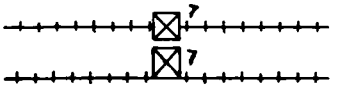
No.	Feature	Symbol
1.	System Identification	
2.	End Point of System	
3.	Route Identification	
4.	End Point of Route	
5.	Segment Identification	
6.	End Point of Segment	
	Gage of Track	
7.	Standard	
8.	Narrow	
9.	Broad	
10.	Number of Tracks — Any Gage Single	
11.	Double	
12.	Three or More	
13.	Tracks in Juxtaposition	
14.	Maximum Gradient	
15.	Radius of Curvature	
16.	Bridge, Overpass, Viaduct, Causeway	
17.	Culvert	
18.	Tunnel, Gallery, Snowshed, Underpass	
19.	Ferry	
	Station	
20.	Passenger	
21.	Freight	

Table A1. Symbols Specified for Railroads (Cont.).

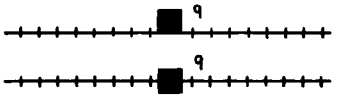
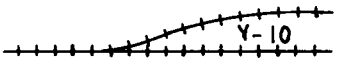
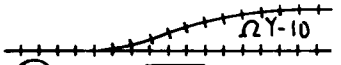
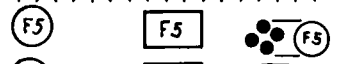
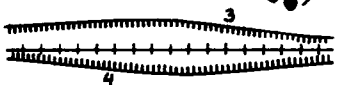
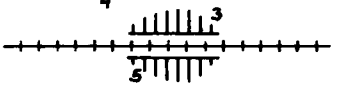
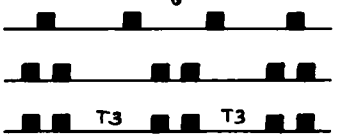
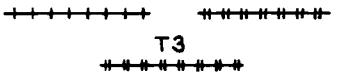
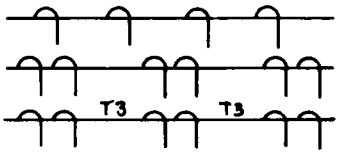
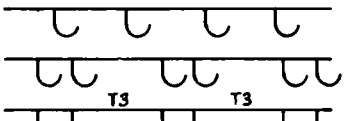
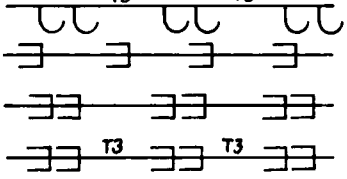
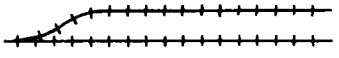
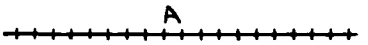
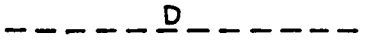
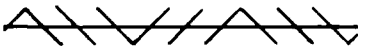
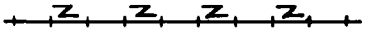
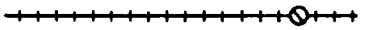
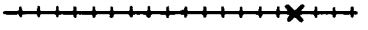
No.	Feature	Symbol
22.	Combination	
23.	Yard Without Hump	
24.	With Hump	
25.	Fuel Storage	
26.	Water Storage	
27.	Maintenance and Repair Facility	
28.	Cut	
29.	Fill	
30.	Embankment, Escarpment	
31.	Special Railroad Cog	
32.	Carline Operating/Nonoperating	
33.	Elevated Monorail	
34.	Aerial Cableway, Ski Lift	
35.	Conveyer Belt	
36.	Siding and Spur	

Table A1. Symbols Specified for Railroads (Cont.).

No.	Feature	Symbol
37.	Abandoned Railway	
38.	Dismantled Railway	
39.	Destroyed Railway	
40.	Electrified Railway	
41.	Underground Railway, Subway	
42.	Turntable	
43.	Signal House	
44.	Grade Crossing	

Pennsylvania Central (PC). The system will be identified on the factor overlay by initials that will be placed alongside the component routes on the factor overlay to clearly identify the system to which each route belongs.

b. System end points are those points at which a RR system begins, ends, or changes identification. There may be no system end points within many map sheets. System end points will always coincide with route and segment end points.

D. Route ID and end points (Symbols 3 & 4):

a. A route is defined as that portion of a system providing through lines between selected points. Routes are usually specified by the system management, but it may often be convenient or appropriate for the analyst to select others. The route will be identified on the factor overlay by abbreviations of the two end points placed in parenthesis, i.e., (Wash-Balt).

b. Route end points are the terminal points selected. There may be no route end points within the area of a 1:50,000 factor overlay. Route end points always coincide with segment end points and may coincide with system end points. Kilometer distances are always measured from route end points.

E. Segment ID and end points (Symbols 5 & 6):

a. A segment is defined as that portion of a route characterized by uniform load bearing, traffic capacity, and operating characteristics. Ene points of segments are defined by nodes that are along the route at which any one of the following conditions occur:

(1) A change in the number of tracks (points at which passing tracks or sidings start or end do not constitute nodes)

(2) A change in the gage of the track

(3) A route terminal

(4) A system terminal

(5) Point at which the route crosses the neatline of the factor overlay

(6) A terminal or junction at which traffic may be diverted onto another route

(7) A change in type of construction such that the load-bearing capacity, speed, or traffic capacity is altered

(8) A point at which electrification starts, ends, or changes method of power transfer

(9) A point at which a change in method of traffic control occurs

(10) International boundary crossings

b. Segments will be numbered sequentially along a route within a map sheet; start at that segment nearest the zero kilometer point.

F. Gage of tracks (Symbols 7, 8 & 9):

The terms standard gage, narrow gage, and broad gage have different dimensional meanings in different areas. The terms must be defined to the nearest .01 meter on both the overlay and the data tables.

G. Number of tracks (Symbols 10, 11, 12 & 13):

a. The number of tracks for single and double track lines is indicated by the number of ticks used with the gage symbol. Routes with three or more tracks are symbolized by the double track symbol supplemented by a "T" followed by a number indicating the actual number of tracks.

b. Lines operated by different systems that closely parallel each other or share a common right-of-way are considered in juxtaposition and are indicated by separate symbols. Symbols for such lines will be displaced from the center line sufficiently to make it clear that there are two distinct lines.

H. Maximum gradient (Symbol 14):

The maximum gradient of each segment is symbolized by arrows placed at the bottom and at the top of the grade whenever the grade is greater than 3%. The arrowheads will be positioned so that the flat end of the first arrowhead marks the bottom of the grade and the pointed end of the second arrowhead marks the top of the grade. The actual grade in percent will be recorded adjacent to the first arrowhead.

I. Radius of curvature (Symbol 15):

The radius of curvature will be shown for all curves with radii of 300 meters or less. The symbol will be placed at both ends of each curve, or section of a curve in the case of compound curves. The symbol will be placed in contact with the track symbol on the inside of the curve. The radius in meters will be recorded adjacent to one of the symbols on the side towards the other end of the curve.

J. Bridge, overpass, viaduct, causeway (Symbol 16):

a. Bridges, overpasses, viaducts, and causeways are defined as those structures longer than 10 meters that carry a line over an obstacle. Structures less than 10 meters long are symbolized as culverts. In exceptional cases overpasses less than 10 meters long may be treated by the symbol if they are considered sufficiently important.

b. Identification numbers will be assigned sequentially within the map sheet. The same bridge number cannot appear twice within the same map sheet.

K. Tunnels, galleries, snowsheds, and underpasses (Symbol 18):

a. This category of feature is defined as any structure which roofs the tracks regardless of length.

b. Identification numbers will be assigned sequentially within the map sheet. The same tunnel number cannot appear twice within the same map sheet.

L. Ferries (Symbol 19):

The ferry symbol may be positioned either within the waterway crossed, as in symbol 19a, or to the side, with a lead line to the location, as in symbol 19b.

M. Stations (Symbols 20, 21, 22):

a. Station symbols will be positioned to indicate whether the station is between or astride the tracks or to one side.

b. Identification numbers will be assigned sequentially within a map sheet. The same number may not be used twice within a map sheet area.

N. Yards (Symbols 23, 24):

a. Yards of all types will be indicated by outlining the area with the single track symbol and placing the code letter Y within the outline followed by the identification number. Where the yard is a gravity or hump yard the code letter will be preceded by the hump symbol.

b. Identification numbers will be assigned sequentially within each map sheet.

O. Maintenance and repair facilities and fuel and water storage facilities (Symbols 25, 26, 27):

Symbolization for fuel and water facilities will be varied

according to the type of facility. Small facilities will be symbolized by the specified circle or rectangle. Structures large enough to be symbolized at scale will be outlined and the code letter and identification number placed within the outline. Clusters of small facilities will be symbolized by the circle or rectangle with lead lines indicating the included facilities.

P. Cuts and fills (Symbols 28, 29, 30):

The conventional symbols for cuts and fills will be supplemented by a number indicating the height or depth of the feature in meters. Vertical or near-vertical features such as retaining walls will be symbolized by the escarpment symbol supplemented by metric height.

Q. Special railroads (Symbols 31, 32, 33, 34, 35):

Special railroads will be treated the same as others except that the system idenfifiers and terminal points need not be shown. Kilometer distances will be measured from the route terminal points.

Explanations are not deemed necessary for symbols 36 - 44.

III. DATA TABLES.

A. General:

A series of four data tables keyed to features on the overlay will be used to provide additional detailed information. These data tables are illustrated in figure A4. Data tables will use the same format as the overlay and will carry the same identification. Where practical, all four tables may be placed on a single overlay-sized page as illustrated.

Where there are too many entries to enter on a single page, two or more pages may be used. Metric dimensions are preferred in all cases, but the unit of measurement will always be given.

B. Data Table #1, Trackage:

a. Column 1; System ID Number and Name: The system ID initial as used on the overlay will be entered, followed by the full identification spelled out.

b. Column 2; Route Zero Kilometer Point: The name and UTM coordinates (± 10m) of the point of origin will be recorded in this column, with the name placed above the coordinates.

c. Column 3; Route Terminal Point: The name, UTM coordinates, and kilometer distance from the zero kilometer point will be listed in sequence within this column.

d. Column 4; Route Loading Diagram: A dimensioned loading diagram for the route will be drawn in this column.

e. Column 5; Segment Identification Number: The three digit ID number for the segment will be shown in this column.

f. Column 6 & 7; Segment Initial Point and Terminal Point: The kilometer point and UTM coordinates for the start and end point of the segment will be entered in these columns. The initial point will always be on the end nearest the Route Zero Kilometer Point.

g. Column 8; Type of Service: A brief statement of the type of service provided by the segment will be placed in this column. Examples: Electrified multiuse RR, Ski Lift, Cog RR, Passenger Subway.

h. Column 9; Power Transfer: This column is used only for electrified routes. Method by which the power is transferred to the engine will be identified as overhead, third rail, or underground.

i. Column 10; Ties: The type of material, dimensions, and spacing of the track ties will be listed vertically in this column.

j. Column 11; Rail Weight: The weight of the tracks will be recorded in this column as weight per unit length.

k. Column 12; Width of Right-of-Way: The total width of the right-of-way will be entered.

l. Column 13; Cross Section: A dimensioned, representative cross section of the segment right-of-way will be drawn in this column. In many cases, a single cross section may be used for several segments.

C. Data Table #2, Bridges:

a. Column 1; Identification Number: This number will be assigned on an overlay basis. The sequence will begin in the upper left corner and progress to the right and down in a normal reading manner.

b. Column 2; System, Route, Segment ID: The system ID initial, route identification abbreviation, and segment ID number will be entered in this column. Stack them vertically in that sequence.

c. Column 3; Total Length: Show the total length of the bridge to the nearest meter.

d. Column 4; Load Classification: Load class of each feature will be recorded in this column, expressed in Coopers E categories.

e. Column 5; Kilometer Point: The distance in kilometers from the Zero Kilometer Point to the nearest end of the bridge is to be entered.

f. Columns 6, 7, & 8; Abutment Location, Type and Construction Material: The UTM coordinates, type of construction, and construction material will be listed in this order in these columns.

g. Column 9; Span Number: Span number(s) beginning at the end nearest the Route Zero Kilometer Point are to be recorded.

h. Column 10; Span Length: Give the length of individual spans stated to the nearest meter.

i. Column 11; Span Type: Construction type of that particular span will be entered in this column. Normally an entire multispan bridge is of one type.

j. Column 12; Cross Section: A dimensioned sketch of each span's cross section will be drawn in this space. Normally the same cross section will be used for each span.

k. Column 13; Pier Number: Pier number(s) from the Route Zero Kilometer Point will be recorded here. The total number of piers depends on the length and construction type of bridge.

l. Columns 14, 15, and 16; Pier Height, Type, and Sketch: The height from base of construction to top of pier, construction material, and a sketch of each pier respectively will be posted in these columns. Dimensions should be accurate to the nearest meter.

m. Column 17; Elevation: An elevation drawing of the entire bridge with each span and pier numbered will be placed in this column. Space is adequate for extra descriptive notes as well as for dimensions.

D. Data Table #3, Tunnels and Ferries:

a. Column 1; System, Route, and Segment: The system initial, route abbreviation, and segment number will be entered in this column, stacked vertically in that sequence.

b. Column 2; Tunnel, Gallery, and Snowshed ID: The sheet ID number is assigned to the feature. These numbers occur in sequence beginning in the upper left corner of the overlay and progressing to the right and down in a normal reading fashion.

c. Column 3; Function: The function performed by this feature, ie., tunnel, gallery, or snowshed will be recorded in this column.

d. Column 4; Length: Total length of feature, portal to portal, will be inserted in this column, stated to the nearest meter.

e. Column 5; Portals (UTM): The UTM coordinates of each entrance portal will be listed in this column. They will be stacked vertically with the upper set being that of the portal nearest the Route Zero Kilometer Point.

f. Column 6; Kilometer Point: The distance in kilometers from the Zero Kilometer Point to the nearest portal of the feature to be entered will be placed in this column.

g. Column 7; Depth: Show the maximum depth below ground level of any portion of the tunnel stated to nearest 5 meters.

h. Column 8; Material: The construction material of the feature is to be posted in this column. In the case of tunnels, the lining material will be stated.

i. Column 9; Cross Section: A dimensioned cross section sketch will be drawn in this space. Several may be necessary to accommodate junctions with other tracks within the feature, especially in the case of subways.

j. Column 10; Ferries ID: The sheet ID number is assigned to the feature. These numbers occur in sequence beginning in the upper left corner of the overlay and progressing to the right and down in a normal reading manner.

k. Column 11; Length of Crossing: The length to the nearest meter of the normal crossing by a fully laden vessel will be entered in this column.

l. Column 12; Type of Vessel: The vessel type, capacity, and power source will be listed in this column.

m. Column 13; Terminals: A plan view of each terminal area will be drawn in this space. The plan shown on the left will be the one nearest the Route Zero Kilometer Point. Each will include the UTM coordinates.

E. Data Table #4, Stations, Yards, and Facilities:

a. Column 1; System, Route and Segment: The system initial, route abbreviation, and segment number will be entered in this column, stacked vertically in that sequence.

b. Column 2; Station ID: The sheet ID number is assigned to the feature. These numbers occur in sequence beginning in the upper left

corner of the overlay and progressing to the right and down in a normal reading manner.

c. Column 3; Function: A short description of the station function with kilometer point and UTM coordinates for location purposes will be recorded in this column.

d. Column 4; Layout: A plan view of the station area will be drawn in this space.

e. Column 5; Yard ID: The sheet ID is assigned to the feature. Each individual yard type will have a number even though it may be physically adjacent to another yard type. These numbers occur in sequence beginning in the upper left corner of the overlay and progressing to the right and down in a normal reading manner.

f. Column 6; Function: A brief statement as to yard type and kilometer point will be entered in this space.

g. Column 7; Layout: A plan view of the yard area will be drawn in this space. Adjacent yard types should be included in the same sketch to best portray their physical relationships.

h. Column 8; Storage and Repair Facilities ID: The sheet ID number is assigned to each storage and repair facility. These numbers occur in sequence beginning in the upper left corner of the overlay and progressing to the right and down in a normal reading manner.

i. Column 9; Function: The function filled by the facility will be entered in this column.

j. Column 10; Items Stocked: This column applies to storage facilities only and will give items stored and in what amounts.

k. Column 11; Layout: A plan and elevation sketch of each separate facility will be drawn in this space.

APPENDIX B. GOVERNMENT AND OTHER SOURCES.

DEPARTMENT OF COMMERCE

Climatic Data	National Oceanic and Atmospheric Administration Environmental Data Service Washington, D.C. 20235
Climatic Data	National Weather Records Center Federal Building Asheville, North Carolina 28801

LIBRARY OF CONGRESS

Misc. Maps	Chief, Photo Duplications Service Library of Congress 10 First Street, SE Washington, D.C. 20540
Misc. Maps	Geography and Map Division Library of Congress Washington, D.C. 20540 Telephone: (202) 370-1261

NATIONAL ARCHIVES AND RECORDS SERVICES

Maps & Cartographic Records	Cartographic Archives Division National Archives and Records Services Washington, D.C. 20408 Telephone: (202) 523-3062

U.S. GEOLOGICAL SURVEY

Current & Historical Topographic Maps	National Cartographic Information Center U.S. Geological Survey 507 National Center Reston, Virginia 22092 Telephone: (703) 860-6045 (Topographic maps, historical topographic maps)

APPENDIX C. IMAGERY SOURCES.

AERIAL IMAGERY

U.S. GOVERNMENT AGENCIES

Aerial Photography Field Office
Agricultural Stabilization and Conservation Service
U.S. Department of Agriculture
2222 West 2300 South
P.O. Box 30010
Salt Lake City, Utah 84125 (Source for all states)

Defense Intelligence Agency
ATTN: DIAAP-10
Washington, D.C. 20315

DMAHTC
6500 Brooks Lane
Washington, D.C. 20335 (World wide survey photography)

Bureau of Land Management
Department of Interior
Washington, D.C. 20240

Cartographic Archives Division
National Archives (GSA)
Washington, D.C. 20408

EROS Data Center
U.S. Geological Survey
Sioux Falls, South Dakota 57198

National Cartographic Information Center (Headquarters)
Geological Survey
Department of Interior
Reston, Virginia 22090

NCIC-Mid-Continent
USGS, 1400 Independence Rd.
Rolla, Missouri 65401

NCIC-Rocky Mountain
USGS, Topographic Division
Stop 510, Box 25046
Denver Federal Center
Denver, Colorado 80225

NCIC-Western
USGS, 345 Middlefield Rd.
Menlo Park, California 94025

National Ocean Survey
Department of Commerce
Washington Science Center
Rockville, Maryland 20852

Soil Conservation Service
Department of Agriculture
Federal Center Building
East-West Highway and Belcrest Rd.
Hyattsville, Maryland 20781

Tennessee Valley Authority
Maps and Surveys Branch
210 Haney Building
Chattanooga, Tennessee 37401

EASTERN U.S. FOREST SERVICE PHOTOGRAPHY

Chief Forest Service
U.S. Department of Agriculture
Washington, D.C. 20250

WESTERN U.S. FOREST SERVICE PHOTOGRAPHY

Region	
1	Federal Building, Missoula, MT 59801
2	Federal Center, Building 85, Denver, CO 80025
3	Federal Building, 517 Gold Ave. SW, Albuquerque, NM 87101
4	Forest Service Building, Ogden, UT 84403
5	630 Sansome St., San Francisco, CA 94111
6	P.O. Box 8623, Portland, OR 97208
10	Regional Forester, U.S. Forest Service, P.O. Box 1628, Juneau, AK 99801

Technology Application Center
The University of New Mexico, Code 11
Albuquerque, New Mexico 87131

STATE AGENCIES

Arizona Highway Department
Administrative Services Division
206 South 17th Avenue
Phoenix, Arizona 85007

State of Arkansas Highway Department
Surveys, 9500 New Denton Highway
P.O. Box 2261
Little Rock, Arkansas

State of Nebraska
Department of Roads
14th & Burnham Streets
Lincoln, Nebraska

State of Ohio
Department of Highways
Columbus, Ohio 43216

Oregon State Highway Division
Salem, Oregon 97310

Virginia Department of Highways
Location and Design Engineer
1401 East Broad Street
Richmond, Virginia 23219

State of Washington
Department of Natural Resources
600 North Capitol Way
Olympia, Washington 98501

Southeast Michigan
Council of Governments
1249 Washington Blvd.
Detroit, Michigan 48226

Illinois Department of
Transportation
2300 South - 31st Street
Springfield, Illinois 62734

Southeastern Wisconsin
Regional Planning Commission
916 North East Avenue
Waukesha, Wisconsin 53186

Wisconsin Department of
Transportation
Engineering Services
4802 Sheboygan Avenue
Madison, Wisconsin 53702

Indiana Highway Department
608 State Office Building
Indianapolis, Indiana 46204

COMMERCIAL FIRMS

Aerial Data Services
10338 East 21st Street
Tulsa, Oklahoma 74129

Aero Service Corporation
4219 Van Kirk Street
Philadelphia, Pennsylvania 19135

Air Photographics Inc.
P.O. Box 786
Purcellville, Virginia 23132

Alster and Associates, Inc.
6135 Kansas Avenue, NE
Washington, D.C. 20011

Ammann International Base Map
and Air Photo Library
223 Tenth Street
San Antonio, Texas 78215

Burlington Northern Inc.
650 Central Building
Seattle, Washington 98104

Cartwright Aerial Surveys Inc.
Executive Airport
6151 Freeport Boulevard
Sacramento, California 95822

L. Robert Kimball
615 West Highland Avenue
Ebensburg, Pennsylvania 15931

Lockwood, Kessler & Bartlett, Inc.
One Aerial Way
Syosset, New York 11791

Mark Hurd Aerial Surveys, Inc.
345 Pennsylvania Avenue South
Minneapolis, Minnesota 55426

Merrick and Company
Consulting Engineers
2700 West Evans
Denver, Colorado 80219

H.G. Chickering, Jr.
Consulting Photogrammetrist, Inc.
P.O. Box 2767
1190 West 7th Avenue
Eugene, Oregon 97402

Fairchild Aeromaps Inc.
14437 North 73rd Street
Scottsdale, Arizona 85254

Grumman Ecosystems Corp.
Bethpage, New York 11714

Henderson Aerial Surveys Inc.
5125 West Broad Street
Columbus, Ohio 43228

Walker and Associates Inc.
310 Prefontaine Building
Seattle, Washington 98104

Western Aerial Contractors Inc.
Mahlon Sweet Airport
Route 1, Box 740
Eugene, Oregon 97401

Murry - McCormick
Aerial Surveys Inc.
6220 24th Street
Sacramento, California 95822

Photographic Interpretation Corp.
Box 868
Hanover, New Hampshire 03755

Quinn and Associates
460 Caredean Drive
Horsham, Pennsylvania 13044

Sanborn Map Company, Inc.
P.O. Box 61
629 Fifth Avenue
Pelham, New York 10803

The Sidwell Company
Sidwell Park
28 W 240 North Avenue
West Chicago, Illinois 60185

Surdex Corporation
25 Mercury Boulevard
Chesterfield, Missouri 63017

United Aerial Mapping
5411 Jackwood Drive
San Antonio, Texas 78238

Teledyne Geotronics
725 East Third Street
Long Beach, California 90812

CANADA

National Air Photo Library
Surveys and Mapping Building
615 Booth St.
Ottawa, Canada K1A OE9

GROUND IMAGERY SOURCES

U.S. Army Imagery Interpretation Group
Building 213
Washington Navy Yard
Washington, D.C. 20374

Defense Intelligence Agency
ATTN: RPP-3
Washington, D.C. 20301

U.S. Army DARCOM Service Support Activity
Audio-Visual Presentations Division
Room 1C13, Pentagon
Washington, D.C. 20310

Appendix D. Scales and Equivalents (Maps and Photographs).

Scale	Feet per Inch	Inches per 1000 Feet	Inches per Mile	Miles per Inch	Meters per Inch	Acres per Square Inch	Square Inches per Acre	Square Miles per Square Inch	CM per KM
1: 500	41.667	24.000	126.720	0.008	12.700	0.0399	25.0910	0.00006	200.000
1: 600	50.000	20.000	105.600	0.009	15.240	0.0574	17.4240	0.00009	166.670
1: 1,000	83.333	12.000	63.360	0.016	25.400	0.1594	6.2730	0.00025	100.000
1: 1,200	100.000	10.000	52.800	0.019	30.480	0.2296	4.3560	0.00036	83.330
1: 1,500	125.000	8.000	42.240	0.024	38.100	0.3587	2.7880	0.00056	66.670
1: 2,000	166.667	6.000	31.680	0.032	50.800	0.6377	1.5680	0.00100	50.000
1: 2,400	200.000	5.000	26.400	0.038	60.960	0.9183	1.0890	0.00140	41.670
1: 2,500	208.333	4.800	25.344	0.039	63.500	0.9964	1.0040	0.00160	40.000
1: 3,000	250.000	4.000	21.120	0.047	76.200	1.4348	0.6970	0.00220	33.330
1: 3,600	300.000	3.333	17.600	0.057	91.440	2.0661	0.4840	0.00320	27.780
1: 4,000	333.333	3.000	15.840	0.063	101.600	2.5508	0.3920	0.00400	25.000
1: 4,800	400.000	2.500	13.200	0.076	121.920	3.6731	0.2720	0.00570	20.820
1: 5,000	416.667	2.400	12.672	0.079	127.000	3.9856	0.2510	0.00620	20.000
1: 6,000	500.000	2.000	10.560	0.095	152.400	5.7392	0.1740	0.00900	16.670
1: 7,000	583.333	1.714	9.051	0.110	177.800	7.8117	0.1280	0.01220	14.290
1: 7,200	600.000	1.667	8.800	0.114	182.880	8.2645	0.1210	0.01290	13.890
1: 7,920	660.000	1.515	8.000	0.125	201.168	10.0000	0.1000	0.01560	12.630
1: 8,000	666.667	1.500	7.920	0.126	203.200	10.2030	0.0980	0.01590	12.500
1: 8,400	700.000	1.429	7.543	0.133	213.360	11.2490	0.0890	0.01760	11.900
1: 9,000	750.000	1.333	7.041	0.142	228.600	12.9130	0.0770	0.02020	11.110
1: 9,600	800.000	1.250	6.600	0.152	243.840	14.6920	0.0680	0.02300	10.420
1: 10,000	833.333	1.200	6.336	0.158	254.000	15.9420	0.0630	0.02490	10.000
1: 10,800	900.000	1.111	5.867	0.170	274.321	18.5950	0.0540	0.02910	9.259
1: 12,000	1,000.000	1.000	5.280	0.189	304.801	22.9570	0.0440	0.03590	8.333
1: 12,500	1,041.662	0.960	5.069	0.197	317.505	24.9100	0.0400	0.03850	8.000
1: 13,200	1,100.000	0.909	4.800	0.208	335.281	27.7780	0.0360	0.04340	7.576
1: 14,400	1,200.000	0.833	4.400	0.227	365.761	33.0580	0.0300	0.05170	6.944
1: 15,000	1,250.000	0.800	4.224	0.237	381.001	35.8700	0.0280	0.05600	6.667
1: 15,600	1,300.000	0.769	4.062	0.246	396.241	38.7970	0.0260	0.06060	6.410
1: 15,840	1,320.000	0.758	4.000	0.250	402.337	40.0000	0.0250	0.06250	6.313
1: 16,000	1,333.333	0.750	3.960	0.253	406.400	40.8120	0.0240	0.06380	6.250
1: 16,800	1,400.000	0.714	3.771	0.265	426.721	44.9950	0.0220	0.07030	5.952
1: 18,000	1,500.000	0.667	3.520	0.284	457.201	51.6530	0.0190	0.08070	5.556
1: 19,200	1,600.000	0.625	3.300	0.303	487.681	58.7700	0.0170	0.09180	5.208
1: 20,000	1,666.667	0.600	3.168	0.316	508.002	63.7690	0.0160	0.09960	5.000
1: 20,400	1,700.000	0.588	3.106	0.322	518.161	66.3450	0.0150	0.10370	4.902
1: 21,120	1,760.000	0.568	3.000	0.333	536.449	71.1110	0.0140	0.11110	4.735
1: 21,600	1,800.000	0.556	2.933	0.341	548.641	74.3800	0.0130	0.11620	4.630
1: 22,800	1,900.000	0.526	2.779	0.360	579.121	82.8740	0.0120	0.12950	4.386
1: 24,000	2,000.000	0.500	2.640	0.379	609.601	91.8270	0.0110	0.14350	4.167
1: 25,000	2,083.333	0.480	2.534	0.395	635.001	99.6390	0.0100	0.15570	4.000
1: 31,680	2,640.000	0.379	2.000	0.500	804.674	160.0000	0.0060	0.25000	3.157
1: 33,333	2,777.778	0.360	1.901	0.526	846.683	177.1360	0.0056	0.38640	3.000
1: 48,000	4,000.000	0.250	1.320	0.758	1,219.202	367.3090	0.0030	0.57390	2.083
1: 50,000	4,166.667	0.240	1.267	0.789	1,270.025	398.5560	0.0025	0.62270	2.000
1: 62,500	5,208.333	0.192	1.014	0.986	1,587.503	622.7440	0.0016	0.97300	1.600
1: 63,360	5,280.000	0.189	1.000	1.000	1,609.347	640.0000	0.0016	1.00000	1.578
1: 75,000	6,250.000	0.160	0.845	1.184	1,905.038	896.7520	0.0011	1.40120	1.333
1: 96,000	8,000.000	0.125	0.660	1.515	2,438.405	1,469.2400	0.0007	2.29570	1.042
1: 100,000	8,333.333	0.100	0.634	1.578	2,540.050	1,594.2250	0.0006	2.49100	1.000
1: 125,000	10,416.667	0.096	0.507	1.973	3,175.006	2,490.9800	0.0004	3.89220	0.800
1: 126,720	10,560.000	0.095	0.500	2.000	3,218.694	2,560.0000	0.0004	4.00000	0.789
1: 250,000	20,833.333	0.048	0.253	3.946	6,350.012	9,963.9070	0.0001	15.56860	0.400
1: 253,440	21,120.000	0.047	0.250	4.000	6,437.389	10,244.2020	0.0001	16.00000	0.395
1: 300,000	25,000.000	0.040	0.211	4.735	7,620.015	14,348.0260	0.0001	22.41880	0.333
1: 500,000	41,666.667	0.024	0.127	7.891	12,700.025	39,855.6270	–	62.27440	0.200
1:1,000,000	83,333.333	0.012	0.063	15.783	25,400.050	159,422.5070	–	249.09770	0.100

Source: DoD, "Image Interpretation Handbook," V.1, TM 30-245/NAVAIR 10-35-685/AFM 200-50, 1967.

APPENDIX E. EQUIPMENT LIST.

Stereoscope, folding pocket type

Masking tape

Mylar, roll 4 ft. wide

Magnification tube

Stapler

Prisma color pencils

Felt tip pens

Ink solvent

Writing pads

Erasers

Pencils

Light table

Reflecting projector

Large copy camera

Paper cutter

Preprinted forms (data tables)

APPENDIX F. FOREIGN MAP SYMBOLS.

The symbology used in the production of F.R.G. and U.S.S.R. maps is presented in Tables F1 and F2, respectively. These maps, when available for your area of interest, can be used either to obtain primary source material or to augment the data obtained from U.S. maps. Both of these countries produce military maps at scales of 1:50,000 and 1:25,000. The amount, detail, and accuracy of the information presented will, of course, vary with the scale and date of publication. A study of the symbology presented in Tables F1 and F2 will reveal that these maps provide considerably more information on railroads and railroad bridge construction characteristics than is presently available on U.S. maps.

If 1:50,000-scale foreign maps are available for your area, they can be substituted directly for the U.S. maps, and with the help of either Table F1 or F2, the analyst will be able to produce the required factor overlay by following the methods provided in the Topographic Map Analysis Section.

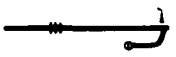
When maps of scales other than 1:50,000 are available, the analyst can either adjust the scales photographically or, more simply, record the information directly from the foreign map to the U.S. map overlay.

Table F1. Federal Republic of Germany (F.R.G.) Map Symbols for Railroads with English Translations.

(1:50,000 SCALE)

Zeichenerklärung	Legend
Verkehrsnetz	***Communications***
Tunnel	*tunnel*
Bahnhof station gare — *Vollspurige Bahn, mehrgleisig*	*railroad, standard gauge, multiple track*
Haltepunkt halt halte — *Vollspurige Bahn, eingleisig*	*railroad, standard gauge, single track*
Schmalspurige Bahn	*railroad, narrow gauge*
Straßen- und Wirtschaftsbahn	*tramway and industrial railway*
Zahnradbahn; Seil- und Schwebebahn	*funicular, aerial cableway and suspended monorail*
Straßentunnel, Eisenbahntunnel	*tunnel, road and railroad*
Brücken und Gewässer	***Bridges and Hydrography***
Eisen-, Stein- oder Betonbrücke	*iron-, stone- or concrete bridge*
Hebe- oder Drehbrücke	*lift or swing bridge*
Holzbrücke	*wooden bridge*
Eisenbahnfähre	*train ferry*
Wagenfähre	*vehicle ferry*
Abkürzungen	***Abbreviations***
EW *Elektrizitätswerk*	*power station*
Hbf *Hauptbahnhof*	*main railroad station*
Hp; Hst *Haltepunkt; Haltestelle*	*halt*

Table F2. Union of Soviet Specialist Republic (U.S.S.R.) Map Symbols for Railroads with English Translations.



THREE-TRACK RAILROADS, SEMAPHORES AND LIGHT SIGNALS, TURNTABLES.

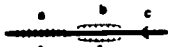
TWO-TRACK RAILROADS AND STATIONS OF ALL CLASSES.

SINGLE-TRACK RAILROADS, SIDINGS, PLATFORMS, AND STOPS ON BROAD-GAGE RAILROADS.

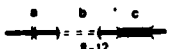
LOCATION OF THE MAIN TERMINAL BUILDING:
a) ALONGSIDE TRACKS;
b) BETWEEN TRACKS;
C) LOCATION UNKNOWN.

ELECTRIFIED RAILROADS:
a) THREE-TRACK D) BLOCK POSTS
b) TWO-TRACK;
c) SINGLE-TRACK;

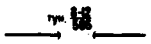
WATCHMAN'S POSTS, LOADING AND UNLOADING AREAS, RAILHEADS, SPUR TRACKS [пут. п.– WATCHMAN'S POST; погруз.– LOADING AND UNLOADING AREA].



a) FILLS; b) CUTS (2 - HEIGHT OR DEPTH IN METERS); c) SECTIONS WITH STEEP SLOPES: MORE THAN 0.020 (IN MOUNTAINOUS REGIONS ONLY).

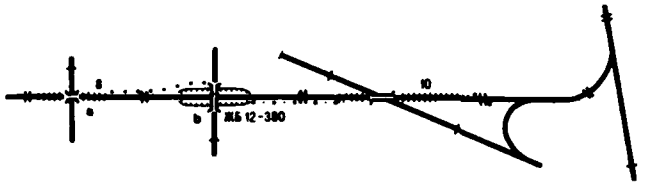


a) CULVERTS; b) TUNNELS (NUMERATOR - HEIGHT AND WIDTH; DENOMINATOR - LENGTH IN METERS); c) TRESTLE BRIDGES [УН. - TUNNEL].



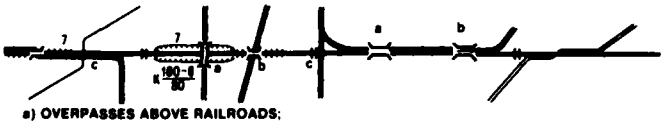
TUNNELS: 8 - HEIGHT, 12 - WIDTH, 585 - LENGTH IN METERS.

RAILROAD BRIDGES 100 M LONG AND LONGER; Ж6 - CONSTRUCTION MATERIAL (Ж6 - *REINFORCED CONCRETE*), 9 - HEIGHT ABOVE SURFACE OF WATER OR GROUND, 200 - LENGTH IN METERS.

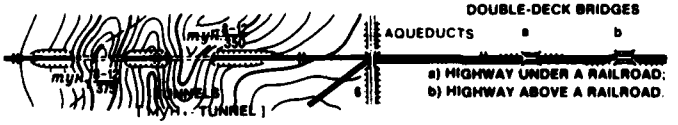


(Ж6 - REINFORCED CONCRETE)

RAILROAD AND HIGHWAY BRIDGES:
a) ON THE SAME FOOTING;
b) ON SEPARATE FOOTINGS.



a) OVERPASSES ABOVE RAILROADS;
b) OVERPASSES ABOVE HIGHWAYS;
c) CROSSINGS ON THE SAME LEVEL.



DOUBLE-DECK BRIDGES
AQUEDUCTS a b
a) HIGHWAY UNDER A RAILROAD;
b) HIGHWAY ABOVE A RAILROAD.

TURNOFFS, OVERPASSES, AND CROSSINGS ON HIGHWAYS AND SUPERHIGHWAYS

BROAD-GAGE RAILROADS UNDER CONSTRUCTION.

BEDS OF DISMANTLED RAILROADS.

NARROW-GAGE RAILROADS AND STATIONS ON THEM; STREETCAR LINES.

NARROW-GAGE RAILROADS UNDER CONSTRUCTION.

FUNICULAR OR GRAVITY RAILWAYS.

ELEVATED RAILWAYS AND SUPPORT TRUSSES.

MONORAILS

A) SUBWAY STATIONS;
b) POINTS WHERE SUBWAY LINES EXIT ONTO THE SURFACE.

DEPOTS, TERMINALS, AND STATION TRACKS DRAWN TO SCALE; PEDESTRIAN BRIDGES.

GLOSSARY OF RAILWAY TERMS

ABUTMENT - An end support in the substructure of a bridge.

ALINEMENT - The location of a railroad as described by curves and tangents.

APPROACH SPAN - A relatively short span between the abutment and the main or channel spans of a bridge.

ARCH BRIDGE - A bridge that consists of an arch and a floor system. The floor system may be carried above the arch or be suspended from it.

ARCH CULVERT - A drainage structure similar to an arch bridge but less than 12 feet in length.

BALLAST (TOPBALLAST) - Selected material (crushed rock, gravel, or cinders) placed on the subgrade or subballast to hold track in line.

BALLASTED BRIDGE - A bridge with solid flooring, carrying ballasted track.

BALLAST DEPTH - The depth from the bottom of tie to top of subgrade (an arbitrary standard for measurement, since ballast actually should surround part of the tie).

BALLAST SHOULDER - The portion of ballast between the end of the tie and the toe of the ballast slope.

BALLAST SECTION - The cross section of a track between and above the toes of the ballast slopes, including subballast, if any.

BALLAST TAMPING - Compacting ballast under crossties to maintain the line and surface of track.

BASCULE SPAN - A movable span that is opened by raising one end.

BEAM BRIDGE - A bridge in which the individual spans are formed by beams, either steel beams or wooden stringers.

BENT - See "pile bent."

BLOCK - A length of track of defined limits, the access of which is controlled by a fixed signal at the entering end on double-track lines and at each end on single-track lines.

BOX CULVERT - A culvert with a drainage opening of rectangular cross section.

BRIDGE CAPACITY - The load-bearing capacity of a bridge expressed by the maximum permissible pressure per axle or by standard design loadings. The latter are based on the weight of a hypothetical locomotive with definite axle spacings and definite proportions of the load on each axle.

BRIDGE SPAN - The superstructure of a bridge between ground supports.

BROAD GAGE - Any gage wider than standard (4 feet 8 1/2 inches).

CANTILEVER BRIDGE - A bridge in which the main supporting members are structurally interrupted at points other than immediately over the ground supports.

CAR RETARDER - Braking device built into the tracks of classification yards to reduce the speed of cars by means of breakshoes pressing against wheel flanges.

CATENARY - A cable suspended between two points.

CAUSEWAY - A section of railroad (or highway) raised on an embankment or fill, usually across marshy ground or a shallow body of water.

CHOKE - The convergent point at the entrance/exit to a group of sidings.

CLASSIFICATION (MARSHALLING) YARD - A yard in which incoming trains are disassembled and new trains assembled on the basis of individual car destinations.

CLEAR SPAN - The distance between faces of a span's supports (piers or abutments), measured at the top of the support. For concrete or masonry arch bridges, the measuring points are the spring lines of the arch.

COACH YARD - Yards used by passenger rolling stock, with facilities for cleaning, servicing, and light repair.

COMBINED BRIDGE - A bridge (usually a long structure) composed of different types of spans; the term may also be used for a combined road-and-rail bridge.

COMPOUND CURVE - Two or more simple consecutive curves of different radii, all in the same direction.

CONTINUOUS SPAN BRIDGE - A bridge with a superstructure that crosses two or more gaps (between substructure supports) without a structural break at intermediate supports.

CRIB PIER - A bridge support of stacked logs interlocked in a rectangular pattern, with the bottom of the pier wider than the top.

CRITICAL SPAN - The span which determines the load class of a bridge. It is the span with the lowest safe load-carrying capacity.

CROSS SECTION (OF ROADWAY) - A graphic representation of permanent way, roadbed, and drainage as these features would intersect a plane surface perpendicular to the center line of track.

CROSSING (TRACK) - A track assembly permitting two tracks to intersect at grade, and consisting of four frogs, one for each rail intersection.

CROSSOVER - A device to allow trains to cross from one track to a parallel track by means of two turnouts and a connecting section of track.

CULVERT - A small bridgelike structure serving as a transverse drain under a permanent way or track. For intelligence purposes, the term is applied to all bridgelike railway structures less than 12 feet (3.7m) in length.

CURRENT OF TRAFFIC - The direction in which trains will move on a main track.

DEAD-END SIDING - Individual sidings that end in buffer stops.

DEPARTURE YARD - A yard immediately adjacent to a classification yard in which assembled trains are held pending departure.

DOUBLE TRACKS - Two main tracks, upon one of which the current of traffic runs in the opposite direction of the other.

ENGINE HOUSE - Building in which locomotives are kept between runs; usually it has some maintenance and minor repair facilities.

EQUIPMENT OR LOADING CLEARANCE - Maximum height and width limits for motive and rolling stock to allow safe clearance through and past all structures over or adjacent to the track. The outline of these limits is called the equipment or loading diagram.

FERRY (RAILWAY) - A site at which railroad trains are conveyed across a water obstacle by a vessel equipped with tracks.

FERRY SLIP - The place where the ferryboat docks to receive or discharge railway trains.

FIXED BRIDGE - A bridge with a superstructure that is fixed in one position.

FIXED SIGNAL - A signal of fixed location indicating that condition affecting the movement of a train.

FLAT (SWITCHING) YARD - A classification yard where the movement of cars is accomplished by a locomotive without material assistance by gravity.

FLOOR SYSTEM - That part of the bridge superstructure that carries the tracks and transmits vehicle loads directly or indirectly to the main supporting member.

FOOTING - The part of the bridge which rests directly on the ground, spreading the load over a sufficient area of soil so that the structure does not sink into the ground.

FOUNDATION - The ground beneath the footing of a bridge that supports the structure and its loads.

FREIGHT TERMINAL - The installation and facilities for handling freight business.

FROG - A rail fitting used where two running rails intersect, providing flangeways that allow the wheels on either rail to cross the other rail.

4-FOOT WAY - Terminology describing the approximate distance between rails on a running track.

GAGE (OF TRACK) - The horizontal distance between the inner faces of the heads of two rails of a track.

GAGING - Bringing two rails into their correct relative positions or gage.

GALLERY - A structure in mountainous terrain designed to guide rock or snow avalanches across the tracks. It may be cut in the face of a cliff and roofed by natural overhang, or it may be of artifical construction. Normally the side facing the valley is open except for column supports.

GAUNTLETTING - Where two adjacent tracks converge and overlap when entering a tunnel.

GIRDER BRIDGE - A bridge whose superstructure consists of two or more parallel girders with transverse floor beams.

GRADE OR GRADIENT - The ratio of rise or fall to a definite horizontal distance on a section of line. (Example: A one-foot vertical rise in 100 feet horizontal distance is a 1:100 or 1 percent gradient.)

GRAVITY YARD - A yard where the classification of cars is accomplished by locomotives with material assistance of gravity. See also "hump yard". The whole yard is on a gentle slope down in the direction of work.

GUARD RAIL - A rail laid inside and parallel with the running rails of a track to prevent wheels from being derailed or to hold wheels in correct alinement to prevent their flanges from striking the points of turnouts, crossing frogs, or switches.

HALF-THROUGH BRIDGE - A bridge with the floor system at or near the bottom edge of the main supporting members; it has no overhead bracing. Some literature applies the term through bridge to half-through and through types alike.

HEAD OF RAIL - The heavy broadened top element of a railway rail.

HEADWALL - Part of a culvert holding back the embankment from either entrance of the culvert. They are made of timber, brick, masonry, or concrete. Commonly called wing walls when set oblique to the entrance.

HORIZONTAL ALINEMENT - The horizontal location and direction of the center line of track, as described by its curves and tangents.

HORIZONTAL CLEARANCE - The distance between vertical members of a structure above track level. It determines the feasibility to pass a load that extends laterally beyond the body of a car.

HUMP YARD - A yard in which the classification of cars is accomplished by pushing them over a summit ("hump"), beyond which they run by gravity. The speed of the cars is controlled by car retarders.

INTERCEPTING DITCH - An outlying ditch constructed at selected sites to relieve the roadbed drainage ditch of carrying surface drainage from adjacent slopes.

JOINT BAR - A steel bar used in pairs for joining rails end to end; also called splice bar or fishplate.

LADDER TRACK - A track connecting successively the body tracks of a yard, particularly a flat classification yard.

LIFT SPAN - A movable span that is opened by raising it vertically at both ends while maintaining it in a horizontal position.

LIGHT RAILWAY - Of normal gage but of lighter construction.

LOADING LIMITS - See "equipment clearance".

MAIN TRACK - Principal track between stations and through yards upon which trains are operated by timetables or train order, or both.

MARSHALLING YARD - A classification yard.

MOVABLE BRIDGE - A bridge with at least one span that can be moved from its normal position to permit the passage of vessels.

NARROW GAGE - Any gage narrower than standard (4 feet, 8 1/2 inches).

OPEN-FLOOR BRIDGE - A bridge in which the track ties form the principal element in the floor system.

OVERALL SUPERSTRUCTURE-LENGTH OF A BRIDGE - Length from abutment to abutment, including the parts of abutments covered by the ends of spans.

OUT-OF-FACE RENEWAL - Renewal of rails or ties over a given section regardless of their individual condition, as distinguished from spot renewal of only decayed ties or worn rails.

PANTOGRAPH - Spring-loaded apparatus on the top of electric locomotives that carry the current from the overhead wires to the engines.

PASSENGER TERMINAL - The installation and facilities for handling waiting passengers.

PASSING TRACKS - Sidings connected at both their ends to the main track and used for the meeting and passing of trains.

PERMANENT WAY - The track and ballast combined. Also called the track structure.

PIER - Intermediate ground supports of a bridge between abutments.

PILE BENT - Intermediate ground supports for a bridge, consisting generally of a row of four or six vertical members called piles that are driven into the ground, surmounted by a cap, and cross-braced.

PILE PIERS - Intermediate ground supports for a bridge, consisting of two pile bents braced to one another.

PIPE CULVERT - A culvert consisting of a concrete, cast iron, corrugated metal, or vitrified clay pipe. Its cross section may be round, elliptical, or flattened on the bottom.

PORTAL - The entrance to a tunnel.

PROFILE - A longitudinal section through a track, showing the ascents and

descents of a railway line. Many diagrammatic profiles also show the horizontal alinement of lines.

RAIL SECTION - The cross-sectional shape and dimensional details of rails, such as width of base and head and depth of web. Each section is identified by a letter, brand name, symbol, etc., that sometimes indicates the weight per unit as well.

RACK RAILWAY - A form of mountain railway, in which additional tractive effort is obtained by use of a cogwheel operating on a rack rail in the center of the track.

REHABILITATION - The repair of existing track and facilities to return them to serviceable condition.

RETAINING WALL - A wall for sustaining the pressure of earth behind it; used at railroad fills or cuts.

RECEIVING YARD - A yard immediately adjacent to a classification yard used for receiving and holding trains until disassembled for classification.

RETRACTILE SPAN - Span that is opened by rolling it back from the opening along a horizontal track.

REVERSE CURVE - Two consecutive simple curves in opposite direction.

RIGHT-OF-WAY - Strip of land occupied by a railway for its tracks and facilities.

ROADBED - The prepared subgrade on which the ballast and track are laid.

ROADBED SHOULDER - The portion of a roadbed lying between the ballast-covered portion and the track drainage ditch in cuts, or the top of slope on embankments.

ROADWAY - The land actually occupied by the permanent way (ballast and track) plus all cuts, fills, and drainage ditches.

ROUTE MILE - Linear distance along a line between two points without consideration of number of tracks.

RULING GRADE - The most difficult grade, as determined by both steepness and length of grade, over which a maximum tonnage train can be handled by a single locomotive.

RUNNING TRACK - A track reserved for movement through a yard. Running tracks are provided for movement in either direction to enable yard engines to pass freely from one part of the yard to another.

SIDING, SIDE TRACK - Auxiliary tracks adjacent to the main track and connected thereto on one end (dead-ended siding) or both ends (double-ended siding). If double-ended sidings serve primarily the purpose of letting trains pass each other, they may be called passing sidings or passing tracks.

SIMPLE CURVE - A circular arc. In track alinement the track immediately at either end of the simple curve is tangent to the curve.

SINGLE TRACK - A main track upon which trains are operated in both directions.

6-FOOT WAY - Terminology describing the approximate distance between two adjacent running tracks.

SKEW BRIDGE - A bridge in which the long axis of one or more of the substructure elements (piers, abutments) is not perpendicular to the center of the bridge. The typical skew bridge crosses diagonally over a stream or rail yard and its piers and abutments are set to conform with the stream flow or rail trackage, the superstructure being modified as necessary.

SLAB BRIDGE - A bridge in which the main members are reinforced or prestressed concrete slabs serving as the floor and resting directly on the abutments or piers; it has no stringers under the slab.

SLEEPERS - The crossties.

SNOWSHED - Roofed structure built over tracks to protect them against snow blockage by either drifts or slides.

SPAN LENGTH - The distance between adjacent substructure elements, the measuring points being the centers of piers and the inner (river) face of abutments.

SPLICE BAR - See joint bar.

SPUR TRACK - A track diverging from a main or branch line, over which no regular train service is maintained.

STANDARD DESIGN LOADING - The load capacity that a bridge is designed to support, based on an equivalent load system. This system makes use of a hypothetical locomotive or series of locomotives with or without a trailing load and with a definite number of axles, definite spacings between axles, and a definite proportion of the load on each axle. It is shown graphically on a standard design load diagram.

STANDARD GAGE - The standard gage of track is 4 feet 8 1/2 inches (1,435 mm).

STATION - A place designated by name on a timetable at which a train may stop for traffic or enter or leave the main tracks, or from which fixed signals are operated.

STORAGE YARD - A yard where cars and locomotives are stored when not in use, awaiting repairs or other disposition.

STRINGER - A simple beam, either of wood or steel, used as a main supporting member in a beam bridge.

STRUCTURE CLEARANCE - Minimum height and width of space provided by bridges, tunnels, and other structures for passage of trains, or the minimum allowable space for this purpose.

SUBBALLAST - Material (sand, gravel, cinders) spread on the finished subgrade of the roadbed and below the top ballast.

SUBGRADE - Finished surface of roadbed, below ballast. The term is used with particular reference to grade elevation.

SUBSTRUCTURE - The piers (or bents) and abutments which comprise the ground supports for a bridge, including the footings of these supports.

SUPERSTRUCTURE - The spanning part of a bridge (bridge span and floor system), including all of the structure resting on the substructure.

SURFACE (TRACK) - The condition of a track as to vertical evenness or smoothness.

SWING SPAN - A movable span that is opened by turning in a horizontal plane on a pivot system located at or near its center.

SWITCH - A pair of movable track rails used to engage the flanges of car wheels, initiating a diversion from one track to another. The term is frequently used in popular parlance to include the entire turnout.

SWITCH ENGINE - An engine assigned to yard service and working within yard limits.

TEAM TRACK - Track on which cars are placed for transfer of freight between cars and highway vehicles.

TERMINAL - The assemblage of facilities provided by a railway at the end points of its line and at intermediate rail centers for the purpose of receiving, servicing, classifying, and dispatching trains and for handling passengers and freight.

TIE - A transverse support to which rails are fastened to keep them in line, gage, and grade.

TIE PLACE - A metal plate interposed between a rail and a tie.

THROUGH BRIDGE - A bridge with the floor system on a level with the lower edge of the main supporting members, these being connected by lateral bracing over the track. Sometimes (particularly in the case of girder bridges) the term through bridge is also applied to half-through bridges.

TRACK FASTENINGS - The term applied to joint or splice bars, bolts, tie plates, spikes, rail anchors, and gage rods.

TRACK MILE - A measure of actual track length, which includes the length of all track used in single, double, or multiple track. For example, there are two track miles in one route mile of double-track railway.

TRAIN DENSITY - Number of trains operated over a line in each direction during a 24-hour period.

TRESTLE BENT - A ground support for a bridge, consisting of a single row of posts surmounted by a cap piece and cross-braced.

TRESTLE PIERS - Two or more bents placed close together and braced to one another.

TRUSS BRIDGE - A bridge with a superstructure consisting of horizontal, vertical, and diagonal members that provide rigidity by their repeated interconnections, usually in triangular form.

TUNNEL BORE - The interior of a tunnel; it may be semicircular, elliptical, horseshoe, or square with an arched ceiling.

TUNNEL LINING - Material (masonry or concrete) lining the interior of a tunnel.

TUNNEL PORTAL - An artifical entryway for a tunnel, usually made of masonry or of concrete.

TURNOUT - An arrangement of a switch and frog by means of which rolling equipment may be diverted from one track to another.

UNDERBRIDGE CLEARANCE - The maximum distance from the water level or the ground to the lowest part of the superstructure.

VERTICAL ALINEMENT (PROFILE) - The longitudinal section along the center-line of a track that shows elevation and depression.

VERTICAL CLEARANCE - The distance available for the passage of rolling stock between the top of the rail and the lowest overhead obstruction.

WYE ("Y") TRACK - Triangular arrangement of tracks on which locomotives, cars, and trains can be turned.

YARD - A system of tracks within defined limits, provided for making up trains, for storing cars, and for other purposes.

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